

EA - SOUTH WEST BOX 17



Environment
Agency



Somerset and the sea

The 1981 storm - 25 years on

We are the Environment Agency. It's our job to look after your environment and make it **a better place** – for you, and for future generations.

Your environment is the water you drink, the air you breathe, the ground you walk on. We work with business, Government and the public to make your environment cleaner, safer and better. The Environment Agency is making your environment a better place.



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Front cover: Weston-super-Mare sea front, 1981

Foreword

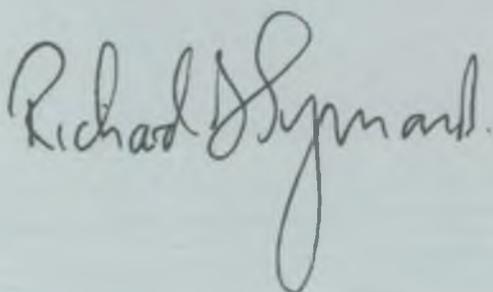
Coastal defences play a vital role in the future of our area.

The 1981 storm that hit Avon and Somerset caused significant damage and demonstrated how vulnerable our coastline can be.

More than £60 million has been spent over the last 25 years improving the condition of our coastal defences, and protecting over 37,000 homes. At today's prices this would be approximately £100 million. This investment has averted major damage in similar surge tide events that have occurred since 1981.

Here in the south west sea levels could rise by up to 86 cm by 2080, putting our coastal communities under greater risk of flooding. Extreme weather events causing serious flooding will be more common.

Continuing to reduce flood risk and adapting to climate change is a major part of our corporate strategy and is the challenge for now and the future.



Richard Symonds
Area Flood Risk Manager - Wessex (North)

ENVIRONMENT AGENCY



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The big storm of Sunday 13 December 1981

The highest tidal levels in the last century were recorded on 13 December 1981 along the Somerset and Avon coastline. A high spring tide of 7.95m AOD (above Ordnance datum) was recorded at Bridgwater with a 1.45m surge. The predicted tide had been 6.5m AOD with a 0.38m surge. At Weston-super-Mare and Avonmouth, the predicted tides were 7.2m AOD. The actual tides recorded were 8.10m AOD at Weston-super-Mare and 8.83m AOD at Avonmouth, with a 1.7m surge. The tides combined with storm force westerly winds - gale force 8 to 10, up to 50 knots.

Sea defence damage and flooding

It is recorded that 12,500 acres of land were inundated with floodwater and 1,072 houses and commercial properties suffered flooding, with floodwater reaching the M5 motorway. The National Farmers Union reported 2,500 sheep, cattle and pigs and 22,000 chickens drowned. Fortunately there was no loss of human life.

Wessex Water Authority, predecessor to the Environment Agency, estimated in excess of £6 million damage to the Somerset coastline between Clevedon and Porlock, necessitating an initial three-year programme of sea defence repair work. 22 locations of sea defences were overtopped or damaged - some extensively - over an 11 kilometre (7 mile) stretch of coast.



Aerial view of Clevedon after the storm



Burnham-on-Sea promenade after the storm



Stolford sea defence damage 15 December 1981



Meteorological conditions on 13 December 1981

Meteorological conditions resulted in a very intense secondary low-pressure area moving rapidly through the western approaches to the Bristol Channel. The rapid movement - about 40 knots - with pressure dropping from 1012 to 962 mb in the Bristol Channel between 0000 hours and 1800 hours, caused a large rising surge in sea level.

The maximum surge level at Hinkley Point on the Somerset coast occurred 11 minutes after predicted high water. The surge of 1.3m elevated the tidal level to 7.4m Ordnance Datum (OD) at 2025 hours. At Avonmouth the surge was 1.7m. Wind that had been blowing from the south in the afternoon at 30 to 40 knots dropped to 25 knots at 1630 hours and to 20 knots by 1845 hours. It then swung west and gradually increased. Suddenly, at 1940 hours wind speed leapt from 25 to 40 knots.



Flood damage - Pawlett, Somerset

Overtopping of the sea defences began at this time with peak tidal level occurring at 2025 hours and staying near that level until about 2130 hours. The westerly wind steadily increased up to 50 knots by 2300 hours, by which time the tide had dropped away from the sea defences.

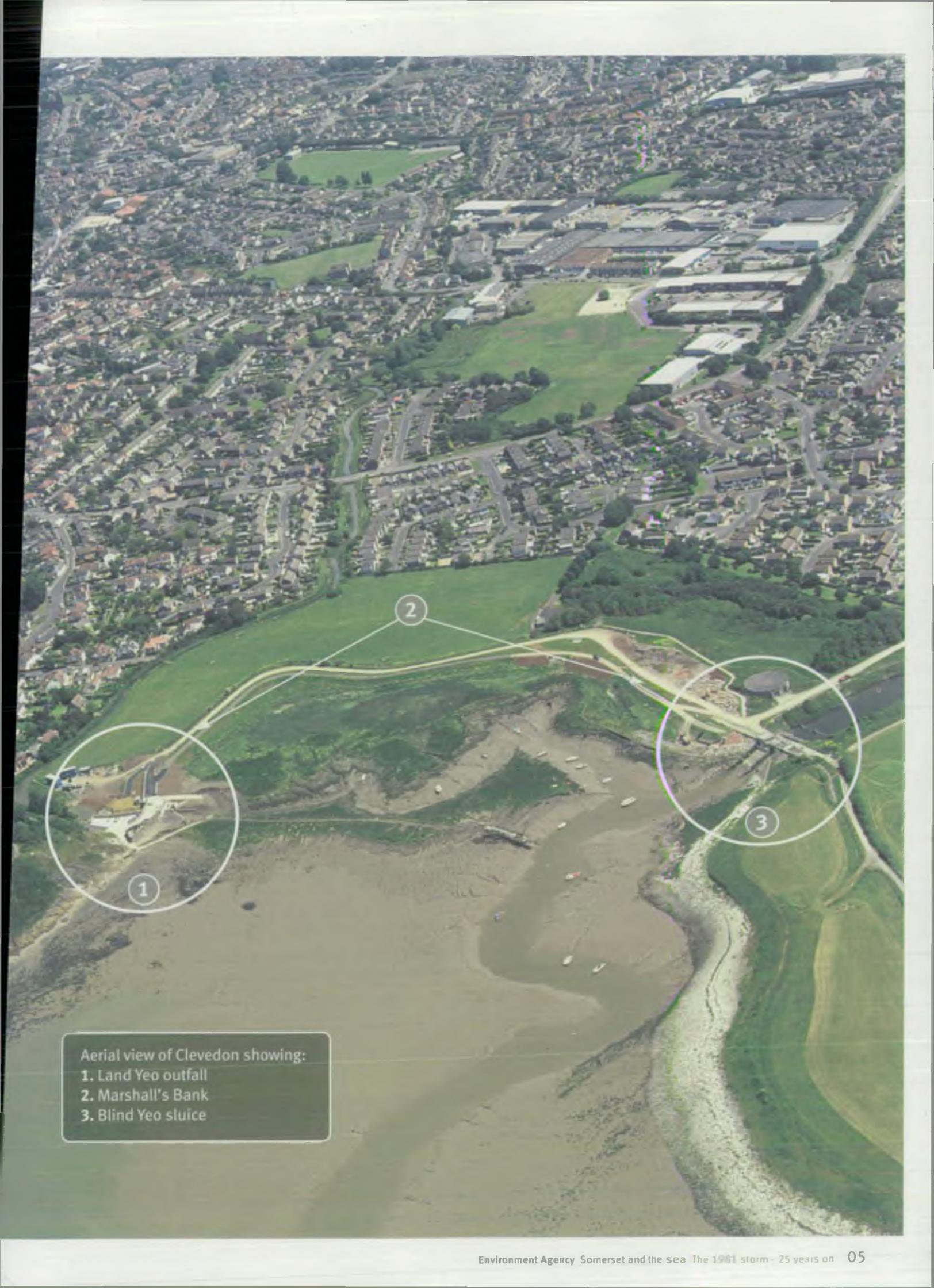
What we have achieved so far

The Somerset coastline has 87 kilometres of tidal rivers with raised embankments and 38 kilometres of sea defences. Its 114 kilometre coastline along the length of the Severn Estuary has the second highest tidal range in the world. Approximately one-fifth of the area is low lying (635km² at or below sea level) and therefore at risk of flooding. Some 18 rivers and streams drain into the Bristol Channel between Portbury Dock, Bristol and Foreland Point near Lynmouth, Devon.

Since the Big Storm of 1981 we have made a lot of improvements to our coastal defences, all aimed at reducing flood risk and adapting to climate change.



Somerset sea defences



Aerial view of Clevedon showing:

- 1. Land Yeo outfall
- 2. Marshall's Bank
- 3. Blind Yeo sluice

1. Land Yeo outfall 2006
2. Clevedon sea wall
3. Kingston Seymour sea defences



Clevedon to St Thomas Head (North Somerset)

Clevedon

Clevedon Town (West Leaze) sea wall - Responsibility for this defence is split between North Somerset Council and us. In 1986-1988 the sea wall and promenade were raised by one metre. The original wall was demolished and rebuilt in masonry-faced reinforced concrete to achieve this.

Land Yeo outfall and Marshall's Bank, Clevedon - In 2005/2006 major improvement work to the outfall and bank was carried out. The £3.2 million scheme reduces the risk of flooding to 3,000 low-lying properties in Clevedon.

Blind Yeo sluice, Clevedon - In 2004/2005 major refurbishment of the sluice was carried out. The Blind Yeo sluice lies at the tidal outlet of the Blind Yeo watercourse, where it meets the Clevedon Pill and Severn Estuary. The Blind Yeo, a man-made river built in 1952, takes flows from the Land Yeo, River Kenn and Nailsea, Tickenham and Kenn rhynes and provides flooding relief for 2,100 acres of land and approximately 1,700 residential properties, together with camping and caravan sites and farms. The cost of the scheme was £1 million.

Clevedon sea wall - The sea wall lies along a section of the Bristol Channel coast, south of Clevedon, running from Kingston Seymour sea wall to the outfall of the Blind Yeo river. It forms part of our chain of defences protecting large, low-lying areas of Somerset from tidal flooding. The flooding caused by the 1981 storm extended as far as the M5 motorway. The sea wall was replaced by an efficient set-back clay bank and front revetment system.

Kingston Seymour

Kingston Seymour - A scheme was carried out at Kingston Seymour, two miles south of Clevedon, to improve and strengthen the tidal defences following damage caused by the 1981 storm. A new 1.4km length of earth bank was built and a line of rock armour was added during the early 1990's.

Blakes

Blakes sea wall - The sea wall runs north-easterly from the Congresbury Yeo and joins the defences at Hurditch's Wharf. It is a section of sea defence that together with the sea walls at Kingston Seymour and Clevedon, provides protection against tidal inundation for a large part of North Somerset.



4. Tidal banks looking south from Clevedon to St Thomas Head

In 1983/1984 improvements were carried out to the sea wall. A feature of the scheme was the formation of a large borrow pit on land near the southern end of the wall. The pit, known as a pool, was created by excavation to provide spoil for the sea defence works. The pool was designed to form a nature reserve once flooded on completion of the project. Avon Wildlife Trust took over management of the site that includes two smaller pools built later. The pools cover several acres in total. The reserve is known as Blakes Pool and has proved to be a valuable environmental enhancement to the area.

Congresbury

Congresbury Yeo tidal banks - Improvement works to the right bank of the River Yeo adjacent to Blakes Pool borrow pit were carried out in 1986 and 1988 and also on the **Mill Leaze outfall** (Congresbury Yeo) in the

1980's. Emergency piling work on the tidal banks of the Congresbury Yeo was carried out in autumn 2006 due to the risk of bank failure during high spring tides.

Wick St Lawrence

Wick St Lawrence sea defence (Wick Warth) - In 1989/1990 a rock armour strengthening scheme was carried out on the existing wall, north of Weston-super-Mare. This was followed in 1990 by bank strengthening to the Commission Bank and raising works in 1991.

River Banwell

New Bow sluice - A tidal exclusion barrier and outfall for the River Banwell - originally built in 1790 - was replaced by a new structure in 1990.

Expenditure

**Clevedon to St Thomas Head -
Total cost of improvements since
1981 = £20.5 million**

5. Brean Cross sluice
6. Sand Bay



Sand Bay to Brean

Sand Bay

Sand Bay - Sand Bay is located immediately north of Weston-super-Mare. It runs north-south between high ground at Middle Hope/Sand Point in the north and Weston Woods/Worlebury Hill in the south, approximately 3,000 metres in length. The sea defence protects the villages of Kewstoke and Sand Bay. A beach nourishment scheme was carried out in 1983/1984. This was one of the first beach nourishment schemes of this scale carried out in Britain. Over 600,000 tonnes of sand were dredged from the Severn Estuary and pumped onto the beach, raising it by approximately three metres at the sea wall.

Uphill

Uphill sea defence - In 1981 properties in the village of Uphill suffered some of the most dramatic flood damage when large volumes of sea water poured over the sea defences. In 1982 the masonry wall was supplemented by a second line of defence - a low earth bank and wall which runs adjacent to the most seaward houses.

In 2003/2004 a new state-of-the-art sluice gate, **Uphill sluice**, was installed to reduce the risk of flooding to approximately 1,000 properties in Uphill and the south of Weston-super-Mare. At high tide the sluice gate closes to keep out tides from the Bristol Channel and at low tide the sluice lets out river water from upstream. The cost of the scheme was £1.8 million.

Axe Estuary/Tidal River Axe

Axe tidal banks - The River Axe discharges into the Bristol Channel (Severn Estuary) at Uphill. The banks are a vital tidal defence for a large area of predominantly agricultural land. In the 1990's a number of schemes were carried out to improve both banks protecting the Brean Peninsula where there are many static caravan parks, residential and commercial properties.

Brean Cross sluice - Originally built in the early 1970's, this is the tidal limit of the River Axe and protects 15,000 acres of agricultural land as well as farms and residential properties. Refurbishment works were carried out in 1985 and 1995.

Expenditure

Sand Bay to Brean - Total cost of improvements since 1981 =
£5.5 million



- 7. Burnham-on-Sea sea wall
- 8. Brean
- 9. Highbridge Clyce
- 10. Construction of the Burnham-on-Sea defences 1983



Brean to Highbridge

Brean

Brean sea defence - The coastline between Burnham-on-Sea and Brean Down protects 330 hectares of land, some 17 houses, 27 hectares of holiday parks and several businesses. Improvement works were carried out in 1984/1985 and in 1996. A 1.4km line of limestone rock was set against the existing sea wall. 122,000 tonnes of rock and stone were used. In 1997 new floodgates were installed to replace stop-boards at both slipways on Brean sea front. The cost of the scheme was £2.15 million.

Burnham-on-Sea defence - The storm of 1981 caused flooding to 400 properties in Burnham and surrounding area. The storm ripped up pavements, tore stone and concrete from the sea wall, promenade and steps - damage totalled £1.5 million. Emergency repairs were carried out and plans commenced to build Burnham's new sea defences.

In 1983 work started on the construction of a new sea wall and promenade, the levels of both being raised by up to one metre. A flight of concrete steps stretches along Burnham's sea front - it absorbs wave energy whilst providing a public amenity. At the time of construction it was Britain's biggest wave return wall - a curve of concrete 3.2 metres high and a 1.6 kilometre

length of sea defence wall. The £7 million scheme was carried out in four phases and took five years, being completed in 1988.

Highbridge Clyce - Refurbishment works to the structure were carried out in 1984/1985 and in 1999/2000 the tidal mitre doors were replaced.

Brue Pill tidal banks - The Pill extends from Highbridge Clyce to its outfall into the Parrett Estuary. The defences protect large areas of Burnham-on-Sea and Highbridge from tidal flooding. A programme of improvement work began in 1995 and was completed in 1998.

Expenditure

Brean to Highbridge - Total cost of improvements since 1981 = £10.3 million



11. Parrett tidal banks improvement works - Moorland, near Bridgwater

12. Hydraulic piling machine pushing in the piles

13. Piling frame on tidal banks at Northmoor pumping station, Moorland



Highbridge to Bridgwater

Highbridge

Huntspill sluice - A major refurbishment of this tidal sluice at the confluence of the River Parrett and River Huntspill, near West Huntspill was carried out in 1992/1993 and 2002.

Huntspill sea defence - This is the sea wall between the Huntspill River to the south and the River Brue to the north. The extent of the damage in 1981 to properties protected by this defence, gave particular urgency to the reconstruction of the defences. Within a year of the event, a new upgraded defence had been constructed to give a high standard of protection to the communities.

Dunball sluice - Tidal sluice and outlet of King's Sedgemoor Drain to the estuary. Works completed in 1997.

Parrett tidal banks

In the 1980s and 1990s a comprehensive programme of improvements to tidal embankments of the tidal River Parrett from Huntspill to Bridgwater and Bridgwater to Burrowbridge, including the River Sow, was completed.

In 2000 another programme of works to the Parrett tidal banks from Bridgwater to Langport began. These improvements are due to be completed in 2007 at an estimated cost of £2.7 million.

Expenditure

Highbridge to Bridgwater - Total cost of improvements since 1981 = £8.8 million

- 14. Tidal defences at Stolford looking towards Hinkley Point power station
- 15. Comwich flood wall and outfall
- 16. Comwich Pill tidal defence



Bridgwater to Hinkley Point

Bridgwater to Hinkley Point

Bridgwater to Comwich tidal defence - Bank strengthening works were carried out on the left bank of the River Parrett estuary between 1993 and 1995.

Stear to Comwich - During the 1980s and 1990s improvements to strengthen the tidal flood banks between Steart Point on the Parrett estuary and North Clyce on the River Parrett were carried out.

Comwich tidal defence - Between 1985 and 1987 an earthbank was built, north of Peel Cottages and a stone retaining wall behind the Cottages. New road drains, outfalls and a masonry flood wall were also built.

Expenditure

**Bridgwater to Hinkley Point -
Total cost of improvements since
1981 = £2.8 million**

17 and 18. Minehead during construction 1997/1998
 19. Minehead sea wall - viewing platforms
 20. Aerial view of completed Minehead sea defences



Hinkley Point to Porlock (West Somerset)

Hinkley Point to Porlock

Lilstock - The sea defence at the village of Lilstock, west of Hinkley Point power station, bridges a natural gap between two lengths of cliff and protects a small number of properties, 10 agricultural buildings and 45 hectares of land. The natural shingle ridge is reinforced by approximately 350 metres of gabion baskets. Over the last 15 years a number of minor improvement schemes have been carried out.

Blue Anchor

Pill River outfall - A tidal outfall was constructed in 2003.

Minehead

Minehead sea defences - The Environment Agency promoted a £12.7 million project to reduce the risk of tidal flooding and generally improve the amenity of the seafront.

Phase 1 - 1997-1999 - involved the construction of a new, raised sea wall. The promenade was also raised and three viewing platforms installed to retain views of the bay.

In 1999 Phase 2 saw the replenishment of the foreshore using 320,000 tonnes of sand and shingle dredged from the seabed near Holm Sands. The beach was raised by approximately two metres.

Porlock

We maintained the natural shingle ridge throughout the 1980s and 1990s until such time that it became uneconomical to continue to do so and the ridge was allowed to breach by the tide.

Expenditure

Hinkley Point to Porlock - Total cost of improvements since 1981 = £13.1 million

Total expenditure on the Somerset coast since 1981 = £61 million



The future

Irrespective of the uncertainties ahead of us with climate change, the Environment Agency is **committed** to reducing flood risk to people, property and to the environment.

Climate change

Climate change and sea level rise will increase the risk of flooding in our area. Sea levels rose by about 150mm in the 20th century and are predicted to rise by about 86cm by around the year 2080. This will threaten sea defences and block rivers' flow even more than now.

Floods in 1994, 1997, 1998, 1999 and 2000 have shown that extreme weather is becoming more frequent. Climate change is becoming universally accepted but its impact is difficult to predict.

Tackling flood risk and climate change

The Environment Agency faces twin challenges in managing flood risk and adapting to climate change. We have a new five year strategy to help us.

Two of our main goals will help fight flooding by:

- reducing flood risk
- limiting and adapting to climate change.

We have set ourselves priorities for making our area a better and safer place. We aim to:

- build new flood defences and improve what we already have, such as flood banks and walls, pumping stations and sluices
- improve flood risk mapping to show people the risk to their homes and businesses. This will ensure we target our work at places most at risk
- issue timely flood warnings to 70 per cent of people at risk by 2010, so they can prepare for flooding
- work closely with planning authorities to prevent the wrong sort of development in areas prone to floods
- ensure that economic development and regeneration take account of the need for flood defences
- make people more aware of the need to change their lifestyles to take account of climate change
- take account of the predicted effects of climate change when we design flood defences and require developers to do the same
- respond to floods quickly and efficiently so we can lessen their effects.

Major urban locations and their properties at risk along our coastline:

Location	Total properties	Properties in flood zone 3*
Weston-super-Mare	30,965	12,209
Bridgwater	15,742	8,558
Clevedon	9,298	6,498
Burnham-on-Sea and Highbridge	7,618	7,775
Portishead	6,317	1,766
Minehead	5,044	867

*In the case of flooding from the sea the flood zone indicates the event of a flood with a 0.5 per cent (1 in 200) chance of happening in any year



Somerset if unprotected by sea defences

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