ADAPTING TO COASTAL FLOODING in the YARMOUTH AREA in the 21st CENTURY

A Report by Yarmouth Coastal Defence Working Group

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SUMMARY

Much of the town of Yarmouth and the surrounding area lie only a couple of metres above mean sea level. Every twenty years or so the coincidence of a Storm Surge with a high Spring Tide brings the sea over the harbour wall and causes flooding. To date the effects of such flooding have been minor but, with sea level predicted to rise at increasing rates in the coming century, flooding will become more serious and more frequent.

This Report, prepared by a local working group, assesses the increasing impact that flooding is likely to have as the 21st Century progresses. It outlines the scientific basis for concern and attempts to identify the local assets at risk from flooding. Possible options for coastal defence in the future are suggested and approximate costs are estimated. At this stage no particular expenditure is advocated. Competition for funding will be intense for both Yarmouth within the Isle of Wight Council‟s strategy and for the Island within the national context. Ongoing research into rising sea levels will clarify the situation and determine what and when specific coastal defence projects will be required.

The purpose of the Report is to raise the issues for discussion with policy makers and the local community. Without action, it is possible that Yarmouth and the West Wight could become two separate islands by 2100.

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Section 1 THE WORKING GROUP

The Island context

The responsibility for management of the coastal defences against erosion and flooding is shared between the Environment Agency and the local Coast Protection Authority [the Isle of Wight Council (IWC)] and the frontage owner. A crucial tool is the preparation of Shoreline Management Plans (SMPs) around the English and Welsh coasts. The Island"s first SMP was published in 1997, with its vision for 50 years, and is now being revised and looking as far as 100 years ahead (SMP2).

The SMP provides the framework for managing coastal flooding and erosion risks along the coastline and estuaries, setting out the policy for coastal defence where defence is appropriate. Strategy Studies provide a more detailed assessment of particular parts of the coastline in order to identify the most suitable type of coastal defence options and schemes. Although most of the Island"s Strategy Studies were completed by 2007, the funds (from the Department for Environment, Food and Rural Affairs) ran out before the West Wight Coastal Defence Strategy Study (WWCDSS) was completed. The coastal consultancy, Atkins, had completed an appraisal for Yarmouth as part of the WWCDSS (see Section V & Appendix B).

Both the Harbour Commissioners and the Town Council tried separately to express concern to the relevant authorities that the WWCDSS should be completed as this covers an important part of the Island"s coastline. However, frustration with the lack of progress led to the setting up of a joint Working Group in 2008 to demonstrate local unity and to channel concern more effectively. The present composition of the Working Group is 2 Yarmouth Harbour Commissioners (one of whom is a geophysicist who has specialised in oceanographic sciences), 3 Yarmouth Town Council representatives, 1 Freshwater Parish Council representative, the West Wight County Councillor, the Estuaries Officer, an environmentalist who also provides the Group"s liaison with Shalfleet Parish Council, and liaison is also made with Totland Parish Council.

The publication of the Working Group"s Report is timely, as the SMP2 draft for the Island was submitted to public consultation from July – October 2010, with its final publication in December. The SMP2 consultation suggested a preferred policy for each length of coast and it requested a response to the proposed policy from the community and from relevant organisations. The policy options used in the SMP2 are:

- ***No active intervention*** (do nothing) –meaning no investment from government funding will be made in coastal defences other than for safety purposes.
- ***Hold the existing line*** –which means the coast protection authority or the landowner can keep the line of defence as it is by maintaining existing defences or changing the standard of protection.
- ***Advance the line*** –involves building new defences on the seaward side of existing defences.
- ***Managed realignment*** –allows natural physical processes to act on a stretch of shoreline by the removal of existing defences altogether or moving them to higher ground.

Local concern about extreme flooding events generated by storm surges and predicted sea level rise (see Section 2)

The most recent dramatic events occurred 16 & 17 December 1989 and on 10 March 2008. There is very little recorded about 1989 but the 2008 event alerted local people and evidence of their concern was shown in responses to the Yarmouth & Thorley Community Plan survey

(2009), in which 310 out of 399 adults said they were concerned about the coastal flooding of Yarmouth.
In the 2008 incident flooding reached Yarmouth Square. The prediction is that the flooding in the Square could be to a height of 0.6m (2 ft) in 2050 and then 1.2m (4 ft) in 2100, seriously affecting the adjoining streets and properties.

The Report's parameters and approach

The Area

Yarmouth, Bouldnor to Port la Salle, Westhill Lane (north end) and Fort Victoria, the Estuary to the Causeway, Thorley Brook and Barnfields Stream. Freshwater Bay is also considered as its defences will impact on the Estuary and Yarmouth.

The importance of Yarmouth to the Island

- Yarmouth is one of four Gateways to the Island and contains important transport routes, making it vital for West Wight and the Island.
- Within the Island Plan Yarmouth is a Rural Service Centre for a wide area, serving important small centres of population.
- The Western Yar Estuary has a significant biodiversity with many national / international environmental designations
- Yarmouth is a diverse Tourist centre
- Yarmouth Harbour is a refuge for vessels, an access point for emergency services to shipping, and a support to marine commercial and recreational activity.
- Yarmouth is an ancient town with many heritage sites and a vibrant community.

Approach and timescale

- **An integrated, holistic approach**. The Group is aware of the importance for Yarmouth of sea defences, or lack of them, at Freshwater Bay, the coast from Yarmouth to Fort Victoria, and Bouldnor to Port la Salle. This holistic approach also extends to neighbouring coastlines and properties beyond these which may be affected by new defences at Yarmouth and vice versa.
  Human activity, such as the construction of harbour walls and groynes, affects the natural movement of sediment (mud, sand, shingle and stones) around the coastline and can result in significant changes to neighbouring areas.
- **Sustainable development and a phased approach**. The Group recognises the challenge of ensuring a sustainable coastal development, i.e. to meet the needs of the present without compromising those of future generations. This is linked to a strategy of a phased programme, quite apart from the constraints of financial resources making this a necessity.

- **Understanding coastal processes**
  Existing coastal defence schemes often shape our view of the coast, our activities and local planning policy. In the past some large scale „hard engineered" structures were seen as the only answer to coastal defence problems. Unfortunately these were often designed without a full understanding of the local coastal processes and the impact the structure would have on neighbouring areas of coast. Some have also proved to be extremely expensive to maintain and unsustainable in the long term due to their position in a changing coastline.

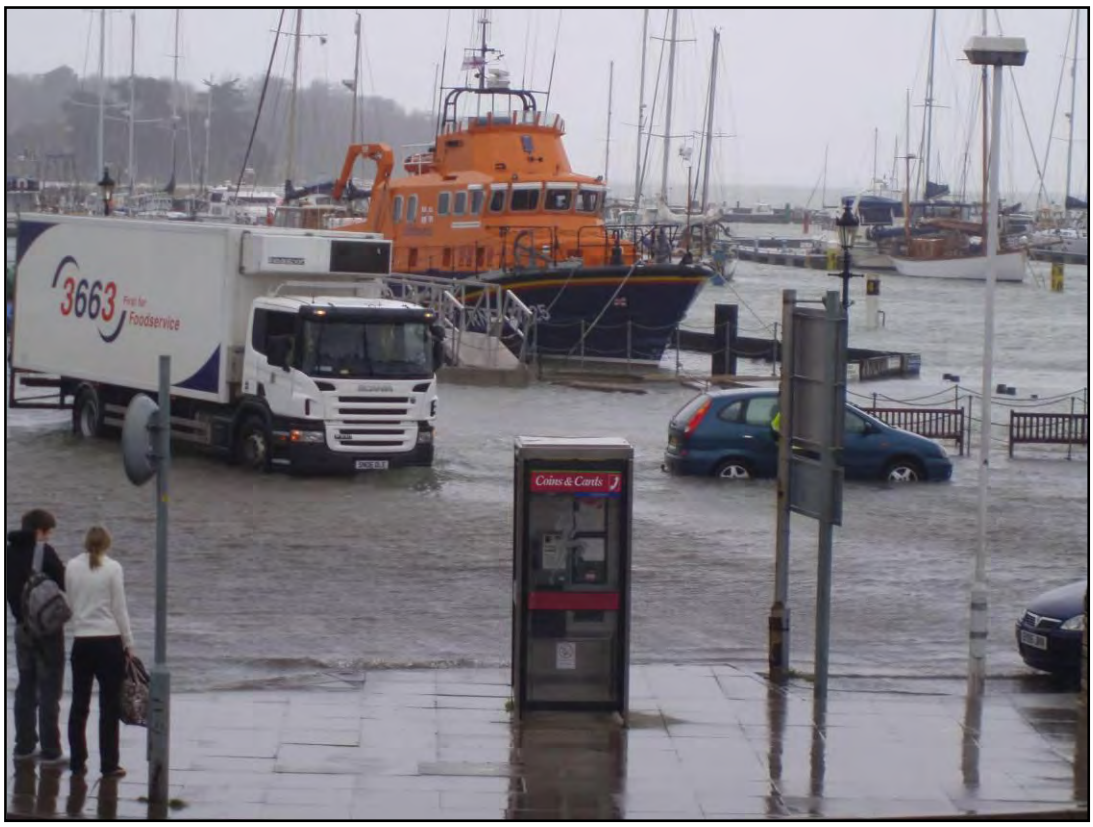
  Greater understanding of the coastal environment has led to a range of coastal defence methods being adopted that suit the conditions of the area, take into account predicted sea level rise and identify the impact of defence schemes on the neighbouring coastline and coastal biodiversity. Alternative methods to hard engineered structures include

management realignment and the enhancement of coastal habitats such as saltmarsh which acts as a buffer and reduces the impact of wind and waves.
Proposed coastal defence schemes have to fit with local planning policy and would be extensively modelled and assessed to understand the implications of their development. Greater awareness of the coastal processes allows schemes to be developed over a longer period of time, giving the environment and local communities time to adapt and ensuring that defences are not over- or under- engineered based on current predictions for sea level rise.

Despite Yarmouth"s historic, present day and environmental importance it is unlikely that a new, large scale offshore structure would be acceptable in terms of cost, impact on the surrounding coastline and sustainability. It is more likely that existing defences will be improved and maintained to help protect the town and that the local communities will continue to be encouraged to prepare themselves for the exceptional flood events that will occur in future.

Fluvial flooding is outside the scope of this Report which covers coastal flooding in the Yarmouth area. It is recognised however that fluvial flooding will have an impact in some parts of the area covered by this Report.

- **Timescale**
  The Report looks at the issues and proposes solutions in terms of phased action by 2020 / by 2050 / by 2100, i.e. planning for the short, medium and long term.



Section 2 THE SCIENTIFIC BASIS FOR CONCERN

Introduction

Sea level fluctuates at a range of different frequencies. Everyone is familiar with waves and with the rise and fall of the tides; many people are also aware of the effects of atmospheric pressure and of the wind in producing extremely high (or low) tides. In extreme cases, storm surges[1] can cause great devastation, such as that which hit the southern North Sea on 31st January – 1st February 1953, when more than 2,000 people were drowned in The Netherlands and southeast England. On a smaller scale, storm surges are almost always present, causing the observed tidal elevations to deviate from their astronomically predicted heights.

On longer time scales sea level has changed even more dramatically. During ice ages sea level falls because water is transferred from the oceans to ice caps and glaciers on land. Since the last glacial maximum (20,000 years ago), sea level has risen about 120 metres as the ice melted. For the last few thousand years global sea level has been fairly constant. The earth also has a "memory" of past events. The formation of an ice cap 2 or 3 km thick depresses the earth"s surface beneath it. When the ice cap melts, the earth"s surface rises back to its unloaded level over a period of several thousand years. This glacial isostatic adjustment is still taking place, even though the last ice sheet covering Scotland and northern England disappeared some 10,000 years ago. So Scotland and northern England are now experiencing uplift whilst southern England is subsiding. In broad brush terms London is sinking at about 1 mm/year, whilst Edinburgh is rising at about 1 mm/year.

The current interest in sea level rise is driven by the concern with global warming and climate change due to the increasing emissions of CO_2 into the atmosphere. On a warming earth one would expect sea level to rise for two main reasons: (1) the seawater is heating up and undergoing thermal expansion; (2) more fresh water is being added to the oceans due to the melting of glaciers and ice caps on land. The melting and retreat of glaciers has been well documented for two centuries.

Storm Surges

On 10th March 2008, Yarmouth experienced a storm surge which led to the high spring tide predicted for just after midday being exceeded by 1.1 m (predicted height 3.0 m; observed height 4.1 m). The water rose above the harbour wall, covered the bus station car park, reached the Square, but did not go very far up the High Street (Figures 1 & 2). The beer cellars of The King"s Head pub were flooded and the ferry terminal"s computers were put out of action because their power sockets were too close to the floor. There was no damage to any of the moorings. None of the pontoons broke loose, so whoever made the decisions about how much freeboard the piles should have had allowed enough for this exigency. Long term residents of Yarmouth could remember previous high tides topping the harbour wall but were somewhat vague about when they occurred. It seems that such an event occurs about every twenty years.

Yarmouth Harbour did not have an operational tide gauge at the time, but the UK National Tide Gauge Network operates Class A tide gauges at Bournemouth and Portsmouth, whose data is accessible over the internet. The storm surge about noon on 10th March 2008 is clearly visible on these records (Figures 3 & 4).

[1] Technical terms are defined in the Glossary at the end of this Section (Page 13)

Figure 1. View from the Harbour Office, 10th March 2008.
(Photo courtesy of Yarmouth Harbour Commissioners)

Figure 2. Where's the harbour wall?
(Photo courtesy of Yarmouth Harbour Commissioners)

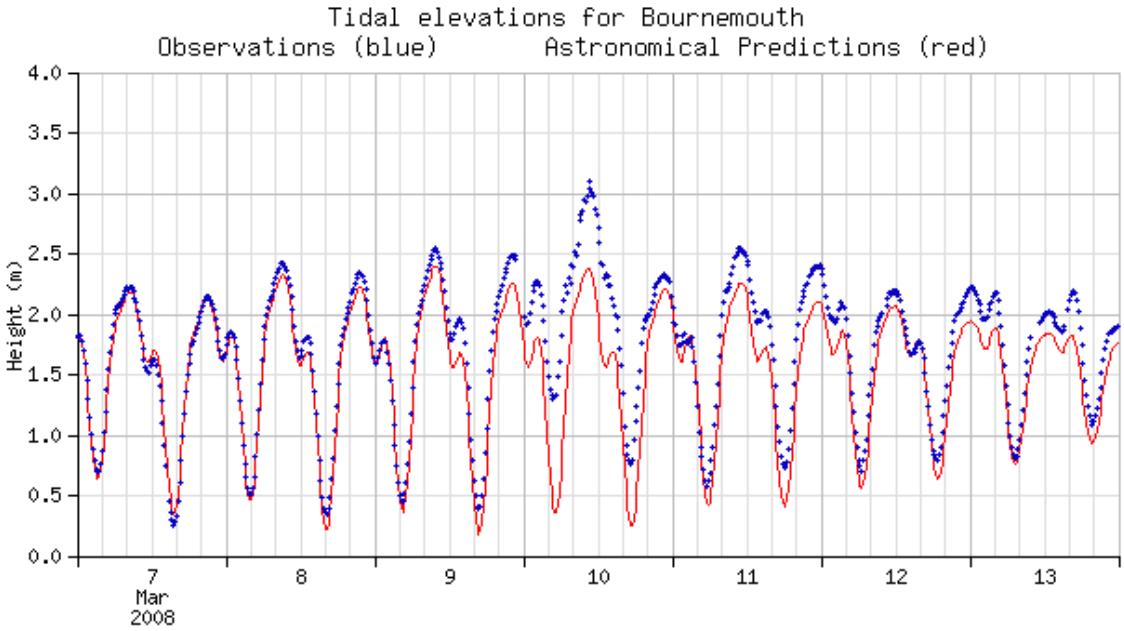


Figure 3. Tidal elevations for Bournemouth for 7th – 13th March 2008 showing a storm surge increment of 0.7m to the high tide which occurred about noon on 10th March. Note that the storm surge continues for several days.
(From http://www.pol.ac.uk/ntslf/networks.html)

At both Bournemouth and Portsmouth the storm surge increment to the astronomical tidal elevation was 0.7 m. Dr Neil Wells, Senior Lecturer in Physical Oceanography and Meteorology at the University of Southampton, reported that the surge reached 0.9 m at Dockhead, Southampton. He also explained that the cause of the high water levels was the coincidence of a very deep depression (central pressure of 965 mb) and extremely high winds in the English Channel with high spring tides. He said that the coincidence of these three factors is unusual, but not without precedence. It is worth noting that the height of the storm surge at Yarmouth was higher than that at Bournemouth, Portsmouth or Southampton. The geographical extent of the storm surge was quite large – it can be seen on the tide gauge records for Plymouth, Weymouth, Newhaven and St Helier. But it appears to have reached its greatest elevation in The Solent.

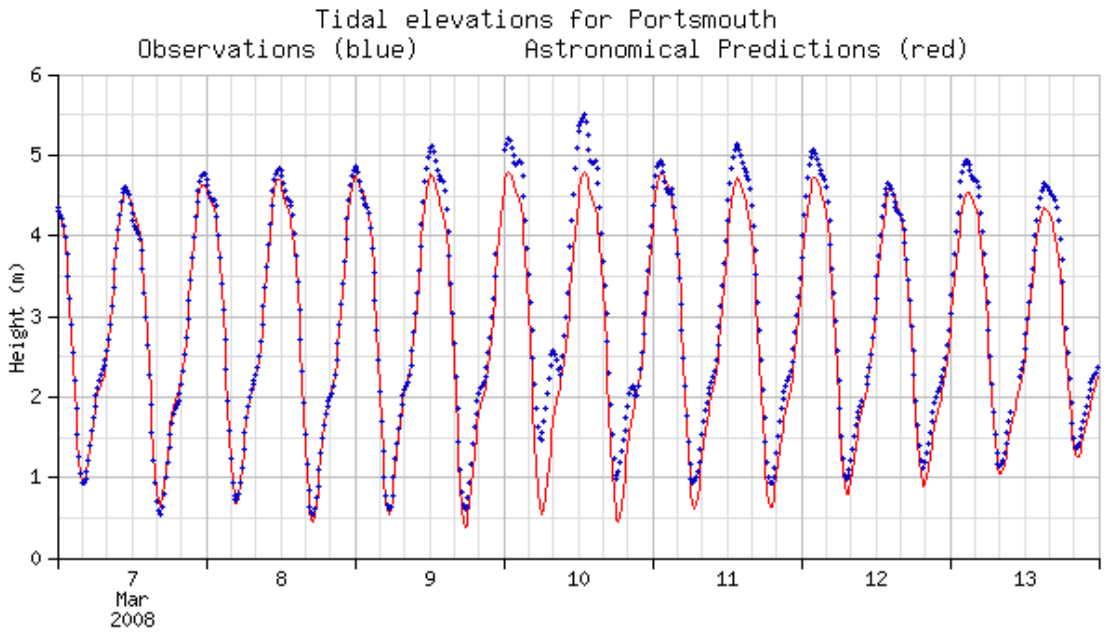


Figure 4. Tidal elevations for Portsmouth for 7th – 13th March 2008 showing a storm surge increment of 0.7m to the high tide which occurred about noon on 10th March.
(From http://www.pol.ac.uk/ntslf/networks.html)

It should be noted that higher storm surges have been observed at Bournemouth, Southampton and Portsmouth than those experienced on 10th March 2008 (Table 1). This may imply that storm surges higher than 1.1 m are possible at Yarmouth. On the other hand, the sequence of meteorological conditions preceding the 10th March 2008 event may have been optimum for maximizing the surge at Yarmouth. In the absence of further information, for the remainder of this discussion it is assumed that the maximum storm surge that Yarmouth will experience through the 21st century will be 1.1 m, a conservative assumption which may be an underestimate.

Place	Height of Storm Surge on 10th March 2008	Maximum observed Storm Surge
Bournemouth	0.7 m	0.98 m[1]
Yarmouth, Isle of Wight	1.1 m	n/a
Southampton	0.9 m	1.45 m[2]
Portsmouth	0.7 m	1.12 m[1]

Table 1. Storm surges observed at Yarmouth and three nearby places.
[1] Data from NTSLF website: http://www.pol.ac.uk/ntslf/networks.html
[2] Personal communication from Ivan Haigh (University of Southampton) 2008.

Rising Sea Level

The best available measurement for the rate at which sea level is rising at Yarmouth at the present time is that obtained from tide gauge data recorded at Portsmouth over the period 1962-2005, which is 1.58 ± 0.44 mm/year [Woodworth et al., 2008]. Portsmouth is the nearest location to Yarmouth for which good quality tide gauge records exist. [The tide gauge at Bournemouth has only been in operation since 1996, too short a period to allow a good determination of the rate of sea level rise.] If this rate of sea level rise persisted over the century, sea level would rise by only 14.2 cm between the present (2010) and 2100. But analyses of land-based tide gauge data, satellite observations of sea level, and modelling, all indicate that the rate of sea level rise is accelerating, so that a linear extrapolation of the Portsmouth data is not a sensible way to predict sea level at Yarmouth through the 21st century.

The Fourth Assessment Report of the IPCC (2007) considers that sea level rise to the end of the century will be in the range 0.18 to 0.59 metres. However, even this prediction is now believed to be an underestimate. At an international scientific conference held in Copenhagen in March 2009, leading experts on sea level rise announced that the IPCC had seriously underestimated the problem. Due to increased understanding of how the land-based ice sheets in Greenland and Antarctica are melting, it is now thought that sea level will rise twice as fast as the IPCC (2007) report predicted. In November 2009, a report entitled "Antarctic Climate Change and the Environment" was published by the Scientific Committee on Antarctic Research, accompanied by the prediction that sea level would rise by up to 1.4 m by 2100. In the face of these rapidly changing and ever more pessimistic announcements, one cannot do better at the moment than to use the DEFRA guidance published in October 2006, already much more pessimistic about sea level rise than the IPCC (2007) report though not as pessimistic as the most recent scientific report. The DEFRA Flood and Coastal Defence Project Appraisal Guidance (FCDPAG3) includes the following rates of sea level rise for Eastern and Southeastern England, in which Yarmouth lies:

1990-2025	2025-2055	2055-2085	2085-2115
4.0 mm/yr	8.5 mm/yr	12.0 mm/yr	15.0 mm/yr

Table 2. Net sea level rise allowances recommended by DEFRA
http://www.defra.gov.uk/environment/flooding/documents/policy/guidance/fcdpag/fcd3climate.pdf

Using these sea level allowances for Yarmouth, the rise in sea level will be:

From 2010 to 2050	0.27 metres
From 2010 to 2100	0.90 metres

Astronomically Predicted Tides

The highest astronomically-generated tide (HAT) experienced at Yarmouth at the present time is 3.1 m above Chart Datum (Yarmouth Harbour Visitors" Guide, 2010/11). This figure will not remain constant throughout the 21st century but, because of known perturbations in the motions of the Moon about the Earth and of the Earth about the Sun, will fluctuate by a few per cent through the century. The next predicted maximum in the highest astronomical tide will occur in 2015. Nevertheless, for simplicity the HAT is assumed to be constant at 3.1 m through the century.

Flooding from the Sea in Yarmouth

The height of sea level in Yarmouth at any time is the sum of the three components discussed above:

SL = AGT + SS + SLR

Where: AGT = Astronomically Generated Tide
SS = Storm Surge
SLR = Sea Level Rise, increasing through the century

Hence the flooding, which will be worst at the highest Spring Tides, will be:

Year	Highest Astronomical Tide	Maximum Storm Surge	Sea Level Rise	Maximum Sea Level Height
2050	3.1 m	1.1 m	0.3 m	4.5 m
2100	3.1 m	1.1 m	0.9 m	5.1 m

Table 3. Prediction of maximum sea level height above Chart Datum at high water for a high Spring Tide.

The experience of 10th March 2008 showed that the sea is level with the top of the harbour wall when its height reaches about 3.9 m above Chart Datum. Hence by 2050 we can expect the sea to top the harbour wall by 0.6 m (2 ft) and in 2100 by 1.2 m (3 ft 11 in). Even without any storm surge, by 2100 the combination of a high spring tide and sea level rise will result in the sea just topping the harbour wall.

Furthermore, flooding will not be confined to high Spring Tides. Even at Neap Tides, in the presence of a major storm surge flooding will begin to occur at high water by 2050, getting progressively worse from then on:

Year	Height of High Tide	Maximum Storm Surge	Sea Level Rise	Maximum Sea Level Height
2050	2.6 m	1.1 m	0.3 m	4.0 m
2100	2.6 m	1.1 m	0.9 m	4.6 m

Table 4. Prediction of maximum sea level height above Chart Datum for a typical high water Neap Tide.

Conclusions

Due to rising sea levels the impact of storm surges in causing floods at Yarmouth will become ever more severe as the century progresses. In the presence of a major storm surge, flooding will be episodic – occurring around high water. Early on in the century it will only be associated with Spring Tides, but as the century progresses it will happen at Neap Tides as well. By 2100, the combination of a high Spring Tide and sea level rise alone, i.e. without a storm surge, will result in the sea just topping the harbour wall.

Glossary

Ordnance Datum Land surveyors mapping the land surface throughout the UK quote all heights relative to the Ordnance Datum (OD). This is defined as the mean sea level at Newlyn, and is a constant used across the whole of the UK.

Chart Datum Marine surveyors making nautical charts and calculating tidal elevations quote all depths and heights relative to the Chart Datum (CD). CD is the lowest height to which the sea can be expected to fall due to astronomical effects. It varies around the UK. At Portsmouth, for example, CD is 2.7m below OD; at Bournemouth it is 1.4m below OD. At Yarmouth, Isle of Wight the Chart Datum is 2.0 m below the Ordnance Datum.

Spring Tides & Neap Tides Sea level rises and falls as a result of the Earth's rotation and of the gravitational forces exerted by the Moon and the Sun. Consecutive high tides (or low tides) occur at intervals of about 12½ hours. The lunar tide-generating force is about twice the solar tide-generating force. The highest tides, Spring Tides, occur when the gravitational forces of the Moon and Sun are working together, which happens near New Moon and Full Moon. At the times of the first quarter and last quarter of the Moon, the Moon and Sun are not pulling together and the heights of the tides are less – these are Neap Tides.

Storm Surge When the atmosphere is quiet, the tides can be accurately predicted from the gravitational effects of the Moon and the Sun. In reality fluctuating winds and changes in the atmospheric pressure modulate the tide. Generally these meteorological effects are minor, but a deep depression and strong winds can force sea level well above its astronomically-predicted height. Such a phenomenon is known as a storm surge. Positive storm surges are obviously more serious because of their potential to cause flooding, but negative storm surges with reduced sea level also occur.

Section 3 LOCAL ASSETS AT RISK

Apart from the real concern of counting what assets could be lost by coastal flooding, this exercise is vital for the achievement of funding. The competition for funding from central government is likely to remain intense. Although the amount spent has more than doubled in the last 10 years, it is impossible to predict future spending in the present financial climate. Allocations are handled nationally and priority is given to schemes protecting large numbers of houses and where significant damage will be caused by flooding and erosion to both man-made and natural features. See Section IV for more detail on funding.

Buildings and Businesses

The data

The valley of the Western River Yar runs from to Freshwater Bay to Yarmouth. The data given in this section is therefore related to that "valley" and adjoining areas: Yarmouth, Bouldnor to Port la Salle, Western Yar Estuary to Freshwater Bay, and Yarmouth to Fort Victoria coastal strip.
Estimates are based on the Environment Agency maps for Flood Warning Area for Yarmouth & west Bouldnor 100026380 (2009), and as shown in the Atkins (consultants) report of 2006 for Freshwater Parish areas.

- Number of residential properties at risk: **411**.
- Number of Listed Buildings at risk: **49** (including 16th Century Yarmouth Castle)
- Much of Yarmouth Conservation Area
- Freshwater Bay Conservation Area
- Number of Local Listed Buildings/Sites at risk: **4**.
- Businesses at risk: **97**.
- Educational / Social buildings at risk: **7**.

Infrastructure

Roads

i) **Yarmouth would become an island** as all roads linking Yarmouth to the rest of the Island would be lost.

- Main Roads at risk:
  A3054 from north end Halletts Shute to W. Yar Bridge
  from W. Yar Bridge to Tennyson Road (just east of Mill Road turning)
  from The Common to Port la Salle
- B3401 at risk from Rofford House to Thorley Manor

ii) **Freshwater and Totland peninsula would become an island** from the effect of loss of all roads/bridges across the flooded Western Yar to Freshwater Bay:

- Yarmouth Swing Bridge over the Western Yar
- Causeway over the Western Yar
- A3055 from a point west of Afton Manor to School Green, Freshwater.
- Black Bridge across Afton Marsh
- At Freshwater Bay: minor road & A3055 road linking Freshwater Bay to Military Road

iii) **Yarmouth:** minor roads in the west and north parts of the town would be lost.

iv) **The Military Road** has suffered greatly from coastal erosion for many years and is threatened with closure near Brook as this Report is being written. If that happens

and if the Bouldnor Road is breached or damaged by flooding, the implications for road links to West Wight would be very serious.

Other infrastructure features in Yarmouth

- Ferry service to mainland
- Ferry Linkspan & Marshalling Area
- The Harbour and facilities
- Bus & Coach Station
- Car Parks: River Road, Market & Pier Squares, the Common.
- The Fire Station
- Yarmouth Lifeboat Station
- Beaches: Norton Spit, Pier Shore.

Other infrastructure features in relevant Freshwater Parish area

- Freshwater Bay car park
- Freshwater Lifeboat Station
- Afton Road Civic Amenities site
- Afton Marsh nature reserve
- Beaches: Freshwater Bay, Fort Victoria.

Utilities

- Fresh water pipes
- Sewerage pipes
- Sewerage pumping station at Norton for pumping to Sandown
- Electricity supplies, substations, and booster stations.
- Telephone services
- Gas supplies and the main supply from Yarmouth - Freshwater is buried in the old railway line route alongside the river, which is at risk of being submerged by coastal flood for more than half its length.

Water Flow Management:

Sluices and tide flaps.

- Freshwater Causeway Bridge: double set under north wall of bridge.
- Barnfields Stream/Western Yar junction: one under east side of bridge on old railway line route.
- The Mill - Thorley Brook/Western Yar junction: double set in sea wall side of path.
- River Yar Boatyard: one in sea wall adjacent to the flagpole
- Old Station: double set in retaining wall.

Natural Environment Assets

The area covered by this Report is within the Isle of Wight"s Area of Outstanding Natural Beauty and is highly valued with tidal waters, mudflats, saltmarsh, wetlands, farmland and woodland all providing important habitats for wildlife. The assets within the area at risk of flooding include these natural habitats and wildlife which are designated under national and international law. The international designations must be taken into account when considering coastal defence options and the impact of the policies within the Shoreline Management Plan 2 will be assessed under a „Habitats Regulations Assessment".

If coastal habitats are able to develop further inland as sea level gradually increases then there is often a general change in the landscape to accommodate this. However this movement can be prevented by natural and man-made barriers such as topography or engineered structures leading to a loss of habitat through a process of coastal squeeze. Around the Western Yar there may be a need to allow the migration of habitats through managed realignment such as allowing tidal waters through the embankments and tidal flaps.

All the designated sites in the area are also considered under planning regulations and bring some form of responsibility whether to the landowner, the Isle of Wight Council or national authorities such as Natural England and the Environment Agency. All public bodies now also have a statutory duty to maintain biodiversity.

The following designations for nature conservation are all within the area considered to be at risk from coastal flooding.

Internationally important areas

Solent European Marine Sites

Yarmouth Harbour and the Western Yar estuary, including Thorley Brook and Barnfields Stream, are part of a network of important coastal sites throughout the Solent that support the movement of wildlife and the interaction of different coastal processes. These areas are internationally important as they are excellent examples of coastal habitats within Europe and support the migration routes of birds across the world. The following three designations form part of the larger Solent site:

- ***Special Area of Conservation (SAC)*** - Areas of open water and land of international importance designated under the EC Habitats Directive for the conservation of natural habitats and wild fauna and flora which are considered rare or endangered on a European scale and are recognised as being under particular threat.

- ***Special Protection Area (SPA)*** - Areas of land and wetland of international importance classified under the EC Birds Directive to conserve the habitats of rare and migratory wild birds.

- ***Ramsar site*** - Sites identified by the signatory states to the International Convention at Ramsar, Iran in 1971, for the protection of internationally important wetlands and wildfowl habitats.

The three designations together are often referred to as the „Solent European Marine Sites" and a management scheme is in place that monitors and regulates many of the activities that occur within it.

Nationally important areas

Sites of Special Scientific Interest (SSSI): **Yar Estuary SSSI**
Freshwater Marshes SSSI

These sites are designated by Natural England under the Wildlife & Countryside Acts as the best examples of the UK's flora, fauna, geological features or landforms. The aim of the site is to maintain the present diversity of animals and plants. For biological sites the designation is based on an established set of criteria that include naturalness, diversity, size, fragility and rarity.

Locally important areas

Local Nature Reserves: **Afton Marsh Local Nature Reserve**

Local Nature Reserves (LNRs) are for both people and wildlife. They are places with wildlife or geological features that are of special interest locally, which give people special opportunities to study and learn about them or simply enjoy and have contact with nature.

Sites of Importance for Nature Conservation (SINCs) are non-statutory local sites designated for conservation, maintenance and enhancement of species and habitats of particular local nature conservation value in the area.

Section 4 FUNDING and LEGISLATIVE CONSTRAINTS

There are a number of constraints on flood defence, mostly contained in legislation of one sort or another. However perhaps the biggest constraint that the present and future generations will have to face is quite simply “cost”. It is particularly unlikely that there will be sufficient public funds to defend all the buildings, facilities and land that we would wish. Private landowners will have to use their own funds to protect their land as little or no public funds are likely to be made available for them. Future coastal defence work may need to involve an element of private funding in partnership with the increasingly limited public funding.

Money

Public funds for flood defence from the sea are held exclusively in 2010 by the Environment Agency, part of central UK government. No funds are available locally or are held by the Isle of Wight Council (IWC). For flood defence to be considered for public funding a process has to be followed with the Environment Agency.

The local authority, in our case the IWC, has produced a Shoreline Management Plan (2) for the whole of the Isle of Wight including the estuaries and this is due to be submitted to central government (i.e. Environment Agency) no later than the end of December 2010. The SMP 2 is by its very nature “broad brush”; it deals with large areas and takes a holistic view. It divides the Island"s coastline into seven areas. It does not, however, take into account the Shoreline Management Plans for the North Solent coast, Hampshire, Dorset and Sussex. Once SMP 2 is approved by the Environment Agency the IWC along with the Environment Agency can work on a more detailed strategy for the West Wight. No money for coastal defence can be allocated until SMP 2 is approved, and is doubtful until the strategy for this area is complete. Even then areas requiring coastal defence expenditure will be in competition nationally. So, realistically, investment in coastal defence for Yarmouth, Freshwater and the Western Yar estuary is, in 2010, several years away and will require serious debate and justification.

It is important not to overlook public amenities and utilities such as roads, railway lines, harbours, water mains, sewage pipes, electricity lines, gas pipes; all of which will require significant investment by local authorities, utility companies and harbour authorities, in order that they may be protected.

Constraints Ashore

Any works for flood defence above Mean Low Water (MLW) will require planning permission from the IWC. In addition much of the centre of Yarmouth lies within a Conservation Area and will therefore require the consent of the Conservation Officer in the IWC. There will also need to be an interesting debate about listed buildings which may be under threat from sea level rise.
Around the Western Yar a number of the environmental designations extend ashore above MLW, notably the Area of Outstanding Natural Beauty (AONB) which will also place some limits on what may be allowed for coastal defence.

Constraints on the Water

There is a whole host of legislation about development on/in the water notably :-

- Habitats Directive
- Food and Environment Protection Act (FEPA) licence
- Coastal Protection Act (CPA) licence

- Marine and Coastal Access Act
- Land Drainage
- Water Quality Directive
- Shellfish Directive
- Environmental Designations mentioned elsewhere in this Report, but including, SSSI, AONB, SPA, SAC, Ramsar etc
- Protected Fishing Areas and Spawning Grounds
- Areas protected for particular plants or wildlife

So there is a wide range of factors to be considered before deciding what will and what will not be protected. Not all decisions may seem logical. Even in the lists above there are bound to be some conflicting directives and/or laws. The process of agreeing what will be defended and in what way, and what will be sacrificed, is therefore likely to be tortuous.

The regulating organisations and legislation frequently change. The information above reflects the situation at the beginning of 2011.

Section 5 OUTLINE OF YARMOUTH COASTAL DEFENCE OPTIONS in 2006

Many local people were unhappy about the options for Yarmouth displayed in Yarmouth Institute on 13 December 2006 by the engineering consultants, Atkins, who had been commissioned by the Isle of Wight Council to produce an appraisal. Although now out of date in some respects, it has been a starting point and is therefore included in this Report.

A map and text of possible options for coastal defence were displayed for each of three coastal areas: Fort Victoria to Sandhard, Sandhard to Yarmouth Pier, and Yarmouth Pier to Port la Salle (east end).
A brief outline is given below; see fuller details / estimate of costs, in Appendix B.

Fort Victoria to Sandhard
1. Do Nothing Option: erosion of property and beach, deterioration of many coastal defences in the next 20 years. Residual life of defences estimated approx. 10 years.

2. Option 1 (Maintain) was discarded: maintain assets for 10 yrs until they collapse and then do nothing, resulting in loss of residential housing and Fort Victoria within 20 yrs.

3. Option 2 (Sustain) was shortlisted: refurbish existing walls and other defences to sustain for 100 years. Defence along front of Chalet Hotel would not be renewed.

4. Option 3 (Improve) was discarded: no more benefits than the sustain option.

Sandhard to Yarmouth Pier
1. Do Nothing Option: breakwater has residual life of 15 years and many coastal defences will deteriorate in the next 20 years. Ferry terminal unsafe by year 20.

2. Option 1 (Maintain) was discarded: maintain existing breakwater but the present risk of flooding to Yarmouth Town centre and impact on the estuary would remain.

3. Option 2 (Do Minimum) was discarded: upgrade breakwater, all other assets maintained over next 100 years.

4. Option 3 (Sustain defences, upgrade breakwater) was shortlisted: upgrade and maintain breakwater, raise seawalls, construct flood protection walls around the town. Ferry terminal would remain operational.

Yarmouth Pier to Port la Salle (east end)
1. Do Nothing Option: residual life of defences approx. 10 years, properties at risk from erosion in 20-50 & 50-100 years time, local traffic disrupted following any breach event.

2. Option 1 (Maintain) was shortlisted: maintain existing walls and structures but residual life of existing defence is 20 years, loss of road and many houses.

3. Option 2 (Sustain) was shortlisted: existing walls maintained over next 20 years and then replaced. Residual life of walls would be 100 years.

4. Option 3 (Improve) was shortlisted: replacement of existing walls now. This may reduce the risk of failure of existing structures in the period before they are refurbished. Residual life of the defence would be 100 years.

Section 6 SOME PROPOSED SOLUTIONS

This Report seeks to put some detail to what defences are possible and their potential costs. It is deliberately staged over the period to 2100 at ten, forty and ninety years i.e. 2020, 2050 and 2100. Some items may be cheaper overall if done together with other items. Timing will have to reflect better scientific prediction and actual experience of sea level rise. At the time of writing this was expected to be exponential growth, so developing much more rapidly in the latter part of the century.

The Working Group aims to be realistic in what can actually be expected for the Western Yar Estuary and the coastline around Yarmouth. The Island will be in competition with other areas for UK government funding, and the Yarmouth area will face similar competition within the Island strategy. Private property is unlikely to get any central government funding for flood defence. We are also mindful of the national and worldwide economic climate in 2010 and the likely unavailability of substantial government funding for flood defence in the near future i.e. the next five years. So we have targeted small relatively cheap measures in the first ten years with the spend reflecting the exponential increase in sea level rise.

These are the proposed solutions from the Working Group and do not necessarily represent the views of the member organisations.

Estimated Costs :-

Ten years to 2020	£190,000
Thirty years 2020 – 2050	£9,790,000
Fifty years 2050 -2100	£26,100,000
Estimated Total Cost to 2100	**£36,080,000**

BY YEAR TEN – 2020

Gates 0.5 metres high in lanes which lead from High Street to the shore (six) – grant funding - £30k
Gate at Pier entrance – grant funding - £5k
Gates on harbour slipways (four) – grant funding - £90k (£30k for emergency slipway, other three £20k each)
Flood boards for house doors – part grant funded - £20k
Supply of flood prevention equipment – Environment Agency
Raise wavebreak on Norton Spit by one or two planks – YHC - £20k
Community flood plan - £5k
Reinforce sea wall at western end of the Common – grant - £20k
Total £190k

BY YEAR FORTY – 2050

Gates on Bridge Street and Quay Street entrances into the town centre – Grant - £100k
Sluices on overflow pipes to prevent ingress of water through drains – water companies - £20k
Raise wavebreak on Norton Spit by half a metre – YHC - £50k
New breakwater one metre higher than existing breakwater – YHC - £4 million
Raise pier by one metre – YHC - £2 million
Raise Gossips cafe by one metre – YHC - £1 million
Raise ferry pier, linkspan etc by one metre - £2 million
Raise river bank around the Green by one metre – IW Council - £500k
Raise gate to Thorley Brook – Central Government - £20k
Reinforce Causeway at Freshwater, allow use as a ford. - £100k
Total £9,790,000

BY YEAR NINETY – 2100

Raise road A3054 by one metre, including the swing bridge - £10 million
Reinforce revetments on road - £1 million
Raise utilities under road - £500k
Norton Spit – No further expenditure
Raise quay wall by one metre - £3 million
Raise sea wall by one metre on north side of the Common to protect the main road to Newport - £5 million
Install gates to one metre at harbour slipways and lanes - £100k
Raise old railway footpath by one metre and reinforce to act as riverbank - £2 million
Install raised bank on South side of Yarmouth close to Thorley Brook to protect properties - £2 million
Allow ingress of water to land on both sides of River over this fifty year period as sea level rises. - £500k
Replace the Causeway at Freshwater – £2 million
Total £26,100,000

N.B. All costs are approximate and are at 2010 levels

Section 7 REPORT CONCLUSION

This Report attempts to inform the public on a complex but vital problem of future coastal management in the Yarmouth area.

We have summarized the history of the area, provided some evidence of historical sea level rise in the UK and worldwide, reflected an average view of sea level rise predictions for the 21st century which show that it is accelerating, and proposed a way of coping with increasing sea level which matches its increase with increased spend.

The Working Group recognises that difficult choices will have to be made about what to defend and what to give up to the sea, and that public money will need to be hard fought for and well spent. Unfortunately it is unlikely that any public funds will be made available for private landowners.

The information contained in the Report will hopefully help those who have to make investment decisions for land and buildings close to the coast. We do not want to be forced into last minute decisions, but wish to have some understanding of future issues, so that when decisions need to be made about buildings and sea defences we can act early to protect the priority areas.

Yarmouth"s situation is possibly one of the most difficult on the Island to resolve due to it being low-lying over a sizeable area, with a river valley potentially likely to create one island of the residual town and another of the Freshwater/Totland peninsula. The area includes very important natural and man-made assets which are at risk, but lacks the population, and therefore priority for national coastal protection funding, of many mainland towns.

The Working Group will distribute its Report to those responsible for future decisions and to the general public. Our concerns, analyses and suggested solutions require greater investigation than we are able to produce but they are presented in the hope that we will increase public awareness of the dangers of sea level rise and that Yarmouth will receive the attention and protection it deserves.

APPENDIX A

HISTORICAL EVENTS relevant to Yarmouth Coastal defences

The events below chart the development and changes to Yarmouth since 1135. The challenge for the future is to adapt to and manage changes of possibly more serious potential than ever before.

1135 Yarmouth granted its first charter
1224 Yarmouth, Southampton and Portsmouth regarded as principal ports on the south coast of England
1305 Yarmouth – fifty houses, probable population 200 – 250
1547 Yarmouth Castle operational
1559 Yarmouth – 26 houses, probably about 100 people
1629 Plan to convert Yarmouth, by cutting through narrow neck of land between the Solent and the Draft Haven (Rofford Marsh) to the east of the town, to an island published.
1662 Plan actually carried out. Passage cut to the east of the town between the Solent and Thorley Brook to make Yarmouth an island
1664 Drawbridge installed to connect the town of Yarmouth to the rest of the Island. The Mill causeway was built to seal off Thorley Haven. Possibly the first wooden tide mill was built at this time.
1668 Sir Robert Holmes became Governor of the Island and decided to live in Yarmouth at the Castle. He reduced its size, filled in the moat and built himself a house (now the George Hotel) on the edge of it.
1706 Ferry across the river from Yarmouth to Norton established.
1766 Yarmouth population 240 and 59 houses.
1793 Present Yarmouth Mill built by William Porter of Newport.
1795 Yarmouth population of 333 and 63 houses
1830 The first regular steamship ferry to Lymington inaugurated.
1836 Tow boats introduced on the ferry crossing.
1841 First census: Yarmouth population 567 and 114 houses.
1843 – 1847 Harbour breakwater built at a cost of £1200.
1860 First Yar bridge opened, a single track timber toll bridge
1871 Yarmouth population 806 and 182 houses.
1876 The Pier was opened and served as a terminus for the ferries
1889 The Freshwater, Yarmouth and Newport Railway opened.
1901 Yarmouth population now 948
1938 New roll on/roll off ferry introduced. New slipway built in Yarmouth harbour.
1948 Yarmouth population now 850 and 200 houses
1951 Freshwater Bay sea wall constructed
1953 The closure of the railway, never having made a profit.
1961 South Quay constructed
1965 River road car parks and the Green completed
1987 Present Yar Bridge opened.
1989 December. Flood event
2001 Census: Yarmouth population 527 (Yarmouth & Thorley was 793)
2008 10 March. Flood event.

The make-up of Yarmouth population cannot be ascertained in the dates before the 2001 Census, i.e. whether or not Thorley is included.

APPENDIX B

FULLER SUMMARY of ATKINS' OPTIONS FOR YARMOUTH

commissioned by the Isle of Wight Council

Date of Atkins' work: displayed in Yarmouth on 13.12.06.
Map and text given for each of 3 coastal areas
Abbreviations: PV = present value. PVd = present value damages.
BCR = benefit cost ratio (PVd ÷ PV cost over 100 yrs).

The 4 Options for coastal defence as described in 2006: Do nothing / Maintain the existing defences/ Sustain by doing the minimum / Improve.

I. Appraisal of Coastal Defence Options SMU8a Fort Victoria to Sandhard, Yarmouth. Sloping beach in fine sand west of Yarmouth Harbour.

Map Legend
Properties at risk from erosion; properties at risk from tidal flooding; existing defence units; 20 year/ 30 year/ 50 year/ 100 year erosion lines; flood extent (1: 200 yr event in 2060); flood extent (1: 200 yr event in 2100)

DO NOTHING OPTION

- Erosion of property and recreation beach; many coastal defences will deteriorate in next 20 years.
- Fort Victoria wall completely broken up by year 10.
- Collapse of remaining structures by year 20.
- Residual life of defences estimated approx. 10 years; breach probability of 0.1.

Present Value Damages (PVd) estimate: £1.0M property + £1.0M recreation.

OPTION 1 (Maintain) Preliminary Option Appraisal**: DISCARD**
Maintain assets for 10 yrs until they collapse and then do nothing.
Influence on coastal processes: eventual erosion of this area may release shingle into the system and could have beneficial effect on Norton Spit.
Risk Assessment: loss of residential housing & Fort Victoria within 20 yrs.

OPTION 2 (Sustain) Preliminary Option Appraisal**: SHORTLIST**
Replacing and refurbishing existing walls as they decay will sustain the existing defences around Fort Victoria for the next 100 years. Residual life of defences = 100 years.
PVd can be reduced by including a regular maintenance programme: Fort Victoria vertical wall refurbished by rock armour in front of existing line; existing gabions refurbished; other defences maintained until end of residual life.
Comments: Defence along front of Chalet Hotel would not be renewed as no loss of assets. Assumed cost of £0.5M to repair any breach.
Influence on coastal processes: refurbishing sea walls would have no significant impact on coastal processes.
Economic assessment: Damages avoided: £1.92M; PV cost over 100 yrs: £0.8M; Benefit Cost Ratio 2.45.
OPTION 3 (Improve) Preliminary Option Appraisal: **DISCARD**
Option to improve the current coast defences would not realise any more benefits than the sustain option.

II. Appraisal of Coastal Defence Options SMU8bSandhard to Yarmouth Pier Narrow sandy foreshore and estuary mouth.

Map Legend
Properties at risk from erosion; properties at risk from tidal flooding; flood defence walls; existing defence units; flood extent (1:200 yr event in 2060); flood extent (1: 200 yr event in 2100)

DO NOTHING OPTION

- By year 10 the timber boarded breastwork fronting Yarmouth Harbour expected to be in a state of collapse.
- Rising sea levels will lead to steepening of the beach and erosion, which will undermine the wall and result in the potential collapse of parts of it.
- Many of the coastal defences expected to deteriorate within the next 20 years.
- The breakwater has a residual life of 15 years and a current breach probability of 0.10. Once breached, wave heights are such that flood levels increase by 0.15m for all events (not propagated in Freshwater).
- The sea wall has a height of +1.7m ODN, the same elevation as the land behind.
- The ferry terminal will become unstable and so unsafe by year 20.
- These additional costs are estimated at £2.2M/year, £68.4M PVd.
- Total present value damages for this SMU are £73.5M.

OPTION 1 (Maintain) Preliminary Option Appraisal: **DISCARD**
Maintain existing breakwater but this option would not reduce the present risk of flooding to Yarmouth Town centre. Actual residual life of breakwater estimated at 20 years with maintenance.
Influence on coastal processes: potentially significant changes to coastal regime if breakwater collapses.
Environmental impacts: potential impact on the tidal prism and dynamics of the whole estuary due to changes to the estuary entrance following collapse of breakwater.
Risk Assessment: this option would maintain current usage of harbour in the short term.

OPTION 2 (Do Minimum) Preliminary Option Appraisal: **DISCARD**
Upgrade breakwater to prevent collapse. All other assets maintained and refurbished over next 100 years.
Comments: residual life of breakwater would be 100 years; breach probability of 0.01.
Influence on coastal processes: No significant change provided the existing alignment of breakwater is followed.
Environmental impacts: potential impact on the tidal prism and dynamics of the whole estuary due to changes to the estuary entrance.
Economic assessments: Damages avoided (PV): £0.4M; PV cost over 100 yrs: £5.67M; Benefit Cost Ratio: 0.08
OPTION 3 (Sustain defences, upgrade breakwater) Option Appraisal: **SHORTLIST.**
Upgrade and maintain breakwater. Raise seawalls to +2.2m ODN now and raise to +2.5m ODN in year 50.
Significant areas of Yarmouth town centre are currently at risk of flooding. This option: construction of flood protection walls around the town in addition to harbour breakwater upgrading (option 2). Ferry terminal would remain operational.
Comments: residual life of breakwater would be 100 years; breach probability of 0.01. Flood defence would be maintained and have a minimum standard of defence of 1.20 throughout the scheme life.
Indicative Standard of Defence: 1 in 20 minimum.
Influence on coastal processes: As option 2 (not if breakwater alignment retained).
Environmental impacts: No change from the existing processes.
Economic assessments: Damages avoided (PV): £72.1M; PV cost over 100 yrs: £7.71M; Benefit Cost Ratio: 9.35
Risk Assessment: This option would maintain the current usage of the harbour. “This benefit has not been included in the Defra assessment given above.”

III. Appraisal of Coastal Defence Options SMU8c Yarmouth Pier to Port la Salle (east end) Boulder-strewn foreshore on clay sub-base with gentle profile east of Yarmouth Harbour. **3 SHORTLIST APPRAISALS.**

Map Legend
Properties at risk from erosion; properties at risk from tidal flooding; existing defence units; 20 year/ 30 year/ 50 year/ 100 year erosion lines; flood extent (1:200 yr event in 2060); flood extent (1: 200 yr event in 2100)

DO NOTHING OPTION

- Many coastal defences can be expected to deteriorate within next 10 years.
- Collapse of remaining structures is expected by year 10.
- Residual life of defences estimated approx. 10 years; breach possibility of 0.1.
- Properties at risk from erosion in 20-50 and 50-100 years time.
- Local traffic disrupted following any breach event. If traffic is diverted, this comes to £167M PVd over 100 years. Cheaper to build a new road, est. cost £4.6M, £3.95M over 100 years Do Nothing.

Total Do Nothing PVd est. approx. £7.4M.

OPTION 1 (Maintain) Preliminary Option Appraisal: **SHORTLIST.**
Maintain existing walls and structures. Life of existing sea walls limited by the sheetpile toe, estimated at 20 years. Thereafter, walls would be allowed to collapse.
Comments: Residual life of existing defence is 20 years; breach probability of 0.02.
Collapse of walls by year 20 is assumed, leading to loss of the road soon after.
Influence on coastal processes: Collapse of walls and reversion to a natural soft cliff would be a major change, but would not be detrimental to adjacent management units.
Economic assessments: Damages avoided: £1.8M; PV cost over 100 yrs: £414k; Benefit Cost Ratio: 4.4
Risk Assessment: Loss of road and many houses.

OPTION 2 (Sustain) Preliminary Option Appraisal: **SHORTLIST.**
Existing walls maintained over next 20 years and then replaced or refurbished following collapse, allowing for sea level rise.
Comments: Residual life of walls would be 100 years; breach probability of 0.02 for years 0-20. This would reduce to 0.01 between years 20 – 100. Existing walls: sloping mass concrete with sheetpile toe; alternative construction forms such as rock revetment may be appropriate in this location.
Influence on coastal processes: Would not change the existing coastal regime.
Economic assessments: Damages avoided (PVd): £7.0M; PV cost over 100 yrs: £2.6M; Benefit Cost Ratio: 2.7
Risk Assessment: This option may be justified on IBCR.

OPTION 3 (Improve) Preliminary Option Appraisal: **SHORTLIST.**
Replacement of existing walls now. This is a benefit as it may reduce the risk of failure of existing structures in the period before they are refurbished.
Comments: Residual life of the defence would be 100 years; breach probability of 0.01 between years 0 – 100.
Influence on coastal processes: Would not change the existing coastal regime.
Economic assessments: Damages avoided (PVd): £7.3M; PV cost over 100 yrs: £3.8M; Benefit Cost Ratio: 1.9

MAPS

1. Western Yar Valley

Showing the main designations for nature conservation in the Western Yar Valley and the 1 in 200 year flood risk zone in 2110 (information from the Environment Agency).

2. Western Yar Valley (north)

Showing the coastal erosion zones over the next 20, 50 and 100 years and the 1 in 200 year flood risk zone in 2110 (information from the Environment Agency) in the northern end of the Western Yar Valley. The map also shows the estimated residual life of existing sea defence structures based on a system of red for those with the shortest residual life, orange for the medium and green for the longest residual life.

3. Western Yar Valley (south)

Showing the coastal erosion zones over the next 20, 50 and 100 years and the 1 in 200 year flood risk zone in 2110 (information from the Environment Agency) in the northern Western Yar Valley. The map also shows the estimated residual life of existing sea defence structures based on a system of red for those with the shortest, orange for the medium and green for the longest residual life.

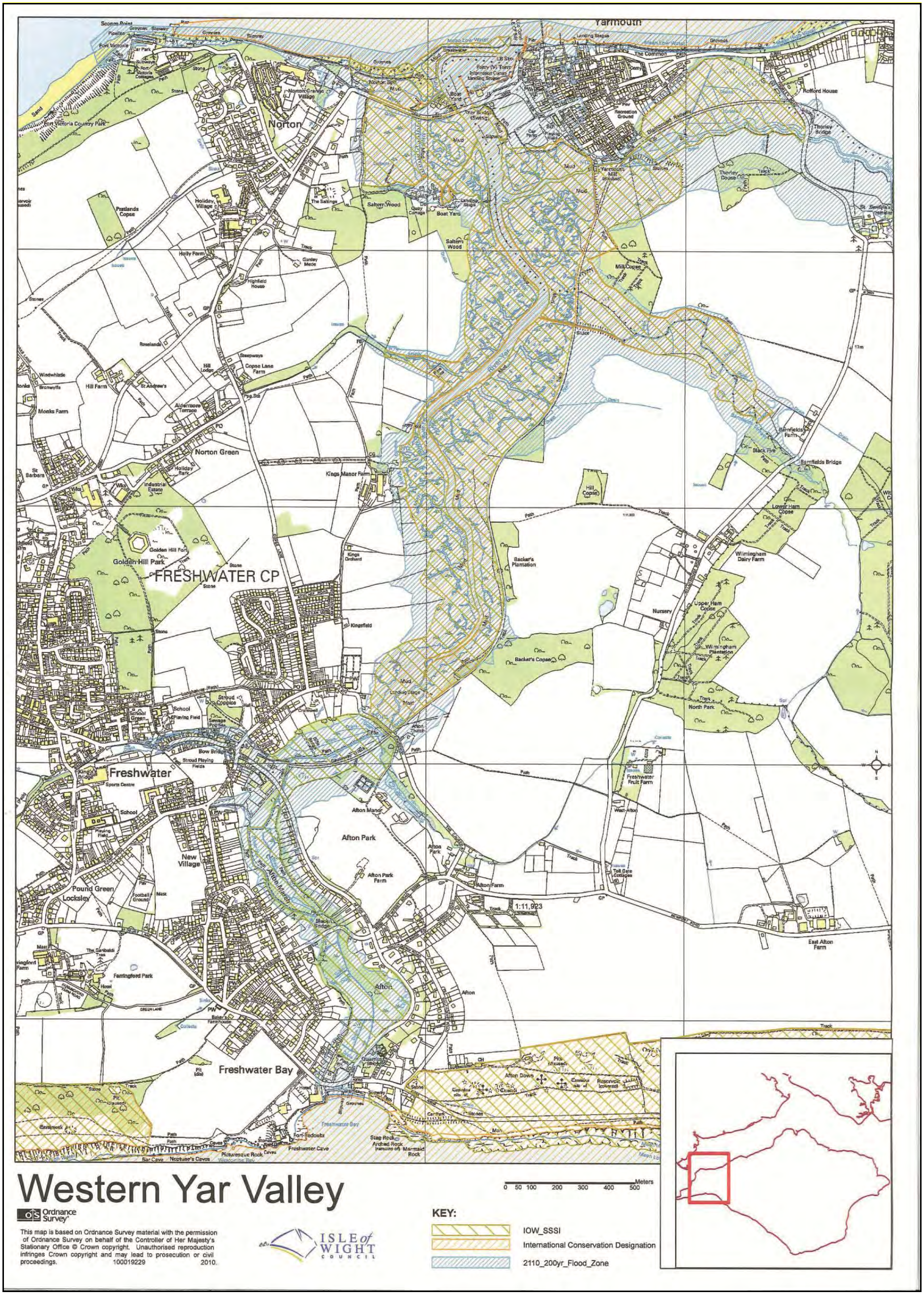
4. Yarmouth area (Flood risk area: 1 in 200 year event present day)

Showing the coastal erosion zones over the next 20, 50 and 100 years and the estimated residual life of existing sea defence structures based on a system of red for those with the shortest residual life, orange for medium and green for the longest residual life.
It also shows the 1 in 200 year flood risk zone in the present day as advised by the Environment Agency.

5. Yarmouth area (Flood risk area: 1 in 200 year event in 2110)

Showing the coastal erosion zones over the next 20, 50 and 100 years and the estimated residual life of existing sea defence structures based on a system of red for those with the shortest residual life, orange for medium and green for the longest residual life.
It also shows the 1 in 200 year flood risk zone in 2110 (information from the Environment Agency).

The following maps were kindly produced by the Centre for the Coastal Environment, Isle of Wight Council.



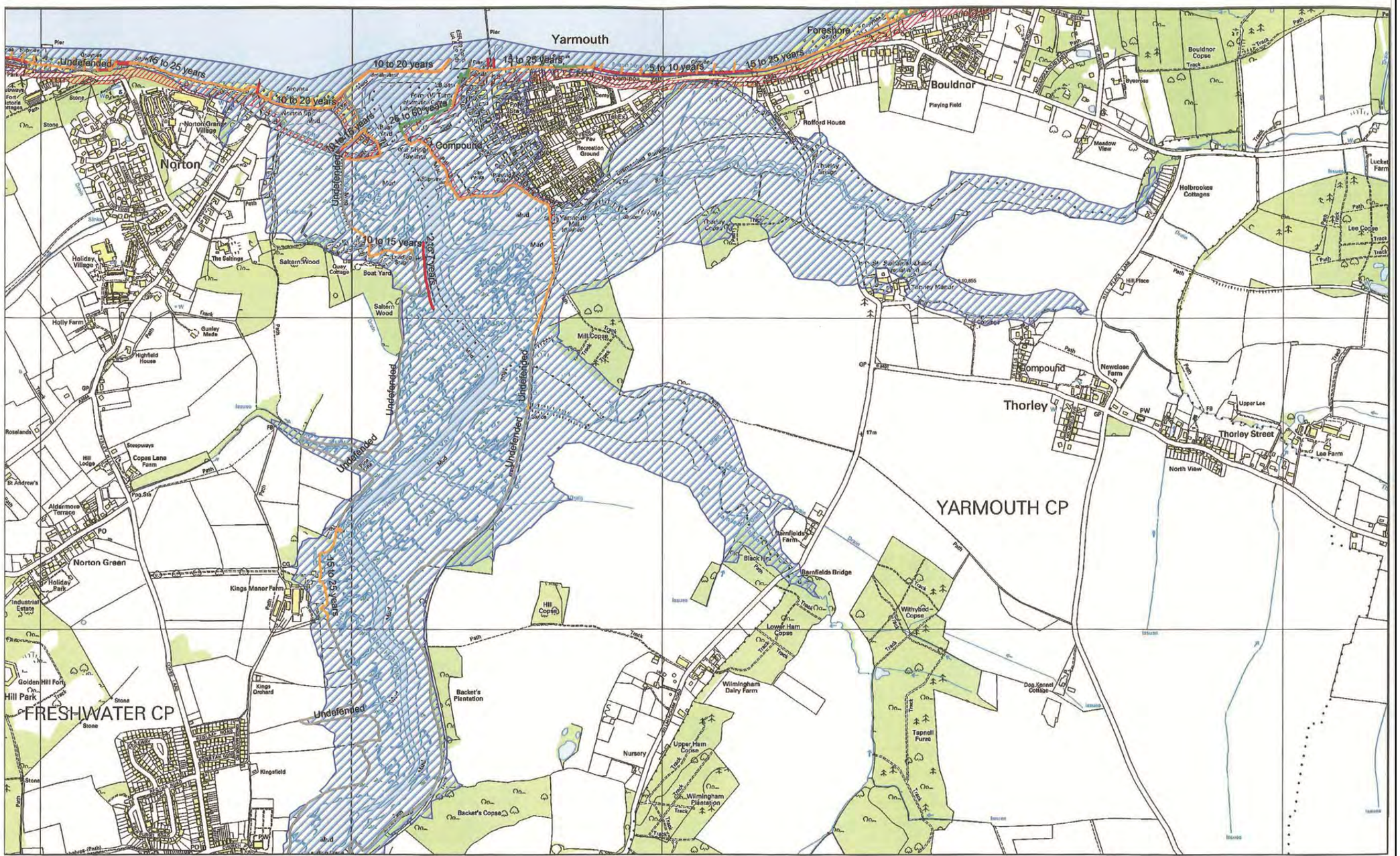
Western Yar Valley

Ordnance Survey

ISLE of WIGHT COUNCIL

KEY:

- IOW_SSSI
- International Conservation Designation
- 2110_200yr_Flood_Zone



Western Yar Valley (North)

KEY:

- NAI_Indicative erosion zone up to 2105_West Wight
- NAI_Indicative erosion zone up to 2055_West Wight
- NAI_Indicative erosion zone up to 2025_West Wight
- 2110_200yr_Flood_Zone

N W E S

1:10,855

0 50 100 200 300 400 500 Meters

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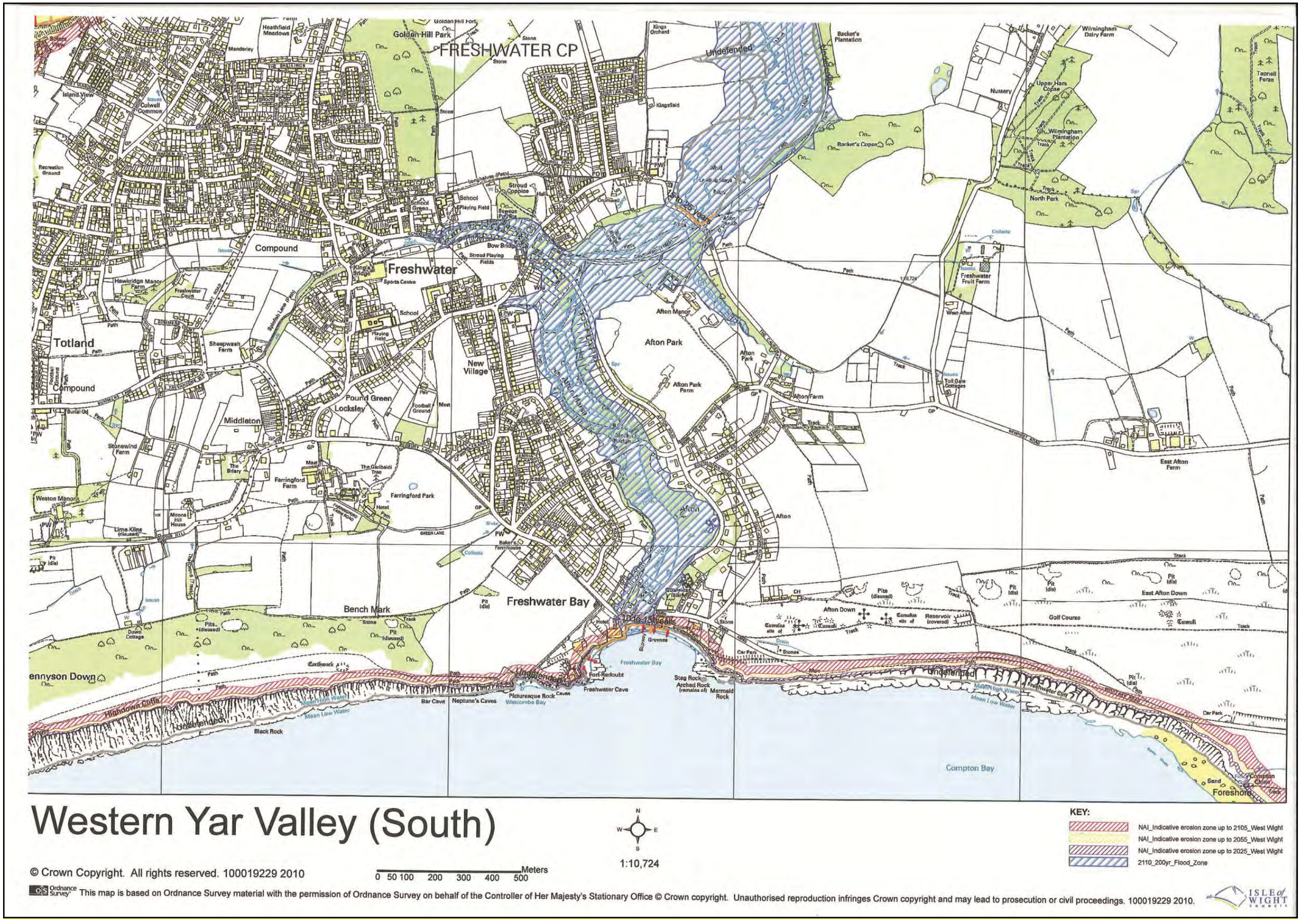
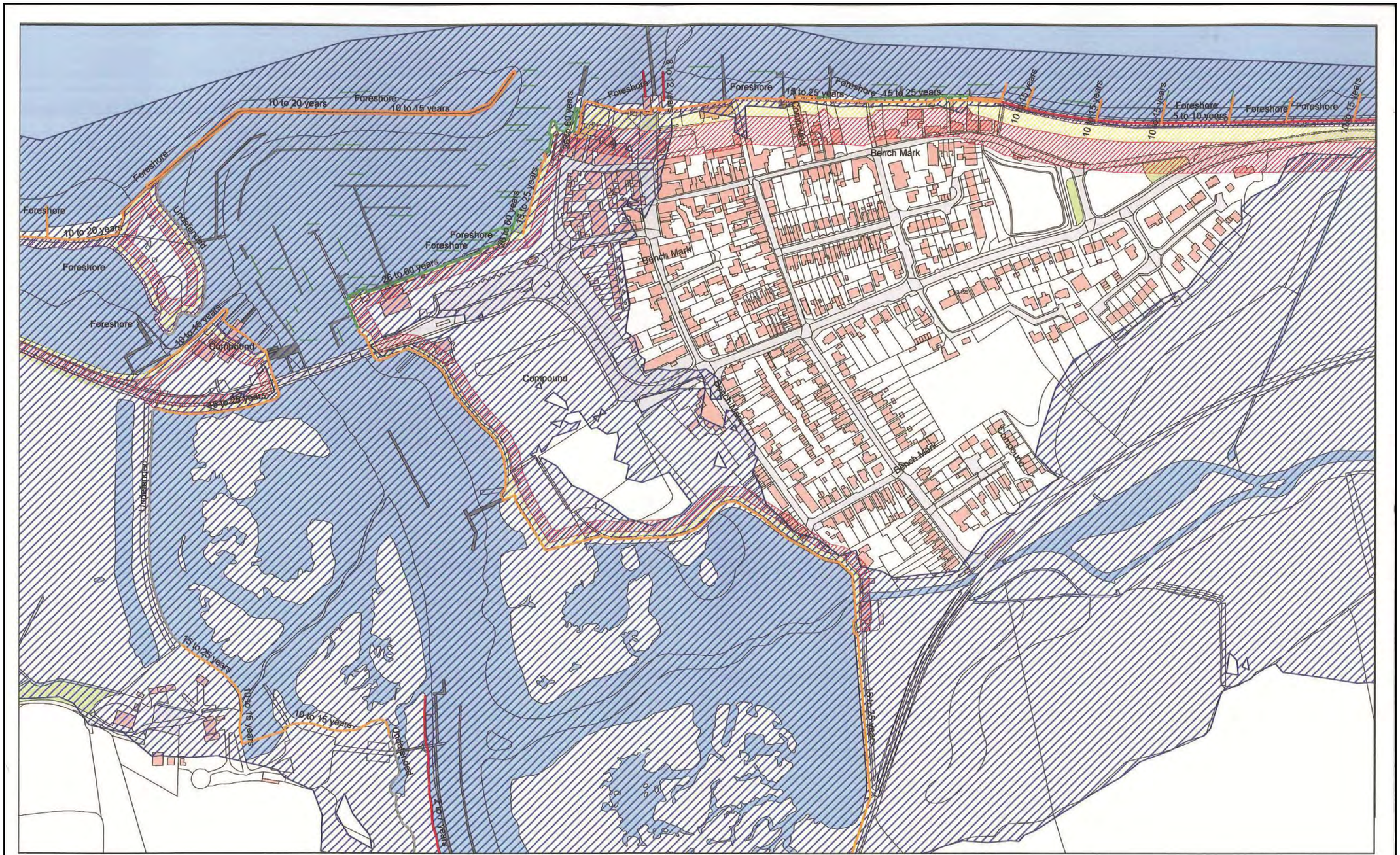
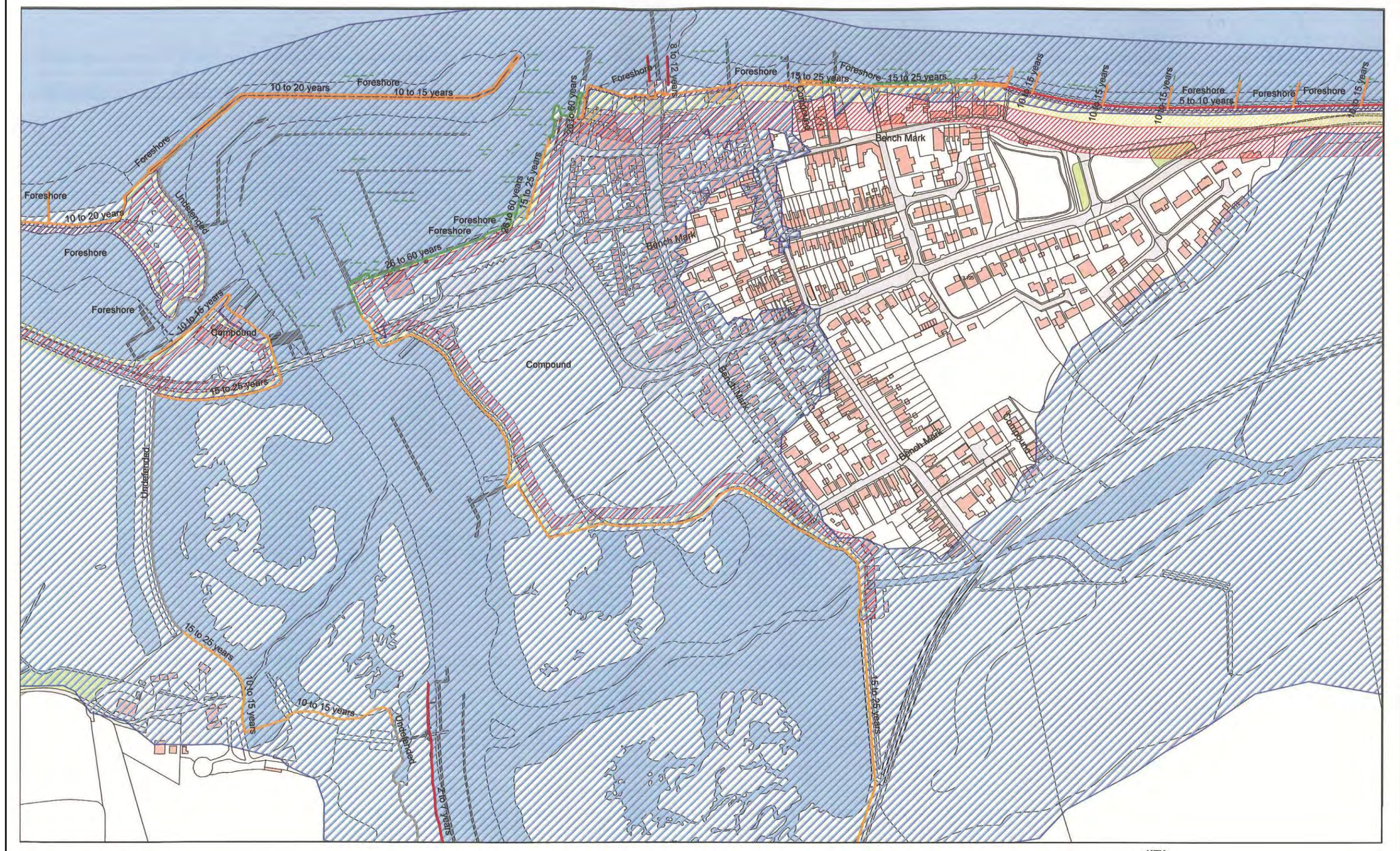


Western Yar Valley (South)





Yarmouth Area

N
W E
S

1:3,125

0 50 100 200 300 400 500 Meters

KEY:

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- NAI_Indicative erosion zone up to 2055_West Wight
- NAI_Indicative erosion zone up to 2025_West Wight
- 2110_200yr_Flood_Zone

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