TABLE OF CONTENTS

1 Qualifications and Experience

1.1 My name is James George Anderson. I am a Programme Manager employed by the Environment Agency based at Kingfisher House, Goldhay Way, Orton Goldhay, Peterborough PE2 5ZR. I have a Bachelor of Science (Honours) in Civil Engineering and I am a PRINCE2 Practitioner. I am a Member of the Institution of Civil Engineers and I am registered as a Chartered Engineer with the Engineering Council.

1.2 I have 33 years' experience of working in civil engineering as a Design Engineer, Project Manager or Project Executive. The last 21 years have been spent working for the Environment Agency planning, developing and delivering flood risk management plans and schemes including the Ipswich Barrier Scheme, a tidal barrier scheme in the River Orwell that is currently under construction and which was also the subject of an application for an order under the Transport and Works Act 1992 (**B/1**).

1.3 I have been Project Executive for the Boston Barrier Scheme (the Scheme) since 2009. In my role as Project Executive I am responsible for delivery of the Scheme to time, cost and quality targets and providing leadership to the project team. Prior to that, I was Project Manager for the Scheme, responsible for the production of the Boston Combined Strategy (**BCS**) (**C/3/4**) that was approved in 2008. I was the Project Manager for the Black Sluice Lock business case. The Black Sluice Lock Scheme was Phase 1 of the BCS and resulted in the creation of a new navigation link between the Haven and the South Forty Foot Drain. This work was completed in 2009. I was Project Executive for the Boston Haven Works Scheme from 2009 to 2012. This Scheme comprised Phase 2 of the BCS and involved the refurbishment of specific river walls in the Haven, upstream of the proposed barrier. These works were completed in 2014.

1.4 In addition to my longstanding involvement in Boston I was also Project Executive for the Ipswich Flood Defence Management Strategy (which includes the Ipswich Barrier Scheme) between 2006 and 2016. The Environment Agency secured the Ipswich Barrier Order (**B/19**) for this Scheme in 2012 and subsequently a marine licence from the Marine Management Organisation (**MMO**) was also secured. The Ipswich Barrier is currently under construction.

2 Scope of Evidence

2.1 The evidence I present explains the need for the improved flood risk management in Boston and the work that has been undertaken to develop the proposed Scheme. My evidence provides my professional opinion on these matters, based both on my longstanding involvement in plans for new flood defence infrastructure in Boston and the numerous technical appraisal and environmental studies that have been undertaken, or have been supported, by the Environment Agency or its predecessor the National Rivers Authority (**NRA**) for a scheme to reduce tidal flood risk in Boston, including the Scheme that is now proposed. I have not undertaken the individual technical appraisal or environmental assessments myself, but I have familiarised myself with and critically reviewed the appraisals and assessments undertaken and their key findings.

2.2 This proof of evidence complements and is supported by that of the other expert witnesses who are appearing on behalf of the Environment Agency and in support of the Scheme, in particular Sun Yan Evans (**EA/2/1**) who deals with surface water and flood risk, Peter Mallin (**EA/3/1**) who deals with design and engineering aspects of the Scheme, Gillian Watson (**EA/4/1**) and Captain

McArthur (**EA/5/1**) who lead on navigation matters, Patrick Franklin (**EA/6/1**) who provides evidence on fisheries, Richard Scriven (**EA/7/1**) who deals with land and property matters, Emma Lunt (**EA/8/1**) who deals with environmental issues, Jenny Timothy (**EA/9/1**) who addresses cultural heritage and Max Forni (**EA/10/1**) who deals with noise and vibration.

3 Evidence Structure

3.1 My evidence is structured as follows:

3.1.1 the need for the Scheme is explained in section 4;

3.1.2 the aims of the Scheme are summarised in section 5;

3.1.3 the benefits of the Scheme are identified in section 6;

3.1.4 support for the Scheme is explained in section 7;

3.1.5 relevant flood risk, environmental, economic and planning policies are summarised in section 8;

3.1.6 the development of the Scheme is explained in section 9;

3.1.7 water level management (and the reasons why it no longer forms part of the Scheme) is considered in section 10;

3.1.8 the Environment Agency's position with regards to the possibility of a lock alongside the proposed barrier is discussed in section 11;

3.1.9 climate change considerations are explained in section 12;

3.1.10 the Environment Agency's plans for works to the Haven banks is explained in section 13;

3.1.11 the estimated cost and funding proposals for the Scheme are summarised in section 14;

3.1.12 alternatives to the proposed Scheme are considered in section 15;

3.1.13 the Environment Agency's commitment to mitigation is summarised in section 16;

3.1.14 issues raised by objectors and in representations and my response to them are addressed in section 17;

3.1.15 I confirm where in my evidence I have addressed the matters about which the Secretary of State particularly wishes to be informed in section 18;

3.1.16 my conclusions are set out in section 19; and

3.1.17 I have provided a statement of truth in section 20.

3.2 Of the matters about which the Secretary of State particularly wishes to be informed, my evidence addresses the following:

Matter 1	The aims of, and the need for, the proposed Boston Barrier and related works ("the Scheme");
Matter 2	The main alternative options considered by the Environment Agency and the reasons for choosing the proposals comprised in the Scheme;
Matter 3	The justification for the particular proposals in the draft TWA Order, including the anticipated flood risk, environmental and socio-economic benefits;
Matter 4	The extent to which the Scheme would be consistent with local flood risk, environmental, economic and planning policies;
Matter 5(b)	The justification for the location, design and operation of the Scheme including questions over the reinforcement and maintenance of 'earth banks' running from the site of the barrier downstream;
Matter 5(c)	The justification for the location, design and operation of the Scheme including the dismissal of a proposed 'sea lock' element of the Scheme on environmental grounds;
Matter 5(d)	The justification for the location, design and operation of the Scheme including the omission of the 'water level management' scheme from the proposed plan at this time and why this is justified;
Matter 7	The compatibility of the Scheme with future climate change scenarios;
Matter 10	The conditions proposed to be attached to the deemed planning permission for the Scheme, if given, and in particular whether those conditions satisfy the six tests referred to in Planning Practice Guidance, Use of Conditions (Section ID:21a);
Matter 11	Having regard to the criteria for justifying compulsory purchase orders in paragraphs 12 to 15 of the DCLG Guidance on the Compulsory Purchase process and the Crichel Down Rules for the disposal of surplus land acquired by, or under the threat of, compulsion (published on 29 October 2015), (a) whether there is a compelling case in the public interest to justify conferring on the Environment Agency powers to compulsorily acquire and use land for the purposes of the Scheme; (b) whether the purposes for which the compulsory purchase powers are sought are sufficient to justify interfering with the human rights of those with an interest in the land affected by the Scheme (having regard to Article 1 of the First Protocol to the European Convention on Human Rights);

(c) whether there are likely to be any impediments to the Environment Agency exercising the powers contained within the Order, including availability of funding;

Matter 12(ii) The adequacy of the current flow calculations and engineering proposals as presented with particular regard to unsuitable water level management;

Matter 14(d) The likely impacts of constructing and operating the scheme on the operation of businesses in the area including the wider regeneration benefits to the Boston area.

4 Need for the Scheme

4.1 The history of flood risk in Boston and the threat it poses to the town is covered in detail in the Environment Agency's Statement of Case (**I/1**) and in the evidence submitted by Sun Yan Evans (**EA/2/1**). I therefore do not repeat this in detail here. However, I have sought to restate the key facts below.

4.2 The market town of Boston lies on the edge of The Wash in the low lying fens, much of which is below mean high water spring tide levels. The tidal river presents a flood risk to Boston, particularly during tidal surges. The town is entirely situated within the floodplain and already relies significantly on tidal flood defences. Boston is at risk from overtopping of existing defences and the breaching of those defences.

4.3 The devastating threat of flooding as a result of tidal surges has been witnessed throughout recent history.

4.4 The 1953 East Coast Flood, which has been documented as one of the worst natural disasters to strike Britain, was as a result of a tidal surge hitting the east coast, including Boston.

4.5 In March 1961, less than 10 years later, another storm surge led to many houses being flooded in Skirbeck quarter by water flowing through displaced brickwork at the Black Sluice.

4.6 The 1978 event was the result of a severe gale in the North Sea that produced a storm tide surge along the east coast of England (surge height of 1.2m in The Wash). This coincided with a high spring tide resulting in a peak tide at Boston of approximately 5.6m AOD. This caused localised flooding due to overtopping and led to the failure of the defences in front of St Botolph's Church (**The Stump**). This resulted in significant flooding in the town.

4.7 On 5th December 2013, Boston experienced significant tidal flooding as a result of a storm tide surge again coinciding with a high tide, which left nearly 700 residential properties flooded and many locations evacuated. During this flood event, water depths to many properties exceeded 500mm. Flooding to this depth - even for short durations-damages carpets, furniture, electrics, plaster and can cause some sewers to discharge through residents downstairs toilets. In 2013, water damage was so extensive that many residents were out of their homes for over six months.

4.8 For those affected by the flood event in December 2013, the floods themselves were only the start. For people affected by the flooding the experience of flood recovery continued long after the flood waters had gone. It extended long after the emergency services had returned to their day to day duties. It was an experience marked in part by coming to terms with the impact of the flood event itself. The process that followed, especially for those that are most vulnerable, was the struggle of rebuilding the social and physical fabric of homes and communities. The process of recovery was one that carried with it the challenge of adjusting to displacement (caravans, living upstairs, rented accommodation, living with family), managing the process of physical recovery (loss adjustors, insurance companies, builders, retailers), trying to maintain normality in everyday life (work, school, child care, illness, deaths, births, celebrations) and trying to rebuild a social life (adjusting to a new home, new community relations, build trust in the future). For a number of residents in Boston the process of recovery following the December 2013 flood took over a year.

4.9 Following the event in December 2013 Boston Borough Council commissioned a survey amongst those flooded, which identified that 419 of the 424 who replied had no contents insurance. This statistic highlights another issue particular to Boston: that the town is considered to have deprivation issues and hence is a government target for investment. Without a reduction in flood risk the town's deprivation issues will struggle to be addressed. Potential new residents and businesses to the town are likely to consider the flood risk before making investment decisions and existing residents and businesses are likely to take the flood risk into account before making any new local investment decisions.

4.10 As mentioned above significant tidal flood events have occurred in 1953, 1961, 1978 and 2013, and, as explained in Sun Yan Evans' evidence (**EA/2/1**), flood events in Boston extend further back in time. In addition there have been numerous high tides that have been close to the level at which Boston would have flooded, including the most recent event on 13th January 2017. Fortunately, in the case of the most recent incident, the large storm surge did not coincide with high tide as initially forecast, thus the high water levels and associated flooding was avoided in Boston. A significant amount of time and investment was nonetheless expended in anticipation of a flood event as explained in Sun Yan Evans' evidence (**EA/2/1**).

4.11 The town relies significantly on its existing tidal flood defences. Currently there are large earth embankment tidal defences downstream of Boston along the banks of the Haven. The Environment Agency currently maintains these banks to a design level of +6.35m AOD. At this level the downstream embankments provide a 1 in 200 year standard of flood protection against overtopping.

4.12 The Environment Agency works to ensure that the embankments are not damaged, as they are an important part of the flood defence assets along the Boston Haven. Further information regarding the Haven flood banks is set out in Section 13 of my evidence.

4.13 The flood defences in the urban area of Boston comprise a number of different structures that are not all maintained by the Environment Agency, as many of these structures are in private ownership. These flood defences consist mainly of concrete or masonry walls on piled foundations, with a number of riparian buildings forming lengths of improvised defences. Significant lengths of the flood defences in the urban area are lower than the embankments further down the Haven. Where they are in private ownership, they are in places not very well maintained. As a consequence the threat from tidal flooding in the urban area of Boston is much higher than further down the Haven. The existing flood defences in the urban area are both

very difficult and expensive to maintain. For some riparian owners they cannot afford these costs. In addition raising the levels of these flood defences in order to provide a higher standard of flood protection is technically challenging, expensive, and will disconnect the town from the river due to these defences being raised from a typical level of 5.9m AOD to 7.55m AOD, a rise of 1.65m, to provide a defence level similar to that provided by the Scheme.

4.14 The urban area of Boston is therefore at risk from overtopping of existing defences and breaching of the defences under an event with a 1 in 50 (2%) annual chance each year. Due to the low standard of the defences, current Environment Agency flood warning practice is to consider issuing severe flood warnings for Boston in discussion with Local Resilience Forum (**LRF**) partners at a 1 in 50 (2%) tidal event, which will help inform the LRF's decision to evacuate high risk locations.

4.15 Based on the advice provided within the Environment Agency publication, Adapting to Climate Change: Advice to FCERM authorities (September 2011) (a copy of which is provided at **Appendix 1** to my evidence (**EA/1/2**)), tidal surge levels with a 1 in 50 (2%) annual chance each year will be over 0.7m higher (1.0m for Upper End Estimate value) in 100 years' time than present day defence crest levels. Even if the flood defences in the urban area of Boston are well maintained they will not provide a sustainable flood defence in light of these predicted climate change levels. The difficulties associated with trying to raise the height of these defences exacerbates this problem.

4.16 Flood risk is a function of probability and consequence. Extreme tidal surges currently have a low probability though the potential consequence of tidal surges are usually much higher and often pose a risk to life. When compared with other hazards that pose a risk to life, such as house fires, the probability of extreme tidal surges is high and hence effective flood defences are essential. The probability of extreme tidal surges will increase over the next 100 years such that tide levels with a current 1 in 200 annual chance of occurring may have a 1 in 10 annual chance or greater.

4.17 The Strategic Flood Risk Assessment for Boston prepared by Boston Borough Council in 2010 (**C/3/3**) identifies that the majority of Boston has a 'medium' or 'high' probability of tidal flooding.

4.18 The January 2012 Association of British Insurers (**ABI**) assessment[1] placed Boston as equal top of their list of areas with most homes at significant flood risk. This is due to the poor condition of the flood defences. This created problems for homeowners in Boston in obtaining affordable insurance to cover the risk of flooding, although this situation has been somewhat alleviated by the introduction of the flood re-insurance scheme introduced by the Government and insurance companies known as 'Flood Re'.

4.19 The tidal flood risk area considered when developing the proposed Scheme contains 17,269 residential properties. Because of the very high number of properties and people whom are at risk of significant flooding this makes the proposed Scheme a 'National Priority Project' for the Environment Agency. This means that the Scheme is fully funded using Flood Risk Management (**FRM**) Grant in Aid (**GiA**). 'National Priority Projects' are subject to high levels of scrutiny and governance within the Environment Agency in order to ensure that sufficient resources is made available to ensure delivery and that project risks are being proactively managed. The Environment Agency reports to the Department for Environment, Food and

[1] http://www.bbc.co.uk/news/business-16794696

Rural Affairs (**Defra**) on a quarterly basis as to the progress of 'National Priority Projects' like the Boston Barrier Scheme.

4.20 As can be seen from the above Boston has a history of serious tidal flooding and is at significant risk from further events in the future. The fundamental purpose of the proposed Scheme is to reduce the risk of tidal flooding to 582 commercial properties and 17,269 residential properties in Boston through the construction of a barrier within the Haven. Following construction of the proposed barrier, tidal flood risk in Boston would be reduced to a 1 in 300 chance (or a 0.33% probability) of flooding in any given year for a period of 100 years.

5 Aims of the Scheme

5.1 The Environment Agency is seeking to reduce the risk of flooding in Boston from the tidal Haven through the construction of the Scheme. The principal objective of the Scheme is to reduce the risk of flooding in Boston from a 'Significant Risk of Flooding', which is the current situation for the vast majority of people and property, to a 'Low Risk of Flooding'. My evidence will set out why this aim is justified for the town of Boston.

5.2 The risk of flooding can be categorised into the 'no-Scheme' and 'Scheme' scenarios:

5.2.1 a 'Significant Risk of Flooding' means that people and property would be affected by a flood having annual chance of greater than 1.3% (1 in 75) but less than 5% (1 in 20); and

5.2.2 a 'Low Risk of Flooding' means that people and property would be affected by a flood having an annual chance of 0.5% (1 in 200) or less.

5.3 The risk categories before and after investment need to take account of any defences already in place, and how climate change in the locality is expected to reduce the effective standard of protection over time. Unless climate change allowances are made, the effective duration of benefits will be reduced.

5.4 Evidence of flood risk in Boston is derived from historical events and predictive modelling of current and future conditions. The historic events have already been mentioned in section 4 of my evidence whilst predictive modelling is covered in the evidence presented by Sun Yan Evans (**EA/2/1**).

5.5 The Scheme is the key component of the Environment Agency's strategic approach to managing flood risk in Boston, as set down within the Boston Combined Strategy (**BCS**) (**C/3/4**) which was approved by the Environment Agency in March 2008. In developing its strategic approach to managing flood risk, the Environment Agency considered and consulted on how best to address the tidal flood risk in Boston, alongside other opportunities to improve the environment and the navigation of the waterway network which surrounds Boston.

5.6 Following approval of the strategic approach, options appraisal and consultation was undertaken and a preferred solution was identified to manage the risk of flooding, leading to the development of the Scheme that is now proposed.

5.7 A full description of the works required to deliver the Scheme is provided in Peter Mallin's evidence (**EA/3/1**). In summary, however, the Environment Agency is seeking to construct, operate and maintain:

5.7.1 a new tidal barrier across the Haven;

5.7.2 new flood walls on both banks of the Haven;

5.7.3 a replacement gate across, and a widening of, the existing entrance to the Wet Dock within the Port of Boston; and

5.7.4 numerous ancillary works to facilitate the above components, including dredging of the river.

5.8 The objectives of the Scheme are set out within the Statement of Aims (**A/4**) which accompanied the Environment Agency's application for the proposed Order and within the Environment Agency's Statement of Case (**I/1**). These are as follows:

5.8.1 **Flood Risk Management:** to reduce the risk to people and the developed and natural environment from flooding;

5.8.2 **Economics:** to further amenity, social and economic opportunities; and

5.8.3 **Environment:** to minimise the adverse impacts on the natural and built environment of the area and to maximise opportunities for environmental enhancement.

5.9 The Scheme will reduce the risk of flooding to 17,269 residential properties and 582 commercial properties in Boston. Following construction of the Scheme, the risk of flooding in Boston will be reduced to a 1 in 300 annual chance of flooding (or a 0.33% probability). This reduced risk of flooding will be sustained over the next 100 years by:

5.9.1 investment in the future maintenance and operation of the Scheme; and

5.9.2 improvements, at the appropriate time in the future, to the flood defence embankments downstream of Boston, to address climate change effects on rising sea levels.

6 Scheme Benefits

6.1 The Scheme will improve the standard of protection in Boston from tidal flooding. Without the Scheme the existing flood defences have a high probability of breach in the next ten years, which would be followed by a rapid inundation of the low lying land behind. Any breach can cause considerable risk to life. The consequence of 'doing nothing' are set out in para 4.4.2 of the Statement of Case (**I/1**).

6.2 HM Treasury requires an assessment of the value that public spending would secure before a spending decision is made (this is known as the '**appraisal**'). This requirement applies to all sectors, not just flood risk management (**FRM**). The Treasury's requirements for the appraisal process are set out in the "Green Book", which was published in 2003 (**C/1/7**).

6.3 Appraisal should be consistent with the guidelines in HM Treasury's Green Book and ensure that public investment in FRM activities is justified, and that alternative options are properly considered. It is recommended that HM Treasury Green Book's Five Case Model is referred to for managing appraisal within the context of wider programme and project management controls. The appraisal should also be proportionate to the complexity of the problem and the information required to demonstrate a decision.

6.4 The appraisal of the Scheme has been managed using HM Treasury Green Book's Five Case Model.

6.5 HM Treasury provides the funding for flood and coastal erosion risk management (**FCERM**). This means that all projects to be funded from public money have to include a project appraisal in line with the requirements of the Treasury Green Book. The Green Book sets out the techniques and issues that should be considered when carrying out assessments of programmes, plans and projects. As a result, it influences what can (and cannot) be included in economic appraisal and drives the approaches set out in FCERM Appraisal Guidance on evaluating investment in FCERM schemes (please see **Appendix 2** to my evidence **(EA/1/2)** for a copy of this guidance).

6.6 Since the FCERM Appraisal Guidance was introduced in 2010, appraisal of the Scheme has been undertaken in accordance with it.

6.7 There are two basic types of FRM benefits:

6.7.1 Direct Benefits - the flood damages or losses which will be avoided by a FRM project or scheme; and

6.7.2 Indirect Benefits - The new investment that will be attracted to a local economy as a result of an FRM investment that would otherwise not have occurred.

6.8 The Environment Agency and other Risk Management Authorities monetise flood damages and flood damage avoided (direct benefits) by using the consistent approach contained in the Multi Coloured Handbook 2010 (**MCH**) and the more detailed Multi-Coloured Manual (2013) (**MCM**)[2].

6.9 Following FCERM Appraisal Guidance and the approach for monetising benefits in the MCH and MCM enables the justification of investment from the public purse to be clearly demonstrated and also facilitates the prioritisation of investment so that those schemes with the greatest return can be prioritised.

6.10 The appraisal work undertaken in respect of the business case for the Scheme found that it will deliver present value benefits of £1,116m[3] and a robust benefit cost ratio (**BCR**) of 12.9:1. The BCR takes into account the amount of monetary gain realised by implementing a proposal against the amount of money it costs to do so. The higher the BCR the better the investment. A BCR of greater than 1:1 indicates a positive economic case for the Scheme as it would deliver benefits greater than costs over the appraisal period.

6.11 The Environment Agency prepared the monetised benefits for the Scheme in accordance with the guidance I have referred to above and it includes a value for 'risk to life'. The reported

[2] http://www.mcm-online.co.uk/manual/
[3] 2015 cost base.

monetised benefits for the Scheme exclude allowances for agricultural losses, indirect and intangible damages or losses to tourism and recreation. The monetised benefits are thus considered a low bound valuation. The benefits calculated were sufficient to demonstrate the high priority of the Scheme and it has secured 100% Flood Defence Grant in Aid funding.

6.12 The Scheme is the central investment of the approved BCS. Within the BCS study area, 17,269 residential properties (households) will benefit from a reduction in the risk of tidal flooding as a result of the Scheme (rising to almost 20,000 homes in 100 years as a result of climate change).

6.13 Defra provides funding to flood risk management authorities including the Environment Agency to manage flood and coastal erosion risk in England. The majority of the funding is given as Flood Defence Grant in Aid to the Environment Agency. Defra Partnership Funding policy sets out how Flood Defence Grant in Aid is allocated to flood and coastal erosion risk management projects. Of the 17,269 households that will benefit from a reduction in the risk of tidal flooding as a result of the Scheme, 14,256 are eligible for Partnership Funding. The 14,256 households that are eligible for Flood Defence Grant in Aid funding contribute towards Defra KPI 930 (OM2) - The number of households moved from the very significant or significant probability of flooding category to the moderate or low probability of flooding category.

6.14 In non-monetised terms, the Scheme will deliver the following benefits:

6.14.1 protection of homes;

6.14.2 protection of public services;

6.14.3 protection of businesses, and hence local jobs

6.14.4 reduce stress and anxiety for those living at risk of flooding; and

6.14.5 reduce the risk to life during a flood event.

6.15 The proposed barrier is designed to protect the town from flood events that would otherwise flood most of the town. As a result, many local and public service assets will be protected by the Barrier including:

6.15.1 Boston Police Station;

6.15.2 Boston Fire Station;

6.15.3 Boston Borough Council Offices;

6.15.4 Job Centre Plus;

6.15.5 Boston Railway Station;

6.15.6 Boston Crematorium;

6.15.7 Primary and Secondary Schools (including Boston Grammar School, Park Academy and Carlton Road Primary School);

6.15.8 Boston West Hospital (private);

6.15.9 GP Surgeries (including Liquorpond Surgery, Parkside Surgery and Greyfriars Surgery);

6.15.10 Boston Library; and

6.15.11 electrical substations.

6.16 Many of these assets are required to support local residents in the recovery stage following a major flood event. Their ability to do so would be hindered by their own need to recover (when potentially their systems are down, equipment is damaged and records challenging to access).

6.17 The Scheme would also reduce flood risk to 582 businesses and hence protect local jobs.

6.18 In early 2013 the Environment Agency carried out an assessment of businesses that would benefit from the increased protection from flooding should the Scheme be implemented. This exercise identified 22 businesses that have a 2% chance, or higher, of being flooded in any year, had a footprint greater than 100m2 and the trade of the business was not transferable to another business that was situated outside of the flood risk area. These businesses included (data correct as of Jan 2013):

6.18.1 Adan Ltd: a privately owned business that is believed to be the only UK manufacture of high torque slow speed hydraulic motors;

6.18.2 Porcher Abrasive Coatings Ltd: a leading UK manufacture of abrasive coated surfaces;

6.18.3 Magnadata International Ltd: one of the world's leading suppliers of passenger transport ticketing services;

6.18.4 Dynamic Cassette International Ltd: producers of over two million ink cartridges and one million remanufactured ink cartridges per month;

6.18.5 Euroflow Engineering: designers and manufacturers of stainless steel processing and handling equipment; and

6.18.6 Metsa wood: an importer and processor of wood products (and one of the largest employers in Boston).

6.19 In addition to the above businesses the retail centre of Boston will also benefit from the Barrier, along with out of town centre retail parks. Several retail businesses were flooded during the December 2013 flood event[4], including: Bizzarro, the Boston Standard, Dewhursts Trophies, Churches and The Magpies Nest. St Botolph's Church (locally referred to as the Stump) also flooded during the December 2013 flood event causing a reported £1m of damage (as reported by the BBC on 5th December 2014).

6.20 Beyond the issue of flood risk affecting a company's decisions to invest in locations at risk of flooding, should a flood occur the consequences can be significant; not only can offices and

[4] http://www.bbc.co.uk/news/uk-england-lincolnshire-30225852

factory premises be flooded, but employees may have their homes flooded as well . Local businesses may question if they are location dependent, and if not, actively consider, or implement, relocation to areas of less flood risk away from Boston. The Environment Agency has witnessed from flood events across the country that some businesses can struggle to recover from flooding, and some businesses may decide not to return. These locally significant impacts are not considered in the monetised calculation of benefits (in accordance with FCRM Appraisal Guidance, Agency FRM projects consider direct benefits (damage avoided) from a national perspective). The locally significant business benefits secured by the Scheme, however, include:

6.20.1 the likelihood of implementing business continuity plans is reduced (and hence less cost and disruption);

6.20.2 unlocking investment (the reduction in flood risk may enable planning approval for new sites to be granted and increase their viability for development);

6.20.3 reduced insurance premiums and increased access to mortgages; and

6.20.4 improved business continuity confidence, potentially increasing overall business confidence to enable greater investment.

6.21 The impact on local jobs from flooding can be devastating. In the short term, whilst businesses are in the recovery stage, the ability to function as a business can be severely restricted meaning productivity levels either drop or staff are released temporarily. In the longer term, should businesses not recover trade lost during the recovery stage, then productivity levels either drop or staff are permanently released. In the extreme businesses can also go bankrupt as a result of flood damage, or decide to relocate their business elsewhere.

6.22 Flooding is a significant risk to people's safety. In 1953 the North Sea floods caused approximately 2,500 fatalities across the UK and northern Europe. The 1952 flooding in Lynmouth caused over 30 fatalities. The 2004 flooding around Carlisle was linked to 3 fatalities whilst in 2007, flooding during June and July was linked to 13 fatalities across the UK.

6.23 Without the Scheme the town of Boston has a relatively high risk to life from flooding compared with other communities at risk of non-tidal flooding. This is not only because of the nature of tidal flooding, with rapid rises in water levels but in this location the North Sea provides an endless supply of water and potentially high flow rates. Further the geography of the town is flat and low lying and there is a relatively low standard of protection offered by the existing defences within the town.

6.24 In identifying the monetised value of risk to life the Scheme has followed Defra's '*Supplementary Note to Operating Authorities, Assessing and Valuing the Risk to Life from Flooding for use in Appraisal of Risk Management Measures*' dated May 2008 (**C/1/13**). The method takes into account local issues, the flood hazard, area vulnerability and people vulnerability.

6.25 The 2008 Note provides guidance on how to convert the impacts on people into monetised benefits. The note identifies that the Department for Transport values the risk of death in the context of road transport at about £1.145M per fatal casualty prevented (2000 prices) and that this value should be uplifted in line with GDP per head.

6.26 Applying the Note to the Scheme identifies benefits of £145m attributable to a reduction in risk to life; which equates to saving around 90 lives in Boston over the lifetime of the Scheme, when using Department for Transport values.

7 Support for the Scheme

7.1 It is clear that the Scheme enjoys support at the national, local and regional level.

7.2 When the then Chancellor of the Exchequer, George Osborne, gave his annual Autumn Statement to Parliament on 3 December 2014 (please see **Appendix 3** to this proof of evidence (**EA/1/2**) for a copy of the Statement) he prioritised the delivery of 1,400 flood defence schemes including the Boston Barrier Scheme.

7.3 Danny Alexander, Chief Secretary to the Treasury at the time, also said:

> "*Floods can devastate our communities, which is why I have fast-tracked the delivery of the £90 million Boston barrier*".

7.4 Similarly, in her response to the 2014 Autumn Statement the then Secretary of State for the Environment, Food and Rural Affairs said:

> "*Flood protection is vital and under our plans Lincolnshire and Northamptonshire will be better protected by 89 schemes being delivered across the region, including the Boston Barrier and Humber schemes, which will bring peace of mind to residents and businesses*."

7.5 The outline business case for the Scheme was approved by HM Treasury in October 2016. In supporting this approval, the Defra Executive Committee stated:

> *"This is a significant project for the local area and an excellent example of what can be achieved by the Defra group acting together in a joined-up and streamlined way."*

7.6 Shortly after submission of the Environment Agency's application for the Order in August 2016 the Agency's Chief Executive, Sir James Bevan, visited Boston. He said:

> "*I've seen the devastating effects flooding can have on communities and so I'm looking forward to the barrier being in place as it will provide one of the best defences against tidal flooding anywhere outside of London*.
>
> *I am confident in the work of the project team and I believe we have come up with the best barrier in the best place to give the best protection for Boston*.
>
> *The local economy will benefit too as, where you have better protection against floods, businesses are more likely to invest, developers are more likely to build and tourism is likely to increase."*[5]

7.7 Matt Warman, MP for Boston & Skegness, also met with Sir James Bevan during his visit to Boston and discussed the Scheme. He was quoted to say:

[5] https://www.gov.uk/government/news/environment-agency-chief-executive-visits-boston-barrier-site

> "*I am delighted that the Boston Barrier will provide the highest level of flood protection to Boston. This project will be one of the largest ever delivered by the Environment Agency and demonstrates the Government's commitment to safeguarding our area's homes and businesses.*
>
> *Importantly, the project will secure increased flood protection as soon as possible whilst still protecting options for future water level management. That means it will fast-track the increased protection from flooding and still offer huge potential for future economic growth*".

7.8 Lincolnshire County Council (**SUPP/3**), Boston Borough Council (**SUPP/1**) and the Black Sluice Internal Drainage Board (**SUPP/2**) have partnered the Agency in its development of the Scheme and are fully supportive of it. They have submitted letters of support to the Secretary of State. In addition, I understand that the Anglian (Northern) Regional Flood & Coastal Committee also sent a letter of support to the Secretary of State advising that:

> "*It is agreed that the provision of a tidal defence barrier in Boston to reduce the risk of flooding is critically needed after the tidal surge of December 2013 and we would encourage action that would promote the earliest possible date of commencement".*

7.9 Without exception, all interested parties who have commented on the proposals to the Secretary State – objections and representations – accept that improved flood risk management is needed.

7.10 There has been consistently strong public support for the need for the Scheme. In winter 2014 a six week public consultation was undertaken in parallel with the consultation undertaken by DEFRA in relation to the updated EIA scoping opinion request. A total of 101 responses were received, of which 83 per cent expressed support for the Scheme. Further information relating to this consultation and others undertaken by the Environment Agency is provided within the Consultation Report (**A/5**) which accompanied the Environment Agency's application for the Order.

7.11 In summary, there is considerable evidence that the Scheme has strong political support at the national, regional and local level and that the compelling need for improved flood risk management in Boston is undisputed.

8 Flood Risk, Environmental, Economic and Planning Policies

8.1 In this section of my proof, I consider the extent to which the proposed Scheme complies with relevant policies relating to flood risk and the economy.

Environmental and Planning Polices

8.2 The extent to which the Scheme complies with relevant planning policies is considered in Emma Lunt's evidence (**EA/8/1**) and I note that she concludes that the Scheme accords with both national and local policies. Chapter 6 of the Statement of Case (**I/1**), Chapter 4 of the ES Main Report (**A/17/1**) and the Planning Statement (**A/12**) explain the planning and environmental policy context for the Scheme.

Flood Risk Policies

8.3 Chapter 6 of the Statement of Case (**I/1**) explains the FRM policy context within which the Scheme has been developed. The following Acts, Regulations, National and Local Strategies, and National and Local plans set out the FRM policy that supports the strategic case for the Boston Barrier Scheme:

8.3.1 Water Resources Act 1991 (**B/20**);

8.3.2 Flood and Water Management Act 2010 (**B/9**);

8.3.3 National Flood and Coastal Erosion Risk Management Strategy for England (**C/1/8**);

8.3.4 EA Corporate Plan 2014 to 2016 (please see **Appendix 4** to my evidence (**EA/1/2**);

8.3.5 EA Flood and Coastal Erosion Risk Management Investment Programme 2015 to 2021(please see **Appendix 5** to my evidence (**EA/1/2**));

8.3.6 Anglian River Basin District Flood Risk Management Plan 2009 (please see **Appendix 6** to my evidence (**EA/1/2**);

8.3.7 Anglian River Basin District Flood Risk Management Plan 2016 (please see **Appendix 7** to my evidence (**EA/1/2**); and

8.3.8 River Witham Catchment Flood Management Plan 2008 (please see **Appendix 8** to my evidence (**EA/1/2**).

8.4 Section 165 of the Water Resources Act 1991 (**B/20**) authorises the Agency to carry out "*flood risk management work*" if two conditions are satisfied as follows:

Condition 1: that the Agency considers the work desirable having regard to the National Flood and Coastal Erosion Risk Management Strategies required under Section 7 and 8 of the Flood and Water Management Act 2010;

Condition 2: that the purpose of the work is to manage a flood risk (within the meaning of the Act) from the sea or a main river. I believe that Condition 2 has been satisfied. The purpose of the Scheme is to manage flood risk from the sea.

8.5 As explained below, the Scheme has been developed with due consideration to the national strategy and the purpose of the Scheme is to manage flood risk from the sea. Accordingly, in my opinion both conditions have clearly been satisfied in respect of the Scheme.

8.6 The Environment Agency, has responsibilities under the Flood and Water Management Act 2010 (**B/9**) to "*develop, maintain, apply and monitor a strategy for flood and coastal risk management in England*". The relevant strategy is "*The National Flood and Coastal Erosion Risk Management Strategy for England*" (**C/1/8**) which was laid before Parliament on 23 May 2011.

8.7 The *National Flood and Coastal Erosion Risk Management Strategy for England* (**the National Strategy**) sets out a framework for action, for what needs to be done by flood risk management authorities in order to reduce the risk of flooding and coastal erosion and its consequences. The overall aim of the National Strategy is to ensure the risk of flooding and coastal erosion is properly managed by using the full range of options in a coordinated way. The Environment

Agency leads the risk based management of flooding from main rivers and the sea in implementing risk management measures. The Environment Agency's functions include bringing forward flood defence schemes such as the Boston Barrier scheme.

8.8 The National Strategy requires that FCRM activities are carefully planned to ensure that appropriate and sustainable options are selected and that they are implemented correctly. Key to this planning and one of the main themes underpinning the National Strategy is the development of plans to identify the opportunities to manage the risks to flooding and coastal erosion where possible and to set out where risk management authorities should take action. These include catchment flood management plans. The River Witham Catchment Flood Management Plan 2008 (please see **Appendix 8** to my evidence (**EA/1/2**)) which covers the Boston area contains a number of key messages and preferred approaches to managing flood risk from the rivers and the sea, with an overall aspiration for the Boston area to 'take further action to reduce flood risk'.

8.9 The National Strategy also states that Regional Flood and Coastal Committees (**RFCC**) should have a major role in coordinating FCRM plans and expenditure. The Scheme has the support of the Anglian Northern RFCC and features in the Capital Programme approved by them.

8.10 To increase levels of certainty and transparency for individual schemes the National Strategy provided that, from April 2012, a new system of allocating national capital funding should be put in place, ensuring that funding is treated equally across projects on the basis of the benefits being delivered and the damages being avoided. As noted in section 6 of my evidence, Defra Partnership Funding policy sets out how Flood Defence Grant in Aid is allocated to flood and coastal erosion risk management projects. The Scheme has secured Grant in Aid funding to cover the whole of the cost of delivering the Scheme.

8.11 The Environment Agency's Corporate Plan 2014 to 2016 (**the Corporate Plan**) (**Appendix 4**) identified that the Environment Agency's overall objective is to protect and improve the environment for people and wildlife to contribute to sustainable development by implementing the policies of government departments. The Corporate Plan also identified how the Environment Agency implements the National Strategy. The Corporate Plan identified six key priorities. Four of the priorities related to flooding and coastal erosion or protecting the environment and so the Scheme would help further these priorities.

8.12 The Environment Agency's *Action Plan Creating a Better Place: Our ambition to 2020* was launched in April 2016. A copy of the Action Plan can be found at **Appendix 9** to my evidence (**EA/1/2**)). It supports Defra's single departmental plan, *'Creating a Great Place for Living'* (**C/1/11**). The aim is for the UK to be better protected against flooding and coastal erosion. The outcome is to provide 300,000 homes across UK better protected from flooding and coastal erosion and our approach is to invest over £2.3 billion over the next 6 years on enhanced flood protection. The Scheme would provide an important contribution to this outcome.

8.13 The Environment Agency FCRM Investment Programme 2015 to 2021 (the **Six Year Programme**) (**Appendix 5**) identifies how the Environment Agency will deliver its corporate target within the budget allocated by central government. The investment programme includes the Scheme as a significant contributor to the corporate target. Boston is ranked 5th out of a total of 1,419 schemes for the number of households that will have a significant reduction in flood risk before April 2021.

8.14 The Anglian River Basin District Flood Risk Management Plan 2016 (**ARBMP**) (**Appendix 7**) sets out how risk management authorities will manage flood and coastal erosion risk over the next 6 years. There is an action within the plan related to the Boston Barrier Scheme as follows:

ACT759 - Boston Barrier Works

Working in partnership with Local Authorities, progress the development of a scheme to construct a FCRM barrier within Boston Haven, with future provision for multi-functional use to partially exclude the tide for water level control to enable safe navigation and a tidal surge barrier.

8.15 The ARBMP has been prepared under the Water Framework Directive (please see **B/27** for the regulations which implement this Directive in the UK), which requires all countries throughout the European Union (**EU**) to manage the water environment to consistent standards. The ARBMP identifies eight obligations on EU countries. Two of the obligations for flooding and coastal erosion or protecting the environment are relevant to the Scheme.

8.16 The first obligation is to prevent deterioration in the status of aquatic ecosystems, protect them and improve them. In undertaking the EIA for the Scheme and producing the Environmental Statement (**A/17**) care has been taken to develop the Scheme to ensure there will be no deterioration in the status of aquatic ecosystems. The EIA has been used to influence the design away from options which would have significant adverse impacts on the environment and this is supported by the results of the WFD compliance assessment.

8.17 All aspects of the Scheme including temporary works were assessed for WFD compliance. The principal risk from the components is a downgrade to morphology. However, the components in question are an integral part of managing flood risk, for which the Witham Transitional is already classified as heavily modified. A 'heavily modified water body' (**HMWB**) is a water body which has resulted from physical alterations by human activity, which substantially change its hydro-geomorphological character, for instance a harbour. In implementing the WFD, the status of the HMWB needs to be assessed in terms of achieving 'Good Ecological Potential' (**GEP**). The location of these components indicates they are unlikely to significantly alter the hydromorphological conditions of the water body, because they are located in areas where there are existing morphological alterations. The introduction of these components is not likely to result in a change to the morphological features of interest, such as mudflats. Therefore, these additional alterations are unlikely to result in a change of status nor prevent the Witham Transitional from meeting GEP.

8.18 Consideration of other relevant WFD quality elements (biological and physico-chemical) has indicated that the Scheme is unlikely to result in significant changes to the parameters of these elements. The Scheme would not result in changes to discharges (combined sewage overflows, treated wastewater and drainage) into the Haven, or significantly alter the hydraulic conditions permanently within the Haven (albeit there will be some small changes around the barrier structure itself). The linear components of the Scheme are in areas which already exhibit engineered features.

8.19 The second obligation is to contribute to mitigating the effects of floods and droughts. The Scheme is designed to mitigate the effects of flooding.

8.20 As a consequence, all aspects of the Scheme are considered to be compliant with the requirements of the Water Framework Directive.

8.21 In conclusion, the proposed Scheme is wholly in accordance with, and helps to achieve the identified objectives set down within relevant flood risk management policies.

Economic Policies

8.22 I have also considered the extent to which the Scheme complies with relevant economic policies.

8.23 At national level, the Government recently published a green paper on industrial strategy, entitled 'Building our Industrial Strategy' (January 2017) (**C/1/12**). This focuses on 10 'pillars' which are to underpin the Government's proposed industrial strategy. 'Upgrading infrastructure' is one of the pillars of the proposed strategy and, at page 11, the Government has highlighted the need to upgrade standards of performance on water and flood defence infrastructure and to better align central Government infrastructure investment with local growth priorities.

8.24 The green paper highlights the importance of infrastructure investment in mitigating potential economic losses, for example from flooding. The green paper also highlights the role of infrastructure investment in levering private sector funding, in particular encouraging private sector participation in house-building in much-needed but challenging sites (page 51).

8.25 The green paper also seeks to join up infrastructure decisions with local economic plans in order to boost productivity and to support areas which have seen historical underinvestment (page 54).

8.26 The proposed Scheme, through delivering new flood defence infrastructure within an area which has seen historic underinvestment, supports the aims of the green paper.

8.27 At regional level, the Greater Lincolnshire LEP Strategic Economic Plan (**SEP**) (**C/2/3**) is the key strategic economic plan setting out the LEP's proposals for economic growth and development in the area of the LEP.

8.28 The SEP highlights the effective management of flood risk and water resources as a critical factor in enabling economic growth in the Greater Lincolnshire area (page 61). The LEP's aim for Greater Lincolnshire is for the region to be seen as a national exemplar for water management, both flood risk management and water supply (page 61), to enable effective water management to make a positive contribution to economic growth.

8.29 The UK's food security relies upon the agricultural, horticultural and food manufacturing industries located in Greater Lincolnshire. The SEP notes that security from the risk of flooding is a key infrastructure requirement for the Greater Lincolnshire area (page 62). The LEP's water management priorities include the Boston Barrier Scheme (page 63).

8.30 At the local level, Boston Borough Council's corporate plan for the period from 2016/2017 to 2019/20 (**C/3/6**), entitled *'Boston – Open for Business'* identifies 'prosperity' as a corporate priority for the Council. The Council seeks to promote a strong economy which generates more and better job opportunities to attract people and businesses to the Boston area (page 4). Boston as an area faces the largest proportionate population growth outside of London (page 3).

8.31 One of the Council's key aims in delivering its priority of 'Prosperity' is infrastructure development (page 4). In particular the Council lists the delivery of the Scheme as key in delivering its corporate priority of 'Prosperity'.

8.32 The (now historic) Boston Borough Council Economic Development Strategy 2011 – 2013 (interim) (**C/3/7**) identified numerous economic and demographic challenges. The Strategy noted that people in Boston were "trapped in a low skills – low wage equilibrium" where historically the proportion of residents with no qualifications has far exceeded the national average.

8.33 Boston has almost twice the national average of employed people working in elementary jobs and well below the national average of employed people working in managerial and professional occupations. Overall average full-time pay in Boston was well below the regional and national averages according to ONS data (page 12). The Strategy highlights that flood risk is seen as a threat to economic development.

8.34 In consideration of the above I consider that the Scheme conforms with, and will help to achieve the objectives of national, regional and local economic policies.

9 Scheme Development

9.1 In this section of my evidence, I explain the key phases in the development of the current proposals for the Scheme.

Boston Haven FRM Asset Condition Surveys

9.2 In the early 1990s the National Rivers Authority (**NRA**) (predecessor to the Environment Agency) undertook surveys that focused on the condition of the flood risk management assets in the Haven. The surveys highlighted problems with the existing flood defences in the urban area of Boston.

9.3 A number of the NRA flood risk assets were found to be in a poor condition. As a consequence works were undertaken to address the poor condition of some key assets as follows:

9.3.1 new piling was installed at the top end of the Haven, towards Grand Sluice; and

9.3.2 existing masonry retaining walls were patched.

9.4 The extent of the works undertaken at that time to the NRA assets following the condition survey constituted a '*do minimum to hold the line of the defences'* approach. '*Hold the line'* involves building or maintaining defences where existing defences are currently situated to defend the area at risk of flooding. '*Do minimum'* involves building or maintaining the defences to existing levels (i.e. the level of flood protection will remain unaltered).

9.5 The condition of a number of assets that form part of the flood defence, owned by third parties, were also of concern. The problem was not just structural; there were also issues about how those flood defences were maintained. The NRA had powers (now passed on to the Environment Agency) to compel third parties to maintain assets that form part of a flood defence. If need be, enforcement action can be taken. However, these powers are often difficult

to enforce especially if the owner of the property does not possess the funds required to undertake the work or disputes the work is necessary at the relevant time.

9.6 I believe that an additional concern held at that time was that the flood defences in the urban area of Boston did not provide flood protection to the indicative standard prevalent at that time. One solution to this problem could have been to '*hold the line of the existing flood defences'* and increase the height of the existing flood defences in order to reduce the risk of tidal flooding. This approach to managing the risk of tidal flooding in Boston would have many problems as I will explain.

9.7 Where third party assets are concerned the NRA (and now the Environment Agency) does not possess the powers to compel a third party owner of an asset to undertake work that will improve the standard of protection provided by that asset. Given the large number of third party assets in the urban area of Boston that form part of the flood defences, this would call into question the viability of raising the height of the existing flood defences.

9.8 I would comment that repairs to some of these defences following the December 2013 event identified that some had been raised in the past (by the Environment Agency, the NRA and others) and that the foundations to these defences were inadequate for their current height. As a result the December 2013 event resulted in water flowing under these defences.

9.9 I believe that the thinking at the time within the NRA was that a different flood risk management solution was needed as it would be very difficult, if not impossible, to pursue a '*hold the line'* approach to managing flood risk in Boston. My belief is based on the knowledge that raising the defences through the town centre would be technically challenging, likely to be opposed by the local authority (or other statutory bodies and residents) due to the high visual impact, and due to significant risk and uncertainty regarding the legal obligations to maintain or improve third party assets that form part of the flood defence. The marginal difference in the economic case between '*hold the line'* and '*advance the line'* could widen if key risks associated with *'hold the line'* were realised making the '*hold the line'* approach even more unattractive. These issues are as relevant today as they were at the time of the NRA study.

Boston Sea Lock (and Barrage) Pre-Feasibility Study 1994

9.10 Around this time, the Port of Boston Limited, the NRA, Boston Borough Council and Lincolnshire County Council commissioned Balfour Maunsell to undertake the Boston Sea Lock Pre-Feasibility Study (**the 1994 Study**) and a report was published in 1994. A copy of the BSLPFS can be found at **Appendix 10** to my evidence (**EA/1/2**).

9.11 Like the current proposal for a barrier, the sea lock and barrage proposal was considered to be able to address the problem of tidal flood risk in Boston. However, the 1994 Study found that there were dis-benefits with the concept of a sea lock and barrage solution including the following:

9.11.1 there were concerns about the impact the sea lock and barrage would have on fluvial flood risk and land-drainage and it was concluded that further hydraulic modelling would be required to devise the correct configuration for the barrage;

9.11.2 there were concerns about the impact the sea lock and barrage would have on the environment, especially the Wash SSI and local nature reserves;

9.11.3 the sea lock and barrage in the location recommended would result in the loss of 23 hectares of sites designated as having particular ecological value;

9.11.4 the effluent outfall from the Boston sewage treatment works that serves Boston and the surrounding area would need to be extended further down the Haven or possibly as far as the Wash to a position below the sea lock and barrage;

9.11.5 the construction of the sea lock and barrage would cause a deterioration of the water quality in the Haven;

9.11.6 the construction of the sea lock and barrage would increase siltation in the Haven increasing the amount of maintenance dredging and disposal of dredgings;

9.11.7 an approach channel between the deep water channels in the Wash and the sea locked would need to be dredged and maintenance dredging would need to be undertaken regularly to deliver the navigational benefits of the sea lock and barrage; and

9.11.8 the sea lock and barrage had a low benefit /cost ratio of 1.55 to 1.

9.12 The barrage and sea lock proposal is a completely different proposition to the proposed Scheme in terms of the associated works, its location, size, complexity, cost and risks. There are also many dis-benefits and constraints associated with a sea lock and barrage located at the mouth of the Haven. In my evidence on alternatives to the Scheme at section 15 I assess the viability of the sea lock and barrage proposal if it were being proposed today.

9.13 Four locations for the sea lock and barrage were considered between 'Pilgrim Fathers Memorial' (just upstream of the Hobhole outfall) and Tabs Head. The 1994 Study assessed the pros and cons of each site and in my view some key conclusions stand out as follows:

9.13.1 Site 1 (upstream of Hobhole) was the most favourable in terms of not affecting the existing Hobhole outfall whilst the other three sites would have a negative flooding impact on the Hobhole drain;

9.13.2 Site 4 (closest to Tabs Head) was the most preferable for navigation reasons. Site 1 upstream of Hobhole outfall was the least favourable for navigation as there would still be a section of river subject to low tides, which would reduce the effectiveness of the sea lock;

9.13.3 Site 1 (upstream of Hobhole) would have marginally the lowest construction cost with costs rising as one moves downstream towards Site 4 (Tabs Head);

9.13.4 Sites 2, 3 and 4 would require progressively more earth embankments to link into the sea banks to create a complete flood defence.

9.14 The preliminary finding of the 1994 Study was that Site 1 (upstream of the Hobhole) was the preferred site despite leaving a section of river subject to low tides, which would reduce the effectiveness of the sea lock.

9.15 The sea lock and barrage proposals, as described in the 1994 Study, were subject to hydraulic modelling, which was undertaken for each of the four sites. The output from the model was not

conclusive and it recommended that further hydraulic modelling would be required to devise the correct configuration for the barrage. However, the study did conclude that for all four locations it would be necessary to provide a new pumping station at Maud Foster Sluice and an extension to the pumping station at Black Sluice because of the negative impact the sea lock and barrage would have on fluvial flood risk and land drainage. In addition, for all locations other than Site 1 (upstream of Hobhole outfall), an extension to the pumping station at Hobhole would be required due to the negative impact the sea lock and barrage would have on land drainage.

9.16 It is my view that, whilst a sea lock and barrage - if designed correctly - could protect Boston from tidal flooding, the proposal would have major dis-benefits in adversely affecting fluvial flood risk and land drainage in the Lower Witham Catchment as well as the Black Sluice Catchment and Maud Foster Catchment.

9.17 This was confirmed in a study commissioned by the Agency in the mid-1990s entitled the Lower Witham Strategy Study (1997) (**the LWSS**). Relevant extracts of the LWSS are provided at **Appendix 11** to my evidence (**EA/1/2**)) which investigated a number of strategic options for reducing fluvial flood risk in the Lower Witham catchment. The Lower Witham catchment extends from Stamp End Lock in Lincoln down to Boston and includes all of the River Witham's tributaries.

9.18 Amongst the options that the LWSS investigated for reducing fluvial flood risk in the Lower Witham, one was the construction of a sea lock and barrage at the mouth of the Haven. Detailed hydraulic modelling of the Lower Witham catchment was undertaken as part of the LWSS and two sea lock options were modelled, one with a sea lock located just upstream of Hobhole outfall and one at a second location at Tabs Head. A minimum water level of 1.3m AoD was retained in the Haven. The modelling demonstrated that whilst a sea lock would offer benefits to Boston in terms of reducing tidal flood risk, the sea lock would significantly increase the fluvial flood risk in the Lower Witham catchment due to holding up flows at the sea lock. This is the opposite of what was anticipated in the 1994 Study (**Appendix 10**).

9.19 Aside from the River Witham there are a number of significant fluvial and land drainage inflows into the Haven, which currently discharge freely except when locked in by the tide. When water is locked in by the tide the free discharge is, in many locations, supplemented by pumping. The 1994 Study (**Appendix 10**) indicated that a retained water level of 1.30m AoD would effectively tide lock most of the inflows into the Haven permanently. The LWSS modelling demonstrated where this is not the case, for example at Grand Sluice, a retained water level of 1.30m AoD would not provide sufficient gradient for the free flow to be unaffected. I would suggest that there are only two viable solutions to this problem:

9.19.1 the retained water level at the sea lock and barrage would need to be lowered to mitigate the increased fluvial flood risk caused by the sea lock and barrage. This would reduce the effectiveness of the sea lock; or

9.19.2 a new pumping station would need to be built at Grand Sluice to allow the passage of water from the River Witham and mitigate the increased fluvial flood risk caused by the sea lock.

9.20 As well as affecting the Lower Witham, the 1994 Study acknowledged that a retained water level of 1.30m AoD would also have an adverse effect on fluvial flood risk and land drainage in

the South Forty Foot Drain and the Maud Foster Drain. If the sea lock was built downstream of Hobhole outfall it would also affect land drainage from Hobhole Drain. In order to mitigate the increased flood risk existing pumping stations would need to be uprated or new pumping stations would need to be built. This would add a significant cost to the sea lock proposal in the short term for the construction of the new pumping facilities, and in the long term for the commuted sums for the affected parties to run those new pumping facilities for the lifetime of the sea lock scheme. This would add significantly to the complexity, cost, risk and constraints of the sea lock proposal. This was not, however, considered in the 1994 Study.

9.21 It should be noted that investing in new and/or adding to the capacity of pumping facilities is something that the Environment Agency and other Risk Management Authorities are moving away from, where possible. Fifty percent of the Environment Agency's carbon emissions are down to pumping. The Infrastructure Carbon Review (2013) (please see **Appendix 12** to my evidence (**EA/1/2**)) sets out a series of actions for Government, clients and suppliers to reduce carbon from the construction and operation of the UK's infrastructure assets, in line with the UK's climate change commitments. The Environment Agency has signed up to the Infrastructure Carbon Review and any investment in new pumping facilities needs to pass very stringent tests.

9.22 The Scheme on the other hand will have limited impact on the inflows into the Haven and would not require the construction of any additional pumping facilities. The LWSS recommend that a sea lock and barrage at the mouth of the Haven should not be considered any further as it provided no benefits for managing fluvial flood risk, and, in fact, would create a dis-benefit.

9.23 For a sea lock and barrage consideration would also need to be given to the effluent outfall from the sewage treatment works that serves Boston and the surrounding area. This would, I believe, need to be extended further down the Haven - or possibly as far as the Wash - to a position below the sea lock and barrage. The extended outfall would need to cross the South Forty Foot Drain, and could be up to two miles long. This would add significantly to the complexity, cost, risk and constraints of the sea lock proposal. This was not considered in the 1994 Study.

9.24 Access requirements for all of the sites were assessed in the 1994 Study as not being significantly different and so were not considered further. However, in my view access arrangements for all of the sites would be very difficult and would get progressively more difficult as you move downstream towards Tabs Head. None are served by the road network. As such, an extensive road improvement scheme on both sides of the Haven would be required in order to construct a sea lock and barrage and also provide the means to operate and maintain the sea lock and barrage in the future. My view is that this would significantly add to the complexity, cost, risk and constraints of the sea lock proposal.

9.25 As the sites become more remote from the land and one enters what is inshore waters the challenges in construction the sea lock and barrage become much greater, as there is more exposure to the elements, such as wind and waves and the tide. This would significantly increase the construction cost of the sea lock and barrage as one move towards Tabs Head.

9.26 Further, the 1994 Study gave no consideration as to how power would be provided to the sea lock and barrage. The nearest know facility is Western Power Distributions sub-station out the outskirts of Boston. Taking power to the sea lock and barrage would therefore add significantly to the complexity, cost, risk and constraints of the sea lock proposal.

9.27 The 1994 Study concluded that due to the size of the new structure - the sea lock was proposed to have a length of 150m and a lock width of 22m - it would need to be constructed 'offline' to avoid interfering with Port of Boston operations, the fishing fleet and the movement of sea going leisure boats. The 1994 Study noted that if the sea lock needed to be aligned with the existing channel, then a dredged diversion channel would also need to have be investigated. At the time it was believed that a diversion channel would be an 'over complication' and this was not considered further. What the 1994 Study did not expressly acknowledge was that constructing the sea lock 'offline' would require a permanent diversion of the river to put the sea lock and barrage into operation. This in itself is a very large undertaking which at times would interfere with Port of Boston operations, the fishing fleet and the movement of sea going leisure boats.

9.28 The 1994 Study also concluded that the tidal river up-stream of the sea lock as far as the Port of Boston would need to be dredged much more frequently following construction, and a wider and deeper approach channel to the sea lock would also need to be dredged out and maintained by frequent dredging.

9.29 The construction of the sea lock and barrage in the location recommended by the 1994 Study would result in the loss of up to 23 hectares of sites designated as having particular ecological value. These sites are some of the most valuable intertidal habitats internationally. This is discussed in Emma Lunt's proof of evidence (**EA/8/1**).

9.30 The construction of the sea lock and barrage would cause a deterioration of the water quality in the Haven. This is also discussed in Emma Lunt's evidence (**EA/8/1**). I note her conclusion that, on environmental grounds, it was correct not to further consider the proposal of a lock and barrage in the locations identified in 1994 Study.

9.31 If we were to consider the cost of the flood risk management elements of the sea lock and barrage proposal, these flood risk management elements alone would be significantly more expensive than the Scheme. This is due to their physical size, the remote nature of the location where they would be constructed, the physical conditions that they would encounter and the extensive amount of infrastructure and mitigation works required. The FRM element of the investment in a sea lock and barrage did not follow the appraisal guidance at the time. However, if one considers the appraisal guidance used in 1994, or since then[6], the FRM element of the investment in a sea lock and barrage in my view wouldn't get past the initial round of economic appraisal.

9.32 The case for a sea lock and barrage in 1994 can be seen as marginal with a BCR of 1.55:1 and that did not include all of the costs to construct and operate the works proposed. In my opinion this is probably one of the reasons why the proposal was never taken forward. As far as the Port of Boston, the NRA, Boston Borough Council and Lincolnshire County Council were concerned, all interest in the proposal for the sea lock and barrage evaporated after the publication of the 1994 Study.

9.33 It is therefore clear to me that a sea lock and barrage were considered uneconomic and unaffordable in 1994, and this would remain the case in the present day.

Boston Haven Flood Management Strategy Study 2003 to 2005

[6] PAGN, PAGN 1-6 then FCRM-AG

9.34 The Environment Agency began to develop a flood risk management strategy between 2003 and 2005 entitled the Boston Haven Flood Management Strategy Study (**BHFMS**) (please see **Appendix 13** to my evidence (**EA/1/2**) for a copy of the Economic Options Appraisal Report comprised within the BHFMS). This work identified a number of strategic flood risk management policies, and options within each policy, to reduce tidal flood risk in Boston.

9.35 The strategic flood risk management policy options were (with sub options identified):

9.35.1 Option 1: 'Hold the Existing Line of Defence'

(a) 1a - reactive maintenance (repair defences following a breach);

(b) 1b - proactive maintenance (maintain defences to the present level);

(c) 1c – wall raising (raise crest levels to maintain current standard of protection for the 100 year study duration); or

(d) 1d – wall raising: (raise crest level to improve the present standard of protection over the 100 year study duration).

9.35.2 Option 2: 'Advance the Existing Line of Defence'

(a) 2a - Barrier construction; or

(b) 2b - Relocation of Grand Sluice.

9.35.3 Option 3: Managed Realignment

(a) 3a – Offline flood storage areas;

(b) 3b – Rural realignment; or

(c) 3c – Urban Realignment.

9.35.4 Option 4: No Active Intervention

(a) Do nothing/walk away

9.36 Initial consultation was undertaken in spring 2004 to identify key environmental issues associated with the proposed Boston Haven Flood Management Strategy and to seek comments and agreement on draft strategic environmental assessment objectives. Key environmental constraints identified at this strategic scoping stage were:

9.36.1 human beings - people and property in Boston, recreational use of the river and riverside open space and access, and river related industries and businesses including the Port of Boston and commercial fishing activities;

9.36.2 flora and Fauna - international conservation importance of The Wash with designations including Ramsar, SAC, SPA and SSSI;

9.36.3 cultural heritage and archaeology - the town of Boston is a historical port with high archaeological potential and numerous buildings and features of heritage importance;

9.36.4 water – there are numerous outfalls into the Haven including those associated with the sewerage network, waste water treatment flood risk and land drainage functions.

9.37 A preliminary screening exercise considered the four flood risk management strategic policies and options within those policies to eliminate any that would not be feasible or viable for further investigation. Options that were considered viable were taken forward into an economic assessment. Refining the options allowed the economic and environmental assessment to concentrate on realistic options.

9.38 '*Option 1: Hold the Existing Line of Defence – 1a Reactive Maintenance'* was not considered to deliver a sustainable approach to managing tidal flood risk. Under this option the Environment Agency would not have taken a pro-active role in maintaining the defences at the existing level to minimise the chances of a breach occurring and causing extensive damage. It was assumed that the mechanism of flooding overtopping and breaching of the defences would occur. This approach was considered to increase the risk of tidal flooding in Boston and as a consequence it was agreed that this option should not be considered further.

9.39 '*Option 1: Hold the Existing Line of Defence – 1d Improve the standard of protection to 1 in 500'* option would have delivered an unusually high standard of protection. Relevant guidance states that consideration should be given to standards above the indicative range if there is evidence of an exceptional benefit return on the additional costs. Consideration was given to improving the standard of protection to 1 in 100, 1 in 300 and 1 in 500. The results identified that the maximum economic efficiency peaks for the 1 in 300 year standard of protection option. The strategy study also modelled the 1 in 1,000 year event beyond the 1 in 500 year event. Modelling beyond the 1 in 1,000 year event was not appropriate as the confidence in the accuracy of modelling damages and predicting costs is reduced for extreme events. The project team consulted with Defra on this issue and they were advised by Defra to adhere to the guidance.

9.40 In addition the '*Hold the Existing Line of Defence – 1d Improve the standard of protection to 1 in 500 option'* would have lead to exceptionally high flood defences along the entire length of the Haven, especially through the urban area. This would have had a significant impact on the local landscape of the town. In certain locations the river would not have been visible and important townscape views would have been obstructed. There would be a high risk of planning permission being refused or requiring mitigation, such as raising walkway levels or creating new walkways along the river corridor and these measures would have added significantly to the cost of this option.

9.41 The *'Hold the Existing Line of Defence – 1d Improve the standard of protection to 1 in 500 option'* could have addressed the risk of tidal flooding in Boston. However, the very high standard of protection would be very difficult to justify from an economic point of view and there were considered to be significant risks and uncertainties regarding planning and costs of this option. As a consequence it was agreed that this option should not be progressed.

9.42 *'Options 2a and 2b: Advance the Existing Line of Defence'* at locations adjacent to or upstream of Black Sluice were considered to have significant issues associated with a barrier located in

the urban environment. Concerns were raised by consultees regarding the historic character of the town, the effects on setting and condition of listed structures, the impact on historic wrecks, the impact on the local fishing fleet and the potential ecological effects. These concerns were greater if the Barrier was to be used to improve navigation in the Haven through the management of water levels, which was an emerging aspiration for a tidal barrier at that time. In addition with '*Option 2b – Relocation of Grand Sluice'*, the permanent impoundment of fluvial water levels upstream of the barrier (moving the tidal limit) was unacceptable to a number of key stakeholders. The loss of cultural heritage was unacceptable to English Heritage. English Nature were concerned about impacts on the Wash. They had ecological concerns about the change to the fluvial limit of the river and the loss of biodiversity, plus impacts on water quality. They were also concerned about the adverse effects on geomorphology and the water level regime.

9.43 In relation to '*Option 2a – Barrier Construction',* a barrier located upstream of Black Sluice would also encroach on the urban area of Boston. This would result in exceptionally high flood defences through parts of the urban area up to the point where the barrier was located. This would have a significant impact on the local landscape of the town. As a consequence it was thought that the '*Advance the Line'* options adjacent to, or upstream of, Black Sluice were not viable and these options were not considered further. There were significant concerns regarding any options that moved the tidal limit. These concerns included impacts on water level management on the Lower Witham; change of heritage setting for Grand Sluice; and environmental impacts.

9.44 *'Option 2 - Advance the Line'* options downstream of Hobhole were considered to have an unacceptable impact on the Wash and its designated environmental sites. English Nature expressed concerns regarding the construction of a barrier downstream of Hobhole and the impacts that this would have on The Wash, sediment movement, fish movements, and water movement. However, the greatest concern was the potential for impact on the geomorphology of The Haven and The Wash. As a consequence it was agreed that '*Advance the Line'* options downstream of Hobhole were not viable and these options were not considered further.

9.45 With regards to '*Option 3: Managed Realignment'*, managed realignment involves identifying an area that has not previously been exposed to flooding by the sea then allowing it to become flooded by removing coastal protection. This would make space for water and potentially reducing flood risk to surrounding areas. A geomorphological assessment was undertaken that considered each of the policy options stated above. The assessment concluded that large scale 'managed realignment' on a part of the Haven did not seem suitable for Boston. However, there were some areas of the channel that had potential for small scale (or localised) realignment to maximise the channel's potential. Major 'managed realignment' as a policy option would not have improved the functioning of the estuary system required to significantly reduce the flood risk to the town.

9.46 In terms of option screening the following factors explain the reasoning behind the decision to remove '*Managed Realignment options 3a, 3b and 3c'* from further economic assessment:

9.46.1 the eventual widening of the channel may increase bed height and have detrimental impacts on navigation of the channel;

9.46.2 major realignment might have had adverse consequence for the efficiency of (ebb tide) water conveyance within the system and this may have added to the flood risk by reducing the amount of freshwater able to be discharged; and

9.46.3 all the banks downstream of a Managed Realignment site would have had to be managed and protected. If a realignment were to be undertaken upstream of the landfill site (now a waste transfer station), there was considered to be a risk of erosion of the landfill site banks.

9.47 The following conclusions were drawn for small scale realignment along the tidal reach:

9.47.1 a sustainable geomorphological option from Grand Sluice to Slippery Gowt would be to maintain the channel in its current form;

9.47.2 between Slippery Gowt and Tabs Head the most sustainable geomorphological option was less clear and a number of options needed to be considered. One sustainable geomorphological option was considered to be to extend the training walls at the mouth if accretion within The Wash were to continue. Another sustainable geomorphological option was considered to be to widen the channel (the exact extent would require detailed work) towards the mouth to reduce constriction of water on the ebb tide.

9.48 Any major realignment of the river channel was considered likely to have a negative impact on navigation, flood risk, land drainage and the stability of embankments.

9.49 As the most sustainable geomorphological option for the urban area of Boston was considered to be maintaining the channel in its current form, there appeared to be little scope for any urban realignment. Urban realignment would seek to set back the flood defences within the town to create more space for water within the urban area and hence reduce flood risk to the town.

9.50 As a consequence of the geomorphological assessment it was agreed that none of the Managed Realignment Options would be considered any further.

9.51 *'Option 4: The No Active Intervention'* - was not considered to be a realistic option as it would lead to the deterioration of the existing flood defences, with associated serious flooding and risk to life. Following consultation this option was rejected as a viable option. However, it was taken forward as the economic 'baseline'.

9.52 In summary, the following options were therefore not taken forward into the economic assessment.

9.52.1 *'Option 1a: Hold the Existing Line of Defence - Reactive maintenance'*;

9.52.2 'Option 1d: Hold the Existing Line of Defence – Improve the standard of protection to 1 in 500';

9.52.3 '*Option 2a: Advance the Line – Barrier located at Tabs Head'*;

9.52.4 'Option 2a: Advance the Line – Barrier located upstream of the Swing Bridge'

9.52.5 '*Option 2b: Relocation of Grand Sluice – tidal limit moved to barrier'*

9.52.6 *'Option 3a: Managed Re-Alignment – Setting Back the Line of the Defence (Off Line Storage)'*

9.52.7 *'Option 3b & 3c: Managed Re-Alignment – Setting Back the Line of the Defence'*; and

9.52.8 *'Option 4a: No Active Intervention'* (although as stated above, this option was taken forward as the economic baseline).

9.53 The following options were taken into the economic assessment.

9.53.1 *'Option 1b: Hold the Existing Line of Defence – Proactive Maintenance'*;

9.53.2 *'Option 1c: Hold the Existing Line of Defence – Sustain the Existing Defences';*

9.53.3 '*Option 1d: Hold the Existing Line of Defence – Improve the Standard of Protection to 1 in 100'*;

9.53.4 '*Option 1d: Hold the Existing Line of Defence – Improve the Standard of Protection to 1 in 300'*;

9.53.5 *'Option 2a: Advance the Line – Barrier Located Upstream of Hobhole Outfall;*

9.53.6 *'Option 2a: Advance the Line – Barrier located Downstream of Black Sluice Outfall';* and

9.53.7 *'Option 2a: Advance the Line – Barrier located at Swing Bridge'.*

9.54 The BHFMS study demonstrated that there was an economically sound case for undertaking work to protect the town of Boston from tidal flooding. The economic appraisal demonstrated that there was little difference between adopting a *'hold the line'* strategic policy over an '*advance the line'* strategic policy. The incremental benefit/cost assessment supported a case for adopting an improved standard of protection to the 1 in 300 year water level for both the *'hold the line'* and '*advance the line'* policy options. This would have substantially improved the existing level of protection that was at a 1 in 50 year's level.

9.55 This stage of the assessment was purely economic and final option selection needed to evaluate environmental and social aspects to ensure a sustainable approach for flood management in Boston.

9.56 A number of issues were identified that would influence the preferred option:

9.56.1 *'Option 1 – Hold the Line'* was considered to give rise to planning issue as raising existing defences were considered likely to have a significant impact on the local landscape of the town;

9.56.2 *'Option 1 – Hold the Line'* was also considered to give rise to legal uncertainties regarding responsibility for asset management and regarding responsibility for improvements;

9.56.3 In relation to *'Option 2 - Advance the Line – Barrier Located upstream of Hobhole outfall',* the geomorphological assessment concluded that caution needed to be

exercised regarding any *Advance the Line* options that involved the construction of a barrier in the Haven between Slippery Gowt and Tabs Head, as that section of the Haven was unlikely to be a viable location for a tidal barrier. In addition I believe that the significance of the proximity of the Wash designated sites (Ramsar, SAC, SPA and SSSI) was understood at the time and the need not to impact on these designated areas also meant that caution needed to be exercised when considering suitable locations for the barrier. For this reason the section of the Haven between Slippery Gowt and Tabs Head would not be a viable location for a tidal barrier.

9.57 Due to the impacts that '*Option 1 - Hold the Line'* would have had on the landscape and historic character of the town and the legal uncertainties surrounding asset ownership, '*Option 1 - Hold the Line'* was not taken forward.

9.58 In relation to '*Option 2 – Advance the Line'*, the strategic study did not categorically rule out locations in the Haven between Slippery Gowt and Tabs Head for a tidal barrier, but subsequent studies and appraisal work ultimately ruled out that section of the Haven as being a viable location for a tidal barrier. The Boston Combined Strategy Study (explained below) considered the strategic approaches to flood risk management and assessed them against the strategic objectives. The solutions that were not environmentally acceptable were identified and not considered further. The approaches that were considered to adversely affect the Wash SSSI/SPA/Ramsar designated areas were not carried forward which included *'Advance the Line'* options in the designated areas or '*Advance the Line'* options close enough to the designated areas to have an impact on the designated areas (for instance between Slippery Gowt and Hobhole).

9.59 The Boston Haven Flood Risk Management Strategy Study recommended an *'Option 2 - Advance the Line'* strategic policy encompassing a barrier that would improve the standard of protection to 1 in 300 chance of flooding in any year. It recommended that the proposed barrier should be located between the Swing Bridge and upstream of the Hobhole Outfall. It was also recommended that the potential to develop a navigable water way through the construction of a barrier should also be investigated.

9.60 At around the same time as this work was being undertaken the Environment Agency produced a separate feasibility study to see how the Fens Waterways Link could be implemented in and around the town of Boston. This work identified that a navigable link could be developed between the River Witham and the South Forty Foot Drain by the construction of a barrage/barrier in the Haven. Towards the end of 2004, a decision was taken to look at how the objectives of the proposed Boston Haven Flood Management Strategy Study aligned with the Boston Waterways Link Feasibility Study.

Boston Combined Strategy Study 2006 to 2008

9.61 Following the recommendation of the draft Boston Haven Flood Risk Management Strategy a decision was made by the Environment Agency, with support from partners, to develop a combined Flood Risk Management and Navigation Strategy for Boston (a multifunctional strategy) and the Boston Combined Strategy (**BCS**) study (**C/3/4**) was undertaken. The strategic options that were considered in the Boston Haven Flood Management Strategy Study to reduce flood risk were considered alongside options to deliver navigation improvements

9.62 In order to develop the multifunctional strategy, preliminary screening of the separate flood risk management and navigation options was carried out using technical and functional criteria, together with strategic environmental assessment, and the valid solutions were combined into six strategic options.

9.63 The screening of the Flood Risk Management approaches produced a similar outcome to the screening undertaken for the Boston Haven Flood Risk Management Strategy Study. This is summarised in the table below.

Screening of Flood Risk Management Approaches				
Approach	Option	Description of Management Option	Issues	Status
Hold the Line	Option 1a	Reactive maintenance	Does not deliver objectives regarding flood risk management and development control. Not supported by Boston Borough Council (BBC) or other Boston Haven FMS Scoping study responses.	No further consideration
	Option 1b	Pro-active maintenance	Not supported by BBC. Flood risk arising from asset failure needs Addressing	Take forward to economic assessment
	Option 1c	Raise defence level for climate change	Concerns about social acceptability of height of stretches of wall in relation to landscape. May be possible to mitigate. English Heritage and BBC concerns.	Take forward to economic assessment
	Option 1d	Increase SoP	Visual intrusion of raised hard defences within town centre. Opposes key social objectives of the strategy. Not supported by BBC within town. English Heritage concerns.	No further consideration
Advance the Line	Option 2a	Flood Barrier between Hobhole outfall and Swing Bridge	Preferred option of number of consultees. Specific local issues about potential location and appearance	Take forward to economic assessment
	Option 2b	Barrier to move tidal limit of river	Loss of cultural heritage unacceptable to English Heritage Does not fit with BBC plans for Boston	No further consideration

			EN concerns about impact on the Wash Ecological concerns about change to fluvial limit of river and effect on biodiversity, water quality, etc. Adverse effects on geomorphology and water level regime	
Realignment	Option 3a	Managed realignment – storage areas	Does not deliver flood risk management. Rejected on technical grounds due to bank works and landfill site constraints, plus geomorphology concerns	No further consideration
	Option 3b	Managed realignment - retreat the line	Does not deliver flood risk management. Major managed realignment may not improve the functioning of the estuary system and may hinder navigation	No further consideration

9.64 The screening of the Navigation approaches led to a number of options not being taken forward in the appraisal.

9.65 A Tidal Lock in isolation at Black Sluice, was rejected as a standalone option as the Haven would still be a full tidal navigation.

9.66 A New Channel to the west of Boston did not support regeneration opportunities for partners as it bypassed the town centre but it was still considered for economic assessment

9.67 The permanent impoundment of fluvial water levels upstream of the barrier by moving the Tidal Limit was unacceptable to a number of key stakeholders. The loss of cultural heritage was unacceptable to English Heritage. English Nature (now Natural England) were concerned about impacts on Wash. English Nature also had ecological concerns about the change to the fluvial limit of river and the loss of biodiversity, plus impacts on water quality. English Nature were also concerned about the adverse effects on geomorphology and the water level regime.

9.68 The screening of the Navigation approaches is summarised in the table below.

Screening of Navigation Approaches				
Approach	Option	Description of Management Option	Issues	Status

New channel to west	A	Channel linking North Forty Foot Drain to South Forty Foot Drain	Does not support regeneration opportunities for partners as it bypasses town centre. Supported by Black Sluice IDB as does not affect Black Sluice	Take forward to economic assessment
Tidal Lock	B	New tidal lock in Black Sluice	Rejected as standalone option as Haven still full tidal navigation.	No further consideration
New barrage and navigation link	Option C1 and Options C2	Barrage to move tidal limit of river plus New navigation link (Black Sluice lock or new cut)	Loss of cultural heritage unacceptable to English Heritage. Does not fit with BBC plans for Boston. English Nature concerns on Wash. Ecological concerns about change to fluvial limit of river and loss of biodiversity, water quality, etc. Adverse effects on geomorphology and water level regime.	No further consideration
	Option C3 and Option C4	Barrage to control tidal range plus New navigation link (Black Sluice lock or new cut)	Location of barrage concerns Port. Some location options of concern to English Nature because of Wash. Gravity discharge of Black Sluice possibly impaired.	Take forward to economic assessment

9.69 A number of the strategic options involved the construction of a barrier or barrage, or a structure that combines the functionality of a barrier and a barrage. A barrier would operate only during

storm tidal surges to prevent inland flooding. A barrage would impound water at certain states of the tide.

9.70 The screening of Flood Risk Management approaches and Navigation approaches was brought together to create an Options list for further appraisal. These Options were identified as I, II, III, IV, V and VI and these options are detailed below:

Option I - Maintain defences and western waterway. Pro-active maintenance of FRM assets and a channel linking the River Witham (via North Forty Foot Drain) to South Forty Foot Drain. The standard of flood protection would decrease over time from a current standard of 1 in 50 years to approximately 1 in 10 years.

Option II - Maintain defences, new barrage and navigation link. Pro-active maintenance of FRM assets, a partial exclusion barrage to control the tidal range within Boston, and a new lock through, or adjacent to, Black Sluice. The standard of flood protection would decrease over time from a current standard of 1 in 50 years to approximately 1 in 10 years.

Option III - Maintain defences and western waterway. Sustain the current standard of protection (1 in 50 years) into the future by raising the levels of existing FRM assets to cater for the effect of climate change and create a new channel linking the River Witham (via North Forty Foot Drain) to South Forty Foot Drain.

Option IV - Maintain defences, new barrage and navigation link. Sustain the current standard of protection (1 in 50 years) by raising the levels of existing FRM assets to cater for the effect of climate change, and create a new partial exclusion barrage to control the tidal range within Boston and a new lock through or adjacent to Black Sluice.

Option V - Flood barrier and western waterway. Provide a flood tide barrier (advancing the line of defence) to increase the standard of protection to a minimum of 1 in 100 years and a channel linking the River Witham (via North Forty Foot Drain) to South Forty Foot Drain to the west of the town centre.

Option VI - Multipurpose barrier and navigation link. Provide a flood tide barrier (advancing the line of defence) to increase the standard of protection to a minimum of 1 in 100 years, combined with a partial exclusion barrage to control the tidal range within Boston, and a new lock through or adjacent to Black Sluice.

9.71 A key part of the strategic appraisal of the above six options was the strategic environmental assessment undertaken (**SEA**) to ensure that environmental and sustainability issues were taken into consideration at an early stage of the strategy development. A copy of the BCS SEA report can be found in the appendices to Emma Lunt's evidence (**EA/8/2**). The Environment Agency voluntarily undertook SEA in accordance with internal Environment Agency policy and Defra guidance, to support the development of the BCS.

9.72 The strategic appraisal and the accompanying SEA adopted an objective led approach to the assessment of flood risk management and navigation approaches in accordance with the Environment Agency guidance. The assessment of the significance of impacts of options was based on predicting the effects of alternatives on the environmental objectives.

9.73 The strategic approaches to flood risk management and navigation were assessed against the strategic objectives, and those solutions that were not environmentally acceptable were

identified and not considered further. In particular those approaches that were considered to adversely affect the Wash SSSI/SPA/Ramsar designated areas were not carried forward. This would include '*Advance the Line'* options in the designated areas or '*Advance the Line'* options close enough to the designated areas to have an impact on the designated areas (for instance between Slippery Gowt and Hobhole).

9.74 The assessment of the significance of impacts of options was based on predicting the effects of alternatives on the environmental objectives. The significance of an impact is defined by a combination of the magnitude of the effect and the importance of the receptor. This was summarised by assigning a grading as shown below:

✗✗	**Major Adverse Effect**: effects arising from carrying out this option have potential to cause severe environmental damage or destruction, are non-reversible and difficult to alleviate.
✗	**Moderate Adverse Effect**: effects arising from carrying out this option have the potential to cause a moderate level of environmental damage, however mitigation could potentially reduce this damage.
⊘	**Insignificant Effect**: implementing the option in the area is unlikely to pose a threat to the quality of the environment. In the event of a minor threat, mitigation may be necessary. Likewise, including the option could lead to minor improvement opportunities, or a chance to maintain current environmental standards.
✓	**Moderate Beneficial Effect**: implementing the option in the study area could lead to opportunities to improve the environment.
✓✓	**Major Beneficial Effect**: implementing the option in the study area could lead to an important opportunity, or series of long term opportunities to improve the environment.

9.75 The strategic environmental appraisal of the combined options is summarised in the second table shown below.

Environmental Appraisal Summary of Combined Options						
	Maintain Defences & Western Waterway	Maintain Defences, Barrage & Nav Link	Maintain Defences for Climate Change & Western Waterway	Maintain Defences for Climate Change & Barrage & Nav Link	Flood Barrier to increase SoP & Western Waterway	Flood Barrier to increase SoP & Barrage & Nav Link
Objective	**I**	**II**	**III**	**IV**	**V**	**VI**
Reduce the risk of flooding to people, property and the environment	✗✗	✗✗	⊘	⊘	✓✓	✓✓
Provide an opportunity for investment, leading to long-term economic improvements and employment benefits	✗✗	✗	✗	⊘	⊘	✓✓
Be an important recreational resource and contribute to the health and wellbeing of local communities	✗✗	✓	⊘	⊘	✓	✓✓
Conserve and enhance the landscape character of the area	✗	✗	✗	✗	✗	✗
Protect and enhance features of archaeological importance and historic character throughout Boston	✗	✗	✗	✗	✗	✗
Protect and enhance biodiversity and designated sites of local, national and international importance	✗	⊘	✗	✗	✗	✗
Ensure the strategy is sustainable in terms of long-term climate change	✗✗	✗✗	⊘	⊘	✓	✓
Ensure there are no adverse changes in water levels, quality and flows within the study area	✗	⊘	✗	✗	⊘	⊘

Environmental Appraisal Summary of Combined Options						
	Maintain Defences & Western Waterway	Maintain Defences, Barrage & Nav Link	Maintain Defences for Climate Change & Western Waterway	Maintain Defences for Climate Change & Barrage & Nav Link	Flood Barrier to increase SoP & Western Waterway	Flood Barrier to increase SoP & Barrage & Nav Link
Objective	**I**	**II**	**III**	**IV**	**V**	**VI**
Ensure favourable geomorphological regimes are maintained	⊘	✗	✗	✗	⊘	⊘
Provide functional local and regional transport routes including a waterborne transport corridor for people and freight	✗✗	✗✗	✗	✗	⊘	✓✓
Ensure the strategy does not conflict with existing land use	✗	✗	✗	✗	✗	⊘

9.76 The most favourable option in environmental and technical terms was found to be Option VI, a multifunctional barrier to improve the standard of protection and control water levels within the Haven, accompanied with a new navigation link.

9.77 Key decisions in the selection of this option were informed by the technical appraisal, the environmental assessment, and the consultation carried out, and can be summarised as:

9.77.1 managed realignment would not sufficiently reduce flood risk and may have geomorphological impacts on the Wash and so was rejected on technical and environmental grounds;

9.77.2 there was an identified need to invest in the repair and maintenance of existing flood assets to manage the risk of flooding due to asset failure and this was factored into the consideration of all options;

9.77.3 the additional height required on existing defences to raise the standard of protection would have impacts that could not be sufficiently mitigated in some locations in order to make the option acceptable to the planning authority or local community;

9.77.4 a navigation barrage that removed the tidal nature of the Haven through Boston town centre was not acceptable to key consultees, such as English Heritage and English Nature; and

9.77.5 the potential location of either a tidal flood barrier, a navigation barrage, or a multifunctional structure was constrained by potential environmental impacts (in particular the sensitivity of the Wash designated areas) and other issues raised by consultees such as the commercial operation of the Port of Boston.

9.78 The preferred option for a standalone FRM strategy was assessed in parallel to the assessment of a multi-functional strategy by considering the elements of the technical appraisal, the environmental assessment, and the consultation carried out that related to only the FRM objectives. This work drew heavily on the Boston Haven Flood Risk Management strategy study. The preferred approach for a standalone flood risk management strategy from a technical and environmental standing was to *Advance the Line*.

9.79 A benefit cost analysis covering 'FRM only' investment in Boston was carried out in order to confirm that the correct investment decision was being made to satisfy the FRM objectives and to assess the appropriate standard of protection. Following consultation with Defra a decision was made that a single standard of protection was appropriate and justifiable for Boston town centre.

9.80 All FRM costs were included in this economic analysis and the *Advance the Line* options also included for FRM asset repair work along the Haven as well as the tidal barrier. This was a conservative cost estimate as flood risk from asset failure upstream of a tidal barrier would change with implementation of the strategy. All barrier options included provision for raising embankments downstream of the barrier in future years.

9.81 The table below summarises the economic analysis for a FRM strategy. The highest benefit cost ratio of the *Advance the Line* options was a tidal barrier delivering a standard of protection of 1 in 200 years. The incremental BCR to the next highest standard of protection is 4. That is sufficiently robust to make the higher standard of protection of 1 in 300 years the leading Advance the Line option in economic terms.

Summary Benefit Cost Ratio for Flood Risk Management Options				
FRM Option	**Do Nothing**	**Advance the Line**		
SoP	Do Nothing	Improve SoP (1 in 100)	Improve SoP (1 in 200)	Improve SoP (1 in 300)
Total PV Cost (£m)		67.5	69.8	72.7
Total PV Damages	1014	213	88	76
Total PV Benefit (£m) (damage avoided)		801	926	938
Benefit Cost Ratio		11.9	13.3	12.9
NPV (£m)		733	856	865
Incremental BCR			54	4

9.82 The preferred option for a standalone FRM strategy was therefore identified to be to *Advance the Line* of defence and increase the standard of protection to a minimum of 1 in 300 chance of flooding in any year with a tidal flood barrier. The same constraints would apply to a tidal barrier and a multi-functional barrier.

9.83 The costs and benefits for each of the multifunctional options were assessed and the preferred combined option with the highest benefit cost ratio was Option VI, a multifunctional barrier to improve the standard of protection and control water levels within the Haven. This option had the highest benefit cost ratio of 10.8, which was significantly higher than any of the other options considered for economic appraisal.

9.84 Option VI, comprised of five phases of work to address flood risk and achieve navigational aims within Boston. The five phases of work were:

9.84.1 a new navigation link between The Haven and South Forty Foot Drain at Black Sluice (now completed);

9.84.2 improvement works to flood assets at risk of failure within Boston town centre (now completed);

9.84.3 a multi-functional barrier within Boston Haven: dual function of a tidal barrage for water level control to enable safe navigation and tidal surge barrier (the tidal surge barrier is the Scheme that is proposed);

9.84.4 waterways facility works (moorings etc.); and

9.84.5 raising of embankment levels downstream of barrier at appropriate future time (to be delivered through a number of phases of work).

9.85 The preferred option would deliver a 1 in 300 (0.33%) annual chance standard of protection against tidal flooding in 100 years, allowing for the predicted effects of climate change over the next 100 years.

9.86 The BCS that included the preferred flood risk management approach was approved by the Environment Agency in March 2008 (**C/3/4**) and Phases 1 and 2 are now complete.

9.87 The multifunctional strategy recommended that the barrier should be within a zone defined upstream by the Swing Bridge and downstream by the entrance to the Port's Wet Dock Entrance. In reaching this conclusion several locations for the barrier were considered, including at Hobhole and the mouth of the Haven. However, the Boston Haven Flood Risk Management Strategy Study (see **Appendix 13** of my evidence (**EA/1/2**)) and the BCS (**C/3/4**) had identified that locations for a barrier downstream of Hobhole Outfall were not viable for technical and environmental reasons. In addition due to the connectivity of the Haven upstream of Hobhole to the Wash designated areas the section of the Haven between Slippery Gowt and Hobhole would not be viable for technical and environmental reasons; further detail on this provided within section 15 of my evidence. Figure 5 at Appendix 4 of the Environment Agency's Statement of Case (**I/1**) illustrates these various locations within the Haven).

9.88 In undertaking the multifunctional strategy study the Environment Agency took into consideration the consultation it had undertaken in previous studies for the Fens Waterways Link and the Boston Haven Flood Management Strategy Study. For the Boston Haven Flood Management Strategy Study scoping consultation relating to FRM was undertaken in Boston (May 2004 and October 2004) and as regards navigation proposals (November 2004). Public consultation undertaken in April 2006 reinforced that ecological constraints surrounding the Wash (designated as a SSSI, Ramsar, SPA and cSAC) were sufficient not to progress further consideration of the location of the barrier near the mouth of the Haven, nor in the stretch of the Haven between Slippery Gowt and Hobhole, due to the likely significant impact on the Wash designated areas. Both (temporary) construction and (permanent) operational impacts on the designated sites were considered to be obstacles.

Appraisal of Options / Locations - 2014

9.89 The approved FRM approach identified within the BCS was to reduce the chance of tidal flooding to 1 in 300 (or 0.33%) annual chance standard of protection against tidal flooding in 100 years, taking into account climate change allowances for 100 years. The preferred option in the multifunctional strategy was to construct a tidal barrier and associated works. Future works would be required to the downstream banks to allow for adaptation to sea level rise.

9.90 Following the Environment Agency's approval of the multifunctional strategy, work started on the detailed appraisal of options for the barrier. This work was primarily focused on where the barrier was to be located within a zone defined upstream by the Swing Bridge and downstream by the entrance to the Port's Wet Dock.

9.91 The development of options and selection of the preferred location has been informed by site investigations, modelling, meetings with the key stakeholders and scoring and weighting of technical, environmental and economic factors. Nine potential barrier option locations were considered in an initial long list. Further details of these nine options is provided within Table 2.7 of the main report of the ES (**A/17/1**).

9.92 All nine potential option locations in the long list were subject to review during internal and external workshops and a Public Open Forum. Stakeholder and project team workshops were held initially for setting of objectives for the assessment and then for the subsequent appraisal of the long list. This work ultimately resulted in the selection of 5 shortlisted options.

9.93 The table below provides a summary of the key events in the development of the Boston Barrier Scheme in date order.

Sequence of key engagement during option selection		
Date	**Event**	**Purpose**
Multifunctional Strategy		
March 2008	Multifunctional strategy approved by EA	The strategy aims to manage the risk from tidal flooding in Boston whilst improving inland navigation and supporting/providing opportunities for the town's regeneration
Boston Barrier Detailed Appraisal		
November 2009	Environmental Stakeholder Workshop	To identify environmental issues, constraints and opportunities, relating to long list options for barrier locations, to be used in the selection of the short list of options for Barrier locations
December 2009	Project Team Barrier Location Options Selection Workshop	To consider a long list of location options, in order to identify a shorter list of feasible location options to be taken forward for further consideration.
January 2010	Public Open Forum 1	To present a reduced list of five location options, in order to understand any concerns or preferences from the local community.
March 2010	Key Stakeholder Workshop	To involve key stakeholders in discussions on the reduced list of five location options, to enable them to influence the option selection process.
September 2010	Public Open Forum 2	To present the short list of three options and invite comments from the local community.
Autumn 2010	Water Level Management (WLM) Report produced by Project Engineers	To identity options for consideration for the management of water levels to provide benefits in terms of improved navigation for inland boating.

Sequence of key engagement during option selection		
Date	**Event**	**Purpose**
November 2010	Workshop for environmental specialists in the project team	To identify the advantages and disadvantages of the three location options and a range of water level management options, in relation to a wide range of environmental topics.
November 2010	Project Team Scoring and Weighting Workshop	To score each option (location and WLM) against a range of criteria, with criteria weighted according to their importance
February 2011	Water Framework Directive Workshop	To carry out a screening exercise to consider whether the options would be likely to comply with the Water Framework Directive.
September 2011	Landscape and Visual Impact Assessment and amended Scoring and Weighting Tables	To inform and update the scoring and weighting tables with information that was not previously available on landscape and visual aspects and Water Framework Directive.
October 2011	Selection of preferred option in agreement with partner organisations (LCC and BBC)	To confirm the preferred option to be taken forward.
October 2011	Drop in session for local residents at Black Sluice Lock Cottages	This drop-in session was held specifically for the local residents that would be immediately affected by the barrier's construction. 34 people attended the session
November 2011	Public Open Forum 3	To present the preferred option to the local community and invite comment.

9.94 The five short listed options (Options A to E) were subject to further public consultation and detailed assessment. These options are illustrated within Figure 6 in Appendix 4 of the Environment Agency Statement of Case (**I/1**).

9.95 A multi-criteria approach was used to compare monetised and non-monetised costs and benefits. The outcome of this assessment recommended that two of the short listed options, Option A (barrier upstream of London Road Quay) and Option D (barrier downstream of the Wet Dock Entrance) be discounted and that Option B (barrier downstream of Black Sluice), Option C (barrier upstream of the WDE) and Option E (barrier downstream of the Maud Foster Sluice) be taken forward to Stage 2 of the appraisal for further more detailed consideration.

9.96 Option A was removed from the shortlist following consultation with consultees who included the Inland Waterways Association, the Port of Boston Limited and the BDFA and technical consideration. The option was identified as requiring more flood wall and flood embankment

raising through the town. It was also identified as not meeting the navigation objectives identified within the multifunctional strategy (provision of a safe navigation link between the Lower Witham and South Forty Foot Drain). The resulting short tidal length between the proposed barrier and Black Sluice Lock was identified as being unsafe for inexperienced inland boaters, particularly the right turn angle into the Black Sluice Lock under tidal flows. Lincolnshire County Council and the Environment Agency's Waterways team highlighted concerns as regards this option on these grounds, with Lincolnshire County Council further identifying that the option would not attract their waterways contribution.

9.97 Option D was also removed from the shortlist as it was identified as having significant impacts on the day to day business operations of the Port during and after construction. In particular, it was considered to unacceptably interfere with the Port's vessel turning circle area at the entrance to the Wet Dock. It was concluded, following consultation with the Port, that these impacts could not be adequately mitigated.

9.98 Whilst Option E gave rise to similar concerns as Option D in terms of the effects it would have on the day to day business operations of the Port, feedback received from the local community demonstrated a strong preference for Option E. This preference was due to a perceived (yet misplaced) view that it would offer improved flood protection over other options. Option E was therefore taken forward for further appraisal to help the Environment Agency better explain how the options provided the same reduction in flood risk and help provide assurance to communities. The further appraisal confirmed that Option E would give rise to significant impacts on the day to day business operations of the Port whilst offering no additional flood protection and it was concluded that it should not be progressed on this basis. The Environment Agency undertook further engagement with local residents in order to address the misplaced perception that the location of the Barrier upstream of Option E would affect their residual flood risk.

9.99 The monetised flood risk benefits were considered to be the same for each of the three remaining options (B, C & E) that were considered. The next stage of appraisal focused on which option offered the most cost effective means of delivering those benefits.

9.100 The cost of Option B (immediately downstream of Black Sluice pumping station) was marginally cheaper than the cost of location Option C (adjacent to entrance to the Port’s Wet Dock) while Option E was considered significantly more expensive (downstream of the Port’s Wet Dock).

9.101 A multi-criteria approach with scoring and weighting was used to compare both monetised and non-monetised costs and benefits for the three options considered in detail for barrier location. The preferred option, selected on the basis of cost effectiveness and scoring and weighting of technical, environmental and economic factors, was Option B.

9.102 Option C was considered to give rise to negative impacts on the Frontier Agriculture facility and the Port of Boston. As such, the cost of mitigation was considered likely to be greater than in the case of Option B.

9.103 Option B, a barrier located approximately 200m downstream of the confluence of the Boston Haven and the South Forty Foot Drain and adjacent to the Port (please see Figure 7 in Appendix 4 to the Environment Agency’s Statement of Case (**I/1**)), was therefore identified as the most cost effective solution. Option B was also identified as the option which minimised impacts on key stakeholders and facilitated the accommodation of mitigation measures.

9.104 As funding for the waterways element of the proposals was not assured to the same extent as the flood risk management elements were, consideration was also given as to how Options B and C would perform in the case of a flood risk management barrier. This was integrated into the options appraisal process with no clear preference for Option B or Option C. However it was identified that Option C would restrict the Environment Agency's ability to deliver its navigation objectives at a later date due to the significant impact that this option would have on the operation of the Port.

9.105 A tidal barrier at Option C would either be:

9.105.1 a very different proposition to the tidal barrier that is proposed in location B if it were designed for the passage of the large vessels that visit the port with a marked increase in cost and time to construct; or

9.105.2 a tidal barrier that could not accommodate the large vessels that visit the ports river side quays. Without the ability to allow large vessels to pass through the barrier, all of the Ports river side quays would be made redundant. This would impact on the Port and its tenants and customers who use the river side quays. This would result in some very substantial claims for compensation. The Port of Boston has indicated that it is strongly opposed to Option C.

9.106 In consideration of all of the aforementioned, the same conclusions can be reached for a flood risk management barrier or a multi-functional barrier, namely that the preferred location for the barrier is approximately 200m downstream of the confluence of the Haven and the South Forty Foot Drain; adjacent to the Port of Boston Buoy Shed (Option B).

9.107 As the public consultation on the option locations suggested that consideration should be given to locations other than Options A to E, the Environment Agency also reviewed other locations closer to the Wash. In particular four locations were considered again at the Mouth of the Haven and other locations between Hobhole and Slippery Gowt. The same conclusion was reached as in the BHFMS and multifunctional strategy that due to the unacceptable impact the barrier would have on the Wash designated sites and the impact on the geomorphology in this part of the Haven none of these locations would be viable for the proposed barrier.

10 Water Level Management

10.1 Since its inception the development of the Scheme has always been primarily focused on reducing the risk of tidal flooding to Boston. The opportunity to create a safe and attractive waterway link via the creation of a stable water level in the Haven was introduced later. As the additional costs to the Scheme to enable water level management (**WLM**) cannot be funded by FCRM Grant in Aid (as the rest of the Scheme is) funding would be required from an alternative source.

10.2 In February 2015 Lincolnshire County Council Executive Committee decided to withdraw funding for the waterway elements of the tidal barrier scheme. The Council reached their decision following work it commissioned to look at waterways benefits in late 2014. This work identified that the Council would not see a return on their investment until the next stage of waterway investment occurs. This next stage of waterways investment is not programmed to commence within the next ten years.

10.3 In view of this funding decision, the Project Board directed the removal of WLM from the scope of the Scheme. It remains the aspiration of project partners, including the Environment Agency, to deliver the waterway elements of the multifunctional strategy in the medium and long term as funding becomes available.

10.4 During the strategic appraisal stage, and the detailed appraisal stage, the options for the Scheme have been assessed both with and without WLM. This approach to assessment was necessary in order to set a cost baseline for the primary objective of the Scheme, namely to reduce tidal flood risk. The cost of enabling additional objectives such as WLM (or habitat creation) had been measured against the FRM cost baseline.

10.5 At all stages of assessment the primary consideration was; what is the preferred option for flood risk management? The next consideration was; what in addition would be required to enable water level management in this location? My evidence in section 9 (on scheme development) sets out the assessment of options and locations in more detail.

10.6 The tidal barrier location proposed is the preferred location to deliver the FRM objective. The location proposed is also the optimum location to deliver WLM.

10.7 When WLM was removed from the scope of the Scheme the Environment Agency considered whether it was necessary to revisit the option and location preferences for the tidal barrier. The Environment Agency concluded that it did not as they had been assessed separately at each stage of Scheme's development and the recommendations of detailed project appraisal for FRM were still valid as nothing had materially changed in the period between completing the detailed appraisal and removing water level management. The Environment Agency is fully confident that a barrier is the right solution to reduce tidal risk in Boston, and that the chosen location for the Scheme is the optimal location.

10.8 Following the decision to revert to the Environment Agency's original proposal to deliver the proposed barrier for FRM purposes, the Environment Agency reviewed the scope of works required to be delivered. The objective of this review was to remove works from the scope of the Scheme which could be reasonably delivered later, as part of any future plans for WLM thus ensuring that the Scheme being delivered for FRM best employed public funds, having regard to the benefits it would deliver.

10.9 The Environment Agency's review identified that it was no longer necessary to relocate permanently the Boston Fishing Fleet, which had been intended to mitigate the effects of operating the Barrier for WLM purposes on their existing operations. To relocate the fishermen permanently would incur additional costs that are not considered to be necessary in order to mitigate any potential impacts of the Scheme.

10.10 The Scheme is the best option to reduce the risk to people and the developed and natural environment from flooding. The design of the Scheme further ensures that the future provision of WLM and a safe and attractive navigation link between the River Witham and South Forty Foot Drain remains possible and as such the proposals do not preclude the longer term delivery of WLM.

10.11 The Scheme has been designed so as not to preclude the future delivery of WLM and the design features which achieve this are explained in the evidence of Peter Mallin (**EA/3/1**).

10.12 What more needs to be done to enable WLM in the future depends on the regime that is agreed upon. Any WLM scheme will require additional authorisations. In addition, a control system for WLM would need to be installed and existing control systems modified. A fish pass would also likely be required. Further detail regarding the likely environmental effects of implementing WLM in the form that the Environment Agency was proposing, can be found in Emma Lunt's evidence (**EA/8/1**).

10.13 In summary, the Scheme as currently promoted is neutral regarding WLM. It does not seek to enable WLM at this time but equally it will not prevent WLM in the future.

10.14 The Scheme is in the preferred location for managing tidal flood risk and is in the only location that can accommodate all of the short listed WLM regimes (chosen by project partners) coupled with suitable mitigation. Other locations suggested for the barrier are not viable for all of the WLM regimes and in many cases there is no viable mitigation for the impacts of some of the WLM regimes in those other locations.

11 Inclusion of a lock alongside the Barrier

11.1 A lock is not required to mitigate the impacts of the Scheme on river users as confirmed in the evidence of Gillian Watson (**EA/4/1**).

11.2 During the early stages of developing the Scheme, as a combined FRM and WLM proposal, it was considered that the provision of a lock might be required to mitigate the impact of the Barrier being closed for WLM on river users returning from or departing to The Wash.

11.3 During engagement with stakeholders it was suggested by a number of local sailors who navigate the Haven that a lock did not provide satisfactory mitigation to the impacts of WLM. This was because it created delays to river users, which meant only the first group to pass through the lock could reach the lock at Grand Sluice before it became tide locked. This meant that following lock users would be unable to return to their moorings on the Witham till the tide fell below Witham levels.

11.4 The project team at the time identified their preferred mitigation to the impact on river users returning or departing to The Wash was to provide WLM at a lower level than initially proposed. The project team also identified that there may be greater mitigation benefit to the impact of WLM on river users by modifying the lock at Grand Sluice rather than including a lock alongside the barrier.

11.5 The WLM regime that that the Environment Agency identified during detailed appraisal that met Navigation objectives and had the least impact on the environment, flood risk, land drainage and existing rivers users, and, where any impacts can be easily mitigated, does not require a lock alongside the barrier. Another WLM regime that involves holding back the tide (all tides or the majority of tides during the boating season) is supported by the IWA and LCC. This WLM regime will need a lock to be constructed adjacent to the barrier to mitigate impacts on existing river users. The Environment Agency believe that a lot more detailed work will be required and suitable mitigation proposed to make the hold back the tide WLM regime acceptable to all parties who would be affected or who would have concerns about that WLM regime.

11.6 As explained in the section above, the possibility of a lock being introduced at a later date has not been precluded.

12 Climate Change

12.1 Throughout development of the Scheme the latest available guidance on climate change has been followed and decisions made regarding the selection of options and locations have been reviewed to ensure they take account of updated guidance.

12.2 The strategic appraisal undertaken for the multifunctional strategy recommended a preferred FRM approach of *Advance the Line* through the construction of a tidal barrier and associated flood defence works. The strategic appraisal of options and locations used the Defra climate change guidance current at the time, the 2006 Supplementary Guidance on Climate Change - *'Treatment of climate change impacts'* (please see **Appendix 14** to my evidence (**EA/1/2)** for a copy of this guidance). This guidance was to be used by Flood Coastal and Erosion Risk Management (**FCERM**) Authorities for strategic appraisal, project appraisal and the design of FCERM schemes until it was withdrawn in September 2011.

12.3 In September 2011, the 2006 guidance was replaced by *'Adapting to Climate change: Advice to FCERM Authorities'* (Defra, 1 September 2011 and updated 13 April 2016) (please see **Appendix 15** to my evidence (**EA/1/2**)). FCERM Authorities must apply this guidance to projects or strategies seeking government flood and coastal erosion risk management grant in aid (**FCRM GiA**) funding. By following the guidance, risk management authorities will carry out a credible economical appraisal that takes account of the uncertainties associated with climate change.

12.4 The detailed project appraisal that was completed in February 2014 established the preferred location of the barrier and included changes in guidance introduced since the multifunctional strategy was approved in March 2008. Changes to project appraisal guidance were followed and the multifunctional strategy recommendations were tested against the new rules. The revised climate change advice was followed and the multifunctional strategy recommendations were tested against the new guidance. It was confirmed that changes to the climate change advice did not alter the recommendations of the multifunctional strategy. However, as a result of the changed advice it was recognised that the design level for the new flood defence would need to change.

12.5 Defra's appraisal policy statement recommends a "*managed adaptive approach*" towards the impact of climate change where possible and sets out some broad principles that should be considered. A '*managed adaptive approach'* is based on taking action when particular trigger points are observed. It is most likely to be appropriate in cases where ongoing responsibility can be assigned to tracking the change in risk, and managing that risk through pre-determined interventions. This provides flexibility to manage future uncertainties associated with climate change. For the earth embankments downstream of the tidal barrier a managed adaptive approach can be taken.

12.6 In some circumstances, a managed adaptive approach may not be technically feasible or does not offer value for money. For example, it may not be possible to manage multiple interventions or it may be economically more efficient to build in a precautionary element at the outset. In these cases, a precautionary approach, with a one-off intervention, may be the only feasible or best option. In the case of the tidal barrier, the hard defences and the wet dock gates it is preferable to take a precautionary approach.

12.7 Considering only precautionary options would lead to greater levels of investment at fewer locations. A managed adaptive approach ensures a fairer and more flexible spread of public investment and therefore should be preferred where possible.

12.8 The Flood Risk Assessment (**A/17/2C**) for the Scheme has considered the climate change conditions following the National Planning Policy Framework (NPPF, March 2012) (**C/1/1**) and has considered the implications of the latest climate allowances set out in Flood risk assessments: climate change allowances (DEFRA, February 2016). A copy of the updated allowances be found in the appendices to Sun Yan Evans' evidence (**EA/2/2**).

13 Haven Flood Banks

13.1 Phase 5 of the multifunctional strategy involves raising of embankment levels downstream of the proposed barrier at an appropriate future time as a 'managed adaptive approach" as defined in Section 12. This phase of the strategy will involve works whenever necessary during the lifetime of the strategy to address settlement and degradation of the embankments or to address rising sea levels due to Climate Change.

Haven Banks Scheme 2017/18

13.2 As part of the staged approach of raising embankment levels downstream of the Barrier, the Haven Banks Scheme is being implemented to fill in existing 'low spots' to provide a minimum crest level of 6.35m AOD. The Haven Banks Scheme has an allocation in the current 6 Year Investment Programme of £1.4M FCRM Grant in Aid. The Environment Agency has planned for these works to commence in 2017/18.

13.3 Planning Permission is not required for these works as the local planning authority has confirmed that the Environment Agency's permitted development rights can be relied upon.

13.4 I understand that a Full Business Case for the Haven Banks Scheme will be submitted to the Environment Agency's National Project Assurance Service (NPAS) for assurance review in July 2017.

13.5 The Environment Agency will oversee the construction and management of the works. The start of construction on site is planned for autumn 2017 with a 3 to 4 month construction period. The works have been planned so as to avoid any conflict with the Scheme.

13.6 The Haven Banks Scheme will re-instate the existing 1 in 200 Standard of Protection along this stretch of the Haven.

Future Haven Embankment Raising in Response to Sea Level Rise

13.7 All barrier options considered since a barrier was first conceived included the need to raise embankments downstream of the barrier in future years in response to sea level rise that is an inevitable consequence of climate change. The Environment Agency is taking a managed adaptive approach to bank raising in line with the Defra Policy Statement on Appraisal of Flood Coastal and Erosion Risk Management (please see **Appendix 16** to my evidence (**EA/1/2**)).

13.8 During the course of preparing the Boston Barrier TWAO, the climate change guidance for developments was updated in Flood Risk Assessments: Climate Change Allowances (UK

Government 19th February 2016. A copy of the updated guidance can be found in the appendices to Sun Yan Evans' evidence (**EA/2/2**). However, the estimate of net sea level rise in the Wash over the next 100 years remains the same as within the National Planning Policy Framework guidelines. Therefore the new guidance on climate change allowance for sea level rise does not change the values adopted in the development of the Scheme.

13.9 The embankments downstream of Boston will need to be raised in the future in response to current predicted climate change, to provide the 1 in 300 standard of protection in Boston at the end of the 100 year lifetime of the Scheme. This work is currently envisaged to be required in 51 years' time (measured from a base year of 2016). The timing of this future investment determines the 51 year duration of benefits period for the Scheme, resulting in the project being economically appraised over a 51 year duration of benefits period. The benefits of the scheme will not begin to be realised until the Scheme has been constructed and is operational in December 2019.The 100 year economic strategic case to invest has also been updated and is still valid.

13.10 Since the multifunctional strategy was approved in 2008 there have been changes in guidance, which prompted a review of its recommendations during detailed project appraisal development. These changes in guidance included: changes to Project Appraisal Guidance (latest guidance has been followed and multifunctional strategy recommendations tested against the new rules); and revised Climate Change advice (latest guidance followed and multifunctional strategy recommendations tested against the new advice).

13.11 This review confirmed the validity of the multifunctional strategy's recommendations. The effect of the changes in climate change guidance between 2006 and 2011 brought forward embankment raising in response to sea level rise from a period towards the back end of the 100 year appraisal period of the multifunctional strategy to only 50 years from now.

14 Costs and Funding

14.1 The anticipated costs of the Scheme are identified in the Estimate of Costs (**A/8**) submitted with the TWAO Application to the Secretary of State. The capital cost of the Scheme is identified in to be £97,395,000 (at 2015 prices). Annual maintenance costs will be in the order of £39,000 at current prices. Both of these figures will be further refined during the development of the Full Business Case for the proposal.

14.2 These costs have been derived through early engagement with our suppliers and verified by cost consultants. The costs include all the components of the works as described in TWAO application documents.

14.3 Due to the substantial economic benefits and the number of homes better protected from tidal flooding, the Scheme is 100% eligible for sufficient Flood Management Grant in Aid to pay the costs of the Scheme, with no external contributions required. Further it is afforded the status of a 'National Priority Project' within the Six Year Programme.

14.4 Accordingly and as stated in the Funding Statement (**A/9**) submitted with the TWAO Application to the Secretary of State, the Environment Agency will fund the cost of implementing the Scheme through its own resources. Funding to facilitate the construction of the proposed barrier has already been included within the Environment Agency's Flood and Coastal erosion risk management investment programme for the period 2015 to 2021.

14.5 Funding contributions are also being sought from local beneficiaries. To date we have secured non-cash contributions (for example the non-recovery of some recoverable costs by a number of organisations). We will continue to seek cash contributions and cost reductions, but since the project qualifies for 100% government funding then progress does not depend on this.

14.6 The Environment Agency will maintain the assets as required so long as there is funding and policy support from Government.

14.7 Blight expenditure is not anticipated to arise as a consequence of this application. However, any such costs as might arise would be met by the Environment Agency.

14.8 I therefore do not consider there be any impediment, with regards to funding, to the delivery of the Scheme.

15 Scheme Alternatives

15.1 In section 9 of my evidence I explained the development of the Scheme, including the reasons taken at the time for ruling out a number of *Advance the Line* approaches (including a sea lock/barrage, moving the tidal limit from Grand Sluice further downstream and a tidal barrier at a number of unviable locations). I have also set out the reasons taken at the time for ruling out the *Hold the Existing Line of Defence* approach, the *Managed Realignment* approach and the *No Active Intervention* approach (retained as the economic baseline).

15.2 In this section of my proof I revisit the reasons for ruling out different approaches and options and set out evidence to demonstrate why those decisions still hold true today and why the only viable proposal for reducing tidal flood risk is the proposed Scheme.

15.3 My evidence in this section of my proof should be read in conjunction with the evidence of Emma Lunt (**EA/8/1**) which covers the environmental matters that need to be considered when proposing any development in the Haven or on the land that surrounds the Haven.

Sea Lock and Barrage

15.4 A number of objectors make reference to the 1994 Study regarding the possibility of a Sea Lock (a copy of this study is provided at **Appendix 10** to my evidence (**EA/1/2**)). This Study, which was commissioned by the Port of Boston Limited, the National Rivers Authority, Boston Borough Council and Lincolnshire County Council, considered the construction of a sea lock and barrage towards the mouth of the Haven. At the time it was believed that the sea lock and barrage could provide benefits to navigation in the Haven as well as FRM benefits. Four locations for the sea lock and barrage were considered between 'Pilgrim Fathers Memorial' (just upstream of the Hobhole outfall) and Tabs Head. In my evidence on scheme development I have assessed the findings of the 1994 Study. There were many reasons at the time why a sea lock and barrage were not progressed any further, with key reasons being:

15.4.1 the impact the sea lock and barrage would have on fluvial flood risk and land-drainage in the Black Sluice catchment, Maud Foster catchment and depending on the location of the sea lock and barrage, the Hobhole catchment;

15.4.2 the impact the sea lock and barrage would have on the environment especially the Wash SSI and local nature reserves;

15.4.3 depending on where the sea lock and barrage were located, the loss of up to 23 hectares of sites designated as having particular ecological value;

15.4.4 the need to extended the effluent outfall from the towns sewage treatment works to below the location of the sea lock and barrage;

15.4.5 the deterioration of the water quality in the Haven;

15.4.6 the increase in siltation in the Haven;

15.4.7 the approach channel in the Wash would need to be dredged and maintained on a regular basis; and

15.4.8 the sea lock and barrage had a very low BCR and did not offer value for money.

15.5 The Lower Witham Strategy Study LWSS (1997) (see **Appendix 11** to my evidence for relevant extracts of this study (**EA/1/2**)) confirmed that the proposal for a sea lock and barrage would have a major dis-benefit in adversely affecting fluvial flood risk and land drainage in the Lower Witham catchment.

15.6 In my assessment of the feasibility of the sea lock and barrage, presented in the 'scheme development' section of my evidence, I highlighted a number of additional key reasons why a sea lock and barrage would not be viable at the mouth of the Haven. For instance:

15.6.1 access arrangements for all of the identified sites would be very difficult and so a significant investment would need to be made in upgrading remote roads that are closest to the four locations and constructing new roads to the four locations;

15.6.2 the challenges in constructing the sea lock and barrage in either of the four locations would be much greater than the middle and upper reaches of the Haven as you are more exposed to the elements such as wind and waves and the tide;

15.6.3 taking power to the sea lock and barrage would add significantly to the complexity, cost, risk and constraints of the proposal;

15.6.4 the sea lock and barrage would need to be constructed 'offline' or a large bypass channel would need to be constructed around the sea lock and barrage – these options would add significantly to the complexity, cost, risk and constraints of the proposal; and

15.6.5 the cost for the FRM only elements of the sea lock and barrage proposal would be significantly more expensive than the Scheme now being promoted by the Agency.

15.7 It is clear to me that a sea lock and barrage were considered uneconomic and unaffordable in 1994.

15.8 In this section of my evidence on alternatives I consider the viability of a sea lock and barrage solution if it were being proposed today. In my view, all of the reasons stated above still stand when assessing the viability of the sea lock and barrage. This would make the sea lock and barrage undesirable, uneconomic and unaffordable.

15.9 In addition there is now substantially greater emphasis and legal precedent on the protection of designated conservation sites, such as the Wash SPA/SAC/RAMSAR/SSSI. Emma Lunt's evidence (**EA/8/1**) explains the reasons why a development such as the sea lock and barrage in the designated areas would not gain approval. This conclusion can be drawn due to the nature of the legislative protection given to designated sites and the likely impact on the Wash SPA/SAC/RAMSAR/SSSI that would result from the construction and operation of a sea lock and barrage between Hobhole and the mouth of the Haven. Emma Lunt's evidence explains that these effects would be of a magnitude exceeding the threshold to gain approval. Further, as there are viable alternatives that do not impact on the designated sites the 'consideration of alternative solutions' test could not be met. She concludes that such an option would not be likely to secure consent.

15.10 The 1994 Study recommends that *'in further development of this study it may be appropriate to consider further sea lock and barrage options upstream of the designated sites*'. This is a clear indication that in 1994 people understood the difficulties that would be faced when developing a FRM scheme near the mouth of the Wash in order to provide flood protection to the town of Boston.

15.11 Moving the sea lock and barrage further upstream from Hobhole would reduce the effectiveness of the sea lock in improving navigation as that would leave a longer length of the Haven that was still tidal.

15.12 Furthermore, in her evidence, Emma Lunt has also explained that habitats between Maud Foster Sluice and Hobhole are likely to provide a functional link for the species of the Wash SPA/SAC/RAMSAR/SSSI. She explains that development in these functionally linked areas should be avoided in the first instance and minimised thereafter by locating new development at the furthest possible distance upstream from the functionally linked area.

15.13 The Environment Agency, local authorities and bodies such as Natural England would take a precautionary approach to any significant development within areas functionally linked to the designated areas, especially if there were other viable locations for the proposal.

15.14 For a significant proposal such as a sea lock and barrage avoiding effects on the designated areas would be seen especially important when the watercourse and surrounding habitat is so connected to the designated areas.

15.15 It is clear to me that a sea lock and barrage upstream of Hobhole would also be considered uneconomic and unaffordable. This is because the sea lock and barrage would be the same conceptually as the proposal at the mouth of the Haven, with only a small reduction in costs as the location would not be quite as remote as Tabs Head or Hobhole.

15.16 Correspondence with the Port of Boston Limited has indicated that the Port would oppose the development of a tidal barrier or sea lock and barrage in the Haven downstream of the port, as they are concerned with the significant impact this development would have on the transit times for vessels to and from the Wash caused by the construction and operation of any large structure in this location.

15.17 If the sea lock and barrage were located closer to the port, then the sea lock and barrage will not meet the primary objective for the sea lock of being a benefit to navigation in the Haven for

large commercial vessels and would be of no interest to the port as it would provide more dis-benefits than benefits to their operations.

15.18 In conclusion, my view is that there is sufficient evidence to conclude that a sea lock would be uneconomic and unaffordable. Furthermore, any location in the Wash designated areas or in close proximity to those designated areas would be unviable due to the impact that the sea lock and barrage would have on the designated areas.

15.19 Taking into account possible locations for a sea lock and barrage in the Haven between the entrance of the Port of Boston's wet dock and Tabs Head, I do not consider that there was a viable option when a sea lock and barrage was first considered in 1994. As nothing has substantially changed since that time, other than the degree of protection afforded to the designated sites since the option was first assessed there is still not a viable option for a sea lock and barrage.

Hold the Existing Line of Defence

15.20 In my evidence on scheme development I have assessed reasons taken at the time for ruling out the *Hold the Existing Line of Defence* approach. In summary, these were:

15.20.1 maintaining the height of the existing defences through reactive maintenance or pro-active maintenance was not seen as being a sustainable solution and did not a deliver the flood risk management objective of reducing the risk of tidal flooding in Boston;

15.20.2 the additional height required on existing defences to raise the standard of protection would have impacts that could not be mitigated in some locations sufficiently to make the option acceptable to the planning authority or community; and

15.20.3 the responsibility to maintain or improve flood risk management assets in the Haven is very complex and uncertain and would take a long time to resolve. It is possible that a resolution may never be found regarding who is legally responsible for maintenance and improvement of all of the flood risk assets in the Haven.

15.21 Due to the impacts that *Hold the Line* would have on the landscape and historic character of the town and the uncertainty and unknown cost due to the legal uncertainties surrounding asset ownership in the Haven the *Hold the Line* option was not taken forward.

15.22 When the *Hold the Line* approach was first looked at the options were either not sustainable, or did not meet the strategic objectives, or there was no clear line of sight regarding who was responsible for maintaining or improving the existing flood defences. Considering all of these factors the *Hold the Line* approach was not viable when it was first considered and as nothing has substantially changed since the option was first assessed, it is is still not a viable approach in my view.

Managed Realignment

15.23 In my evidence on scheme development I have explained why a *Managed Realignment* approach was ruled out.

15.24 When first considered, it was concluded that *Managed Realignment* would not sufficiently reduce flood risk in Boston and further, that it might have geomorphological impacts on the Haven and the Wash. Given the same consideration today it is clear that *Managed Realignment* would not sufficiently reduce flood risk in Boston. In addition concerns about the geomorphological impacts on the Haven and the Wash are nowadays far greater than they were.

15.25 *Managed Realignment* was in the past rejected on technical and environmental grounds and in my view that would remain the case today.

Advance the Existing Line of Defence

15.26 In my evidence on scheme development I have assessed reasons taken at the time for ruling out a number of *Advance the Line* approaches for a tidal barrier (or a sea lock & barrage) at a number of unviable locations.

15.27 The distinction between a tidal barrier and a barrage is:

15.27.1 a tidal barrier's primary function is to hold back extreme flood tides to help manage tidal flood risk. Tidal barriers are normally open to allow the natural tidal regime to prevail. Tidal barriers can also be used to partially include or partially exclude the tide for a number of purposes;

15.27.2 a barrage's primary function is intended to fix the tidal limit, to hold up the tide, by being closed for the majority of the time and opened only to allow fluvial flows to pass through the barrage. Barrages can also be used as a tidal barrier to help manage tidal flood risk.

15.28 As noted both types of structure can be used to manage the risk of tidal flooding. However, the manner in which they operate for the majority of the time is markedly different. A tidal barrier will let the normal tidal regime prevail unless it is being used to control water levels. A barrage will permanently alter the tidal regime unless the barrage is designed to only partially exclude the tide.

15.29 A number of parties first started thinking about the FRM benefits of a tidal barrier (or a sea lock & barrage) in the Haven in the early 1990s. While the objectives of these studies did vary they did have one common theme: they would provide a means of reducing the risk of tidal flooding in Boston.

15.30 The genesis of the tidal barrier options and locations for managing tidal flood risk were assessed and reported in the scheme development section of my evidence.

15.31 A number of possible locations in the Haven for a tidal barrier were easily ruled out because of the unacceptable impact of the tidal barrier on the environment. The remaining locations in the Haven were investigated further to see if any one location could balance the competing needs of river users, both commercial and leisure users; and the needs of FRM authorities who depend on the Haven for managing fluvial flood risk, land drainage and surface water drainage.

15.32 The studies from 2003 onwards considered the feasibility of a tidal barrier to provide protection from tidal flood risk. The strategic studies undertaken between 2003 and 2008 confirmed that it was not viable to construct a tidal barrier at the mouth of the Haven due to designated areas.

The studies also found it was not possible to construct a tidal barrier in close proximity to the designated areas due to the unacceptable impact such a major development would likely have on those designated areas. In addition these studies also found it was not possible to construct a tidal barrier upstream of the Swing Bridge due to the impacts that the tidal barrier would have on heritage and visual amenity. This narrowed down the area where a tidal barrier could be located to a zone between the Swing Bridge and just downstream of Maud Foster Sluice.

15.33 Five locations were considered for the tidal barrier in the zone between the Swing Bridge and just downstream of Maud Foster Sluice. This led to the Scheme that is now proposed with the tidal barrier located downstream of Black Sluice.

15.34 Between 2006 and 2015 a secondary objective was considered for the tidal barrier to manage water levels in the Haven to improve navigation. Due to the very complex nature of water level management (WLM) in the Haven it was not possible to agree a WLM regime that satisfied the needs of all of the river users. The navigation objective was dropped from the scheme in 2016 and the reasons for doing this are covered in more detail in section 10 of this evidence. The tidal barrier scheme remains neutral as far as WLM is concerned and is being promoted in a way that does not prejudice the introduction of a WLM regime in the future.

15.35 Working upstream from the mouth of the Haven the following locations have been considered for a tidal barrier and/or a sea lock & barrage (for clarity each location has been designated by a letter):

(a) Tabs Head (Mouth of the Haven);

(b) between Tabs Head and Cut End Cottages;

(c) between Cut End Cottages and Downstream of Hobhole Outfall;

(d) upstream of Hobhole Outfall to a distance of 2 kilometres measured from the edge of the designated areas;

(e) between a point 2 kilometres in distance from the edge of the designated areas to downstream of Maud Foster Sluice;

(f) adjacent to Maud Foster Outfall;

(g) adjacent to the Wet Dock Entrance;

(h) upstream of Wet Dock Entrance;

(i) downstream of Black Sluice Outfall;

(j) between Black Sluice and the Swing Bridge; and

(k) upstream of London Road Quay.

15.36 When alternatives have been considered the choice of locality for a tidal barrier and/or a barrage was not arbitrary but coincided with a section of the river that could be characterised in some way more generally in relation to a number of common constraints. Consideration of the impact of a tidal barrier and/or a barrage in a particular location will hold true for the whole

of the relevant section of the Haven. The following sections of the Haven can be characterised as having the same common constraints along that section of the river (for clarity each section of river has been designated by a number):

15.36.1 Tabs Head to downstream of the Hobhole Outfall (this includes locations (a), (b) & (c));

15.36.2 upstream of Hobhole Outfall to a distance of 2km measured from the edge of the Designated Areas (includes location (d));

15.36.3 from a point measuring 2km from the Designated Areas to downstream of the Wet Dock Entrance (includes locations (e), (f) and (g));

15.36.4 upstream of the Wet Dock Entrance to the Buoy Shed - (includes location (h));

15.36.5 downstream of Black Sluice Outfall to the Buoy Shed - (includes location (i)); and

15.36.6 between Black Sluice and upstream of London Road Quay - (includes location (j) & (k))

15.37 In the following sub-sections I provide my views on whether each location / section of the Haven could be an appropriate setting for a tidal barrier. I also present evidence for the selection of the preferred location / section of the Haven, which is downstream of Black Sluice Outfall and opposite to the Port of Boston Buoy Sheds.

Tabs Head (Mouth of the Haven) to Downstream of Hobhole Outfall (includes locations (a), (b) & (c))

15.38 This section of the Haven can be characterised as having the following constraints for a tidal barrier:

15.38.1 it would give rise to potential significant effects that impact upon the integrity of the Washes SPA/SAC/RAMSAR/SSSI designated sites;

15.38.2 it would result in the loss of intertidal habitats (the losses due to a barrage will be far greater than the losses due to a tidal barrier);

15.38.3 it would require construction of new access roads and upgrading of existing roads and other infrastructure that would also damage habitats outside of the river channel itself but within the wider grazing marsh;

15.38.4 it would result in increased disturbance for wildlife from noise;

15.38.5 it would require substantial off line construction and realignment of the river channel over a substantial length of the Haven to avoid an unacceptable impact on port operations during the construction stage;

15.38.6 it would impact on existing river users, both commercial and leisure during its construction phase (even if constructed off line) and would be likely to have significant impacts on the day to day business operations of the Port of Boston during and after construction;

15.38.7 it would be very expensive in comparison to other locations in the Haven and as the flood risk benefits for a tidal barrier are the same whatever the location of the tidal barrier, therefore the BCR would be low in comparison with other options for a tidal barrier;

15.38.8 use of the barrier to manage water levels would impact on existing river users, both commercial and leisure during its operational phase, therefore increasing the time it takes to transit from the Haven to the Wash and to return;

15.38.9 use of the barrier to manage water levels would impact on the ability to discharge fluvial flows and land-drainage from the River Witham, The South Forty Foot Drain (Black Sluice), and most significantly the Maud Foster Drain and Hobhole Drain.

15.38.10 use of the barrier to manage water levels would result in the partial loss of a fully tidal estuary;

15.38.11 use of the barrier to manage water levels would result in a reduction in water quality due to impoundment; and

15.38.12 use of the barrier to manage to manage water levels would require the outfall from the sewage treatment works to be extended to a position below the sea lock.

15.39 In 2010 the Port of Boston Limited explained that a tidal barrier located anywhere downstream of the Wet Dock entrance would have significant and unacceptable impacts on the day to day business operations of the Port during and after construction, which is a matter of public interest due to the economic role played by the Port.

15.40 In addition, if the tidal barrier was to be used in the future to deliver WLM aspirations in a location downstream of the Port it would lead to unacceptable navigational constraints to all commercial shipping movement.

15.41 Consent for a tidal barrier located between Tabs Head and Hobhole is highly unlikely to be given due to the fact that availability of alternative solutions (to address the Wash habitat legalisation requirements) could not be disproved, as there are other alternatives that would fulfil the key objective of providing improved flood protection to the town of Boston (i.e. the proposed Scheme). This one factor would rule out this section of the Haven for a tidal barrier as being viable. Taking on board all of the constraints for a tidal barrier in this section of the Haven this was not a viable option when it was first considered and it is still not a viable option in my view.

Upstream of Hobhole Outfall to a distance of 2km measured from the edge of the Designated Areas (includes location (d))

15.42 This section of the Haven can be characterised as having the following constraints for a tidal barrier:

15.42.1 it would give rise to potential significant effects that impact upon the integrity of the Washes SPA/SAC/RAMSAR/SSSI designated sites;

15.42.2 it would result in the loss of intertidal habitats (the losses due to a barrage would be far greater than the losses due to a tidal barrier);

15.42.3 it would require construction of new access roads and upgrading of existing roads and other infrastructure that would damage habitats outside of the river channel itself within the wider grazing marsh;

15.42.4 it would result in increased disturbance for wildlife from noise;

15.42.5 it would require substantial off line construction and realignment of the river channel over a substantial length of the Haven to avoid an unacceptable impact on port operations during the construction stage;

15.42.6 it would impact on existing river users, both commercial and leisure during its construction phase (even if constructed off line) and it would have significant impacts on the day to day business operations of the port during and after construction;

15.42.7 it would be very expensive in comparison to other locations in the Haven. As the flood risk benefits for a tidal barrier are the same whatever the location of the tidal barrier the BCR would be very low in comparison with other options for a tidal barrier.

15.43 As already stated earlier in this section, in 2010 the Port of Boston explained that a tidal barrier located anywhere downstream of the Wet Dock entrance would have significant and unacceptable impacts on the day to day business operations of the port during and after construction, which is a matter of public interest due to the economic role played by the Port.

15.44 In addition, if the tidal barrier was to be used in the future to deliver WLM aspirations, in a location downstream of the Port it would lead to unacceptable navigational constraints to all commercial shipping movement.

15.45 Consent for a tidal barrier located between Hobhole and for a distance of up to 2 kilometres from the edge of designated areas is highly unlikely to be given as availability of alternative solutions could not be disproved as there are other alternatives that would fulfil the key objective of providing improved flood protection to the town of Boston (i.e. the proposed Scheme). This one factor would rule out this section of the Haven for a tidal barrier as being viable. Taking on board all of the constraints for a tidal barrier in this section of the Haven this was not a viable option when it was first considered and it is still not a viable option in my view.

From a point measuring 2km from the Designated Areas to downstream of the Wet Dock Entrance (includes locations (e), (f) and (g))

15.46 This section of the Haven can be characterised as having the following constraints for a tidal barrier:

15.46.1 it would require substantial off line construction and realignment of the river channel over a substantial length of the Haven to avoid an unacceptable impact on port operations during the construction stage

15.46.2 it would impact on existing river users, both commercial and leisure during its construction phase (even if constructed off line) and would have significant impacts on the day to day business operations of the port during and after construction;

15.46.3 it would result in the loss of intertidal habitats (the losses due to a barrage will be far greater than the losses due to a tidal barrier);

15.46.4 it would require construction of new access roads and upgrading of existing roads and other infrastructure;

15.46.5 it would result in increased disturbance for people from noise; and

15.46.6 it would be very expensive in comparison to other locations further upstream in the Haven. As the flood risk benefits for a tidal barrier are the same whatever the location of the tidal barrier, then the BCR would be very lower in comparison with other options for a tidal barrier.

15.47 In 2010 the Port of Boston explained that a tidal barrier located anywhere downstream of the Wet Dock entrance would have significant and unacceptable impacts on the day to day business operations of the port during and after construction, which is a matter of public interest due to the economic role played by the Port.

15.48 In addition, if the tidal barrier was to be used in the future to deliver WLM aspirations in a location downstream of the Port it would lead to unacceptable navigational constraints to all commercial shipping movement.

15.49 Feedback received from the local community has demonstrated some support for a tidal barrier in this section of the Haven. This support was due to a perceived (but misplaced) view that it would offer improved flood protection over other options. Modelling has confirmed that a tidal barrier in this section of the Haven offers no additional flood protection. The Environment Agency has engaged with the local community in order to address the misplaced perception that a tidal barrier in this section of the Haven would affect their residual flood risk.

15.50 Due to reasons including the significant impacts on the day to day business operations of the port during and after construction and that a tidal barrier in this section of the Haven is very expensive in comparison to other locations further upstream in the Haven, this section of the Haven was not viable for a tidal barrier. Taking on board all of the constraints for a tidal barrier in this section of the Haven this was not a viable option when it was first considered and it is still not a viable option in my view.

15.51 In addition to the above, the impact of a tidal barrier in location (g) adjacent to the Wet Dock entrance would have a significant impact on the operation of the ports turning basin and access to the riverside quays that would affect Port operations. A tidal barrier located adjacent to the Wet Dock entrance would also restrict the Environment Agency's ability to deliver its navigation objectives at a later date due to the significant impact that WLM would have on the operation of the Port’s riverside quays. A tidal barrier adjacent to the Wet Dock Entrance is not a viable section of the Haven for a tidal barrier when it was first considered and it is still not a viable option in my view.

Upstream of Wet Dock Entrance to the Buoy Shed – (includes location (h))

15.52 This section of the Haven can be characterised as having the following constraints for a tidal barrier :

15.52.1 it would make all or a large proportion of the Port’s riverside quays inaccessible without suitable mitigation

15.53 Without suitable mitigation works to allow large commercial vessels to pass through the tidal barrier, the alternative would be to compensate the Port and those of its tenants who use the river side quays for the permanent loss of the river side quays. Either of these two options would have a negative impact on the cost of the tidal barrier making it more expensive that a barrier located downstream of Black Sluice.

15.54 The closer the tidal barrier is to the Wet Dock entrance the more this would restrict the Environment Agency's ability to deliver navigation objectives at a later date due to the significant impact that WLM would have on the operation of the Port's riverside quays.

15.55 No other constraints need assessment to reject this location in the Haven. This was not a viable section of the Haven for a tidal barrier when it was first considered and it is still not a viable option in my opinion.

Between Black Sluice and Upstream of London Road Quay - (includes location (j) & (k))

15.56 This section of the Haven can be characterised as having the following constraints for a tidal barrier :

15.56.1 it would require more flood wall raising through the town that would impact on the landscape and historic character of the town;

15.56.2 it would not be possible to meet the navigation objectives of providing a safe navigation link between the Lower Witham and South Forty Foot Drain in the future;

15.56.3 it would impact on the fishermen's quays and require all or part of the fishing fleet to be permanently relocated.

15.57 Consideration of these constraints lead to the conclusion that this was not a viable section of the Haven for a tidal barrier when it was first considered and it is still not a viable option in my view.

Downstream of Black Sluice Outfall to Buoy Shed - (includes location (i))

15.58 A tidal barrier in this section of the Haven was assessed as having the least impact on existing river users, if designed carefully with due regard to navigational safety.

15.59 A tidal barrier in this section of the Haven would affect recreational river users during construction. A suitable scheme of mitigation works has been developed in consultation with recreational river users to ensure that the proposed Scheme is acceptable to the existing river users.

15.60 A tidal barrier in this section of the Haven, would, during construction affect commercial river users who moor upstream of Grand Sluice during construction. As explained in the evidence of Gillian Watson (**EA/4/1**), navigational assessments have shown that the Boston Belle will be able to pass through the proposed cofferdam navigation channel when stemming the current, or at HW slack. However, we recommend that such vessels should not transit the cofferdam navigation channel with a following current.

15.61 The Agency has been in contact with the owners and operators of the vessel and have offered compensation. The proposed compensation would address any losses arising from the Boston

Belle being unable to navigate through the barrier construction location. It is hoped that a legal agreement can be reached with the owners and operators of the Boston Belle in the near future and the Environment Agency are continuing dialogue to this effect. This is explained further in the evidence of Richard Scriven (**EA/7/1**).

15.62 A tidal barrier in this section of the Haven would affect the operation of the Boston Fishing Fleet during construction. A suitable scheme of mitigation works has been developed in consultation with the fishermen and the Environment Agency has secured the agreement of the Port of Boston Limited to its proposal to temporarily relocate the Fishing Fleet to a new location with the Port during construction of the barrier.

15.63 A tidal barrier in this section of the Haven would affect the operation of the Port and Frontier Agriculture Limited's operations during construction and operation. A suitable scheme of mitigation works has been developed in consultation with the Port and Frontier Agriculture to ensure that the proposed scheme is acceptable to both parties. The Port of Boston Limited has now withdrawn its objections and expressed its full support for the Scheme. At the time of writing, discussions between the Environment Agency and Frontier Agriculture Limited are advanced and it is anticipated that all of their concerns will be satisfactorily addressed shortly.

15.64 In conclusion, none of the alternatives considered to reduce tidal flood risk are be viable in my opinion. The evidence to reject options to *Hold the Existing Line of Defence* and *Advance the Existing Line of Defence* is substantial and persuasive.

15.65 The evidence clearly demonstrates that only sustainable means of reducing tidal flood risk in Boston is to *Advance the Line of the Defence* through the construction of a tidal barrier. In promoting a tidal barrier in this section of the Haven the Environment Agency has sought to balance the interests of all parties and mitigate all impacts.

15.66 It can be seen from the evidence that the best location for a tidal barrier is clearly downstream of Black Sluice Outfall in the location proposed by the Environment Agency opposite the Port of Boston's Buoy Shed.

16 Commitment to Mitigation

16.1 In planning the Boston Barrier Scheme, the Environment Agency has sought to maximise the benefits of the Scheme while minimising any adverse impacts. The Environment Agency has drawn on its experience of planning and constructing flood defence schemes across the UK, principally the Ipswich Barrier scheme to ensure that wherever possible, relevant experience and lessons learnt have been applied to the Boston Barrier Scheme.

16.2 Throughout the planning process, the challenge to the Environment Agency has been to minimise the impact of the proposed barrier on land owners and river users whilst ensuring the town of Boston is at a reduced risk from future flooding.

16.3 The Environmental Statement (**A/17**) has assessed the likely impacts of the Scheme. The Environmental Statement concluded there would be no permanent major adverse residual effects. The adequacy and outcomes of the Environmental Impact Assessment is set out in more detail in the evidence of Emma Lunt (**EA/8/1**).

16.4 The approach to mitigating the impacts of the Scheme has been embedded through the design of the Scheme itself and supported through the public consultation process that has been undertaken to shape its development.

16.5 The proposed planning conditions presented in the Environment Agency's request for a direction deeming planning permission to be granted for the Scheme (**A/10**) provide further safeguards to ensure any potential adverse impacts of the Scheme are mitigated. The draft conditions put forward have been developed in consultation with Boston Borough Council, the local planning authority.

Construction mitigation plans

16.6 The Environment Agency, in delivering the Scheme, will adopt a best practice approach to construction. This means meeting the requirements of all relevant legislation, codes of practice and latest standards and seeking to limit adverse impacts on the local community, river users and the environment so far as reasonably practicable.

16.7 The Environment Agency through the proposed planning conditions will prepare a number of plans and method statements to minimise the impacts of construction works. These will include standards and procedures for managing the environmental impact of constructing the barrier, hours of working and environmental, public health and safety aspects of the project that may affect the interests of local residents, businesses and the general public. Emma Lunt's proof of evidence (**EA/8/1**) explains in more detail the conditions proposed.

16.8 During construction, the Environment Agency will control the effects of noise and vibration from within the construction sites and a draft Construction Noise and Vibration Management Plan (**CNVMP**) is to be agreed with the local planning authority as required under condition 6 of the Environment Agency's Application (**A/10**). A draft of the CNVMP has been prepared and can be found within the appendices to Max Forni's evidence (**EA/10/2**) whilst content of the CNVMP is described in more detail in his proof of evidence (**EA/10/1**).

16.9 Since submission of the application for the Order an additional condition is now proposed requiring the Environment Agency prepare a Navigational Management Plan (**NMP**) which will introduce a number of measures to support safe navigation during construction, and once the barrier is in operation. A draft of the NMP has been prepared and can be found within the appendices to the evidence of Peter Mallin (**EA/3/2**). Peter Mallin (**EA/3/1**), Gillian Watson (**EA/4/1**) and Captain McArthur (**EA/5/1**) all provide further detail on the proposed NMP in their evidence.

16.10 The Environment Agency is fully committed to the conditions proposed, to delivering the proposed construction management plans and method statements to ensure the impacts of the Scheme will be mitigated in so far as reasonably possible.

Impact on property and river users

16.11 The Environment Agency has sought to minimise the extent of land and rights acquired under the TWAO, so as to take only land and interests necessary for the construction and operation of the Barrier and associated works.

16.12 The Environment Agency has consulted widely throughout the development of the Scheme proposals and the views of the public, landowners, local interest groups and others have been

taken into consideration. Further details on the consultation undertaken by the Environment Agency can be found in the consultation report submitted with the application (**A/5**).

16.13 The proof of evidence of Richard Scriven (**EA/7/1**) sets out in detail the Environment Agency's evidence regarding the potential impacts of the Scheme on land owners and occupiers, as well as the potential impacts of the Scheme on other interested parties. In particular, Richard Scriven's proof describes where discussions have reached with land owners and others and the mitigation proposed to them.

17 Issues raised by Objectors and in Representations

17.1 I set out the Environment Agency's response to the main issues raised within the objections and representations made to the application and raised in statements of case received from third parties, in so far these issues fall within the scope of my evidence. Where issues that have been raised are not addressed below they are addressed in the proofs of other Environment Agency witnesses. The other witnesses may also comment on the same issues as I do below but from the view point of their own specialisms.

17.2 The comments received fall into general themes and to avoid repetition I have grouped the objections by these themes. My evidence expands on the Environment Agency's position as explained with the Statement of Case (**I/1**).

Alternative location of Barrier downstream from its current location or at the mouth of the Haven or upstream from its current location

17.3 The following objectors have commented that the location of the barrier should be downstream from its current location: Councillor Brown (**OBJ/7**), BDFA (**OBJ/22**), Mr Smith (**OBJ/21**), Mr Matthews (**OBJ/2**) and Mr Ransome (**OBJ/1**).

17.4 RA Brewster and Sons and Tricia B Shellfish Ltd (**OBJ/16**) state that the location should be upstream where the river is straighter.

17.5 The location of the proposed barrier has been selected following a detailed and extensive options appraisal process. Further detail on the choice of location and why an alternative location at the mouth of the Haven, downstream or upstream is not being delivered is set out in sections 9 and 15 of my evidence.

Downstream flood banks

17.6 Frampton Parish Council (**REP/1**) and Councillor Brown (**OBJ/7**) have raised questions regarding the downstream haven flood banks. I have addressed explained the position with regards to works to the earth banks downstream of the barrier in section 13 of my evidence.

Works for the Port of Boston

17.7 Captain Franklin (**OBJ/8**) and Councillor Brown (**OBJ/7**) have questioned the proposed works within the Port of Boston. These works are necessary to mitigate the impacts of the Scheme on the Port of Boston and to enable to Port to remain in operation whilst the Environment Agency constructs the Barrier and once the Barrier is in operation. The impacts of a barrier on the Port of Boston in any location have been considered as part of the options appraisal

process as can be seen in section 15 of my evidence. Further information regarding the works proposed within the Port of Boston is provided in the evidence of Peter Mallin (**EA/3/1**) and Richard Scriven (**EA/7/1**).

Provision of a lock as part of the Scheme

17.8 The inclusion of a lock has been raised by Mr Bowles (**OBJ/14**), Mr Despicht (**OBJ/15**), Mr Smith (**OBJ/21**) and Mr Booth (**OBJ/10**). I set out at section 11 of my proof why a lock is not being provided as part of the proposed Scheme.

Provision of a Sea Lock at the Mouth of the Haven

17.9 Captain Franklin (OBJ/8) argues that we should provide a sea lock at the mouth of the Haven, as considered in the 1994 Study. I have considered the possibility of a sea lock at the mouth of the Haven in sections 9 and 15 of my evidence and explain why such a proposal has not been progressed.

Future introduction of water level management

17.10 From the comments received it is clear that there are some parties who would welcome the introduction of WLM and others who would be strongly opposed to it. The Environment Agency is not delivering WLM as part of the proposed scheme but equally the Scheme has been designed so as not to preclude the future delivery of WLM. The Environment Agency's position with regards to the future delivery of WLM is set out in section 10 of my evidence.

Impact on Statutory Rights of Navigation

17.11 It has been suggested that the Environment Agency is unaware of our obligations and responsibilities in regard the maintenance of statutory rights of navigation. The Canal and Rivers Trust is the statutory navigation authority in respect of the River Witham whilst the Port of Boston holds navigation responsibilities for all vessels navigating from the Sea through to Grand Sluice. The Environment Agency is the navigation authority for the South Forty Drain upstream of Black Sluice Lock through to Donington High Bridge.

Impacts on Navigation

17.12 The proofs of evidence of Gillian Watson **(EA/4/1**), Peter Mallin (**EA/3/1**) and Captain McArthur (**EA/5/1**) address in detail the issues raised by objections regarding their concerns over navigational safety due to the location of the Barrier. As set out at section 16 of my proof the Environment Agency is committed to delivering a NMP which will introduce measures relating to safe navigation through the site of the proposed Barrier both during construction and operation of the Scheme.

Consultation and Communication

17.13 The Environment Agency in developing the Scheme has sought to balance the views of the public and others with technical assessments and environmental assessments. The consultation report (**A/5**) sets out the extensive consultation we have undertaken. Whilst it is disappointing to hear that some interested parties feel they have not been listened to, this is not the case.

17.14 The Environment Agency has, in addition to listening to people's concerns undertaken detailed modelling to identify the best Scheme. The models used have been developed over a number of years and have been tested over known events. Further information regarding the modelling undertaken and how this has demonstrated that the Scheme will reduce tidal risk is provided in the evidence of Sun Yan Evans (**EA/2/1**).

17.15 The Environment Agency continues to communicate with the public and river users to ensure the proposal are understood through newsletters and social media. Since August 2015 the Environment Agency has operated the Boston Community Hub, located on Marsh Lane, Boston, each Wednesday between 12.30pm and 7.30pm. The Hub arrangement has been established to enable members of the public and interested parties to speak to a member of the Environment Agency's team should they have any questions regarding the Scheme.

17.16 The IWA (**OBJ/24**) stated that *'at no stage of the project has EA formally consulted the IWA even though we were a statutory consultee'* In Section 4.5 of the Consultation Report it states that the IWA were provided with a copy of the draft ES. The Environment Agency did in fact receive a formal written response to this consultation. Furthermore, the Consultation Report (**A/5**) outlines other instances where the Environment Agency involved the IWA in consultation on the design development of the Scheme. I can confirm that the Environment Agency has carried out consultation during the development of the Scheme.

Impact on Boston's Fishing Fleet

17.17 The proof of evidence of Richard Scriven (**EA/7/1**) sets out in detail the current position in relation to the Boston Fishing Fleet and the mitigation proposed to them. The Environment Agency had been in detailed discussions with the Fishing Fleet for a number of years to seek to understand how best to mitigate the impacts of the Scheme on the fishermen. The proposals have developed over time to reflect the Environment Agency's developing proposals for the barrier.

17.18 As set out in the Agency's Statement of Case (**I/1**), permanent relocation of the fishing fleet was considered when the Environment Agency was looking to also deliver WLM. As the Scheme now proposes a barrier for FRM purposes only, the Environment Agency does not consider it necessary to permanently relocate the fishing fleet downstream of the proposed Barrier location.

17.19 The mitigation proposed is a reflection of detailed discussions to understand the workings of the fishing fleet and detailed technical assessments. The Environment Agency is committed to continuing discussions with the Fishermen.

Operation of the Barrier

17.20 The Environment Agency's Statement of Case (**I/1**) alongside the evidence of Peter Mallin (**EA/2/1**) describes how and when the barrier will operate. The Environment Agency will undertake regular testing of the barrier to ensure that it is fully operational when needed. The Environment Agency intends, where reasonably practicable, to schedule testing and inspection of the barrier to ensure the least disruption to river users.

Order Powers are excessive

17.21 The IWA suggests that the powers we seek under Article 7(e) of the proposed Order are excessive. This power would enable the Agency to '*direct the owner or master of any vessel or structure sunk, stranded or abandoned or moored or left (whether lawfully or not) to remove or relocate it and, if there be no person board any such vessel or structure to attend to such direction, to do so itself'.*

17.22 These powers may only be exercised in connection with the construction, maintenance and operation of the Scheme and within the Order limits. It should be noted that the Agency already enjoys similar powers[7] but that the Order would allow the Agency to take action sooner, having regard to the desirability of being able to progress construction of the Scheme.

18 Response to Statement of Matters

18.1 The Secretary of State has set out the Matters about which she particularly wishes to be informed. My evidence has address the following matters (or aspects of them):

Matter 1 The aims of, and the need for, the proposed Boston Barrier and related works ("the Scheme")

18.2 The aims of, and the need for, the Scheme are explained in sections 4 and 5 of my evidence.

Matter 2 The main alternative options considered by the Environment Agency and the reasons for choosing the proposals comprised in the Scheme

18.3 The main alternatives considered by the Environment Agency are explained in sections 9 and 15 of my evidence.

Matter 3 The justification for the particular proposals in the draft TWA Order, including the anticipated flood risk, environmental and socio-economic benefits

18.4 The benefits of the Scheme are described in section 6 of my evidence.

Matter 4 The extent to which the Scheme would be consistent with local flood risk, environmental, economic and planning policies

18.5 The Scheme's compliance with relevant policy is addressed in section 8 of my evidence and in Emma Lunt's evidence (**EA/8/1**).

Matter 5(b) The justification for the location, design and operation of the Scheme including questions over the reinforcement and maintenance of 'earth banks' running from the site of the barrier downstream

18.6 The Environment Agency's proposals with regards to the Haven flood banks are explained in section 13 of my evidence.

[7] See, for instance section 21 of the Anglian Water Authority Act 1977

Matter 5(c) The justification for the location, design and operation of the Scheme including the dismissal of a proposed 'sea lock' element of the Scheme on environmental grounds

18.7 I have explained why the Environment Agency does not consider a sea lock to be the preferred solution for the delivery of improved flood risk management in Boston in sections 9 and 15 of my evidence.

Matter 5(d) The justification for the location, design and operation of the Scheme including the omission of the 'water level management' scheme from the proposed plan at this time and why this is justified

18.8 The reason for the omission of WLM from the Scheme is explained in section 11 of my evidence, which explains that the Scheme will neither deliver nor preclude its future delivery.

Matter 7 The compatibility of the Scheme with future climate change scenarios

18.9 The regard which the Scheme has had to future climate change scenarios is explained in section 12 of my evidence.

Matter 10 The conditions proposed to be attached to the deemed planning permission for the Scheme, if given, and in particular whether those conditions satisfy the six tests referred to in Planning Practice Guidance, Use of Conditions (Section ID:21a)

18.10 The conditions we propose be attached to the deemed planning permission are mentioned in section 16 of my evidence and explained in greater detail in the evidence of Emma Lunt (**EA/8/1**).

Matter 11 Having regard to the criteria for justifying compulsory purchase orders in paragraphs 12 to 15 of the DCLG Guidance on the Compulsory Purchase process and the Crichel Down Rules for the disposal of surplus land acquired by, or under the threat of, compulsion (published on 29 October 2015)

(a) whether there is a compelling case in the public interest to justify conferring on the Environment Agency powers to compulsorily acquire and use land for the purposes of the Scheme;

(b) whether the purposes for which the compulsory purchase powers are sought are sufficient to justify interfering with the human rights of those with an interest in the land affected by (having regard to Article 1 of the First Protocol to the European Convention on Human Rights);

(c) whether there are likely to be any impediments to the Environment Agency exercising the power contained within the Order, including available of funding;

18.11 In sections 4, 5 and 6 of my evidence, I have explained the considerable need, aims and benefits of the Scheme. In my opinion there is a compelling case in the public interest for the Scheme to proceed. Richard Scriven's evidence (**EA/7/1**) explains in detail the nature and

extent of the powers being sought to compulsorily acquire and use land for the Scheme and why all of the interests sought are necessary and justified. My evidence has also explained, in section 14, that the Scheme is fully funded and I do not consider there to be any impediments to our ability to deliver the Scheme.

Matter 12 (ii) The adequacy of the current flow calculations and engineering proposals as presented with particular regard to unsuitable water level management

18.12 I have addressed water level management in section 10 of my evidence whilst Emma Lunt also considers the effects of WLM, as previously contemplated by the Agency, in her evidence (**EA/8/1**). Flow calculations for the Scheme are explained in Sun Yan Evans' evidence (**EA/2/1**).

Matter 14(d) The likely impacts of constructing and operating the scheme on the operation of businesses in the area including the wider regeneration benefits to the Boston area.

18.13 The impacts of constructing and operating the Scheme on businesses in the area is addressed in the evidence of Richard Scriven (**EA/7/1**) and Peter Mallin (**EA/3/1**). In section 16 of my evidence I have confirmed the Agency's commitment to mitigation to reduce impacts as far as reasonably practicable.

19 Conclusions

19.1 Boston and the surrounding area is at very high risk of serious, life threatening and damaging tidal flooding. The December 2013 flood event illustrated the severe impacts of flooding to the town. Flooding has historically posed a risk to Boston and is an event that is predicted to occur more frequently in the future due to climate change.

19.2 The Environment Agency is taking action to ensure the level of flood protection is increased to better protect Boston and the surrounding area from future flood events. The proposed barrier is the solution which will provide the best flood protection to Boston and local area and complies with policy, recommendations of scheme development studies and scheme appraisal guidance.

19.3 The Scheme has strong political support both at national, regional and local levels. Without exception, all those who have commented on the proposals to the Secretary State - objections and representations - accept that a barrier is necessary.

19.4 Consultation on the proposed barrier has been extensive, especially with those who are set to be affected. The Environment Agency recognises it will not be possible to address the needs of everyone and that it will never be able to entirely remove the potential impacts. However, it has sought to balance all interests and mitigate all impacts in developing the Scheme. The proposed barrier also keeps the option open for a WLM solution being introduced in the future, even though it does not form part of this Scheme.

19.5 Extensive modelling of the flood effects have been undertaken, with appropriate validation. This is explained in detail in the evidence of Sun Yan Evans (**EA/2/1**). I am confident that the proposed barrier will work and will offer the protection needed to Boston.

19.6 Whilst the Environment Agency has worked hard to try and demonstrate how the proposed barrier will work, and the level of protection it will offer, there are still some misapprehensions. For example, some still consider a location further downstream would offer a better level of flood protection. This is not correct.

19.7 There are very good substantiated reasons for locating the proposed barrier where it is currently proposed - with or without WLM. I am confident that the assessments and consultations undertaken have identified the correct location for the proposed barrier. Downstream locations would have greater costs and greater environmental impacts than the proposed location. Downstream locations would prejudice the operations of the Port of Boston, who are directly (and indirectly through the businesses they support) a key contributor to Boston's economy.

19.8 For other rivers users, concerns remain over the impacts on them during the construction and operation of the proposed barrier. The barrier proposal has undergone numerous detailed assessments to identify what the potential effects will be. It is recognised that there will be some effects on navigation. The NIA (**A/17/2C**) reported these effects and mitigation measures that the Environment Agency proposes be employed to address them.

19.9 The Environment Agency recognises that third parties have raised concerns about the effects of the barrier on navigation. We have developed a draft Navigational Management Plan to document and commit to the mitigation measures we propose be implemented. The proposals are explained in the evidence of Gillian Watson (**EA/4/1**) and Peter Mallin (**EA/2/1**). We have proposed a new planning condition to give effect to the provisions of the NMP.

19.10 The Environment Agency considers any residual effects to be not substantial and to be acceptable in light of the greater good of delivering improved flood protection for Boston. The Environment Agency considers that the public interest in flood protection outweighs those residual effects.

19.11 There is a compelling case in the public interest to construct the barrier. It is necessary to interfere with land and navigation rights to construct and operate the proposed barrier. For those with interests in land that maybe impacted by the proposed Scheme, compensation can be claimed under the compensation code. This is explained further in the evidence of Richard Scriven (**EA/7/1**).

19.12 In final conclusion, Boston and the surrounding area are at a high risk of tidal flooding and this risk will be addressed by the Scheme. The scheme will directly benefit 17,269 homes and 582 commercial properties. The Scheme has been developed in accordance with policy, appraisal guidance and following extensive consultation. The Environment Agency is confident a barrier is the right solution, confident the right location has been selected for the barrier and confident that appropriate mitigation, or compensation, is in place for residual effects.

20 Statement of Truth

I hereby declare as follows:

20.1 Insofar as the facts stated in this Proof of Evidence are within my own knowledge I believe them to be true, and that the opinions I have expressed represent my true and complete professional opinion.

20.2 This Proof of Evidence includes all facts which I regard as being relevant to the opinions which I have expressed and that I have drawn the inquiry's attention to any matter which would affect the validity of those opinions.

20.3 I understand that my duty to the Inquiry is to help it to help it with matters within my expertise and I have complied with that duty.