Defra

Isles of Scilly Water Interests Survey

Report on Flood Defences

11/8185

Issue 1 | August 2011

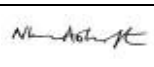
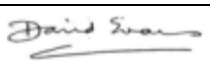
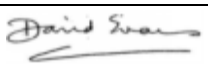
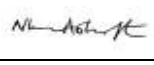
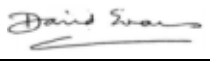
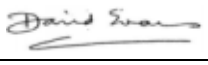
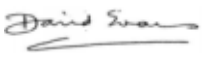
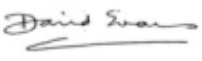
Ove Arup & Partners Ltd
4 Pierhead Street
Capital Waterside
Cardiff
CF10 4QP
Wales
United Kingdom
www.arup.com

Job number 217862-00

ARUP

Document Verification

ARUP

Job title		Isles of Scilly Water Interests Survey			**Job number** 217862-00
Document title		Report on Flood Defences			**File reference** 4-50
Document ref		11/8185			
Revision	**Date**	**Filename**	11-095 Isles of Scilly Report Rev 001.docx		
Draft 1	17/08/11	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Naomi Ashcroft	David Evans	David Evans
		Signature			
Issue 1	26/08/11	**Filename**	217862 – Isles of Scilly Report Rev 002.docx		
		Description	Issue to Defra		
			Prepared by	Checked by	Approved by
		Name	Naomi Ashcroft	David Evans	David Evans
		Signature			
Final	14/11/11	**Filename**	217862 – Isles of Scilly Report Rev 003.docx		
		Description	Final Issue		
			Prepared by	Checked by	Approved by
		Name	Naomi Ashcroft	David Evans	David Evans
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document Verification with Document	✓

Contents

References

Tables

Figures

Appendices

Environment Agency NFCDD Record of Defences

1 Introduction

WRc and Arup have been appointed by Defra to:

- conduct a survey of the sources of pollution, pathways and implications to drinking water and the water environment on the Isles of Scilly;
- examine existing means of water supply and waste treatment networks; and
- assess the capacity and state of flood management assets.

This information will be used as the basis to inform the Regulatory Impact Assessment to be implemented on the Isles of Scilly.

Arup‟s task has been to focus on the flood management assets working with WRc on any potential impacts to or from the water supply and wastewater infrastructure.

The objective is to achieve a better understanding on the number and status of existing flood and coastal protection assets and the level of maintenance required to ensure that these assets remain in a good condition and an adequate level of flood risk protection is achieved for the Isles of Scilly.

This report identifies the status of existing flood defences and gives recommendations on items that warrant further investigation, study or intervention to ensure that the existing defences continue to provide the appropriate level of protection.

Where intervention needs are identified, recommendations are given along with costs, expressed in terms of high, medium and low cost options.

The report has been prepared following a review of the 1997 Shoreline Management Plan (SMP) and the recommendations from the most recent SMP2, dated February 2011, prepared by Royal Haskoning. To ensure a continued strategic approach and to maximise funding potential, it is suggested that recommendations are considered alongside the policy options proposed in SMP2.

2 Methodology

A visit to the Isles of Scilly was undertaken by the WRc/Arup Team between 18 and 22 July 2011.

A meeting was held with Neville Gardner (Chief Technical Officer for the Isles of Scilly Council) on Monday, 18 July to gain an initial understanding of and maintenance associated with the water supply network, the wastewater infrastructure, waste management and to determine the location and extent of existing formal flood defences. This was followed by site visits to the Foul Pumping Station in the centre of Hugh Town, the De-Salination Plant at McFarland‟s Down, the Water Pumping Station near Higher Moor, the Bio-bubble wastewater treatment plant and pumping station serving Old Town and the existing flood defences at Porthcressa and Town Beach, both in Hugh Town and the existing flood defences at Old Town. During the site visit we were

accompanied by Eddie Williams who supervises the 12 strong Direct Labour Force (DLF) and maintains the De-Salination Plant and Water Pumping Station. The Team also met Matt Thompson and Matt Honeychurch who help to run the Water Pumping Station.

This was followed by visits to St Agnes and St Martin"s on Tuesday, 19 July; visits to Tresco and Bryher on Wednesday, 20 July. The remaining time was spent on St Mary"s.

On Tresco the Team were met by Steve Ash who is retained by the Duchy of Cornwall Estate.

The aim of liaison with the Isles of Scilly Council and the Duchy of Cornwall was to:

- gain an understanding of the concerns with regards to flooding;
- identify any significant historic flood events and associated historical flood records;
- establish the existing maintenance regime; and
- determine any previous or planned repairs to the structures.

The Island surveys comprised a visual inspection of the defences to validate and confirm any issues identified. The inspections followed the Environment Agency"s Condition Assessment Manual that contains procedures for the grading of flood defences according to structural condition.

The subsequent evaluation considered the adequacy of the existing flood protection relative to the perceived and, as far as is possible, actual flood risk where this can be assessed from existing data. The flood risk is related to both rising still water levels and wave over-topping, the local topography, proximity to critical infrastructure and access routes, density and vulnerability of the local population and impact on the Islands" economy (mainly tourism and horticulture).

The standard of protection required will vary depending on the perceived risk and this in turn dictates the level of action appropriate for each defence.

3 The Study Area

The Isles of Scilly is an archipelago of over 200 low-lying granite islands and rocks located some 28 miles south west of Land"s End. The islands have a combined land mass of 16km^2.

There are 5 inhabited islands. The largest is St Mary"s with a land mass of 6.29km^2 and a population of 1670, out of a total of 2150 inhabitants on all of the islands. The other inhabited islands are Tresco, St Martin"s, St Agnes and Bryher. In the summer tourist season the population increases to 5000.

The Duchy of Cornwall owns most of the islands and, as a result, most properties are leasehold; only the built up area of Hugh Town is known to be freehold. Tresco is let in its entirety to the Tresco Trust, whilst any uninhabited islands or untenanted land is leased to the Isles of Scilly Wildlife Trust.

The Isles of Scilly Council (IoS) is the smallest unitary authority in England and Wales.

On four out of five of the populated islands potable water supply and sewage treatment are private – mainly boreholes and septic tanks. On St Mary"s, the water supply and sewage disposal is public with the IoS Council acting as an undertaker; a unique position in England and Wales since water privatisation.

4 Geology and Geomorphology

The solid geology of the islands is granite. The granite is part of a huge batholith stretching from Dartmoor to the submarine outcrop of Haig Fras, some 100km to the WNW of the Isles of Scilly but only exposed in places where the overlying cover rocks have been stripped by weathering and erosion.

The maximum glacial limit during the Quartenary reached as far south as the north coast of the of the Isles of Scilly, eroding the rocks over which it passed and depositing glacial tills (sand, gravel and clay) at its limit. Periodic periglacial weathering of the granite during the Quaternary created granite tors and a weathered mantle around their bases. The result of granite weathering and erosion of low cliffs and platforms takes two forms: an angular head and the production of much sand which is often blown up into small ridges and dunes.

During the interglacial period, when the climate was warmer, raised beaches formed around the islands as a result of relatively high sea levels. There are traces of raised beaches or platforms at 3 to 8m above the present sea level. Sub-marine contours around the archipelago show clearly that the whole group of islands is the result of the erosion and submergence of the once continuous granite batholiths. There is evidence to suggest that the archipelago is still sinking.

Large tracts of shoreline are dominated by rugged and steep sea cliffs which plunge into the sea with little or no inter-tidal area. The geomorphology of the coastline is characterised by hard, craggy cliffs, resistant headlands and bays containing wide sandy beaches formed from sand, gravels or cobbles and areas of both static and mobile dunes.

The islands have low cliffs of unconsolidated head material, known locally as „ram", overlying the granite and which are prone to erosion. They are positioned immediately behind many of the beaches and foreshores and are almost all actively eroding and retreating landward. Examples were noted at the eastern end of Porthcressa, where the coastal footpath has had to be closed, at Porthloo beneath the residential properties on the north side of the bay and at Old Town Beach, south of the church on the west side of the bay.

Figure 1: Ram cliff at Porthloo threatening property above (July 2011)

Figure 2: Ram Cliff east side of Porth Cressa, below allotments where coastal footpath has been diverted inland (July 2011)

Given their location, some 28 miles off the south west coast of Cornwall, the islands are subject to a very high-energy wave climate. There are, however, sheltered locations within the archipelago where the accumulation of sand has occurred leading to the formation of significant size beaches.

5 Physical Coastal Processes

5.1 Wave Climate

According to the latest Shoreline Management Plan, St Mary‟s is very exposed to Atlantic waves and swell from the west, south and east. It is sheltered from the north west by Tresco and Bryher. The annual 10% exceedance wave height is likely to be around 3.0 to 3.5m.

Tresco is sheltered from the extremes of the Atlantic wave climate along all but its north facing shoreline.

Bryher is more exposed, particularly along its indented west coast. The annual 10% exceedance wave height to the north west is likely to be around 3.0m to 3.5m.

St Martin‟s is exposed to waves and swell from the north west, north and north east. It is very sheltered along its south and south facing shorelines and this is the reason why beaches of sediment have established. The annual 10% exceedance wave height to the north is likely to be around 3.0m to 3.5m.

St Agnes is very exposed to the Atlantic wave climate from most directions although some shelter is provided to the west from uninhabited islands and islets. The annual 10% exceedance wave height off-shore is likely to be around 3.0m to 3.5m.

5.2 Tidal Flow

The mean spring tidal range at St Mary‟s is 4.9m. Tidal currents are not as influential on shoreline morphology as the wave climate, but can attain significant velocities in the narrow channels between the islands.

5.3 Processes

The pattern of sediment transport around St Mary‟s tends to be from north to south (Futurecoast 2002) in response to tidal currents. Wave energy drives transport from both the west and east which tends to counteract the tidal current transport. Generally, there is no dominant direction of net movement, due to the exposure of the islands from all directions.

The northern tip of St Mary‟s, Bar Point, has a significant sub-tidal bar (Crow Bar) extending out from it in a north-westerly direction. This bar is a focus for near-shore wave and tidal transport.

On St Martin‟s, finer sediment is evident along the sheltered south and south western shores where significant beaches have formed.

Net accumulation of finer sand and sediments is evident along the sheltered east, south and west shores of Tresco.

Bryher displays beaches along its sheltered east coast.

Sediment accumulations exist at Periglis Cove, Porth Conger and Porth Killier on St Agnes. There is no recognisable trend for sediment transport due to exposure to

waves and tidal currents from many directions. Periodically the sand bar between St Agnes and Gugh is washed away during storms but it re-establishes itself during calmer periods in the same position.

The SMP2 considers how the coastline of the Isles of Scilly would evolve in the absence of formal defences. Generally the granite exposures will remain resistant to erosion and thus help to maintain the general form and behaviour of the coastline over the next century. However, the lower lying inter-tidal areas will be more sensitive to increases in sea level and any increase in wave energy received at the shoreline. These areas will become more vulnerable to over-topping, over-wash or breach. Beaches that are constrained by the defended or developed nature of their backshore and immediate hinterland, may be subject to erosion of the shoreface, lowering of beach levels and loss of inter-tidal area. This would be applicable at Porthcressa and Town Beach, Hugh Town and at Old Town Bay.

Potential baseline erosion rates have been quoted in SMP2 as follows:

Location	Historic recession rate (m/100 year)		Projected 100 year erosion rate (m)	
	Lower	Upper	Lower	Upper
Old Town, St Mary's	10	20	17	37.8
Porthloo, St Mary's	10	15	15.2	28.4
Gugh, St Agnes	-	-	5.6	14
Lower Town, St Agnes	8	12	11.4	20.8
The Town, Bryher	12	12	13.8	21.7
Middle Carn, Bryher	22	32	21.1	30.7
East coast, Tresco	15	15	21.8	33
Skirt Island, Tresco	13	17	18.1	30.3
New Grimsby, Tresco	30	30	34.4	54.4
Chapel Down, St Martins	15	15	18.1	23.7
Higher Town, St Martins	27	33	30.9	59.8

(Sea level rise assumed rates: 0.06m to year 2025; 0.34m to year 2055; 0.96 to year 2105)

Table 1: Potential baseline erosion rates as quoted in SMP2

6 Local Topography and Infrastructure

All of the islands are relatively low lying. St Marys has elevations up to 45 m AOD, Tresco, St Martin‟s and Bryher have elevations up to 42 to 44m AOD, whilst St Agnes is slightly lower at 30m AOD.

The majority of the population is focused in and around Hugh Town, in the south west corner of St Mary‟s. The development sits on a sand isthmus separating Buzza Hill and the bulk of St Mary‟s to the east from the Garrison to the west. At its narrowest point between Town Beach (to the north) and Little Carn, Porthcressa (to the south), the width is only 130m, measured from the top of both beaches.

Figure 3: Looking down over Hugh Town from the Garrison, with Town Beach on the left (north) and Porthcressa on the right (south)

Figure 4: Hugh Town nestled on the sand isthmus between the Garrison and Buzza Hill

Figure 5: Bench mark in the centre of Hugh Town at 2 feet AOD

The second highest concentration of the population is at Old Town on the south side of St Mary‟s, and separated from Hugh Town to the west by Peninnis Head.

Smallholdings and individual properties are scattered around the rest of St Mary‟s, connected to Hugh Town by predominantly single track roads, although some are classed as A roads.

The airport is located on a granite headland on the south side of St Mary‟s at an elevation of 36m. It is not considered to be at risk from flooding or coastal erosion. A new runway was constructed in 1990 which now permits larger fixed wing aircraft (twin-engined otter) to land, enhancing tourism on the islands.

The main supplies for the island are brought in via The Quay at Hugh Town and then distributed around St Mary‟s or to the off islands. The light house at the end of the Quay was demolished during the December 1989 storm. The Quay protects the harbour on the north side of Hugh Town and, in part, Town Beach.

The hospital and electric power station both lie on higher ground on the east side of Hugh Town. There is an industrial estate and council depot located behind the beach at Porth Mellon. This is also the site for the island‟s waste incinerator.

The population on Tresco is focused around Old Grimsby on the north east side of the island and New Grimsby on the north west side. The latter is relatively sheltered by Bryher lying immediately to the west. Tresco Abbey is located in the southern half of the island close to Abbey Pool. This is also where the heliport is located.

Figure 6: The channel separating Tresco from Bryher (in the background)

On Bryher and St Agnes the population lies within the central higher areas of the islands. St Agnes is connected to Gugh, to the east, by a sand bar which is exposed at low tides. Both Bryher and St Agnes are exposed to Atlantic storms being located on the west side of the archipelago.

St Martin‟s is a little more sheltered, lying in the lee of Tresco in terms of the prevailing south westerly storm direction. Here a ridge runs east to west along the centre of the island and the main road runs parallel but to the south of it. The main settlements at Lower Town (on the west side), Middle Town and Higher Town (east side) follow this road.

The Isles of Scilly are recognised as an Area of Outstanding Natural Beauty. The islands also fall within a Natural Area, originally defined by English Nature to conserve nature in England. The Natural Area extends for a 12 mile radius around the archipelago. The islands‟ relatively isolated location, long history of human occupation and extreme maritime climate have resulted in the development of an island complex of international wildlife interest.

The entire coastal and marine zone is also designated a Special Area of Conservation (SAC). There are discrete Special Protection Areas (SPAs) and Ramsar wetland site designations on all islands apart from St Mary‟s. There are many Sites of Special Scientific Interest (SSSIs) throughout the archipelago for a range of biologically and geologically important interest features.

The main industry on the islands is tourism and recreation. Visitors start arriving in April for the bird watching season. Most tourists stay on St Mary‟s but hotels have been constructed on Tresco at Old Grimsby, on Bryher at Great Popplestone (to the west) and on St Martin‟s in Lower Town.

Due to the mild climate the islands have also profited from horticulture, in particularly bulb growing, although the supporting topsoil is relatively thin and poor in nutrients. High hedges help to protect the land from the prevailing winds.

The Isles of Scilly also profit from the historic environment with Bronze Age barrows, Iron Age hill forts, Neolithic stone circles, quoits and cairns prevalent on

most of the main islands. There are 230 Scheduled Monuments on the Isles of Scilly, the highest density per hectare of any English Authority.

Construction of the Garrison on St Mary‟s was begun around 1600 to protect the islands and harbour from invasion. The Garrison walls remain a valuable asset for English Heritage who are keen to see them protected against the risk of erosion.

7 Hydrology and Water Supply

There are no main rivers or ordinary watercourses on the islands. St Marys has two inland freshwater wetland areas, one at Lower Moor, above Old Town and the second at Higher Moor, above Porth Hellick. Both are predominantly groundwater fed but have small surface water run-off contributions from the local catchment area. Both wetland areas are SSSIs. There are remains of peat cuts and baulks, relating to when the mires served as a valuable source of fuel.

The Lower Moor catchment is relatively flat, originating to the east of Porth Mellon at 5m AOD, and sits below the level of residential development to the east (Hugh Town) and to the south east (Old Town).

Surplus water from the Lower Moor drains into Old Town Bay via a small leat. At high tide seawater makes its way into the leat, even though there is a flap valve near the downstream end of the system. This was witnessed during the site visit. This means that the Lower Moor water body is saline.

Figure 7: Lower Moor sitting below property on the east side of Hugh Town

The Higher Moor catchment is steeper and originates at Holy Vale (12m AOD) close to the centre of St Mary‟s.

Figure 8: Higher Moor in the background, draining to Porth Hellick

Surplus water drains south from Higher Moor to the Porth Hellick bay in a small, narrow channel. At Higher Moor, the water level in Porth Hellick Pool is kept artificially high to ensure that there is no saline intrusion.

There is a much smaller surface water catchment area draining towards Watermill Cove to the north east of St Mary"s. This would appear to originate at the two road side "duck" ponds to the east of Telegraph Hill and at a level of over 35m AOD. Other than the small duck ponds there is little attenuation along this system. There is a basic silt trap just as the runoff enters the cove.

Figure 9: One of two "duck" ponds adjacent to the highway collecting surface water runoff and draining to Windmill Cove via roadside drainage ditches

Water supply for St Marys originates from the groundwater abstraction wells at both Higher Moor and to a lesser extent from those at Lower Moor. There are 5

borehole abstraction wells: Venns, Carrs and Hales at Higher Moor and Rocky Hill and Joneys at Lower Moor. Carrs Well is only used in periods of high demand. The water supply for St Mary"s is supplemented in the peak season by the De-salination Plant, located on the east side of the island. Use of the De-salination plant during the off-season allows the groundwater levels to re-charge and reduces the risk of saline intrusion.

Figure 10: St Mary's De-salination Plant, built in 1993

On Tresco, there is the freshwater wetland area comprising Great Pool and Abbey Pool adjacent to the Priory and located in the southern half of the island. Although the two water bodies are linked only the Great Pool is designated a SSSI.

Figure 11 - The Abbey Pool, Tresco

Figure 12: The Great Pool, sitting in a natural depression and draining west (right) towards Farm Beach, south of New Grimsby

On St Agnes there is the Big Pool SSSI in the north west corner of the island, protected from the north and west by formal defences. The island depends on the aquifer for its fresh water supplies via borehole abstraction.

Figure 13: Big Pool, St Agnes with Lower Town in the background

There is a small pool of water, known as Great Pool, located on the west coast of Bryher, close to the hotel and out-falling to Great Porth. Saline intrusion was noted during the inspection due to the sand deposits at the mouth of the pool. There are three water abstraction boreholes on Bryher supplying fresh water to the island. These are all located just to the north east of Great Pool.

Figure 14: Great Pool on the west side of Bryher

There are no freshwater waterbodies on St Martin‟s.

There are three reservoirs on St Mary‟s all in the form of above or below ground storage tanks. Water extracted from groundwater boreholes or sea water treated at the de-salination plant is all treated and distributed via the water pumping station above Higher Moor.

Figure 15: Water Pumping Station above Higher Moor

From here potable water is distributed around St Mary‟s via 3 reservoirs. All water passes through the reservoir at Telegraph Hill. The reservoir is in three parts; the original below ground concrete tank and two more recent cylindrical steel tanks buried to roof height level. Their combined capacity is 200,000 gallons (909m^3).

From the Telegraph Hill reservoir water is either fed to the Buzza Hill reservoir (east) of Hugh Town or to the Garrison reservoir or directly to consumers elsewhere on the island. The Buzza Hill reservoir is a partially buried concrete

tank and can hold up to 60,000 gallons. However, due to a leak, the capacity is held at 37,000 gallons (168m^3), below the level of the leak.

On the Garrison, the reservoir is an above ground tank with a dividing wall. It is believed to hold 21,000 gallons (95.5m^3). In the event of a catastrophic failure, the Isles of Scilly Council believe that the water would run into the sea without impacting upon any properties. In such an event the Garrison‟s water supply would have to be fed from the Buzza Hill reservoir, which currently feeds the Porthcressa side of Hugh Town up to Sally Port.

Given their storage capacity and position in relation to local ground levels none of these reservoirs fall under the Reservoirs Act 1975 or the Flood and Water Management Act 2010, which looks at risk to human life from a breach of a reservoir over 25,000m^3 in size, to be reduced to 15,000m^3 under the 2010 Act.

8 Drainage

Only Hugh Town and Old Town, St Mary‟s have a formal piped foul drainage system. All other properties and small holdings rely on septic tanks.

The Hugh Town foul sewerage system is a gravity system and extends as far as the Hospital to the south east and the trading estate to the north east. The system drains to a pumping station in Porthcressa View. The building is now surrounded by residential development and the rising main which takes the effluent out to Morning Point, on the south east corner of the Garrison, has been built over. This makes any future up-grade at this location very difficult.

Figure 16: Sewage Pumping Station, in the heart of Hugh Town

Figure 17: Discharge of foul effluent at Morning Point with St Agnes in the background

Due to the low lying nature of Hugh Town there is a problem of low velocities in the foul system due to slack gradients. This generally means that some sections of the system are prone to blockage. This is often the case on the run from the Mermaid Public House which is held up when the steeper run from the Garrison, which it meets in Hugh Street, by the paper shop, is running at full capacity.

These blockages are not recorded other than via the DLO's timesheets for clearance work.

There have been no known sewer collapses.

There is known to be infiltration into the sewerage system, but the extent and proportion that is saline is not known.

The foul sewer runs along the top of Town Beach and here the manholes have been raised and bolted down to try and avoid the system being swamped by high tides.

Figure 18: Foul sewer running along the top of Town Beach

A bio-bubble treatment plant serves Old Town and discharges final effluent into the leat and to Old Town Beach. From this bio-bubble treatment plant, excess effluent is also pumped via a rising main to the Hugh Town foul sewerage system before being pumped to the discharge point at Morning Point.

Only Hugh Town has a surface water drainage system with numerous outfalls on Town and Porthcressa Beaches.

Figure 19: Surface water outfall onto Town Beach behind the Atlantic Hotel, Hugh Street

Inundation of the surface water system by seawater occurs regularly given that the run crosses the top of Town Beach. Manholes in this location were reported to be filled with sand. This is along the downstream end of the surface water run so is unlikely to create an immediate flood risk.

Flooding of Hugh Street via the surface water system is not that uncommon either during particularly high tides, with seawater coming up through the road gullies near the Atlantic Hotel. However, no property flooding has been reported as a result. It was noted that the flap valve on the Town Beach surface water outfall was detached from the end of the pipe and the pipe was cracked a short distance back from the end.

Figure 20: Hugh Street, adjacent to the Atlantic Hotel.

A further issue occurs in this location. It is possible for foul effluent to back up and flow into the surface water system at the slipway by the Atlantic Hotel, as part of an informal Combined Sewer Overflow arrangement, and discharge onto Town Beach via the existing but fractured surface water outfall.

9 Flood Defences

A number of formal defence structures, including seawalls, embankments and revetments are located on St Mary"s. These include:

- The 1995 seawall and rock armour at Porthcressa, Hugh Town;
- The 1930s seawall at Little Porth, forming a continuation of the defence at Porthcressa;
- The seawall at Old Town, originally built following storms in 1962, but re-built at its eastern end in 2000 following settlement damage;
- The revetment system and rock armour at Porth Minick, also protecting the hinterland around Old Town, constructed in 2000;
- The seawall at Town Beach, likely to date back to the 1930s.

There is also the quay and harbour walls that provide protection to the north side of Hugh Town and Town Beach. In particular the walls that protect the vehicular access to the quay are listed on the Environment Agency"s National Flood and Coastal Defence Database (NFCDD, Ref No 690/8908/01). Due to their extent and access requirements a detailed inspection of these walls was not undertaken during July"s visit.

Please refer to Drawing Nos 217862-001 to 217862-006 in Appendix A showing the location of flood defences and the areas of flood risk for each of the five inhabited islands.

Appendix E includes an extract from the EA"s NFCDD, listing flood defence assets on the Isles of Scilly.

Figure 21: Quay wall protecting vehicular access, Hugh Town

Figure 22: Quay wall, Hugh Town

Other formal defences on the islands include:

- A seawall and rock armour at the Island Hotel, Old Grimsby, Tresco. Believed to have been built in 2000 to halt erosion of a ram cliff undermining the hotel extension;
- An old seawall at the north end of Appletree Bay, Tresco;
- A seawall, concrete revetment reinforced embankments, rock armour and erosion control matting at Porth Killier, Porth Coose and Periglis on St Agnes, believed to have been built in 1996;
- An old seawall supplemented with rock armour in the 1990s at Great Popplestone, Bryher;

- A seawall built in the 1960s to protect the Old School House, Great Porth, Bryher, supplemented with rock armour in the 1990s; and
- A 500m long stone wall protecting the coastal path in Green Bay, Bryher.

Although not formal defences sand dunes to the rear of the following beaches on St Mary‟s help to provide a natural defence against coastal inundation:

- Porth Mellon;
- Porth Thomas;
- Porthloo;
- Porth Hellick.

Porthloo, Porth Mellon and Porth Hellick help to protect St Mary‟s groundwater supply from saline intrusion, whilst Porth Mellon also provides a defence to St Mary‟s industrial estate and the waste incinerator.

It should be noted that the defence at Porth Hellick is included on the EA‟s NFCDD database, which suggests that it is man-made.

There are no formal defence structures on St Martin‟s although there would appear to have been some recent revetment works undertaken in front of the hotel but behind the quay wall at Lower Town.

Figure 23: Revetment works in front of the hotel at Lower Town, St Martin‟s

The Isles of Scilly Council are responsible for maintaining the defences at Porthcressa, Town Beach, Old Town and Porth Minick. All other defences are maintained by the Duchy of Cornwall Estate.

A budget is set aside by the Isles of Scilly Council specifically for the maintenance of flood defences. However, an annual figure was not forthcoming.

10 Flooding Mechanisms

The topography and general setting of the Isles of Scilly suggest that the main concern is coastal flooding rather than inland flooding with the main threat coming from the west and the Atlantic Ocean. This was confirmed by Neville Gardner at the meeting on the 18th July and is evident from a review of both Shoreline Management Plans.

Storm surges, when low pressure systems can create sea level rises of up to 1m over normal levels, originate deep in the Atlantic Ocean so the south west facing coastline is most exposed to the resulting storm impact. Defences need to resist both high water levels and the extreme wave climate resulting in over-topping as well as scour and loss of fines as material is drawn out with each receding wave.

The more sheltered coastlines remain at risk when high tides coincide with storm surges.

Flooding from the sea defences being over-topped is more likely to occur if particularly high tides coincide with bad weather conditions such as high winds and storm surges. High tides (spring tides) occur every month during new and full moon, with the largest tides a day or two after the full or new moon nearest to the equinoxes. The spring equinox is usually the 21st March, and the autumn equinox, the 23rd September.

According to the Council of the Isles of Scilly Shoreline Management Plan 1997 (SMP1), analysis of the 1989/90 storms by Proudman Oceanographic Laboratory (POL) indicated that the return period of the damaging storms were 1 in 50 years. The extreme water level for a return period of 50 years at St Mary‟s was calculated by POL to be 3.55 m AOD. For comparison, at the time, the Highest Astronomical Tide (HAT) was 3.3 m AOD and the Mean High Water Spring (MHWS) tide was 2.79 m AOD. It must be noted that the gauging station was destroyed during the 1989/90 storms and so these figures can only be taken as an approximation.

There is no historical evidence of surface water flooding on the islands. If high intensity rainfall events occurred, there used to be a build up of surface water at Rams Valley, behind Porthcressa, where there is a local depression. However, this has reportedly been resolved with the addition of a second, dual surface water pipe to double the discharge capacity. The outfall goes to Porthcressa Beach.

Figure 24: Rams Valley, Porthcressa. Generally the door thresholds are at street level in this locality

At Trewince, on the A3110 towards Telegraph Hill, there is a tendency for surface water runoff to be directed into the local fields and in so doing, debris picked up and carried by the flow, is deposited over a manhole cover. This is cleared by the DLO and does not result in any property flooding.

There is no highway drainage on the islands.

The Isles of Scilly Council is aware that at The Mermaid Public House flooding has occurred on more than one occasion. Located at the western extent of Town Beach, at times of tide-locking and excess surface water run-off, sewage has been forced back into the property through toilets located in the basement. This is primarily the result of a cross connection between the foul and surface water drainage systems close to the Atlantic Hotel which needs to be addressed as a matter of some urgency.

The risk from fluvial and pluvial flooding is considered to be very low. During periods of heavy rain, runoff is either attenuated in the Higher and Lower Moor areas, away from residential areas, or it finds its own way to the coast. In Hugh Town, it is of course possible for the surface water system to become tide locked during storm conditions. However, at these times, a greater risk will be posed by the risk of coastal flooding and over-topping. There is a potential low spot in the centre of Hugh Town, along Hugh Street and near the Mumford Paper Shop, where surface water ponding could occur. Given that the surface water system often backs up into Hugh Street from high tides and has not resulted in any property flooding, it is unlikely that ponding from surface water alone would result in property flooding.

At the depression in Rams Valley it would be advisable to review the capacity of the surface water system in the light of higher intensity rainfall events becoming more frequent.

Generally though, it is felt that surface water will make its way to the coast, before threatening development.

10.1 Historical Flood Records

Historical flood records from fluvial, pluvial or coastal flooding are very limited as there would appear to have been very few flooding incidents on the islands in recent times.

The concentration of critical infrastructure in such a low lying position as Hugh Town makes it very susceptible to storm surges, unusually high tides and in the future, increasing sea levels. Therefore it is remarkable that there have been no significant flooding incidents to date.

The flood event that took place between 16 and 17 December 1989 would appear to be the most notable. During this event the sea defences at Porthcressa, on the south side of Hugh Town, were damaged and significant erosion took place. At the same time the defences at Old Town and Porthloo were over-topped. It is believed that this event was followed shortly afterwards by two further events of the same magnitude in the early 1990s.

Figure 25: Porthcressa sea defences prior to the December 1989 storm event

Figure 26: Erosion behind the greenheart timber of the Porthcressa Sea Defences following the December 1989 storm event

Figure 27: Over-topping of the sea defences at Old Town, St Marys (December 1989). Sand bags were used to help prevent sea water running back to the nearby cottages. Now 1 tonne sandbags are deployed.

Figure 28: Old Town cottages susceptible to over-topping of the defences. It is understood that 1 or 2 properties were flooded in December 1989. The cottages in this vicinity have now been fitted with flood boards

Figure 29: Inundation of the land behind Porth Minick (December 1989)

Figure 30: Porthloo following the December 1989 flood event. A terrace of 6 properties was threatened and there was significant erosion of the ram cliff.

The Isles of Scilly Flood Plan, produced by the Devon, Cornwall and Isles of Scilly Flood Resilience Forum also makes reference to more recent flooding in 2005, whilst the Preliminary Flood Risk Assessment refers to flooding in October 2004. No further information on these potential flood incidents has been established.

Review of the first SMP also makes reference to storm events in 1962 damaging Porthcressa and on Bryher damaging the seawall at Popplestone/Great Pool during Easter 1994 and again in early 1995.

There would appear to be very few incidents of property flooding. The cottages on the east side of Old Town Bay, shown in Figure 27, are susceptible but are now fitted with flood boards and the 1 tonne sandbags deployed add a further line of defence in the event of a bad weather/high tide warning. These sand bags also help to protect the more recent properties in Trench Lane which sit on lower ground.

Figure 31: Properties in Trench Lane, Old Town, on lower lying ground behind the sea wall.

The photographs below show the vulnerability of lower lying properties in Porthcressa during bad weather conditions.

Figure 32: Storm event at Porthcressa with the properties shown below under threat

Figure 33: Low lying properties behind the sea defences at Porthcressa

On the north side of Hugh Town, Town Beach is less susceptible to storms battering the coast line. However, given the proximity of the properties to the beach there is a risk of still water flooding if a high tide coincides with a storm surge.

Figure 34: Properties adjoining Town Beach, Hugh Town. The vegetation is indicative that a number of properties are currently outside the tidal zone. However, this may change with rising sea levels.

Amazingly there is only one record of property flooding on Town Beach due to the low threshold level of a window installed for a basement.

Figure 35: Town Beach, St Marys. Low window threshold has increased risk of property flooding

High tides sometimes leave ponding on the Thoroughfare which runs behind these properties backing onto Town Beach and parallel with Hugh Street. However, no properties are believed to have been affected.

Figure 36: High tides inundating the Thoroughfare behind Town Beach

High tides sometimes inundate Hugh Street, via the slipway and surface water drainage system at the Atlantic Hotel, formerly the Custom House. Both these inundation routes have since been fitted with stop logs to help prevent serious inundation but the surface water drainage system remains a flood route, until the flap valve and discharge pipe are repaired.

Figure 37: Inundation of Hugh Street via the Atlantic Hotel slipway and surface water drainage system during a high tide

10.2 Flood Mapping and Prediction of Coastal Erosion

The Isles of Scilly have not been mapped for fluvial flood risk as there are no main rivers or ordinary watercourses on the Islands. Neither have they been included in the pluvial surface water mapping extents for the British Isles.

One other dataset available from the Environment Agency is the National Receptor Dataset (NRD). This relates to receptor vulnerability to flooding and provides details of social, economic, environmental and cultural receptors. Although the NRD does cover the Isles of Scilly its use is restricted by the lack of flood mapping data to help identify areas of risk.

The latest SMP2 would appear to include a 2105 200 year flood extent along with erosion risk zones, if there is no active intervention up to 2025, 2055 and 2105.

Extracts from the SMP2 would appear to show coastal inundation of the area behind Old Town, threatening the Lower Moor area.

In Hugh Town there is some coastal inundation, from Town Beach, likely to be via the Thoroughfare or Atlantic Hotel Slipway as discussed above.

11 Visual Inspection of Flood Defences

The flood defences inspected between 18 and 22 July are described below. The inspections followed the Environment Agency‟s Condition Assessment Manual that contains procedures for the grading of flood defences according to structural condition. These are detailed below:

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

Table 2: Grading of flood defences according to Environment Agency‟s Condition Assessment Manual

A summary is provided for each asset inspected and where intervention is considered necessary, costs are provided in terms of low, medium and high bands. These bands are defined as:

Low – Less than £100,000

Medium – Between £100,000 and £500,000

High – Greater than £500,000

For cross reference, the recommendations from the latest SMP have also been included.

11.1 St Mary’s

St Mary‟s is the most populated island with the main concentration focused in Hugh Town and to a lesser extent, Old Town. Given that Hugh Town is so low lying it is critical that this land remains defended.

Inundation would lead to flooding of a significant number of residential properties, including a care home, most of the commercial interests, the Town Hall, the Sewage Pumping Station and at least one electricity sub-station.

Inundation of Hugh Town would also lead to St Mary‟s Quay being cut off from the rest of the island. Most deliveries are brought to the islands by ship. Although the airport would still be functioning, being on the higher ground above Old Town, provision of supplies would be seriously hampered.

Hugh Town is currently protected by the Porthcressa sea defences and Town Beach defences. Porthcressa is most exposed to storm surges from the southwest. On the north side of Hugh Town, Town Beach is slightly more protected but is still susceptible if storm surges coincide with high tides.

Similarly, the Old Town sea defences provide some protection for the west side of Old Town as well as the new school development, whilst the Porth Minick

defences help to defend Old Town from the south. Both defences protect the island‟s water supply that is partly sourced from Lower Moor.

11.1.1 Porthcressa

11.1.1.1 Background Information

The original defence at Porthcressa dates back to the 1960s but was severely eroded during the December 1989 event. The erosion was most severe at the eastern end of Porthcressa and came very close to damaging the electric power cable and other services in the bank.

The Isles of Scilly Council effected temporary repair using gabion baskets to resist further storms, of significance those in 1990/91

A new defence was constructed in 1995 some 2m in front of the original defences and are as described in Section 16.1. The new defence comprises a stone faced reinforced concrete wall, 225m long and piled at 6m centres. The seawall is 1.6m high with its crest at 6.0m AOD. Toe protection is provided by an Armorflex cable tied concrete block revetment.

Figure 38: Construction of the defence at Porthcressa, showing the concrete revetment toe protection

At the same time a new slipway was constructed at Buzza Street. The design is sufficient to allow access to the beach for the Isles of Scilly Council‟s 22 tonne 360^{o} excavator for beach and revetment maintenance. South of the slipway, 90m of rock revetment was built to protect the exposed ram cliff from further erosion.

Sand transportation was noted as being a problem on the beach. Sand is often washed to the western end and has to be re-distributed.

Little Porth lies at the western end of Porthcressa and the stone wall is believed to have been constructed in the 1930s by the Duchy of Cornwall Estate, although it is now maintained by the Isles of Scilly Council. The far western end ties in with the Garrison wall. It is reported that seaweed often has to be cleared away from

the footpath immediately to the rear of this wall and from the roofs of the houses behind, the property thresholds sitting lower than the footpath level.

Figure 39: Little Porth, defence ties into Garrison wall

11.1.1.2 Visual Inspection Notes

Little Porth:

At the eastern end, at Little Carn, the wall starts off as a regular stone wall with mortared joints, the blocks being 410 mm long by 220 mm high and the wall 410mm in depth. The wall is approximately 1.5m to 2.0m high at the eastern end, increasing in height moving towards the Garrsion wall. The measured height will depend on the volume of sand deposited in front of it.

Figure 40: Sea wall at Little Porth

Figure 41: There is a footpath retained to the rear of the wall and this separates the defence from the property boundaries.

Figure 42: Stone buttresses are visible along the rear of the wall at its eastern end

Figure 43: Limited spalling on the face of the stone blocks

Figure 44: Joints sealed with mastic filler. Where the mastic filler is missing, vegetation is starting to become established

Vegetation is becoming established in small voids where either the mortar or mastic filler is missing.

Towards the Garrison wall end the construction changes to what are possibly concrete filled pre-cast concrete blocks.

Figure 45: Change of construction to pre-cast concrete blocks

Figure 46: Change of construction from stone to concrete blocks

The toe of this section of the wall is visible as mass concrete, poured directly onto the rocky outcrop on which the wall is founded. The toe is further protected by natural rock revetment.

There is some loss of mortar and spalling at the face. Again vegetation is developing where there are small voids. There is evidence of re-pointing of the mortar joints. Very close to where the wall ties into the Garrison wall, the concrete block wall has been built around a rock intrusion and a void has formed beneath it.

Judging by the vegetation at the toe of this section of wall, it would appear that it is outside of the mean high tide level. However, there is potential for this void to open up during storm conditions which could impact on the integrity of the rest of the wall.

Figure 47: Wall ties into Garrison wall and is protected at toe by natural stone revetment. The mass concrete foundation is also visible.

Figure 48: Wall built around rock intrusion with void below

Porthcressa:

The visible element of this wall is the random block stone wall with mortared joints, topped with 600mm x 150mm deep concrete copings. The wall is jointed at regular intervals, filled with mastic.

Figure 49: The seawall constructed in 1995, some 2m in front of the original defences

Figure 50: Joints, at approximately 20m spacing, sealed with a mastic filler

Sand transportation along the beach was visible, with significant accumulations noted at the western end.

Figure 51: Bottom end of wooden steps buried in sand transported along the beach

To the rear of the wall, the ground level is raised further and retained by a dry jointed stone wall. The total width of the defence, between the top of the beach and road behind is approximately 30 – 40 m.

Figure 52: Above the seawall is a dry jointed stone wall

The surface water outfall from Rams Valley discharges onto the beach at the eastern end of the Bay.

Figure 53: The outfall from the Rams Valley catchment discharges to the beach

Figure 54: Looking from Rams Valley up towards Porthcressa. Any over topping of the wall would run back down towards Rams Valley.

Figure 55: The main distribution cable to the Power Station runs beneath the wall

Figure 56: Rock armour placed at the eastern end as part of the 1995 scheme. Eroding ram cliffs are visible in the background

Figure 57: Any over-topping of the wall at Porthcressa will run directly into the centre of Hugh Town

Figure 58: Development to the rear of the Porthcressa defences

11.1.1.3 Summary and Recommendations

Consequence of failure	High: Residential and commercial centre of Hugh Town; Foul sewage PS; Electricity power transmission cable; Quay cut off from rest of St Mary"s
Condition Grade (see Table 2)	Little Porth – 3; Porthcressa - 1
Short term Intervention	Little Porth: Address void at western end; Continue to re-point as required.
Cost	Low
SMP2	Narrow inter-tidal zone subject to coastal squeeze effects and long term sustainability of current shoreline position is unlikely. Recession mapping indicates up to 20m of erosion. Short term: Hold the Line; Monitor coastal squeeze impacts; Long term: Managed realignment. At this location this may mean widening at some points to protect Porthcressa and Buzza Roads and to avoid the overall narrowing of the isthmus
	Occurrence of a significantly large storm exceeding the design standards of the Porthcressa defences represents the greatest magnitude of immediate risk to Hugh Town. Consider scheme to route over-topping through to a discharge point in the harbour.
	Land use planning – area to be identified as Coastal Change Management Area
	Requirement for a detailed strategy for the Hugh Town area identified. To consider the long term implications of climate change for the whole settlement.

Table 3: Summary and Recommendations for Porthcressa

11.1.2 Old Town

11.1.2.1 Background Information

The original sea defence was built in 1963 and is believed to be reinforced concrete and masonry. It is understood that the original reinforced concrete seawall is tied to the splash wall on the far side of the road.

Work was undertaken in 2000 after the existing masonry wall began to settle at the eastern end, closest to Old Town. This caused the wall to start cracking and fines were washed out from behind impacting on the road above.

The work in 2000 extended the wall around the eastern end of the bay to a slip and replaced the masonry wall with a mass concrete stone faced wall.

During the course of the works in 2000, peat was discovered beneath the foundations of the wall. This is likely to have contributed to its settlement.

The defences help to protect Old Town and the Lower Moor area. However, wave over-topping is not uncommon and, in the event of a severe storm, 1 tonne sand bags are placed across the road to prevent run-off into the adjacent Trench Lane estate, the Cafe and adjacent cottages.

The leat from Lower Moor outfalls at this location. The outfall pipe discharges some distance down the beach and is protected by stone revetment. Although there is a non-return valve on the pipe network, set back from the outfall in a manhole beneath the road to Trench Lane, seawater is known to flow up into the leat with each high tide. Potentially seawater may also be seeping beneath the wall in to the road foundations, although this needs to be proven.

Figure 59: Location of sand bag defence deployed in preparation of a severe storm. Leat from Lower Moor is culverted and runs beneath Trench Lane and under the road to the Bay. A non-return valve is located on the system in a manhole at the junction with Trench Lane

Figure 60: Trench Lane looking back up towards the road and Old Town Bay

Figure 61: Ponding behind the wall at location of works in 2000

Figure 62: Discharge pipe from the Lower Moor area, protected by stone revetment

11.1.2.2 Visual Inspection Notes

The defences at Old Town can be broken down into the following elements, working from east to west around the bay:

1. Mass concrete wall with stone cladding built in 2000;
2. Reinforced concrete wall built in 1963, tied to splash wall to rear of road;
3. Natural sand dune with some rock revetment;
4. A concrete wall, age unknown, built behind an original but now dilapidated seawall;
5. Stone wall with mortared joints and addition of a concrete toe at a later date; and
6. Dry stone wall.

Figure 63: Mass concrete wall with stone cladding and the 1963 reinforced concrete wall retaining the road

Figure 64: Dune with some rock revetment

Figure 65: Concrete wall built behind a previous seawall

Figure 66: Stone wall with toe reinforced with concrete

Figure 67: Dry stone wall beneath the Church

Figure 68: Erosion of the loose head deposits at far western end of dry stone wall, beneath Church

Mass concrete wall with stone cladding built in 2000:

Mastic filler was noted to be missing from the joints and vegetation was becoming established. A number of the stones facing the concrete were displaying fracture lines.

It would appear that the wall is toed into the rock outcrop at the far eastern end of the bay. Adjacent to the slip, a void is developing at the toe, where the stone wall supports the road down to Tolman Head. It is assumed that the mass concrete wall is sufficiently keyed in at foundation level, to ensure the integrity of the wall. However, it would be beneficial to seal the void to help ensure that the stone facing remains intact in this location.

Figure 69: Void forming at toe of stone work

Figure 70: Mastic filler coming away from joints

Figure 71: Mastic filler missing completely from joint

Figure 72: Fracture lines appearing on stone cladding and re-pointing repairs notable

Figure 73: Some loss of mortar

Reinforced concrete wall built in 1963, tied to splash wall to rear of road:

The wall is reported to be reinforced concrete and retains the road between Hugh Town and Old Town. The wall forms the left hand channel of the road. The wall is approximately 450mm deep and sits approximately 400mm above road level. There are open square drainage outlets at regular intervals along the wall to ensure surface water and any over-topping can drain back onto the beach. Generally at each of these locations the road would appear to have been re-surfaced.

The wall is jointed at regular intervals (approximately 25m) but the mastic filler from most joints is missing. There is minor spalling at some of these joints, and to a lesser extent at the toe of the wall.

There is a splash wall running along the far side of the road, helping to protect properties in Trench Lane and the lower lying grazing land. It is believed that the two structures are tied together. A dry stone wall lies behind above and behind this splash wall. At the western end of the bay the road level drops down towards two dwellings and the new school building, which is nearing completion.

There is a bench mark on the western end of the wall.

Figure 74: Wall retaining the road which runs between Hugh Town and Old Town. Note repairs to road surface adjacent to the drain outlets

Figure 75: Drainage outlet onto beach. Mastic filler missing from joints

Figure 76: Minor spalling at joint

Figure 77: Splash wall on far side of road, running the length of the seawall.

Natural sand dune with some rock revetment:

At the end of the reinforced concrete wall there is a mixture of stone revetment and vegetated sand dune, forming protection to a house known as "Nowhere", from where "Sea Safaris" are run, some allotments, and the main road leading to the new school building and Hugh Town.

The coastal path runs behind this section of the beach.

Judging by the vegetation, high tide does not reach this revetment/sand dune on a daily basis.

Figure 78: Rock revetment at the western end of Old Town Bay

Figure 79: Rock revetment and sand dune with a cover of vegetation

Concrete wall, age unknown, built behind an original but now dilapidated seawall:

The wall is jointed at regular intervals, the mastic filler is beginning to deteriorate, allowing vegetation to establish.

Figure 80: Previous flood wall, now dilapidated, acts as toe protection. There is a benchmark at this eastern end of the wall.

The original concrete pour lines are visible in the face of the wall. There is a concrete toe which is protected by rock armour. The aggregate is exposed at locations along the toe. This may be due to poor vibration of the concrete during the original pour.

Figure 81: Concrete wall running to the rear of a previous wall

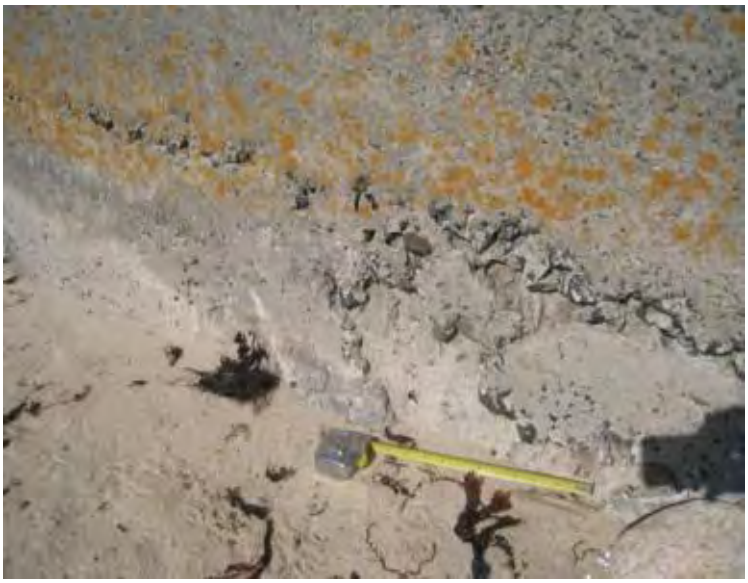


Figure 82: Exposed aggregate at toe

Figure 83: Concrete wall. Joints and pour lines visible. Toe is protected by rock revetment

Figure 84: Only one location of spalling was noted, at the western end

There are drainage holes in the wall, to drain the coastal path retained by the wall. However, the holes lie above the path level, so there is likely to be ponding.

Figure 85: The coastal path runs to the rear of the wall leading to the Church and Peninnis Head

Stone wall with mortared joints and addition of a concrete toe at a later date:

It is likely that the concrete toe for this stone wall was poured when the adjacent concrete wall was built. The height of the concrete toe reduces moving westwards around the bay. The stone work has mortared joints at the end closest to the bay but becomes dry jointed at its far end.

Figure 86: Stone wall with concrete toe

Figure 87: Signs of re-pointing and repair to stone work

Figure 88: Spalling at joint and exposed aggregate finish of toe

Figure 89: Voids beginning to open up where shape of stone makes mortar joints difficult to install

Dry stone wall:

Right at the far western end of the bay, beneath the Church graveyard, a dry stone wall supports the coastal path.

Figure 90: Coastal path, running very close to the top of the dry stone wall

Although not subject to daily high tides, erosion is threatening this end of the wall and the coastal path above.

Figure 91: Erosion of cliff to rear of and adjacent to stone wall

Further incidents of erosion were noted in Old Town Bay. Continuing around towards Peninnis Head, the ram cliff is retreating and a makeshift gabion basket/mattress has been installed to try and halt the retreat.

Figure 92: Retreating coastline, Old Town Bay

On the east side of Old Town Bay, a repair was noted in the cliff edge supporting the road to Tolman Head. This repair, concrete bagwork, has been undertaken by the Duchy of Cornwall Estate who is responsible for the maintenance of this road.

Figure 93: Coastline around the eastern end of Old Town Bay, with concrete bag repair in the centre of the picture

11.1.2.3 Summary and Recommendations

Consequence of failure	High: Residential area of Old Town; New school building; Bio Bubble and PS; Lower Moor area; Main road connecting Hugh Town to Old Town
Condition Grade (See Table 2)	2 (All elements)
Works Proposed by School Developer (August 2011)	Timber baulks to be added to original 1960"s seawall, adjacent to the road, to increase the height of the defence by 300mm
Short term Intervention	Address void at western end in stone cladding face; Continue to re-point as required; Re-seal joints to protect them from future spalling; Install new non-return valve on outfall from Lower Moor Leat to reduce saline intrusion.
Cost	Low
Medium Term	Investigate extent of seepage through road and beneath defence at location of Lower Moor Leat outfall, particularly with predicted sea level rises and increased wave run up.
Cost	Low for investigation; Medium – for any potential remediation
Long Term Intervention: SMP2	Erosional pressure and risk of inundation of Lower Moor Area dictate that this is one of the most pressurised frontages on the Isles of Scilly. Recession mapping indicates up to 30m of erosion by 2105. Short term: Hold the Line; Monitor sea level rise and changes to beach morphology; Long term: Managed realignment to give a less pressured defensive line. At this location this may mean re-aligning the road or up-grading an alternative higher route. It should be noted that the existing alternative route is threatened by coastal squeeze at Porth Mellon.
	The latest flood mapping (2105 200 year) does appear to show still water inundation reaching Trench Lane and the Lower Moor area, including the school building. This needs further investigation to determine the remedial works required to potentially raise the defence level. In the first instance the modelling should be reviewed with the addition of 300mm to the defence level, based on the works proposed this summer.

Table 4: Summary and Recommendations for Old Town

11.1.3 Town Beach

11.1.3.1 Background Information

Town Beach is not so susceptible to the Isles of Scilly wave climate, as it is in part protected by the harbour wall and its northerly aspect means that it is sheltered from the prevailing Atlantic storms.

There is, however, potential for still water over-topping if a high tide coincides with a rise in sea level brought about by a storm surge.

The defence extends from Holgate‟s Green, past the Rechabite Slip and out towards the Lifeboat Station. The age of the defence is not known, but it is likely to date back to the 1930s when the harbour was developed and Holgate‟s Hotel sat on the site of Holgate‟s Green.

The wall running out to the Lifeboat Station may date back as far as 1899, when the lifeboat station was built.

Repair works are due to take place this autumn over a 224m length of the wall. The proposed work includes re-pointing and filling of voids that have been formed by the waves pulling out the fines to the rear of the wall. The works are being funded by Defra and a spend of between £60k to £80k is forecast.

It was noted that the wall has no proper toe to it, so undermining is likely to be a long term problem.

Figure 94: Seawall at Town Beach, St Mary's

The road that runs along The Strande and Lower Strande is founded on sand, so loss of the defence would quickly lead to rapid erosion of the infrastructure behind and have a serious consequence on access and utilities besides the residential and commercial properties.

Figure 95: Properties over-looking Town Beach. Door thresholds are set at street level so once over-topping occurs the risk of property flooding is high.

11.1.3.2 Visual Inspection Notes

The wall comprises random stone blocks with mortar joints. Between the access steps, at the eastern end of the wall, out to the Lifeboat Station, toe protection has been provided but this is now severely damaged and fractured. Voids have formed at the toe and up to 1.6m above toe level. Some voids are nearly a metre deep.

Figure 96: Stone sea wall running out to Lifeboat Station

Figure 97: Toe of wall has failed in places

Figure 98: Voids are common along this length, from toe level up to 1.6m above toe level

Figure 99: Undermining of toe

Voids continue to be a problem moving in a westerly direction towards the Rechabite Slip. There is a splash wall above this section of the seawall, which reduces in height from approximately 2.5m to 1.5m towards the Rechabite Slip.

Figure 100: Secondary splash wall

Figure 101: Evidence of previous re-pointing. Protection of the toe of the sea wall appears to stop. The splash wall can be seen above the sea wall.

Figure 102: Further voids developing beneath the concrete cap

Figure 103: Void measured to be at least 800mm deep

Figure 104: Rechabite Slip. There are no stop log grooves provided at this slip for flood boards.

Beyond the Rechabite Slip, the height of the seawall reduces and there is no secondary splash wall. Loss of pointing, voids and some damage to the top of the wall, lowering its defence level, are the main problems.

Figure 105: View towards the west end of Town Beach, with properties backing directly on to the beach beyond the extent of the wall.

Figure 106: Temporary filling of voids

Figure 107: Voids opening up top and bottom of wall

Figure 108: Loss of stone from top of defence

Figure 109: Pedestrian access at western end of Town Beach. Arrangement could compromise defence level. Manhole cover on foul drainage system is shown in foreground.

The following photographs illustrate the proximity of residential property to the sea along Town Beach. As yet there has only been one incidence of property flooding but, with sea level rise predicted, the risk of flooding is likely to increase in the future.

Figure 110: Properties lying at the top of Town Beach

Figure 111: Town Beach property

Figure 112: Town Beach property

Figure 113: Town Beach property

Figure 114: Town Beach property. The known flood incident occurred to the property on the right hand side, through the low window

Figure 115: Slip through to the Thoroughfare, Town Beach

Figure 116: Town Beach Property. Note surface water manhole in foreground. Manholes were reported to be full of sand.

Figure 117: Town Beach property

Figure 118: Town Beach property

Figure 119: Town Beach property

11.1.3.3 Summary and Recommendations

Consequence of failure	High: Residential and commercial centre of Hugh Town; Damage to road infrastructure Quay cut off from rest of St Mary"s
Condition Grade (See Table 2)	4
Short term Intervention	Proposed work to re-point and fill voids behind stone wall must be undertaken this autumn, to ensure the integrity of the wall. Undertaking the works this autumn will avoid the wall having to endure another season of winter storms in its current state. The need for these works were first identified in 1997, so it is of concern that it has taken over 14 years to implement. The use of flood boards at the Rechabite Slip is recommended along with a review of the use of flood boards or raising the defence level at the western end of Holgate"s Green where a pedestrian access

	route alongside the Custom House is lower than the defence level
Cost	Low
Medium term intervention	Consider individual flood proofing of property lying at the top of Town Beach. Besides sealing the fabric of the building, this would also include sealing the surface water system to try and prevent infiltration by rising tides, resolving any cross-connections with the foul sewer and sealing individual property foul pipes from backing up
Cost	Medium
SMP2	Narrow inter-tidal zone subject to coastal squeeze effects and long term sustainability of current shoreline position is unlikely. Recession mapping indicates up to 20m of erosion. Short term: Hold the Line; Long term: Managed realignment. There is little scope for re-alignment for the Town Beach frontages, but the Town Beach defence could be re-aligned by as much as 25m although this would result in loss of the promenade along the Strande.
	Requirement for a detailed strategy for the Hugh Town area identified. To consider the long term implications of climate change.
	The latest flood mapping (2105 200 year) does appear to show still water inundation reaching Hugh Street via the Thoroughfare. This needs further investigation to determine the remedial works required.

Table 5: Summary and Recommendations for Town Beach

11.1.4 Porth Minick, Old Town

11.1.4.1 Background Information

The area behind Porth Minick was inundated during the December 1989 storm event when the dune at the crest of the beach was breached. The area at risk comprises allotments and grazing land, with a housing estate set further back. Although water entered the housing estate in 1989, it did not cause any property flooding.

In 2000, a cable-tied *Armorflex* concrete block revetment with flanking rock shoulders was constructed concurrently with the Old Town seawall works.

Figure 120: Old Town, viewed from the Airport and illustrating the lower lying property behind Porth Minick

11.1.4.2 Visual Inspection Notes

No detailed visual inspection was undertaken of the Porth Minick defence.

11.1.4.3 Summary

Consequence of failure	High: Residential centre for Old Town; New school building; Water supply from Lower Moor BHs; Bio-bubble and pumping station; Arable land/allotments
Condition Grade (See Table 2)	Not Graded
SMP2	SMP Flood Risk Mapping shows that extreme tide levels in isolation do not present a risk. This indicates that flooding mechanism is driven by storm waves over-topping the defence. Short term: Hold the Line Long term: Managed realignment Natural defence maintained to required standard but with some re-alignment to prevent coastal squeeze. Economic justification may prove difficult in the future.

Table 6: Summary and Recommendations for Porth Minick

11.1.5 Porth Mellon

11.1.5.1 Background Information

Although not a formal hard defence, the sand dune helps to protect the low lying hinterland behind the beach, which provides a route for flood water into the Lower Moor area and would threaten the island‟s water supply.

Due to the lie of the land, any over-topping would pass through the island‟s trading estate, before reaching the Lower Moor area.

The sand dune is maintained by the Duchy of Cornwall Estate, who are concerned about erosion and try to maintain a good cover of vegetation over its extent.

An old slip at the town end of the dune was used for launching sea planes during World War II.

The beach is popular for recreation, with the gig sheds at the top of the beach and a boat park nestling in the area between the sand dune and the A3111. The bay is popular for kite surfing.

11.1.5.2 Visual Inspection Notes

The sand dune has a covering of marram grass. Although this is dense in places the natural defence level offered by the dune has been compromised by informal access routes being established over the dune, probably by the recreational users of the beach. In one location, adjacent to the boat park, there is a clear gap through the dune. High tide would appear to rise one or two metres short of meeting the toe of the dune.

Figure 121: Porth Mellon beach, looking south towards Hugh Town and the Trading Estate

Figure 122: Informal access route causing erosion of dune and reduction in crest level

Figure 123: Gap in sand dune, likely to have been created for access. Embankment is over 2m high in this location.

Figure 124: Erosion of the dune as a result of pedestrian access pressures

Figure 125: Gig sheds and fish restaurant on beach frontage

There is a slip through the dune close to the junction with the trading estate. Transportation of sand off the beach and onto the road is a regular problem. The flood boards are often deployed to try and mitigate this. At the time of the inspection a silt trap and highway gulley were being cleared of sand by the DLO.

Figure 126: Slip through dune with flood boards

Figure 127: The A3111 runs behind the beach, providing access to the local trading estate

11.1.5.3 Summary and Recommendations

Consequence of failure	High: Commercial Properties and Trading Estate; Waste Management Site; Water Supply at Lower Moor.
Condition Grade (See Table 2)	4
Short term Intervention	It is recommended that access on to the beach is formalised to avoid ad hoc access routes continuing to reduce the defence level and integrity of the natural defence. Once access is formalised it is recommended that the areas of erosion and gaps in the dune are filled and vegetated
Cost	Low
Medium/long term intervention	Reinforcement of the sand dune with concrete revetment is recommended, in consideration of future flood design levels. However, SMP2 recommends managed re-alignment in the medium to long term
Cost	Medium
SMP2	Realignment approach is preferred beyond 2025, allowing room for the dune to roll back without reducing its height or width and, at the same time strengthening the natural dune. Improving the defensive standard in the south west corner, where the sand dune already backs on to the road, may need to be considered as part of the overall re-alignment.
	Land use planning – area to be identified as Coastal Change Management Area

Table 7: Summary and Recommendations for Porth Mellon

11.1.6 Porth Thomas

11.1.6.1 Background Information

Figure 128: Porth Thomas

There is a natural sand dune defence at Porth Thomas which protects a small number of dwellings. Three properties have their thresholds at the same or below the top of the beach level. The other dwellings are set slightly higher up on the south side of the bay.

11.1.6.2 Visual Inspection Notes

The bay is not used as heavily as Porth Mellon and hence there is less impact on it from pedestrian access.

The dune is well vegetated and there is a clear distinction between the toe of the vegetated dune and high tide level.

Figure 129: Access route on to beach

11.1.6.3 Summary and Recommendations

Consequence of failure	Low: Residential property flooding
Condition Grade (See Table 2)	2
Short term Intervention	It is recommended that access on to the beach is formalised to avoid ad hoc access routes forming and reducing the defence level and integrity of the natural defence in the future
Cost	Low
SMP2	The SMP is predicting up to 15m of landward recession. However, the implications are limited to encroachment onto the coastal path and potentially some property boundaries. The preferred plan is to take a "Do Nothing" approach, with no active intervention.

Table 8: Summary and Recommendations for Porth Thomas

11.1.7 Porthloo

11.1.7.1 Background Information

The natural defence at Porthloo protects a number of semi-detached properties, a boat park, one detached property, an art gallery and a couple boat workshops.

The dune was breached in the 1989 storm and the area behind was inundated.

Figure 130: Porthloo

Figure 131: Boat Park, Porth Loo, with road going up the hill towards the Golf Club

There is a small potential for any over-topping/inundation to contaminate the Lower Moor SSSI, which lies to the east.

11.1.7.2 Visual Inspection Notes

At the northern end of the bay ram cliffs were very predominant and continued erosion is likely to threaten the property immediately above the cliff in the long term. SMP2 estimates that inland erosion may be as much as 30m by 2105.

The sand dune is protected by rock revetment on its front face. Some of the revetment comprises old concrete slabs from demolition waste.

As is common with the other sand dunes, pedestrian access across the top of the dune continues to threaten its defence height and the localised loss of vegetation could create a weak spot in the event of inundation.

Figure 132: Ram cliff at the north end of Porthloo

Figure 133: Properties at risk from coastal erosion

Figure 134: Dune is protected by stone revetment, which includes demolition waste in places

Figure 135: Pedestrian access over the top of the dune has locally reduced the vegetation cover and lowered the defence height

Slots are provided at the slip, close to the boat workshops at the southern end of the bay. However, given the vegetation covering these slots they do not appear to be in active use.

Figure 136: Slip through sand dune with provision for flood boards

Figure 137: Provision for flood boards

11.1.7.3 Summary and Recommendations

Consequence of failure	Medium: Residential Properties; Road infrastructure; Art Gallery; Boat yards; and Potential to contaminate Lower Moor SSSI.
Condition Grade (See Table 2)	3
Short term Intervention	It is recommended that access on to the beach is formalised to avoid ad hoc access routes forming and reducing the defence level and integrity of the natural defence in the future. Maintenance of the flood boards and slots should take place to ensure that they can be deployed during a storm event. Undertake topographic survey and modelling to check over-topping impact on Lower Moor SSSI.
Cost	Low
SMP2	Although Porthloo is more exposed to direct wave action than Porth Thomas and Porth Mellon, the preferred strategy is one of no active intervention (NAI) with managed re-alignment of Porthloo Lane in the medium/longer term. There would be encroachment on property boundaries with possible total loss of one or two properties

Table 9: Summary and Recommendations for Porthloo

11.1.8 Porth Hellick

11.1.8.1 Background Information

Porth Hellick is very exposed to south-easterly storms and waves and inundation could have significant strategic implications for the freshwater supply to St Mary's. SMP2 predicts up to 65m of erosion by 2105. This would cut through the existing sand dune.

Figure 138: Higher Moor SSSI

11.1.8.2 Visual Inspection Notes

Although this beach is less popular due to its distance from Hugh Town, trampled access routes over the top of it and local loss of vegetation are a problem.

Figure 139: Low embankment at the back of Porth Hellick, helping to protect the Higher Moor SSSI

Figure 140: Outfall from Higher Moor, with erosion path formed in the dune behind

Figure 141: Penstock on the upstream end of the leat discharging from Higher Moor

11.1.8.3 Summary and Recommendations

Consequence of failure	High: Water Supply from Higher Moor affected
Condition Grade (See Table 2)	3
Short term Intervention	It is recommended that access on to the beach is formalised to avoid ad hoc access routes forming and reducing the defence level and integrity of the natural defence in the future. Investment towards protecting the outfall and upgrading the flow control system from Higher Moor is also recommended to further enhance the security of the potable water supply.
Cost	Low
SMP2	The SMP proposes managed re-alignment as a means of strengthening the defensive embankment by allowing the beach to roll back in response to sea level rise and to encourage the deposition of sediment so that a more robust defence in the form of natural dunes is established.
	A strategic investigation into the combined risks of over-topping and inundation, percolation and groundwater levels for St Mary"s. This should consider: Lower and Higher Moors; Porth Mellon; Porth Hellick; Porth Minick/Old Town. We would suggest that the study also includes Porthloo.
	The latest flood mapping (2105 200 year) does appear to show still water inundation reaching the area behind the sand dune and Higher Moor. This needs further investigation to determine the remedial works required to potentially raise the defence level.

Table 10: Summary and Recommendations for Porth Hellick

11.2 Tresco

11.2.1 Island Hotel

11.2.1.1 Background Information

The hotel dining room extension is threatened by erosion of a ram cliff with a rate of erosion estimated in 1997 of 0.6m in four years.

We believe that the current flood defence was constructed in the year 2000. The works were undertaken through the Isles of Scilly Council but the Duchy of Cornwall Estate has recently taken over the maintenance. This currently involves regular monitoring of its condition.

11.2.1.2 Visual Inspection Notes

The defence comprises a mass concrete retaining wall faced with granite. The wall follows the shape of the cove and rock armour has been placed at either end.

On the south side of the cove the wall is topped with a low but wide earth embankment. Moving towards the hotel, to the north, the embankment is replaced with concrete hollow blocks which have been planted so that there is a good covering of vegetation. These concrete hollow blocks are each 200mm high and at the far north end are 7 units high.

The wall is over 1m deep. The toe is not visible, protected by rock revetment of varying size. The wall is jointed and the mastic filler is still in a reasonable condition.

Figure 142: Island Hotel: southern end of defence

Figure 143: Island Hotel: north end of defence

Figure 144: Granite faced wall with concrete hollow blocks above

Formal planting has been established at ground level to the rear of the concrete hollow blocks. This planting follows the line of the hotel building and is only a few metres away from the face of the building.

Figure 145: Planting of concrete hollow blocks

There is some erosion on the top of the embankment at the southern end of the defence, likely to have been caused by guests looking for a better view or accessing the cove.

Figure 146: Erosion and poor vegetation noted on embankment

It is not known when the hotel was built but its location and the need for it to be defended so early in its design life questions the planning process.

11.2.1.3 Summary and Recommendations

Consequence of failure	Medium: Island Hotel – loss of building and impact on island economy
Condition Grade (See Table 2)	2
Short term Intervention	The defence was potentially built to limit encroachment from erosion as opposed to reduce the risk of over-topping. It is recommended that the Duchy of Cornwall Estate temporarily fence off the area of erosion on the embankment and topsoil and re-seed to encourage a good vegetation cover. Monitoring of the structure"s condition should continue on at least a 6 monthly basis and after each significant storm event.
Cost	Low
	It would be timely to review the planning process for the Isles of Scilly and the need to ensure new development is sympathetic with the dynamic environment. Such a review would fit well with the creation of Coastal Change Management Areas as suggested under SMP2
SMP2	Erosion rates are predicted to be up to 25m over the next 100 years which may present a risk to the Hotel and associated facilities. This risk may not be significant until 2105 but to the south, residential properties adjacent to the Old Grimsby Quay maybe at risk by 2055. This more exposed frontage may require some realignment in the longer term.

Table 11: Summary and Recommendations for Island Hotel, Tresco

11.2.2 Appletree Bay

11.2.2.1 Background Information

The Appletree Bay defence lies at the northern end of Appletree Bay to the west of the heliport. The road running south from New Grimsby to the Abbey Gardens runs close to the top of the wall.

During the 1989 storm the beach accreted by 2m and the seawall and roadway were destroyed. The roadway was subsequently diverted further inland. The high water mark at this point has reportedly retreated by between 6 to 9 m between 1987 and 1992.

The original date of the seawall is not known but it could date back to the 1960s based on construction type.

11.2.2.2 Visual Inspection Notes

The concrete wall is supported by four buttresses at its southern end. The reinforcement in the buttresses has become exposed and the steel is now corroding.

Figure 147: Appletree Bay defence

Figure 148: Southern end of wall is supported by four buttresses

Figure 149: At its northern end the wall runs into an existing rock outcrop

There are numerous areas where the concrete has started to spall. At some joints the wall is displaced from the adjacent section.

Figure 150: Section of wall displaced from adjacent section, potentially due to corrosion of steel ties

Figure 151: Fracture has occurred, in places coinciding with the original concrete pour lines

Figure 152: Where fracture has occurred these sections are now prone to weathering

Figure 153: The road from New Grimsby runs to the rear of the stone wall which has been reinforced at its toe

Figure 154: The ram cliffs between Appletree Bay and New Grimsby continue to erode, threatening the grazing land and local road

11.2.2.3 Summary and Recommendations

Consequence of failure	Medium: Impact to island‟s water supply from Abbey Pool; Heliport; Potential loss to island road.
Condition Grade (See Table 2)	3
Short term Intervention	It is suggested that patch repairs are undertaken on the wall before the defects become irreparable. Long term monitoring of the wall‟s condition should also be undertaken at least 6 monthly and after each significant storm event.
Cost	Low
SMP2	Erosion of the shoreline may exceed 30m over the next 100 years. However, a no active intervention approach is preferred, as it allows natural evolution of the coast and will continue to provide new sediment inputs to the beaches and dunes, helping to maintain their stability and healthy response to sea level rise. This approach would satisfy the objectives relating to the AONB and Heritage Coast designations.
Medium/Long term	If a “no active intervention” approach is to be followed the Duchy of Cornwall Estate will need to consider: How to make this wall stable as it deteriorates in terms of public safety; and Diversion of the local road and coastal path.

Table 12: Summary and Recommendations for Appletree Bay, Tresco

11.2.3 New Grimsby

During the visit it was evident that a number of actions have been taken by the Duchy of Cornwall Estate to try and ensure the integrity of the coastline at New Grimsby. Some of this work has been brought about by the development of beach front holiday homes. Again the planning decisions relating to the location of this development need to be questioned given the dynamic nature of the coastline.

The defence wall and splash wall protecting the road leading to New Grimsby quay and adjacent property are both listed on the EA‟s NFCDD database.

The following photographs note a number of works and assets around New Grimsby protecting new holiday homes, existing dwellings and the road in and out of New Grimsby.

Figure 155: Timber revetment beneath holiday homes near Timothy's Corner

Figure 156: Original seawall at New Grimsby

Figure 157: Continuation of dry stone seawall at New Grimsby, protecting local road

11.2.4 Outfall from Great Pool

Great Pool sits in a natural depression in the southern half of the island. Although it is connected to Abbey Pool to its south, only Great Pool is designated as a SSSI. Great Pool drains in a westerly direction towards Farm Beach.

There is a control gate on the outlet, adjacent to the road, which helps to prevent saline intrusion.

Figure 158: Outlet from Great Pool

11.3 St Agnes

11.3.1 Porth Killier

11.3.1.1 Background Information

A ram cliff containing internationally important prehistoric remains was partially protected by a 1931 cobble and concrete wall and boulders. A new defence was constructed in 1996 comprising an 85m long granite faced mass concrete wall with rock armour at either end.

The defence continues westwards, towards Big Pool, in the form of an embankment reinforced with a tied concrete block revetment and erosion control matting. This finishes with rock armour at its western end.

11.3.1.2 Visual Inspection Notes

The granite faced mass concrete wall is in a relatively good condition. It is 850mm deep and retains a local track immediately to the rear which gives access to the Big Pool area. However, rutting from farm vehicles would appear to have exposed the reinforcement matting on the back face of the embankment, at the toe. This matting is exposed higher up the back face at one location where footfall has caused erosion.

Figure 159: Granite faced mass concrete wall

Figure 160: Wall finished at rock armour and reinforced embankment continues

Erosion of the soft ground in front of the toe of the wall has occurred and this could begin to undermine the wall. Without further details on the foundations for the wall the impact of this on the wall"s stability is difficult to judge. However, it is important that this in monitored and if necessary voids filled to ensure that long term settlement of the wall is avoided.

Figure 161: Erosion of the soft ground in front of the toe of the wall is taking place. This needs to be monitored and action taken to avoid settlement of the wall in the long term

The reinforced embankment is now 15 years old and is showing signs of significant deterioration. The soft material above the revetment has been eroded leaving an unstable and exposed face. At some locations the toe of the revetment is exposed. The weight of the blocks themselves is unlikely to be sufficient to resist uplift during a storm so protection of the toe needs to be resolved.

Figure 162: The concrete block revetment is clearly visible on the front face of the embankment. Erosion of the crest has taken place leading to an unstable face

Figure 163: The embankment continues in westerly direction with partial vegetation cover

Figure 164: The toe of the concrete block revetment is exposed and the ties between blocks are visible

Figure 165: The embankment finishes with rock armour at its western end

Figure 166: Reinforcement matting is visible at the toe on the back face. This has probably been exposed by rutting caused by farm vehicles, wider than the track provided

11.3.1.3 Summary and Recommendations

Consequence of failure	Medium: Potential impact to island‟s water supply and ancient archaeology; Impact to arable land
Condition Grade (See Table 2)	Wall: 3 Embankment: 4
Short term Intervention	Currently, there are areas of weakness along the embankment. These need to be repaired to ensure that the potential for a breach is minimised. The erosion at the foot of the mass concrete wall needs to be monitored
Cost	Low
Medium term intervention	The embankment would appear to be reaching the end of its design life. Work needs to be undertaken to ensure that the standard of protection is maintained into the future.
Cost	Medium
SMP2	The main issue for St Agnes is the threat from erosion and inundation at the Big Pool, the islands main drinking water supply. Once the design life of the defences around Big Pool is exceeded there would be risks of ground water contamination from seawater during frequent storms. The preferred plan of Hold the Line aims to make provision for the defence of this area, as it is so strategic to the well-being of the local community and the economy of the island.

Table 13: Summary and Recommendations for Porth Killier, St Agnes

11.3.2 Porth Coose

11.3.2.1 Background Information

A low dune separates the beach from the Big Pool SSSI and was vulnerable to erosion and breaching. Following the 1989/90 storms 20 tonnes of boulders were placed in the weakest section of the dune, and a new defence was constructed in 1996. The defence comprises a tied concrete block revetment reinforced with erosion control matting.

A rail and boulder groyne which connects Porth Coose and Ginamoney Carn, was previously in a poor condition but was reportedly strengthened in 1996.

11.3.2.2 Visual Inspection Notes

The embankment is showing signs of erosion along the crest. In places the ties to the concrete block revetment are exposed and the reinforcement matting is broken from general wear. The vegetation cover on the front face is sparse in a number of discrete locations. The back face has a good vegetation cover and appears to be satisfactory.

Figure 167: View looking towards Ginamoney Carn

Figure 168: Concrete revetment exposed on front face of embankment

Figure 169: Erosion matting and concrete revetment exposed

Figure 170: Erosion matting damaged from foot traffic and cable tie exposed

Figure 171: Rock armour headland between Porth Coose and Periglis

11.3.2.3 Summary and Recommendations

Consequence of failure	Medium – island water supply affected along with grazing land
Condition Grade (See Table 2)	Embankment: 3
Short term Intervention	Currently, there are areas of weakness in the embankment where the revetment and erosion matting are exposed and the matting damaged. These areas need to be monitored and if their condition worsens repairs are to be undertaken. The risk of erosion from foot traffic needs to be reviewed and the coast path potentially diverted off the crest of the embankment.
Cost	Low
SMP2	The main issue for St Agnes is the threat from erosion and inundation at the Big Pool, the islands main drinking water supply. Once the design life of the defences around Big Pool is exceeded there would be risks of ground water contamination from seawater during frequent storms. The preferred plan of Hold the Line aims to make provision for the defence of this area, as it is so strategic to the well-being of the local community and the economy of the island.

Table 14: Summary and Recommendations for Porth Coose, St Agnes

11.3.3 Periglis

11.3.3.1 Background Information

The bay adjacent to Porth Coose is Periglis, again with a natural embankment helping to protect Big Pool. Although there was some concern with regards to the stability of the embankment, the work in 1996 raised the height of it to fill a local depression and reinforced it with erosion control matting.

The outfall from the Big Pool goes beneath the embankment. There is a flap valve on the end, although at the time of the inspection the flap valve and concrete head wall were buried in sand on Periglis Beach.

11.3.3.2 Visual Inspection Notes

The erosion control matting was not visible and there was a reasonable cover of vegetation which has been supplemented in places by rock revetment. Erosion has occurred along the top of the crest from its use as a coastal path around the bay.

Figure 172: Periglis looking towards Lower Town

Figure 173: Embankment is protected by a mixture of vegetation and haphazard stone revetment

Figure 174: Outfall from Big Pool runs beneath the Periglis Embankment with concrete headwalls on both the front and rear faces

Figure 175: The headwall and flap valve on the front face is buried with sand

11.3.3.3 Summary and Recommendations

Consequence of failure	Medium: Potential impact to island‟s water supply; Impact on Lower Town; Impact to grazing land.
Condition Grade (See Table 2)	3
Short term Intervention	6 monthly inspections of the embankment are recommended to monitor for any developing areas of weakness. The risk of erosion from foot traffic needs to be reviewed and the coast path potentially diverted off the crest of the embankment.
Cost	Low
SMP2	The main issue for St Agnes is the threat from erosion and inundation at the Big Pool, the islands main drinking water supply. Once the design life of the defences around Big Pool is exceeded there would be risks of ground water contamination from seawater during frequent storms. The preferred plan of Hold the Line aims to make provision for the defence of this area, as it is so strategic to the well-being of the local community and the economy of the island.

Table 15: Summary and Recommendations for Periglis, St Agnes

11.4 Bryher

11.4.1 Great Popplestone, Little Popplestone and Great Par

11.4.1.1 Background Information

Great Popplestone, Little Popplestone and Great Par all lie on the north west side of Bryher to the west of Great Pool and the Hell Bay Hotel.

At Great Popplestone, a dilapidated seawall was damaged in the December 1989 event and lost further height in 1994 and 1995. The seawall was supplemented with rock armour in 1995 to enhance the protection afforded to the Great Pool and Hell Bay Hotel.

Little Popplestone lies at the northern end of the Great Popplestone bay and was subject to erosion. In the mid nineties, rock revetment was placed beneath the sand to slow down the rate of erosion.

A 1960s mass concrete wall supported by timber piles supports the Old School House and a number of individual dwellings at the top of Great Par. The seawall was supplemented with rock armour and a diaphragm wall was installed at a later date to prevent seawater percolating beneath the newly placed rock armour.

All defences serve to protect the island‟s water supply from seawater inundation as well as the hotel.

There is also a stone wall believed to be 500m in length at Green Bay that protects the coastal path. The low-lying cottages are believed not to be threatened. This wall was not inspected in July 2011.

Figure 176: View looking south towards Great Pool and Hell Bay Hotel

11.4.1.2 Visual Inspection Notes

Again, the main issue with the defences in this location is the pressure from walkers and local erosion at discrete locations along the crest of embankments that could create a weak point in the defence.

It is clear that the old seawall at Great Popplestone is redundant and the defence is provided by the rock armour placed in front of it. The wall will continue to deteriorate and this needs to be monitored in terms of the impact on the stability of the rock armour.

Attention needs to be given to the outfall from Great Pool. Repairs to the end of the discharge culvert and re-introduction of a flap valve are recommended.

Figure 177: View over Great Popplestone, from Little Popplestone

Figure 178: Erosion of ram cliff continues at Little Popplestone

Figure 179: Natural embankment at Great Popplestone supplemented with vegetation cover and stone revetment

Figure 180: Great Popplestone embankment

Figure 181: Old seawall at Great Popplestone. Supplemented with rock armour to front face

Figure 182: To the rear of the wall there is a mass of stone, soft material and rock revetment

Figure 183: There has been a fracture at the centre of the wall

Figure 184: Old School House and associated dwellings lying above the rock armour defence

Figure 185: Outlet from Great Pool flows beneath Great Par embankment

Figure 186: Outlet from Great Pool lies high up the beach at Great Par. The concrete surround has been fractured and there is an absence of a flap valve.

11.4.1.3 Summary and Recommendations

Consequence of failure	Medium: Potential impact to island‟s water supply; Hotel.
Condition Grade (See Table 2)	None given as defences were difficult to distinguish
Short term Intervention	6 monthly inspections of the embankment are recommended to monitor for any developing areas of weakness. The risk of erosion from foot traffic needs to be reviewed and the coast path potentially diverted off the crest of the embankment. The old seawall needs to be monitored as it deteriorates to ensure it does not impact on the stability of the rock armour. The discharge culvert from Great Pool needs up-grading.
Cost	Low
SMP2	35m of recession is predicted at the north end of Great Par over the next 100 years. Hold the line is the preferred policy up to 2025 and potentially beyond given the pressure on the dwellings and hotel and the impact on the island‟s economy. At Great Popplestone, less erosion is predicted but a hold the line and monitoring policy is recommended to assess the impact on Great Pool. At Little Popplestone, 50m of erosion is predicted in the next 100 years but a no active intervention approach is suggested given the limited justification for works.

Table 16: Summary and Recommendations for Bryher

12 Flood Warning

A Flood Plan was prepared for the Isles of Scilly in 2010 by the Devon, Cornwall and Isles of Scilly Local Resilience Forum. This helps to formalise the responsibilities of Isles of Scilly Council within the coordinated response of a number of agencies to an incident of flooding.

The Flood Plan advises that the Flood Forecasting Centre (a partnership between the Environment Agency and the Meteorological Office) provides the Isles of Scilly Council via e-mail, text alert and/or fax both extreme rainfall alerts and National Flood Guidance Statements.

The Isles of Scilly Council also receives Severe Weather Warnings from the Meteorological Office via the National Severe Weather Warning Service (NSWWS).

The Isles of Scilly Council also monitor the weather forecasts themselves, particularly when there are significant Spring tides.

Weather/flood warnings are disseminated as follows:

- Council website;
- Community Message Board;
- Tourist Information Office;
- Town Hall;
- Radio Scilly;
- Radio Cornwall;
- Posters;
- Door knocking in specific vulnerable locations or by telephone for the off-islands;
- Direct to the Isles of Scilly Fire and Rescue Service.

General flooding advice on how to be prepared in the event of a flooding incident has also been distributed to all householders.

Living so close to the sea, it is felt that most islanders will be more familiar with dealing with a flood event, compared to the general population of the UK.

In the event of a flood warning the Council also undertakes the following:

- Additional checks of storm drains;
- Deploys storm boards on the Atlantic Slipway, Thoroughfare and Porth Mellon Beach;
- Deploys 1 tonne sand bags (kept loaded in storage) which are ready in Old Town. A chicane is formed using these bags across Old Town Road to keep the road passable to traffic. Additional bags are placed if it‟s necessary to close the road. If required the Isles of Scilly Fire and Rescue

Service are on call to pump out any water that breaches this line of defence;

- Sandbags are placed around Hugh Town Foul Pumping Station.

Figure 187: Sand bags in storage ready for deployment across Old Town Road

Although procedures are clearly documented in the Flood Plan, the reality of potentially having to evacuate Hugh Town at some point in the future must be given appropriate consideration and advance planning.

13 Climate Change Allowance

According to SMP1, in the long term, the areas vulnerable to erosion will extend beyond those stretches of coast which are presently affected as water levels increase due to global warming. It is noticeable that St Martin's is relatively unaffected by the process of global warming and coastal erosion since its dwellings are all constructed at a high level. The most vulnerable area historically has been Hugh Town on St Mary's which has been built on the sand bar connecting the high land of Garrison Hill and Buzza Hill.

SMP1 gave the recommendation that the design still water level (SWL) should be the level of the 1 in 5 year return period and that any structures designed should have design lives of 50-60 years. A design SWL of +3.6 mAOD was recommended, taking account of the increase in sea levels due to global warming expected in this time period.

The Council of the Isles of Scilly prepared a Climate Change Strategy for 2011. Within this report are climate change predictions for the South West of the UK, as published in the UK Climate Projections Briefing Reports (2009), and these include:

- By the 2080s models predict slight weakening in storm tracks and tracks moving further south;
- The frequency, duration or intensity of anticyclones is unlikely to change;

- There is little consistent evidence of a projected systematic change in wind speed;
- A high degree of uncertainty underlies the anticyclone and wind projections; there is no compelling evidence to suggest that a marked change is likely to occur;
- A relative sea level rise (baseline 1990) of 19cm by 2040;
- Storm surge levels, predicted to exceed current levels at a one in 2, 10, 20 or 50 year events are not projected to increase by more than 9cm in the SW and uncertainty in projections suggests this is within the normal variability seen from historic data;
- Offshore waves relative to mean annual wave height predicted to increase by 1 meter by 2080.

Records of mean high water level at St Mary‟s were analysed by the Council for the last 20 years and these showed the expected and observed trend for the sea level rise for the South West. A recommendation was made to continue to collect and analyse this data on a regular basis in order to improve understanding of changes in the local climate, and hence aid in planning for response to future extreme weather events.

14 Tsunami Threat

Defra commissioned a report in 2005 titled "The threat posed by Tsunami to the UK". This concluded that there is a very small possibility that tsunamis with an effect on the UK could be generated by seismic or landslide events. For most scenarios, the report indicates that wave heights produced at the UK coast by tsunamis are unlikely to exceed those predicted for major storm surges. All major areas of development on UK coasts have defences that have been designed to withstand such surge waves. However, a tsunami wave could occur on top of a storm surge and therefore have the potential to exceed defences. Also, if a tsunami hit when conditions were calm, communities would not be as prepared as on the build up of a storm.

The most significant tsunami to strike Europe in modern times occurred in 1755 and caused devastation to the coasts of Portugal, Spain and Morocco. The wave also struck the south western parts of the British Isles with local waves of up to 3m in the Scilly Isles and in Cornwall. It took almost four hours to reach the UK, and during this time had lost most of its destructive power, since the continental shelf around the UK acts to slow down such waves.

The 2005 Defra report concluded that a strong, potentially damaging tsunami reaching the coasts of the UK resulting from a passive margin earthquake in the Sole Bank area (western Celtic Sea) or associated with the Rockall Trough, is credible. A tsunami reaching the UK from the Azores-Gibraltar region (responsible for the 1755 Lisbon earthquake) is a possible event, but it‟s highly unlikely that a future tsunami from this source would be worse than that of 1755.

The UK has national seismic and oceanographic monitoring networks, though these are not currently used to detect tsunami events. The 2005 Defra report recommended that a tsunami warning system be developed and incorporated into

the work of the Meteorological Office, although there is no evidence that this has been achieved. The UK is a member state of the Intergovernmental Coordinating Group of the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS). The Tsunami Early Warning and Mitigation System developed by this group was tested successfully for the first time this summer (2011) and a full evaluation of the system is still to be made.

15 Economic Assessment

Previously Outcome Measures (OMs) formed the performance framework for the government‟s investment in flood and erosion risk management in England. However, the 'Outcome Measure score' system used to prioritise the EA‟s programme up to 2011/12 is to be discontinued.

Under the new *Flood and Coastal Resilience Partnership Funding* system, any project starting in 2012/13 will be funded according to a new set of criteria. The reforms aim to allow more schemes to go ahead and to give each community more of a say in what is done to protect them.

Three aspects of a project will influence the amount of national funding available:

- The value of benefits for householders as a result of a flood or coastal erosion risks being managed, especially in deprived areas and where risks are significant;
- The value of other benefits achieved, such as the benefits to businesses, agricultural productivity and protection for national and local infrastructure, across the whole life of the scheme;
- The environmental benefits of the scheme, needed to maintain healthy eco-systems as well as offset any habitats lost when defences are built to protect people and property.

The maximum amount of funding for a project will be based on multiplying each of the aspects above by a set of payment rates, which are fixed amounts of national funding per unit of outcome or benefit achieved. Payment rates for protecting households will be higher in deprived areas, so that schemes in these areas are more likely to receive funding. Funding from Defra will increase in line with the value of the benefits being delivered. However, Defra are now looking for local communities to contribute to the funding of schemes where possible.

SMP2 provides a brief summary of damages for erosion and potential flood risk within the whole of the Isles of Scilly Policy Development Zone if there is no active intervention. The damages are discounted to give present values.

The results are as follows:

Assessment of Erosion Damages (No Active Intervention)		
Epoch	**Number of Properties**	**Present Value Damages x £1000**
0 – 20 years	0	0
20 – 50 years	12	794
50 – 100 years	39	579
Total	51	1373

Table 17: Assessment of Erosion Damages taken from SMP2

Assessment of Potential Flood Risk (No Active Intervention)		
Epoch	**Number of Properties at risk from still water only**	**Present Value Damages x £1000**
Flood risk tidal 2025	3	49
Flood risk tidal 2055	3	26
Flood risk tidal 2105	33	64
Total	33	139

Table 18: Assessment of Flood Damages taken from SMP2

To achieve a benefit cost ratio of at least one, the above summary demonstrates that any future erosion protection schemes throughout the Isles of Scilly should have a combined cost of no more than £1.3m.

Similarly, for the flood risk management schemes, the justifiable spend would be limited to no more than £135, 000. However, it should be noted that this figure does not take in to account damage that is likely to be caused by wave damage.

In addition, the Isles of Scilly are unique and loss of a small area could have a significant impact on the island‟s economy, particularly if this small area was Hugh Town. Under the new funding system the loss of critical assets such as water supply and road infrastructure may carry more weight to help to secure a government funding stream.

However, to assist with economic justification there needs to be clear evidence for the need for the scheme which can be established through the Isles of Scilly Council maintaining comprehensive records of flood incidents and implementation of the strategies as recommended by SMP2.

Should a private landowner wish to construct and maintain their own defence, and the defence is on land in their ownership, then that is an investment decision to be made by the individual landowner. Any new structure would need to comply with planning regulations and the landowner would need to demonstrate that they would not be increasing flood risk elsewhere, as a result of their works.

16 Supporting Documentation

The following documents relate to flood risk and as such have been reviewed as part of this exercise:

16.1 Shoreline Management Plan 1995-1997, by Aspen Burrow Crocker Ltd.

The first Shoreline Management Plan (SMP) for the Isles of Scilly was prepared by Aspen Burrow Crocker Ltd, between 1995 and 1997, following the Ministry of Agriculture, Fisheries and Food (MAFF) Guidance.

Much of the SMP is based on the Isles of Scilly Council‟s assessment of the December 1989 storm damage as well as an inspection of flood defences undertaken by DHV in September 1991.

As part of the DHV study areas of risk were identified as:

Location	Area considered to be at risk
St Mary's	
Porthcressa Beach	The timber cribwork wall, footpath and mount suffered considerable damage during the 1989 storm. This defence was repaired but then replaced in 1995 by a stone-faced reinforced concrete wall and extended to the south-east by a rock revetment.
Old Town Bay	A reinforced concrete seawall was built in 1963 and protects an estate of houses. The masonry eastern end of the seawall, between the reinforced concrete and the slip, began to fail in late 1996 and was replaced in 2000 with a stone-faced mass concrete wall.
Porth Minick	The dune at the crest of the beach was breached during the 1989 storm causing flooding of the bulb fields behind and causing flood waters to enter the housing estate, but no houses were flooded. In 2000 a cable-tied *Armorflex* concrete block revetment with flanking rock shoulders was constructed concurrently with the Old Town seawall.
Porth Hellick	This is the main source (70% by volume) of St Mary‟s fresh water. Its defences suffered no damage during the 1989 storm and remained intact. However, the Council is concerned about its long term stability
Porthloo	Extensive flooding and erosion of the ram cliff threatened a road and six terraced houses during the 1989/90 storms. A monitoring programme was instigated in March 1997.
Town Beach	Stoplogs were fitted to prevent flooding from the slip by the *Atlantic Hotel* during spring high tides. Occasional flooding of the road still occurs via the road gulleys and stormwater drainage system. Only the eastern half of Town Beach (from Holgate‟s Green to Carn Thomas) has a formal seawall. A 1997 report noted general dilapidation and incipient collapse near Holgate‟s Green.

Table 19: Areas of Risk on St Mary‟s as identified by DHV in 1991

Location	Area considered to be at risk
Tresco	
Appletree Beach	The beach accreted by 2m during the 1989 storm and the seawall and roadway were destroyed. The roadway was subsequently diverted further inland. The High Water mark at this point reportedly retreated by 6-9m from 1987-1992.
Timothy"s Corner	The dry stone wall has been partially demolished by sea action over time with erosion removing the reserve between the road and the cliff (reportedly 4m in 40 years). Four cottages and a road containing the main sewer and water main are threatened by continued erosion.
Island Hotel, Old Grimsby	There are signs of an old seawall some 7m seaward of the existing ram cliff. The hotel dining room extension is threatened by erosion of this ram cliff with a rate of erosion estimated in 1997 of 0.6m in four years.
Quay, Old Grimsby	There is a low point at the root of the quay in Raven"s Porth which was flooded in the 1989 storm.
Crab"s Ledge	Over-exploitation of the beach for sand lead to coastal erosion.
Pentle Bay	In the mid-1990s records were taken at Pentle Bay which showed eroded material was being taken offshore by tidal means to form a bank at the north of the bay between the Great Pentle Rock and Lizard Point.

Table 20: Areas of Risk on Tresco as identified by DHV in 1991

Location	Area considered to be at risk
St Martin's	
Higher Town Bay	A 700m dynamically stable dune system protects disused bulb fields, a well and a cricket ground.
Lawrence"s Bay	Half of the 600m long bay consists of a dune whilst the other half is an eroded ram cliff which is backed only by disused bulb fields.
Neck of the Pool	A 600m dune system protects a well and a campsite, and has indications of possible erosion.

Table 21: Areas of Risk on St Martin"s as identified by DHV in 1991

Location	Area considered to be at risk
Bryher: Works were undertaken to the island in 1992, comprising of rock revetments at Great and Little Popplestones and Great Porth, and sand fences at the south of the island.	
Great Popplestone	The 1989 storm eroded 1,000 tonnes of rock from Popplestone Brow which sheltered a 70 year old wall within the bay at Great Popplestone. Emergency repairs were undertaken on the wall and concern given to future failure due to increased storm exposure. Overtopping at Little Popplestone threatened the island‟s water supply.
Great Porth	Inundation recorded between Great Porth and the Great Pool, with concerns that this breach could cause a threat to the *Hell Bay Hotel* and cut off two cottages.
Stony Porth	Beach receded in 1989 storm and continues to erode. The land behind is a SSSI designated for a rare dwarf pansy.
Green Bay	The 1989/90 storms damaged a stone wall which kept out high waters, but the low-lying cottages in the bay are not threatened. The banks are covered with exotic plants (mesembryanthemum and agapanthus) which form good ground cover and resistance to erosion.

Table 22: Areas of Risk on Bryher as identified by DHV in 1991

Location	Area considered to be at risk
St Agnes and Gugh	
Porth Killier	A ram cliff contains internationally important prehistoric remains and was partially protected by a 1931 cobble and concrete wall and additionally by boulders. A new defence was constructed in 1996.
Porth Coose	A low dune separates the beach from the Big Pool SSSI and was vulnerable to erosion and breaching. Following the 1989/90 storms 20 tonnes of boulders were placed in the weakest section of the dune, and a new defence was constructed in 1996. A rail and boulder groyne connects Porth Coose and Ginamoney Carn, which was previously in poor condition and strengthened in 1996.
Periglis	The defences consist of a shallow dune which occasionally overtops.
Big Pool SSSI	A breach of the natural defences would threaten the water supply to the Lower Town area. Coastal protection works around the SSSI completed in 1996, consisting of a mass concrete sea wall, concrete block revetment, rock armour and erosion control matting.
The Bite	The sand dune vegetation comprises of marram grass and mesembryanthemum. Erosion was reported after the 1989 storm.
Cove Vean	Cliff damage was reported after the 1989/90 storms in this sheltered cove.
St Warna‟s Cove	Cliff falls reported after the 1989/90 storms in this rocky cove.
Bergecooth	The ram cliff backs a beach consisting of boulders varying in size from 2-3 tonne at the low water mark to 300mm diameter at the foot of the cliff.

Table 23: Areas of Risk on St Agnes as identified by DHV in 1991

The defences were also surveyed by MAFF Flood and Coastal Defence Division in 1993 as part of the Coast Protection Survey of England (CPSE).

The report states that the defences at that time were built on an ad hoc basis as erosion and over-topping problems have become evident. The defences comprise a variety of structural types varying from rubble mounds to stone walls, timber cribwork, and mass and reinforced concrete structures. The protection offered generally has a low return period owing to the great expense of building anything more substantial to a formerly subsistence level community.

An appraisal report was prepared by DHV including preliminary designs and benefit/cost assessments and presented to MAFF in April 1992.

Due to the low density of population and relatively poor quality and low productivity of the land, only Hugh Town would justify an indicative standard of protection with a high return period in the order of 50 to 150 years. Old Town may justify a standard of protection of 50 years but all other locations would vary between 5 and 20 years. A design still water level of +3.6m AOD was recommended in this SMP.

Subsequent to the CPSE, new coast defence structures were constructed at three locations on Bryher and at Porthcressa, Porth Minick and Old Town on St Mary‟s and at three locations around Big Pool on St Agnes.

See Appendix B for December 1989 storm damage report, Appendix C for relevant extracts of the CPSE and Appendix D for Chapter 7 of the SMP on Coastal Defences and Structures.

Summary details of the works and proposed works as of 1997 are listed below. With the exception of Porthcressa, it is believed that these were designed (design sea level and wave height) for return periods of 5 to 10 years.

Location	Storm damage/ existing defences	New Defences built mid 1990s
St Mary's		
Porthcressa Beach	Timber cribwork defence with a 2m wide footpath at 6m AOD, concreted for a limited length at its west end. Originally built in 1963 following storm damage in 1962 which threatened to break through sand dunes, then the only defence to Hugh Town.	Stone faced reinforced concrete wall, 225m long, constructed during 1995, approx 2m south of the timber cribwork that was partially removed. Seawall is 1.6m high with its crest at 6.0m AOD. Toe is protected by an Armorflex cable tied concrete block revetment. The concrete wall is piled with pile caps at 6m centres. New slipway built at Buzza Street. South of slipway 90m of rock revetment was built to protect the exposed ram cliff from further erosion.
Porth Minick (embayment to the south east of Old Town)	Low lying land behind small embankment flooded. Council and Duchy of Cornwall owned housing estates are at the limit of the areas flooded	Preferred scheme: cable tied concrete block revetment fixed at a crest level of 6m AOD extending down the beach and overlain by 1 -2 m of sand. Re-establish vegetation cover over new revetment and protect revetment at its flanks by rock armour shoulders. Believed to have been undertaken the same time as the works to Old Town
Old Town	Cracks began to open up in 1996 in the original seawall (built 1963) at north east corner of Old Town Bay. Cause of failure was undermining. Opening up of the cracks caused loss of fines from the road behind and the integrity of the wall was threatened. The Isles of Scilly Council instructed a replacement as a matter of urgency.	Seawall was replaced with a masonry faced mass concrete vertical wall with foundations allowing 1 m erosion of beach levels. Provides same level of protection as previous defence but more resistant to breaching. It is expected to overtop in extreme conditions.

Table 24: Works following the 1989 storm damage on St Mary"s

Location	Storm damage/ existing defences	New Defences built mid 1990s
Bryher		
Popplestones/Great Pool	Old, dilapidated seawall reportedly lost 3.5m in height during the storms of 1989/90 and 0.5m in Easter 1994. Cracked in Easter 1994 and 10m of wall lost in early 1995	Protected by new rock revetment of imported Cornish Armorican Granite, overlain at its flanks
Little Popplestones	Erosion of north edge of sand dunes threatened to flood and contaminate island"s freshwater supply	Sand dune system reinforced with a short rock revetment buried beneath the sand.
Old School House, Great Porth	1960"s mass concrete wall supported by timber piles Excavation for placing new revetment lead to water percolating under the sea wall	Supplemented in 1995 by rock armour revetment extending east and south of the seawall to protect the low lying and vulnerable part of the beach. Alleviated by construction of a diaphragm wall

Table 25: Works following the 1989 storm damage on Bryher

Location	Storm damage/ existing defences	New Defences built mid 1990s
St Agnes		
Big Pool SSSI	Protected by low volume sand dunes which are slowly eroding. Big Pool sits in a headland with Porth Killier to the east, Porth Coose to the north west and Periglis to the west. Periglis and Porth Coose are separated by a spit of land reinforced in the 1960s by a cribwork of old railway lines? (timbers) containing boulders sourced from the beach. The dune backing Porth Coose is considered to be the weakest link in the natural defences with erosion of up to 40m^3/yr. Although erosion rates at Periglis are between 10 - 35m^3/yr, there are no severe problems reported	Scheme finished in 1996 comprised cable tied concrete block revetment system buried into the existing dunes and beaches at Porth Killier and Porth Coose with erosion control matting reinforcing the graded and bulked-out shallower back face. An 85m long granite faced mass concrete wall protects the east of Porth Killier where the cliff is vertical and there are internationally important archaeological remains which need protecting. At Periglis the bank was raised slightly to fill a local depression and erosion control matting was apparently used on the rear face.

Table 26: Works following the 1989 storm damage on St Agnes

Location	Storm damage/ existing defences	New Defences built mid 1990s
Projects under consideration in 1997/98		
Tresco		
Island Hotel, Old Grimsby	Extension of the hotel is very close to an eroding ram cliff	Likely solution will be a mass concrete sea wall faced with masonry and with rock armour toe protection.
South Beach (Crab"s Ledge)	Road south of Great Rock between Sea Carn and Skirt Island at risk from erosion	Protection using cleft log fencing dug into the beach was proposed in 1995 but no works were undertaken.

Table 27: Projects under consideration in 1997/98 on Tresco

Location	Storm damage/ existing defences	New Defences built mid 1990s
Projects under consideration in 1997/98		
St Mary's		
Town Beach	Inspected in March 1997 by Aspen Burrow Crocker.	Conclusions: • Wall to north of steps at extreme eastern end in a serviceable condition but needs some pressure pointing in next 5 years to reinstate it. Toe needs further protection; • Seawall west of Rechabite Slipway is reaching the end of its life and is in need of extensive repair or even replacement. Isles of Scilly Council planning remedial works following Tresco Island Hotel works.

Table 28: Projects under consideration in 1997/98 on St Mary"s

The Conclusion of SMP1 was to instigate a programme of shoreline monitoring to assess change. The aim was to undertake the monitoring on a 5 yearly basis at the location of the new defences built on Bryher and St Agnes supplemented with the pre-and post-construction surveys.

On Tresco, pegs have been monitored along South Beach and Pentle Bay to help establish erosion rates during the winter gales. A topographic survey was to be commissioned to help determine the risk to the Heliport and the water supply with the continued erosion of South Beach and Pentle Bay.

Further survey was proposed for Appletree Point to ascertain the extent of erosion in front of the wall and to determine more precisely the exact extent of hinterland area threatened by a breach. This is essential information for the design of potential replacement flood defences and the economic cost benefit analysis.

Monitoring was to be established at Porth Cressa, Old Town and Porth Minick to determine the effect of the new structures.

Bar Point remains an area of some concern and should be monitored at the same time as the adjacent shorelines on Tresco.

No coastline monitoring was considered necessary for St Martin‟s as most development is on the higher ground.

The SMP1 was to be a working document with an action plan for each of the Management Units as defined in the SMP. The following are locations where coastal protection schemes were to be a priority on the basis of risk to significant assets.

Location	Requirements
St Agnes	No needs identified other than monitoring
Bryher	No needs identified other than monitoring
Tresco	Island Hotel - Design work proposed for 1997/98 with construction scheduled for 1998/99
	Continued monitoring of South Beach, Pentle Beach and Appletree Bay, due to high erosion rates recorded in 1996/97
St Martins	No needs identified
St Mary‟s	Post construction monitoring at Porthcressa, Porth Minick and Old Town Bay Monitor long term trends of reduction in beach levels at Town Beach and Porthloo. Scheme was proposed at Porthloo by the Isles of Scilly Council and stakes were established to monitor the erosion of the ram cliff. Initial measurements taken in 1997 and logged on Isles of Scilly Council‟s GIS Porth Hellick – cause for concern although stable at flanks. To be monitored. Works have subsequently been undertaken in 2000.

Table 29: Locations where coastal protection schemes were considered to be a priority under the initial SMP

16.2 Isles of Scilly Flood Plan by the Devon, Cornwall and Isles of Scilly Local Resilience Forum, version 1, June 2010

The Isles of Scilly Council forms part of the Devon, Cornwall and Isles of Scilly Local Resilience Forum (LRF) which provides an opportunity to share information amongst the three local authorities and the Environment Agency and to ensure that all flood risk is understood. A Memorandum of Understanding is to be established to set out the aims, objectives and responsibilities of member organisations. This will also help to ensure more effective communications with residents at risk of flooding, provide more coordinated emergency response plans and lays the foundations for longer term management strategies.

The Flood Plan outlines the roles and responsibilities of the Isles of Scilly Council within the coordinated response of a number of agencies to an incident of flooding. The Plan details:

- Flood Risk;
- How flood and severe weather warnings are disseminated;
- Measures undertaken when the risk of flooding is perceived;

- The roles and responsibilities of agencies that might be involved in the response to a flooding incident on the Isles of Scilly;
- Evacuation and Shelter;
- Recovery.

The Plan identifies the location of vulnerable concentrations of the population on the five inhabited islands.

16.3 Cornwall and Isles of Scilly Shoreline Management Plan Review (SMP2) extending from Rame Head to Hartland Point, Royal Haskoning, February 2011

The SMP review was completed on behalf of the Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG). Members of CISCAG formed the SMP Client Steering Group (CSG), including representatives, from the Local Authorities, Environment Agency, Natural England, English Heritage and the National Trust who have overseen and guided the production of the SMP.

Since the first SMP there has been significant progress on how climate change and sea level rise may affect the coast and a shift towards longer term sustainable development and land use planning. As such the aims of the SMP are quoted as:

- To reduce the threat of flooding and coastal erosion to people and their property; and
- To deliver the greatest environmental, social and economic benefit, consistent with the Government‟s sustainable development principles.

The SMP Review provides a long term policy framework over the next 20, 50, 100 years to guide the management of the coast. The Isles of Scilly SMP area is divided into 60 individual policy units each with a preferred policy option for each of the three time periods up to the year 2105.

The generic shoreline management policy options considered in SMP2 are defined by Defra and are described below:

No active intervention (NAI):	A decision not to invest in providing or maintaining defences or natural coastline.
Hold the line (HTL):	Maintain or upgrade the level of protection provided by defences or natural coastline.
Managed realignment (MR):	Manage the coastal processes to realign the „natural‟ coastline configuration, either seaward or landward, in order to create a future sustainable shoreline position.
Advance the line (ATL):	Build new defences seaward of the existing defence line where significant land reclamation is considered.

The SMP Review notes that the Isles of Scilly coastline experiences one of the highest energy wave climates in the British Isles, due to its extreme off-shore westerly location. Understanding the implications of this wave energy is essential for the future of the coastline, and wave impact is one of the key points for the SMP2 to address.

The wave climate is seasonal with the more energetic wave activity in the autumn, winter and early spring period (October to April). During the winter months, the North Atlantic produces wave energy more consistently than any other ocean and much of the energy reaches the west coast of Great Britain. Much of the wave energy reaching the Isles of Scilly is in the form of swell. Swell waves are generated great distances from land by low pressure systems and lose very little energy. Swell waves tend to behave differently from locally generated wind waves and can in some situations create worse flooding problems.

Wave impacts on communities include direct wave driven flooding, erosion caused by wave action, risk to life, structural damage, disruption to transport routes and impact to coastal habitats.

Monitoring of the waves will help to understand how changes in wave climate may affect the shape and position of the shoreline in the future. The South West Regional Coastal Monitoring Programme (SWRCMP) was set up in 2006 and uses remote sensing and ground based survey techniques to capture a wide range of physical characteristics along the coastline on a regular basis to monitor changes caused by waves and tides.

Wave buoys are deployed at discrete locations around the Cornish coastline. The SMP2 recommends that wave buoys are deployed to record both the easterly and westerly wave climates at Hugh Town.

At the same time, due to the plan form of the archipelago and the sheltering effect that some islands can have on the others, there are some sheltered frontages, for example, New Grimsby on Tresco and Green Bay on Bryher.

A particular risk for the Isles of Scilly is “coastal squeeze” where the coastal strip is trapped between rising sea levels and man-made defences, narrowing the foreshore as the mean high tides encroach landwards but the defences remain static.

16.3.1 Key Conclusions of the Isles of Scilly SMP Review

	Policy	Priority Actions
Hugh Town - Harbour and Town Beach		
Frontages along the harbour and to the rear of Town Beach, along the Lower and Higher Strand will become more vulnerable to wave over-topping and storm inundation. Regular monitoring and maintenance, with some improvement is required in the short term. Adaptation of the Hugh Town settlement around the harbour is anticipated in the future.	*Hold the line* is preferred. For Town Beach *managed realignment* is recommended beyond 2055.	• Wave climate study & monitoring; • Beach and cliff erosion monitoring; • Local Development Framework to identify St Mary's as a Coastal Change Management Area; • Strategy to assess flood and coast defence options including adaption and managed realignment; • Island strategy to assess risk to fresh water supply; • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 30: SMP2 Policy and Priority Actions for the Harbour and Town Beach, Hugh Town

	Policy	Priority Actions
Hugh Town - Porthcressa		
The Porthcressa frontage is generally pressurised, with residential development exposed to wave over-topping and inundation. The narrow intertidal zone is subject to coastal squeeze effects. Dealing with risks along the Porthcressa frontage is central to managing the overall risk to Hugh Town and so needs to be considered as part of the wider detailed strategy.	*Hold the line* is preferred in the short term (next 15 years). *Managed realignment* is preferred in the medium to long term.	• Wave climate study and monitoring; • Beach and cliff erosion monitoring • Strategy to assess flood and coast defence options including adaption and managed realignment; • Local Development Framework to identify St Mary's as a Coastal Change Management Area; • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 31: SMP2 Policy and Priority Actions for Porthcressa, Hugh Town

	Policy	Priority Actions
Porth Mellon - St Mary's		
Significant pressure on the Porth Mellon frontage from climate change dictates that a careful management approach is required. Erosion risk to Telegraph Road, boatsheds, gig sheds and cafe and strategic risk to Lower Moor. A future management strategy needs to accommodate the increases in sea level rise and avoid coastal squeeze while at the same time prevent serious inundation to the Lower Moors area, where the bulk of the freshwater supply for St. Mary's is situated.	*Hold the line* is preferred in the short term. *Managed realignment* is preferred in the medium to long term, to roll back and strengthen the defensive line.	• Beach and erosion monitoring and post storm damage surveys • Beach and Dune Management Plan • Potential realignment of highway • Managed realignment strategy • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 32: SMP2 Policy and Priority Actions for Porth Mellon, St Mary's

	Policy	Priority Actions
Old Town Bay and Porth Minick, St Mary's		
Erosion along the Old Town frontage and the risk of inundation of the Lower Moors during storms dictated that this is one of the most pressurised frontages on the Isles of Scilly. The effects of climate change will exacerbate these risks. The main road between the airport and Hugh Town, and the Old Church may be at risk within the next 50 years.	*Hold the line* is preferred in the short term. *Managed realignment* is preferred in the long term, to roll back the defensive line.	• Wave climate study and monitoring • Beach and erosion monitoring • Beach management plan • Managed realignment strategy • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 33: SMP2 Policy and Priority Actions for Old Town and Porth Minick, St Mary's

	Policy	Priority Actions
Porth Hellick, St Mary's		
Increasing flood risk at Porth Hellick relates to possible saline contamination of the freshwater supply to St Mary's obtained from the Higher Moors.	*Hold the line* is preferred in the short term. *Managed realignment* is preferred in the long term, to provide a sustainable and robust defence to the Higher Moors area.	• Beach and erosion monitoring • Managed realignment strategy • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 34: SMP2 Policy and Priority Actions for Porth Hellick, St Mary's

	Policy	Priority Actions
Appletree Bay and Tresco Flats, Tresco		
The low cliffs along the south-west facing shoreline of Tresco demonstrate active erosion which is likely to accelerate as rises in mean sea level become more rapid. Access routes up as far as New Grimsby Harbour may be affected. Due to the natural characteristics of the frontage, any defence would be undesirable under the SMP2 objectives.	An ongoing policy of *no active intervention* is preferred at Appletree Bay and Tresco Flats, whilst at New Grimsby *hold the line* is preferred.	• Beach and cliff erosion monitoring and post storm damage surveys • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 35: SMP2 Policy and Priority Actions for Appletree Bay and Tresco Flats, Tresco

	Policy	Priority Actions
Big Pool, St Agnes		
If overtopping or failure of defences around the Big Pool were to occur there would be risk of saline contamination of the main fresh water supply to St Agnes. The defence of this area is strategic to the well-being of the local community and the economy of the island.	A continuous *hold the line* policy is preferred from Pereglis Skips to Ginamoney Carn and then from Ginamoney Carn to Browarth Point. There is an additional recommendation to maintain the defences at Porth Killier to reduce wave inundation from the north east	• Beach and cliff erosion monitoring adjacent to Big Pool • Island strategy to assess risk to fresh water supply • Wave climate study and monitoring • Isles of Scilly Flood and Coastal Risk Management Strategy

Table 36: SMP2 Policy and Priority Actions for Big Pool, St Agnes

16.3.2 Community Adaption Locations

St Mary‟s has been identified as both a Coastal Change Management Area (CCMA) and a location where an adaption strategy would be appropriate due to the significant potential impacts on the community. On St Mary‟s it is quoted that over 100 private properties maybe affected by increased flood risk and erosion in the future, along with community assets and infrastructure, including roads, pumping station, the hospital, fire station, incinerator, the industrial park and drinking water supply reservoirs.

16.3.3 Highways at Risk

The list below, taken from SMP2, identifies roads and locally important access routes around the inhabited islands that could be affected by future coastal erosion and the threat of flooding:

- Hugh Street (Hugh Town, St Mary‟s)

- Higher Strand (Hugh Town, St Mary‟s)
- Buzza Road (Hugh Town, St Mary‟s)
- A3111 (Porth Mellon, St Mary‟s)
- Old Town Road (Old Town, St Mary‟s)
- Trench Lane (Old Town, St Mary‟s)
- Harbour Road (New Grimsby, Tresco)
- Appletree Road (Tresco)
- Cruther‟s Neck (St Martin‟s)

16.3.4 The Action Plan

The Client Steering Group (CSG) have approved the Action Plan based on the Preferred Plan. The Action Plan lists the identified measures necessary to implement the intent of management identified by the Preferred Plan. It identifies partners and sources of funding as well as categorising the actions into low, medium and high priorities. Through signing up to the Action Plan, each CSG partner is demonstrating a commitment of intent to undertaking each action, as priorities allow and funding permits.

It is intended that the SMP Action Plan remain a “live” document with details of completed and on-going studies and actions are reported via the CISCAG website.

16.4 Isles of Scilly Preliminary Flood Risk Assessment, Preliminary Assessment Report, JBA Consulting, May 2011

Under the Flood Risk Regulations 2009 and the Flood and Water Management Act 2010, the Isles of Scilly Council, as Lead Local Flood Authority (LLFA), has a responsibility for managing local flood risk from sources such as surface water, groundwater and ordinary watercourses.

The production of a Preliminary Flood Risk Assessment (PFRA) serves to review historic flood events, establish the potential for future flooding as well as determine any “areas of significant flood risk”, known as Flood Risk Areas. No Flood Risk Areas have been proposed for the Isles of Scilly.

The PFRA was unable to establish a specific number of people or properties at risk of flooding on the islands due to lack of fluvial or surface water flood mapping. However, it has established a database structure for recording the mandatory information necessary for documenting all future flood incidents.

Work on developing the Council‟s Local Flood Risk Management Strategy, required under the Flood and Water Management Act 2010, is due to start later this year.

The Environment Agency remains responsible for assessing the risk of flooding from main rivers, the sea and large reservoirs. There are however, no main rivers or ordinary watercourses located on the Isles of Scilly.

16.5 South West River Basin District

The Water Framework Directive requires the production of river basin management plans for each river basin district. The Isles of Scilly are included in the South West river basin district. There are six waterbodies associated with the islands, four groundwater and two coastal. All waterbodies are currently good status, and predicted to remain at good status, through to 2015, the end of the first planned cycle of river basin management plans.

16.6 Environment Agency National Flood and Coastal Defence Database (NFCDD)

A list of defences on the Isles of Scilly, held on the EA‟s NFCDD system, was provided in October 2011. Details are included in Appendix E.

17 Conclusions

The significance of a flood defence is dependent on the scale of the population protected, the critical assets defended and the subsequent impact should the defence be breached.

Storm surges originate deep in the Atlantic Ocean so the south west and south facing coastline of the Isles of Scilly is most exposed to the resulting storm impact. Defences need to resist high water levels, wave over-topping and extreme wave erosion.

The more sheltered coastlines remain at risk from still water conditions when high tides coincide with storm surges.

Hugh Town on St Mary‟s is the most populated area and represents the commercial centre for the Isles of Scilly. It is however, located on a narrow sand isthmus with Town Beach to the north and Porthcressa Beach to the south, exposed to storm surges. Other than the 1989 storm event there have been very few flood events and even during this event, the majority of the damage was to the flood defences themselves, as opposed to damage resulting from property flooding. However, with climate change predictions the risk of catastrophic inundation of Hugh Town does remain a very significant threat that needs to be addressed in future flood risk management work. This has been captured as a key recommendation in SMP2.

Given the remoteness of the Isles of Scilly and their need to remain as self-sufficient as current day living practices dictate, it could be argued that flood defences protecting property, critical infrastructure and natural resources should all be given an equal weighting. For example, loss of a defence protecting St Mary‟s water supply will affect the whole of the island‟s population and severely hamper the tourism on which the island‟s economy relies. The economic justification for any future work needs to bear this in mind.

Short and medium term recommendations have been provided for each of the assets visually inspected. To avoid abortive spend it is important that these recommendations are undertaken with reference to the latest SMP2 strategies and recommendations.

18 Recommendations

18.1 Hugh Town - maintain integrity of existing defences

Given the low lying location of Hugh Town the first priority is to maintain the integrity of its defences.

The need for the capital works between Holgate‟s Green and the Lifeboat Slip at Town Beach is recognised as urgently required given the substantial voids measured within the stone wall. Works are planned for this autumn and it is vital that these works are completed before the next winter season to avoid the risk or irreparable damage from winter storms.

The Porthcressa defences are in a reasonable condition but it is recommended that regular monitoring and maintenance is continued.

18.2 Maintenance of critical defences

As a minimum a 6 monthly inspection routine should be established and the findings and any subsequent maintenance recorded. The frequency of the inspections should be increased if particular areas of concern arise. Inspections should also be made after each significant event to check for storm damage. This recommendation is applicable to all critical defences where maintenance is either undertaken by the Isles of Scilly Council or the Duchy of Cornwall Estate. Communication between the two bodies on the on-going maintenance and integrity of the defences is recommended.

Critical defences on the Isles of Scilly are considered to be:

St Mary‟s	Porthcressa, Old Town, Porth Minick, Town Beach, Porth Mellon, Porth Hellick and Porthloo
Tresco	Island Hotel, Old Grimsby and Appletree Bay
St Agnes	Porth Killier, Porth Coose and Periglis
Bryher	Great Popplestone and Great Par
St Martins	No defences

Table 37: Critical Defences

A number of the assets listed above are natural sand dunes but are significant in protecting the islands‟ assets. At a number of locations, erosion from the public is evident, either because the defence is crossed reaching the beach, or because the coastal path runs along the top. If a defence level is to be maintained, either access needs to be diverted or the embankment strengthened.

Porth Mellon on St Mary‟s and Porth Killick on St Agnes are two assets which require a review. Porth Mellon is a popular beach for recreation but its defence role is jeopardised by areas of erosion. At one location, near its mid-point, there is a clear gap right through the embankment.

On St Agnes, reinforcement of the defence at Porth Killick, implemented in 1996, would appear to be reaching the end of its design life. Remedial works to stabilise it are recommended.

18.3 Monitoring of change

A programme of shoreline monitoring to assess change was recommended as part of the Action Plan following completion of SMP1.

It is not certain how the results of this shoreline monitoring are collated and reviewed or even if the monitoring has continued beyond 1997/98. Certainly if monitoring data is available, the results should be reviewed on an annual basis so that the impact of changes on the flood defences can be assessed.

SMP2 also recommends shoreline monitoring to assess the impact of beach erosion on the existing defences and to help manage and plan the future re-alignment.

A particular risk identified for the Isles of Scilly is "coastal squeeze" where the coastal strip is trapped between rising sea levels and man-made defences, narrowing the foreshore as the mean high tides encroach landwards but the defences remain static.

By assessing the impact and rate of beach erosion the risk posed to the existing defences can be assessed and appropriate remediation proposed that is sympathetic with the natural on-going coastal processes.

Given that the Isles of Scilly have a very high energy wave climate, SMP2 comments that it is important to understand the implications of wave energy on the future of the coastline. As such it recommends that wave buoys are deployed to record both the easterly and westerly wave climates at Hugh Town. The South West Regional Coastal Monitoring Programme (SWRCMP) may be able to assist with this.

18.4 Flood Warning

A Flood Plan was prepared for the Isles of Scilly in 2010 by the Devon, Cornwall and Isles of Scilly Local Resilience Forum.

Extreme rainfall alerts and National Flood Guidance Statements are issued by the Flood Forecasting Centre and the National Severe Weather Warning Service (NSWWS) issues Severe Weather Warnings.

The Plan identifies the location buildings for vulnerable communities including the local schools and care homes.

It comments that national guidance suggests that in the event of an emergency the public are to shelter unless there is a clear and obvious danger to life and a decision to evacuate would be taken by the Police Incident Commander. If the decision is taken to evacuate properties the Council will open a designated Rest Centre in accordance with the Council‟s Rest Centre Plan. The location of this Rest Centre is not given in the Flood Plan, but it obviously needs to be on higher ground and accessible by road. The hospital, airport or even the golf club are all potential options.

The evacuation of Hugh Town is not an impossibility given its low lying nature and vulnerable location and the Flood Plan should include for this eventuality. If such an event were to occur during a summer storm, the Flood Response Team would have to accommodate both the local residents and tourist numbers. Such an emergency response requires effective planning and coordination.

The Flood Plan provides an effective structure for the management of emergency responses. Given the small and tight-knit community on the Isles of Scilly there is a tendency for local workforce to have more than one job. In a flood response situation it is important that there are sufficient resources to ensure that all roles are fulfilled and that resources will not be stretched by trying to meet competing priorities.

18.5 Strengthening of Existing Defences

The consensus of most research is that we will experience an increase in sea levels over the next 50 years. Investigations for St Mary"s have already proven that sea levels are following the rising trend predicted for the south west.

Any future design proposals need to take into account climate change predictions but also review changes noted from the monitoring of the coastline and wave climate referred to in Section 13 to ensure the designs are adequately future-proofed.

We must be mindful that the Isles of Scilly are an Area of Outstanding Natural Beauty and any modifications to existing defences need to be sympathetic to the overall attractiveness of the islands besides the evolving coastline.

SMP2 would appear to indicate inundation from still water tidal conditions (2105) at Old Town, Town Beach and Porth Hellick. The SMP2 strategy for Porth Hellick is managed realignment. However, at Old Town and Town Beach where the short term policy is to Hold the Line, the height of the defences need to be reviewed against climate change predictions.

Also, at Town Beach, consideration needs to be given to flood-proofing the property frontages.

18.6 Upgrading of foul and surface water drainage systems

Only Hugh Town has both a piped gravity foul and surface water drainage system. The systems are antiquated and the foul system suffers from blockages due to the slack gradients through Hugh Town. Both systems suffer infiltration. This is accentuated where the systems run across the top of Town Beach and have to endure daily tidal fluctuations above them. The surface water system often provides a route for tidal water to back up in to Hugh Street. There are cross-connections between the two systems, which reduces the capacity of the foul system and leads to pollution incidents at the surface water outfall outside the Atlantic Hotel.

Although there has only been one regular incident of foul flooding at the Mermaid Public House and no reported surface water flooding incidents, it is recommended that the cross connections between the two systems are addressed in the first instance and the surface water outfall at the Atlantic Hotel repaired with the re-

instatement of the flap valve. This will help to minimise backing up in the surface water system.

Flood-proofing the foul system as part of flood-proofing the Town Beach properties generally needs to be given consideration alongside the sewerage strategy for Hugh Town.

18.7 Recommendations from the SMP2

The latest SMP by Royal Haskoning provides erosion and still water flood predictions up to 2105 for the whole of the Isles of Scilly.

One key priority action is to prepare a Flood and Coastal Flood Risk Strategy specifically for the Isles of Scilly.

Within that Strategy, a key recommendation is the requirement for a detailed strategy to be undertaken for the whole of Hugh Town, considering the very longer term implications of climate change.

The SMP goes on to recommend that the strategy must consider the costs and sustainability of managing the risks in-situ, versus the costs and wider social and economic implications of gradually re-locating to the higher ground to the east. There is significant uncertainty with regards to climatic predictions and this makes Hugh Town"s location more vulnerable. The strategy should also address the implications for building stability from rising water levels and percolation.

The SMP also recommends that there is a strategic investigation into the combined risks posed by over-topping and inundation besides percolation and groundwater levels for St Mary"s. Assessing the risk to the islands" fresh water supply, this should include the Lower and Higher Moor areas, Porth Mellon, Porth Hellick, Old Town Bay and Porth Minick.

The SMP gives priority areas that need to be considered over the next 5 to 10 years. These are:

Hugh Town, Harbour and Town Beach;

Hugh Town, Porthcressa;

Porth Mellon;

Old Town Bay and Porth Minick;

Porth Hellick;

Appletree Bay and Tresco Flats; and

Big Pool, St Agnes.

Policy options are presented for each over 3 timescales: up to 2025, up to 2055 and up to 2105.

Any works to flood defences should be undertaken with reference to these policy options.

The Action Plan, developed as part of the SMP captures all intended actions necessary to deliver the objectives at a local level. It should be used to help

prioritise flood and coastal risk management medium and long term planning budgets.

Although the initial economic justification for future work looks poor, the number of properties affected by flooding does not take into account flooding through wave dominated events and more work is apparently required to quantify property numbers.

Support from the Land Use Planning System is advised for areas that have been identified as Coastal Change Management Areas. This includes Porthcressa, the Harbour and Town Beach. Generally, following the guidance laid down in Planning Policy Statement 25 to avoid inappropriate development in areas at risk of flooding should be adhered to.

References

[1] Council of the Isles of Scilly Shoreline Management Plan, Aspen Burrow Crocker, October 1997.

[2] Cornwall and Isles of Scilly Shoreline Management Plan, Royal Haskoning, February 2011, commissioned by the Cornwall and Isles of Scilly Coastal Advisory Group (CISCAG).

[3] Cornwall and Isles of Scilly Shoreline Management Plan, Strategic Environmental Assessment Scoping Report, Royal Haskoning, July 2009, Final Report.

[4] Isles of Scilly Climate Change Strategy 2011, Council for the Isles of Scilly.

[5] Isles of Scilly Preliminary Flood Risk Assessment, Preliminary Assessment Report, JBA Consulting, May 2011.

[6] Isles of Scilly Flood Plan, Devon, Cornwall, Isles of Scilly Local Resilience Forum, Version 1, June 2010.

[7] Storm Damage Reports, Council of the Isles of Scilly, December 1989.

[8] Report on Existing Sea Defences and Proposals for Remedial and Additional Works, DHV Burrow-Crocker Consulting April 1992.

[9] Coast Protection Survey of England, Summary Survey report, PB1667, MAFF 1994.

[10] Isles of Scilly Technical Document: Part 2, Environmental Legislation Water.

[11] Defra and Environment Agency, Isles of Scilly Landfill Sites, Follow-on Site Investigation, SLR Consulting Ltd., December 2009.

[12] A Report on the future requirements for sewage treatment provisions on St Mary‟s Isles of Scilly, H2OK Consultants, 2002. Compiled for the Council of the Isles of Scilly.

[13] National Area Boundary (NA113) Document – Isles of Scilly.

[14] The Isles of Scilly Area Assessment, Audit Commission, December 2009.

[15] The Isles of Scilly Local Plan, A 2020 Vision, adopted November 2005, the Council of the Isles of Scilly.

[16] Initial Characterisation of the Isles of Scilly for the purposes of the Water Framework Directive, Steve Fletcher, Environment Agency October 2004.

[17] A Catalogue of Tsunamis in the UK, D Long & CK Wilson, Marine, Coastal and Hydrocarbons Programme Commissioned Report CR/07/077, British Geological Society 2007.

[18] The threat posed by tsunami to the UK, study commissioned by Defra Flood Management, June 2005.

[19] Assessing the hazard for the UK and Irish Coasts, study commissioned by Defra, Health and Safety Executive and Geological Survey of Ireland, 2006.

[20] Intergovernmental Coordinating Group of the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS), http://www.ioc-tsunami.org/.

[21] UK Futurecoast Project, 2002, Halcrow Group, Defra.

[22] Cornwall and Isles of Scilly Coastal Advisory Group website.

[23] National Oceanography Centre website.

[24] UK Climate Change Predictions, Murphy et al (2009), UK Climate Projections Science Report: Climate Change projections. Met Office Hadley Centre, Exeter.

[25] UK Climate Change Predictions, Lowe et al (2009), Climate Projections Science Report: Marine and Coastal projections. Met Office Hadley Centre, Exeter.

[26] Environment Agency Flood and Coastal Risk Management Outcome Measures, http://www.environment-agency.gov.uk/research/planning/122070.aspx.

Appendix A

Drawings

A1 Drawing List

217862-001: St Mary‟s, Location of Flood Defences and Areas of Risk

217862-002: Hugh Town, St Mary‟s, Areas at Risk of Flooding

217862-003: Tresco, Location of Flood Defences and Areas of Risk

217862-004: Bryher, Location of Flood Defences and Areas of Risk

217862-005: St Agnes, Location of Flood Defences and Areas of Risk

217862-006: St Martin‟s, Areas of Risk

A2

Isles of Scilly Council
Assessment of 1989 Storm Damage

1. Old Town Bay - Sea wall undermined. Estate of 9 bungalows and Café threatened
2. Porth Minick - Bulb fields flooded. Estate of 66 properties threatened
3. Porth Hellick - Vulnerable shingle beach protecting island's water supply
4. Porthloo - Damage to earth embankment. Damage to boat park and 6 houses threatened
5. Porth Mellon - Industrial estate and Council depot vulnerable behind sand dunes
6. Town Beach - Damage to Strand Promenade over 50m
7. St Mary's Pier - Damage to main pier and lighthouse destroyed
8. Car Park - Sea wall destroyed
9. Porthcressa - Damage to sea defences and erosion over 200m. Whole of Hugh Town threatened.

Key

- Area liable to flooding if not defended
- Areas subject to erosion and where flooding has occured as identified in 1989
- Serious damage occurred and repairs required as identified in 1989

Areas of Risk identified by the DHV Burrow-Crockers' 1992 Report

- Porthcressa
- Old Town Bay
- Porth Minick
- Porth Hellick
- Porth Loo
- Town Beach

Ponds adjacent to highway draining to Watermill Cave

Porthloo

De-Salination Plant

Town Beach

Water Pumping Station

Walls protecting vehicular access to Quay

Outlet for Higher Moor

Porthcressa

Lower Moor

Bio-Bubble and Pumping Station, Old Town

Porth Hellick, Higher Moor and Holy Vale

Telegraph Reservoir (220,000 gallons)

Penzance - St Marys

Crow Bar

BAR POINT

WATERMILL COVE

The Road

Old Kelp Pits

Little Porth

HOLY VALE

Porthloo

PORTHLOO

TREWINCE

PORTH THOMAS

Sunnyside Farm

St Mary's

Carn Friars Cottage

St Mary's Pool

PORTH MELLON

TOWN BEACH

LOWER MOOR

Airport Bungalows

PORTHCRESSA

AIRPORT

PORTH HELLICK

Garrison Reservoir 21,000 gallons

Buzza Reservoir (37,000 gallons)

OLD TOWN BAY

PORTH MINICK

TOLMAN HEAD

The Murrs

PENINNIS HEAD

Legend

Public Amenity

- Education Facility
- Hospital
- Police Station
- Place of Worship
- Heritage Site
- Airport

Transport Network

- Foot Path
- Main Road
- Road
- Track
- Ferry Route

Other

- Contour (5m)
- Contour (m)
- Spot Height (meters)
- Surface Running Water
- Surface Water
- Building
- Woodland
- Foreshore
- Land
- Tidal Water

- Erosion as seen in July 2011
- Formal Flood Defence as seen in July 2011

Issue	Date	By	Chkd	Appd
P1	2011-07-12	LC	NA	NA

Kilometers: 0 0.2 0.4 0.8

ARUP
4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client: **DEFRA**

Job Title: **Isles of Scilly Water Interests Survey**

Drawing Title: **St Mary's Location of Flood Defences and Areas of Risk**

Scale at A1: **1:15,000**

Drawing Status: **Preliminary**

Job No	Drawing No	Issue
217862	001	P1

14/11/2011 10:53:33

\\Global\Europe\Cardiff\Jobs\217000\217862-004 Internal Project Data\4-80 GIS\02 Map Documents\IslesofScilly_Water InterestsSurvey.mxd

Legend

- Area liable to flooding if defences not maintained
- 10m Contour Line

Issue	Date	By	Chkd	Appd
P1	2011-08-15	LC	NA	NA

Metres
0 60 120 240

ARUP

4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client
DEFRA

Job Title
Isles of Scilly
Water Interests Survey

Drawing Title
Hugh Town, St Mary's
Area at Risk of Flooding

Scale at A4
1:5,000

Drawing Status
Preliminary

Job No	Drawing No	Issue
11-095	002	P1

A4
14/11/2011 10:56:56
Template A4: Version 2

A2

Isles of Scilly Council
Assessment of 1989 Storm Damage

1. Damage to sea wall, foundations to road drawn out causing road to drop and wall to collapse
2. Damage to sewage outfall
3. Damage to New Grimsby Quay
4. Damage to Long Point
5. Seawall running from slipway at Timothy's Corner to 'The Bay' has become vulnerable threatening road above
6. Old Grimsby Quay
7. Erosion and undermining of cliff edge leading to loss of grazing land

Key

- Area liable to flooding if not defended
- Areas subject to erosion and where flooding has occured as identified in 1989
- Serious damage occurred and repairs required as identified in 1989

New Grimsby seawall

New Grimsby Quay

Timber revetment near Timothy's corner

New holiday homes - New Grimsby

Great Pool outlet

Great Pool

Erosion of cliff threatening grazing land

Appletree Bay and sea defence

Island Hotel

Old Grimsby

Old Grimsby Quay

Abbey Pool

Areas of Risk identified by the DHV Burrow-Crocker's 1992 Report

- Appletree Beach
- Timothy's Corner
- Island Hotel, Old Grimsby
- Old Grimsby

Legend

Public Amenity

- Education Facility
- Hospital
- Police Station
- Place of Worship
- Heritage Site
- Airport

Transport Network

- Foot Path
- Main Road
- Road
- Track
- Ferry Route

Other

- Contour (5m)
- Contour (m)
- Spot Height (meters)
- Surface Running Water
- Surface Water
- Building
- Woodland
- Foreshore
- Land
- Tidal Water
- Formal Flood Defence as seen in July 2011

Issue	Date	By	Chkd	Appd
P1	2011-07-11	LC	NA	NA

Kilometers: 0 0.15 0.3 0.6

ARUP
4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client
DEFRA

Job Title
Isles of Scilly Water Interests Survey

Drawing Title
Tresco
Location of Flood Defences and Areas of Risk

Scale at A1
1:11,000

Drawing Status
Preliminary

Job No	Drawing No	Issue
217862	003	P1

14/11/2011 10:53:19

\\Global\Europe\Cardiff\Jobs\217000\217862-004 Internal Project Data\4-80 GIS\02 Map Documents\Issues\Scilly_Water InterestsSurvey.mxd

A2

Isles of Scilly Council
Assessment of 1989 Storm Damage

1. Stony Porth in need of attention
2. Old School House area - requires reinforcement of sea defences. Houses and hotel vulnerable.
3. Area liable to floodinbg if Old School House and Popplestone Bay not remedied
4. North end of Popplestone Bay damaged. Island water supply threatened,
5. Fields inundated - defence bank needs raising.
6. Liable to flooding with sea defences breached.

Key

- Area liable to flooding if not defended
- Areas subject to erosion and where flooding has occured as identified in 1989
- Serious damage occurred and repairs required as identified in 1989

Bryher

Little Popplestone - Transition between boulder tombola and sand dune reinforced with rock revetment

Erosion of loose head material known as "Ram"

Great Popplestone

Great Pool with Hotel and Great Par in background

Great Popplestone old seawall

New sub-station

Old School House - Revetment and seawall

Outlet from Great Pool

Southern end of Great Par showing low lying land

Great Pool outlet onto Great Par

HELL BAY
EXISTING SUB-STATION
Gweal
GREAT POOL
Stone wall protecting coastal path
GREEN BAY
STINKING PORTH
GREAT PAR
Merrick Island
STONY PORTH
RUSHY BAY

Areas of Risk identified by the DHV Burrow-Crocker's 1992 Report

- Great Popplestone
- Great Par
- Stony Porth
- Green Bay

Legend

Public Amenity
- Education Facility
- Hospital
- Police Station
- Place of Worship
- Heritage Site
- Airport

Transport Network
- Foot Path
- Main Road
- Road
- Track
- Ferry Route

Other
- Contour (5m)
- Contour (m)
- Spot Height (meters)
- Surface Running Water
- Surface Water
- Building
- Woodland
- Foreshore
- Land
- Tidal Water

- Erosion as seen in July 2011
- Formal Flood Defence as seen in July 2011
- Formal Flood Defence not inspected in July 2011

Issue	Date	By	Chkd	Appd
P1	2011-07-11	LC	NA	NA

Kilometers
0 0.1 0.2 0.4

ARUP
4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client
DEFRA

Job Title
Isles of Scilly Water Interests Survey

Drawing Title
Bryher
Location of Flood Defences and Areas at Risk

Scale at A1
1:8,000

Drawing Status
Preliminary

Job No	Drawing No	Issue
217862	004	P1

14/11/2011 10:53:09

\\Global\Europe\Cardiff\Jobs\217000\217862-0004 Internal Project Data\4-80 GIS\02 Map Documents\IslesofScilly_Water InterestsSurvey.mxd

A2

Porth Coose - Concrete block revetment with erosion control matting

Porth Coose and Big Pool

Concrete revetment blocks and erosion control matting

Granite faced mass concrete wall protecting hinterland and ancient archaeology

Outlet for Big Pool - Flap valve buried in sand

Periglis with Lower Town in the background

Old life boat slip and old Quay showing signs of erosion

Campsite above Bergecooth

Porth Coose
Periglis
Bergecooth
Lower Town
Porth Killier
Big Pool
St Agnes
Cove Vean
St Warna's Cove
Gugh
Wingletang Carn
Clapper Of Works
The Brow
Muncoy Neck

Areas of Risk identified by the DHV Burrow-Crocker's 1992 Report

- Porth Killier
- Porth Coose
- Periglis
- Blanket Bay
- The Bite
- Core Vean
- St Warna's Cove
- Bergecooth

Isles of Scilly Council Assessment of 1989 Storm Damage

1. Pair of cottages and separate dwelling in danger
2. Well and borehole under threat
3. Water supply borehole under threat
4. Marram grass bank below houses eroded

Key

- Area liable to flooding if not defended
- Areas subject to erosion and where flooding has occured as identified in 1989

Legend

Public Amenity

- Education Facility
- Hospital
- Police Station
- Place of Worship
- Heritage Site
- Airport

Transport Network

- Foot Path
- Main Road
- Road
- Track
- Ferry Route

Other

- Contour (5m)
- Contour (m)
- Spot Height (meters)
- Surface Running Water
- Surface Water
- Building
- Woodland
- Foreshore
- Land
- Tidal Water
- Formal Flood Defence as seen in July 2011

Issue	Date	By	Chkd	Appd
P1	2011-07-11	LC	NA	NA

Kilometers
0 0.1 0.2 0.4

ARUP
4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client
DEFRA

Job Title
Isles of Scilly Water Interests Survey

Drawing Title
St Agnes
Location of Flood Defences and Areas at Risk

Scale at A1
1:8,940

Drawing Status
Preliminary

Job No	Drawing No	Issue
217862	005	P1

14/11/2011 10:52:56

\\Global\Europe\Cardiff\Jobs\217000\217862-004 Internal Project Data\4-90 GIS\02 Map Documents\IslesofScilly_Water InterestsSurvey.mxd

A2

Isles of Scilly Council
Assessment of 1989 Storm Damage

1. Erosion of sand dunes and marram grass threatening arable land
2. Old Quay - large rocks washed out of structure. Structure acts as defence to nearby fields and boat house
3. Gardens and fields encroached by sea
4. Low lying arable land and campsite under threat if sand dunes and marram grass breached

Key

- Area liable to flooding if not defended
- Areas subject to erosion and where flooding has occured as identified in 1989

St Martin's Hotel

Arable land threatened at Higher Town Bay

Neck of the Pool

Neck of the Pool - campsite and farm land protected by sand dune

Lawrence's Bay

Old Quay - acts as a defence

Areas of Risk identified by the DHV Burrow-Crockers' 1992 Report

- Higher Town Bay
- Lawrence's Bay
- Neck of the Pool

Legend

Public Amenity

- Education Facility
- Hospital
- Police Station
- Place of Worship
- Heritage Site
- Airport

Transport Network

- Foot Path
- Main Road
- Road
- Track
- Ferry Route

Other

- Contour (5m)
- Contour (m)
- Spot Height (meters)
- Surface Running Water
- Surface Water
- Building
- Woodland
- Foreshore
- Land
- Tidal Water

14/11/2011 10:53:44

Issue	Date	By	Chkd	Appd
P1	2011-07-12	LC	NA	NA

Kilometers: 0 0.125 0.25 0.5

ARUP
4 Pierhead Street
Cardiff CF10 4QP
Tel +44 29 2047 3727 Fax +44 29 2047 2277
www.arup.com

Client: **DEFRA**

Job Title: **Isles of Scilly Water Interests Survey**

Drawing Title: **St Martin's Location of Areas of Risk**

Scale at A1: **1:10,000**

Drawing Status: **Preliminary**

Job No	Drawing No	Issue
217862	006	P1

\\Global\Europe\Cardiff\Jobs\217000\217862-004 Internal Project Data\4-90 GIS\02 Map Documents\IslesofScilly_Water InterestsSurvey.mxd

Appendix B

Isles of Scilly Council December 1989 Storm Damage Report

ASPEN
Aspen Burrow Crocker

Appendix 1

Council Assessment of December 1989 Storm Damage

Council of I.O. Scilly. Appendix E

COUNCIL OF THE ISLES OF SCILLY

STORM DAMAGE, ST. MARY'S - DECEMBER 1989

SEE ATTACHED PLAN

1. Old Town Bay:

   Damage to sea defences - sea wall undermined as indicated in red. Estate of 9 bungalows plus cafe threatened as indicated hatched blue.

2. Porth Minick:

   Shingle bank flattened as indicated in red and area behind flooded. Bulb fields destroyed by sea water and rocks. Estate of 66 houses, hatched blue, threatened by sea.

3. Porth Hellick:

   Vulnerable shingle bank with water catchment area, hatched blue, supplying two thirds of the Island's water supply.

4. Porthloo:

   Damage to earth embankment. Flooding of Porthloo Green, hatched red, used as boat park in winter - damage to several boats. 6 houses behind Green threatened by sea.

5. Porthmellon:

   Vulnerable industrial estate and Council depot behind low sand dunes.

6. Town Beach:

   Damage to the Strand promenade. Concrete surface destroyed for an area of 50 metres.

7. St. Mary's Pier:

   Damage to main pier. Cracks opened up and top concrete surface destroyed. Lighthouse at end of pier completely demolished. Full survey report awaited.

8. Car Park:

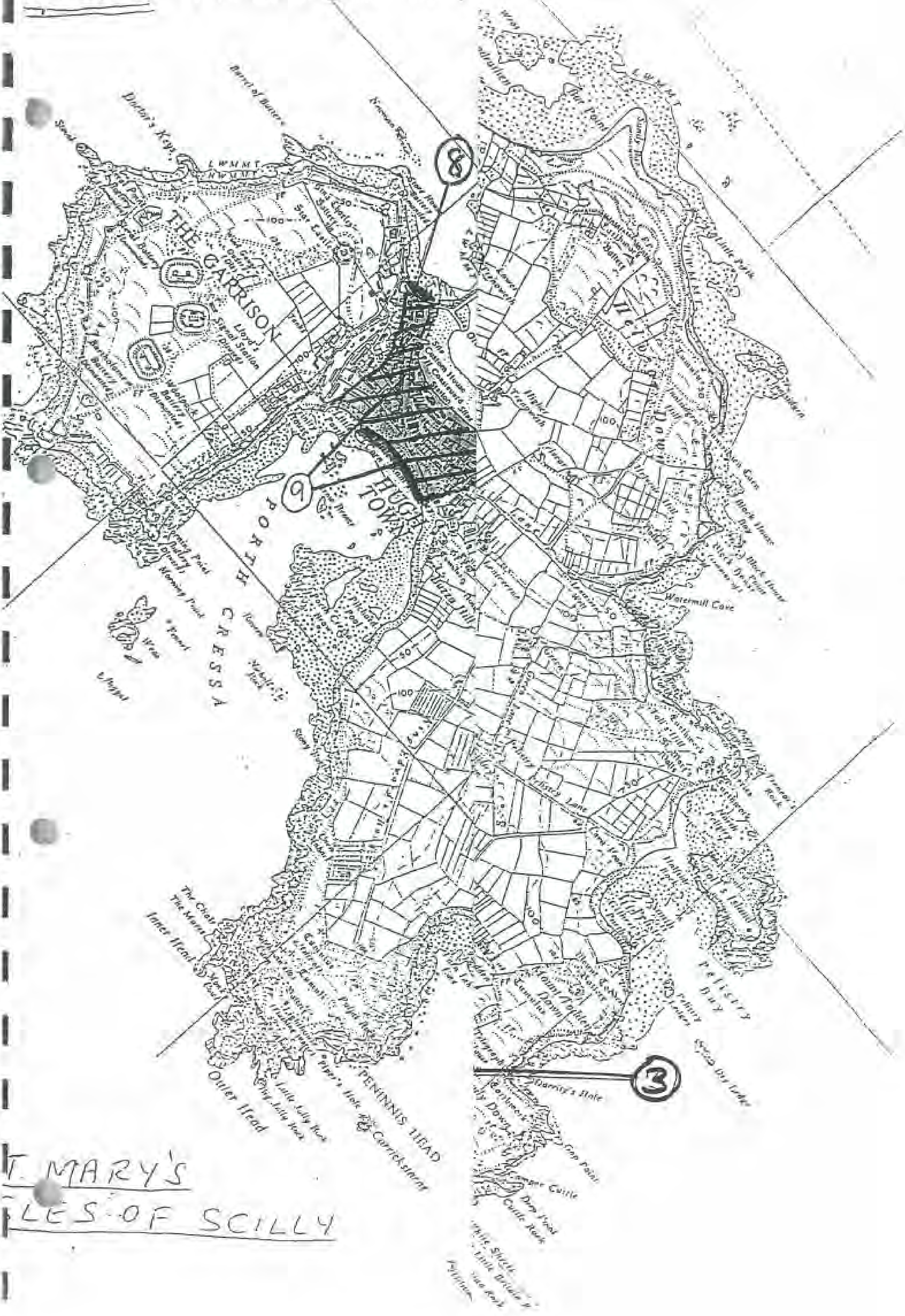
   Sea wall destroyed for length of 15 metres which protects car park.

45717 CC

9. Porthcressa:

   Damage to sea defences. Embankment washed away behind timber front, over a length of 200 metres. Many planks broken and uprights weakened. Whole area of Hugh Town threatened if this embankment is destroyed.

F4007



T. MARY'S
ILES OF SCILLY

Council of I. o. Scilly

STORM DAMAGE REPORT, ST. AGNES - DECEMBER 1989

NUMBERED AS ATTACHED PLAN:

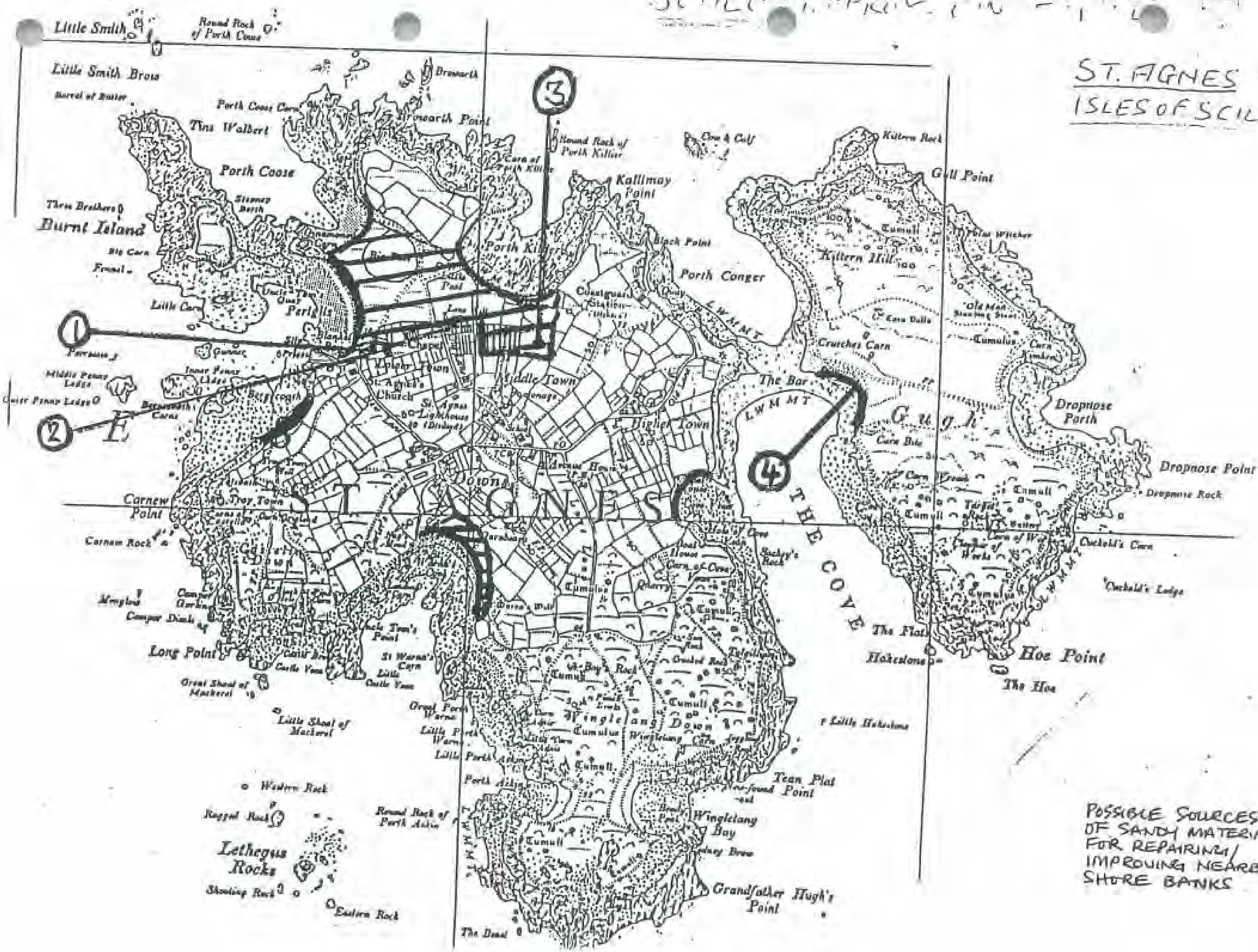
1. A pair of cottages and separate dwelling in considerable danger.
2. Well and bore hole used by several Islanders and their water supply under threat.
3. Bore hole used as water supply under threat.
4. Marram grass bank below houses eroded.

Red Line - Serious damage already occured and repairs urgently needed

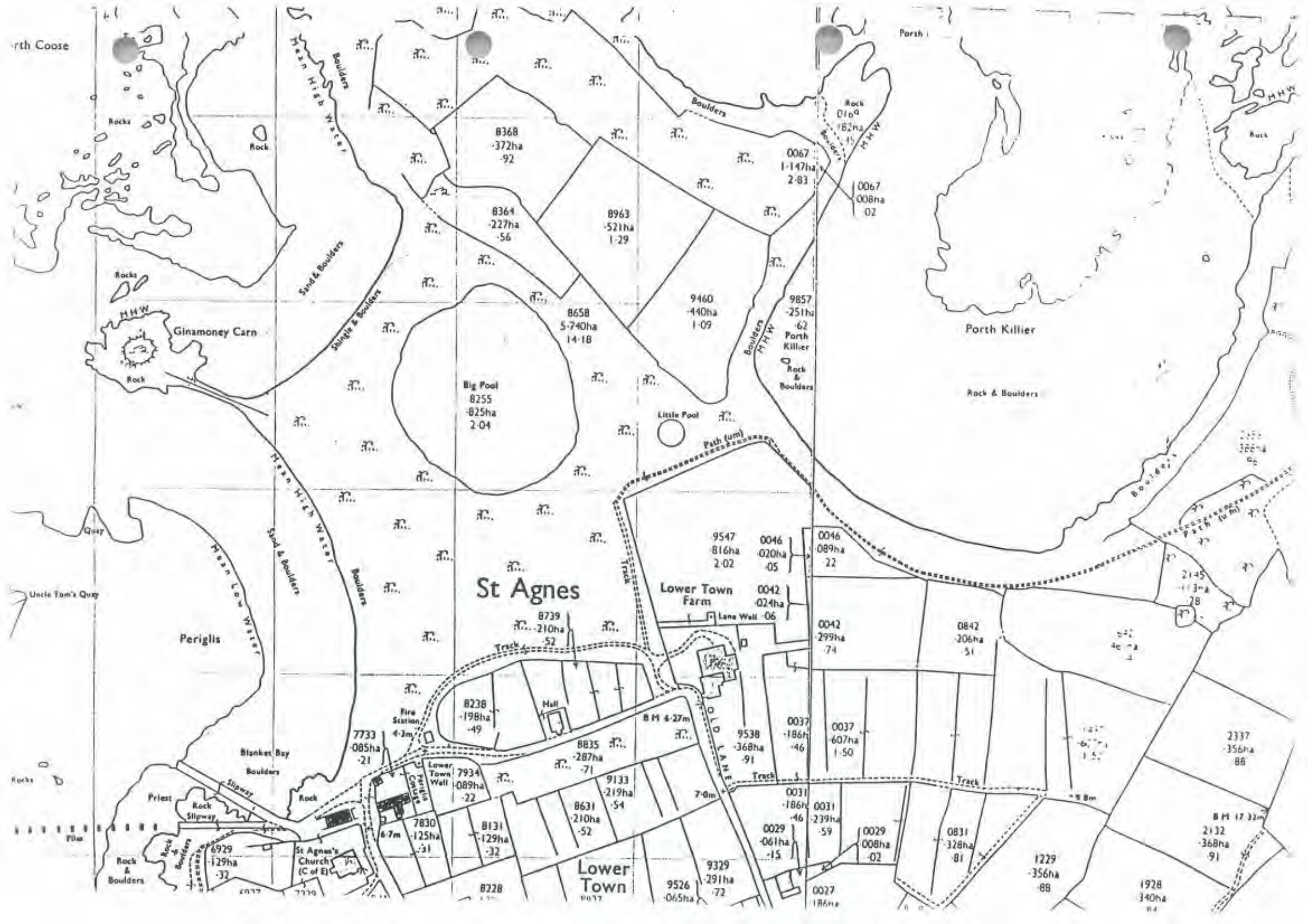
Blue Line - Areas subject to erosion and where flooding has occured

Blue Shaded - Areas liable to flood if repairs not effected.

ST. AGNES
ISLES OF SCILLY



POSSIBLE SOURCES OF SANDY MATERIAL FOR REPAIRING/ IMPROVING NEARBY SHORE BANKS


St Agnes
Lower Town
Porth Killier
Ginamoney Carn
Periglis
Lower Town Farm
Big Pool
Little Pool
Old Lane
Track
Path (um)
Hall
Fire Station
Lower Town Well
St Agnes's Church (C of E)
Blanket Bay
Uncle Tom's Quay
Mean High Water
Mean Low Water
Sand & Boulders
Shingle & Boulders
Boulders
Rock & Boulders
Rocks
Rock
Slipway
Priest
Pilot
MHW
BM 6·27m
BM 17·32m
8368 ·372ha ·92
8364 ·227ha ·56
8963 ·521ha 1·29
9460 ·440ha 1·09
8658 5·740ha 14·18
8255 ·825ha 2·04
9857 ·251ha ·62
0067 1·147ha 2·83
0067 008ha ·02
9547 ·816ha 2·02
0046 ·020ha ·05
0046 ·089ha 22
0042 ·024ha
0042 ·299ha ·74
0842 ·206ha ·51
8739 ·210ha ·52
8238 ·198ha ·49
7733 ·085ha ·21
8835 ·287ha ·71
9538 ·368ha ·91
0037 ·186ha ·46
0037 ·607ha 1·50
7934 ·089ha ·22
9133 ·219ha ·54
8631 ·210ha ·52
0031 ·186ha ·46
0031 ·239ha ·59
0029 ·061ha ·15
0029 008ha ·02
0831 ·328ha ·81
7830 ·125ha ·31
8131 ·129ha ·32
6929 ·129ha ·32
9329 ·291ha ·72
9526 ·065ha
8228
2337 ·356ha 88
2132 ·368ha ·91
1229 ·356ha ·88
1928 340ha
2145 ·113ha ·28

STORM DAMAGE REPORT, BRYHER - DECEMBER 1989

NUMBERED AS ATTACHED PLAN:

1. Stony Par in need of very urgent attention and is considered too large for long-term local repair. Red shaded area flooded by sea on various occasions since December. Damage to defences continue inland so thirty feet. Land near Rushy Bay liable to sea intrusion if defences not remedied.

2. Old School Houses area requires reinforcement of sea defence. Modest cost to employ JCB and local labour sufficient to remedy. Red shaded area indicates present sea intrusion. The houses are under severe threat; hotel and other property vunerable.

3. Area liable to flooding if Old School Houses and Popplestone Bay (4) not remedied.

4. North end of Popplestone Bay has damage to the bank. Red shaded area indicates flooded area behind the bank and flooding is within thirty feet of Island water supply source. Modest cost to effect sufficient repair.

5. Sea has inundated fields near Brow four times in last ten months. The defence bank requires raising about three feet for a length of about 150 feet. Other local repair required to the bank.

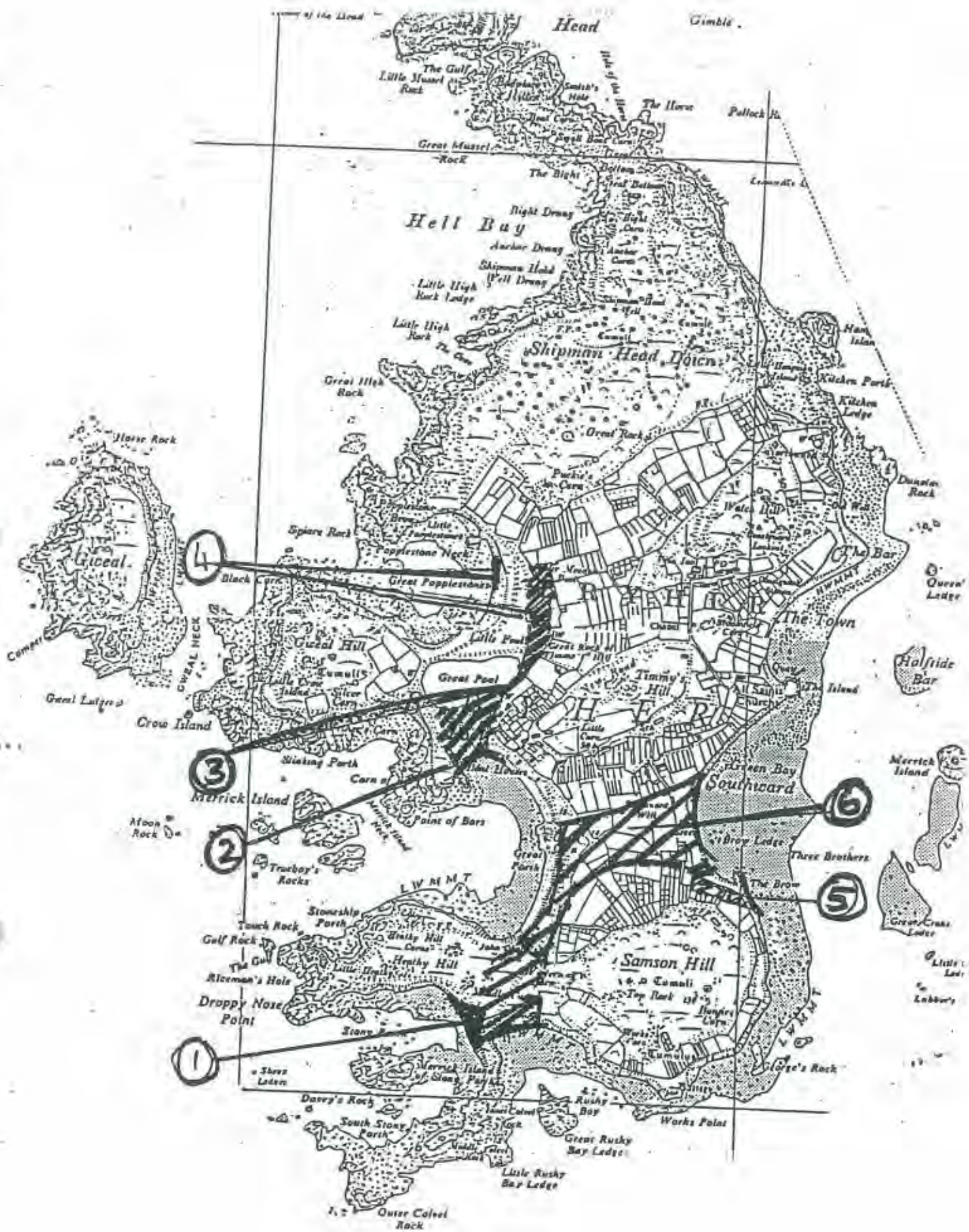
6. Vunerable area which has become liable to flooding with sea defences breached/damaged. Could split the Island in two.

Red Line - Serious damage already occured and repairs urgently needed

Blue Line - Not applicable

Red Shaded - Areas already inundated by sea

Blue Shaded - Areas liable to flood if repairs not effected



SCALE: APPROX. 6 IN. TO 1 MILE

STORM DAMAGE REPORT, ST. MARTIN'S - DECEMBER 1989

NUMBERED AS ATTACHED PLAN:

1. Part of the sand dunes and some of the marram grass lost. If further dunes and grass lost the roadway and arable land comes under threat.
2. Some marram grass is being washed away - saline intrusion of the water table likely if the sea breaks through. Fields liable to flooding.
3. The Old Quay has suffered damage with large rocks washed out of structure. At present unusable by boatmen in adverse weather when the New Quay cannot be used. The Old Quay also helps to protect nearby fields and a boathouse.
4. Partial sea defence work undertaken by Royal Marines in past but the nearby fields are still being undermined.
5. Some of the marram grass torn away and the nearby garden and fields are being encroached by the sea.
6. Some of the marram grass disappearing causing roadway and nearby fields to be under threat.
7. Area of low lying ground, arable land and campsite under threat if sand dunes and marram grass (8) are breached.
8. Part of the sand dunes and some of the marram grass have been washed away/damanged from Babs Carn to Neck of the Pool. Damage so severe in places that only a very narrow width of marram grass remains. Area (7) would be liable to flooding.

Red Line - Serious damage already occured and repairs urgently needed

Blue Line - Areas subject to erosion

Red Shaded - Areas already inundated by sea

Blue Shaded - Areas liable to flood if repairs not effected


ISLES OF SCILLY
SCALE. APPROX. 6 IN TO 1 M
DAMAGE ALREADY OCCUR
SUBJECT TO EROSION
LIABLE TO FLOOD IF
Pernagie Isle
Round Rock
Porth Morran Quay
Porth Morran
White Island
Stony Porth
East Withan
Chad Point
Chad Girt
Camper Porth
Camper Point
Jacky's Point
Anthony
Plumb Island
Rushy Carn
Butter Porth
Round Rock
The Cove
Little Ledge
Great Merrick Ledge
Pernagie Point
Scilly Point
Top Rock Hill
Cumuli
Porth Seal
Tinkler's Point
Little Bay
Little Merrick Ledge
Little Ledge of Mackerel Rocks
Mackerel Rocks
ST MARTIN'S BAY
Sheep Ledge
Great Bay
Tinkler's Hill
Lookout
Middle Town
Lower Town
Southward Carn
Wine Cove
Turfy Hill Point
Turfy Hill
Francheman's Grave
Pencelle Well
Plains House
Yellow Rock
Rockyboy Carn
Jack's Ledge
Dog Ledge
Round Rock Ledge
Tearing Ledge
Fleming Ledge
Murr Rock
Papplestone Corner
Bread & Cheese Cove
Old Rock Table
Chapel Down
John Bazzy's Hill
Middle Right
1
2
5
6

COUNCIL OF THE I.O.SCILLY

STORM DAMAGE - DECEMBER 1989

Notes to accompany map of Tresco showing problem areas.

SECTION (a)

1. Sea wall at Appletree Bay

This is as per our original letter dated 22nd December 1989. Damage to the sea wall has allowed the sea to 'draw out' the foundations of the road, causing the road to drop and the wall to collapse.

2. Main sewage outfall at New Grimsby

Damage has occurred to the pipes out in the channel between Tresco and Bryher.

3. New Grimsby Quay

Although this is not, at this point in time, a major problem, damage has occurred to the Quay. However as this is our main landing place, it is cause for concern.

4. Long Point - Old Grimsby

Damage has again been caused at Long Point. As I understand this tends to be an on going situation with regular repairs having to be carried out.

SECTION (b)

5. Sea Wall/Road - New Grimsby

The sea wall running from the slipway at Timothy's Corner to the area called 'The Bay' has become vulnerable. The main concern here is that as the main road runs along the top of the sea wall, any future erosion could have a major effect on the islands activities.

6. Area around Old Grimsby Quay

There is a general concern as to the above area, although one cannot be specific, we have had problems with sea water this week, due to the combination of high tides and strong winds.

SECTION (d)

7. Coastal area between Plumb Hill and Appletree Point

There is a general problem with erosion along the above area. The fields running along the edge of the cliffs are being undermined and it is almost inevitable that subsidence will occur, thus losing valuable grazing land. This could also become a danger to unsuspecting tourists.

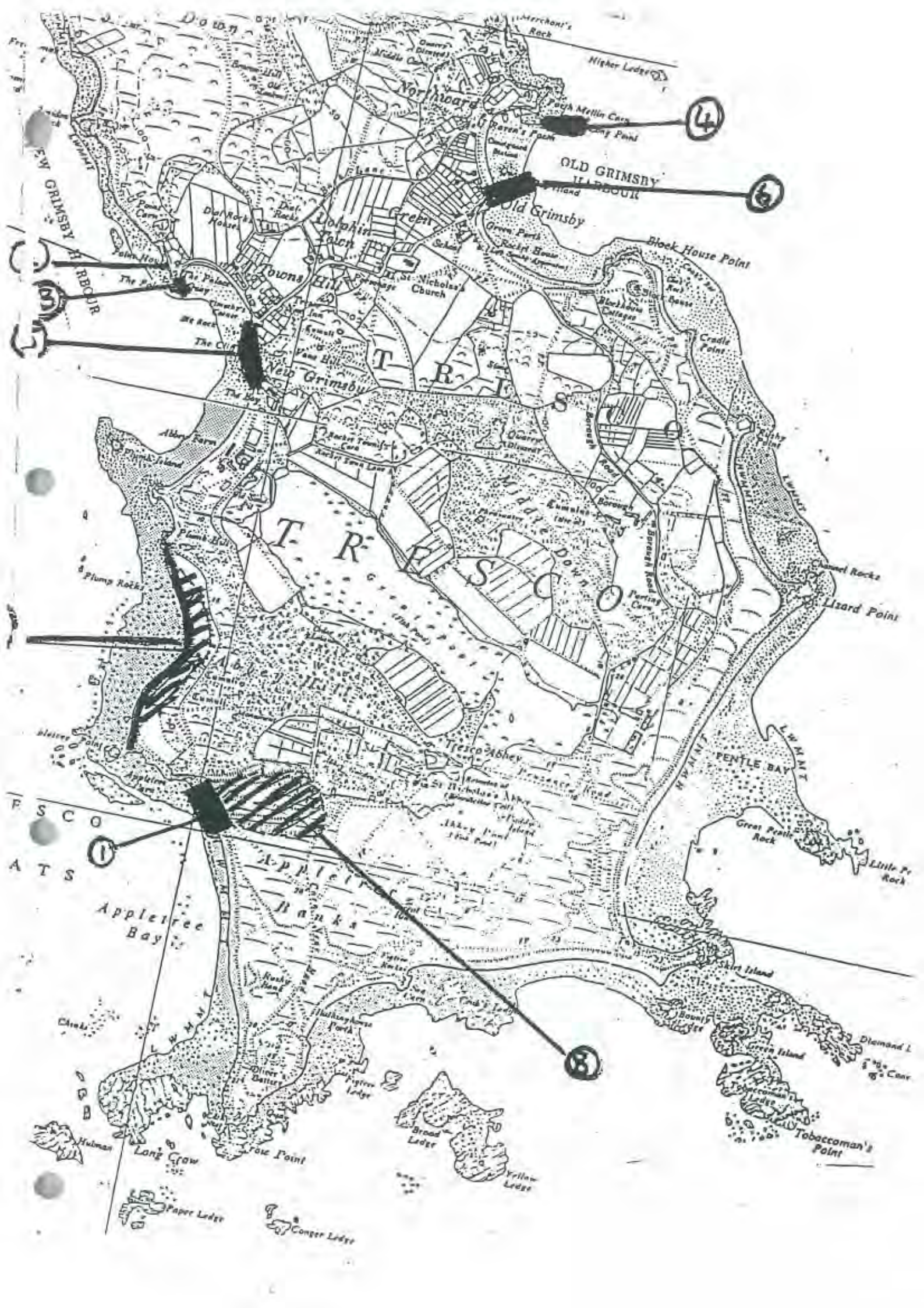
8. Area behind Appletree Bay Wall (see note 1.)

As the land behind the area damaged (as per note 1.) is low-lying there is a possibility that the sea could flood this area, which leads to the Abbey Gardens.

N.B. Although not relating to the December damage, the storms of last week brought down a very large number of trees, many of which were providing some shelter against the regular high winds. As it is an extremely long term growing process to replace these trees, then it is envisaged that more inland areas may well suffer damage in the future.

D. I. OUGHTON
31st January 1990

Red Block - Serious damage already occured and repairs urgently needed
Blue Block - Areas subject to erosion
Blue Shaded - Areas liable to flood if repairs not effected


Down
Northward
Old Grimsby
Dolphin Farm
Towns Hill
New Grimsby
Abbey Farm
Plumpton Island
Plump Rocks
Tresco Abbey
Appletree Banks
Appletree Bay
Pentle Bay
Great Pentle Rock
Little Pentle Rock
Lizard Point
Block House Point
Cradle Point
Rushy Point
Channel Rocks
Skirt Island
Green Island
Diamond Rock
Tobaccoman's Point
Broad Ledge
Yellow Ledge
Paper Ledge
Conger Ledge
Long Crow
Five Point
Huiman
Higher Ledge
Merchant's Rock
OLD GRIMSBY HARBOUR
NEW GRIMSBY HARBOUR
TRESCO
1
3
4
6
8

Appendix C

Extracts from the Coast Protection Survey of England (1993)

ASPEN
Aspen Burrow Crocker

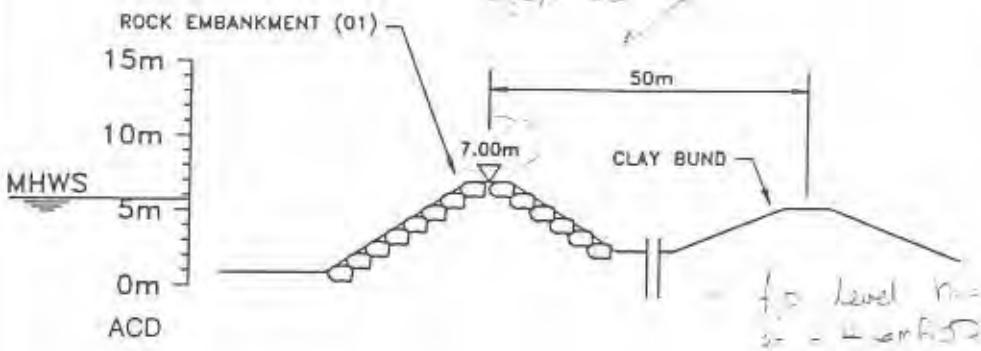
Appendix 2

Extracts from the Coast Protection Survey of England 1993

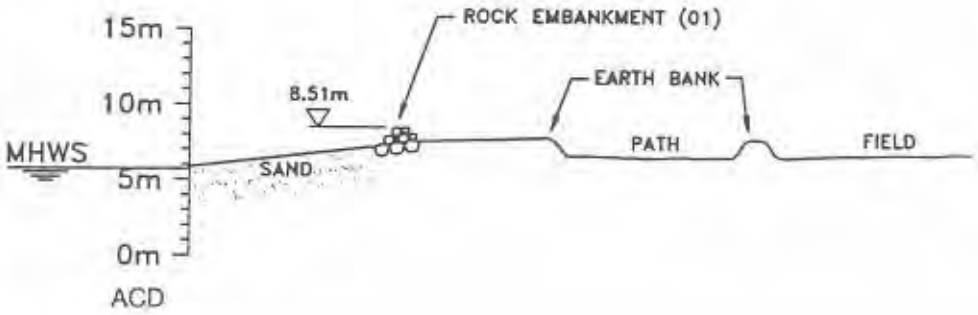
ISLES OF SCILLY 690/89

ISLES OF SCILLY 690/89

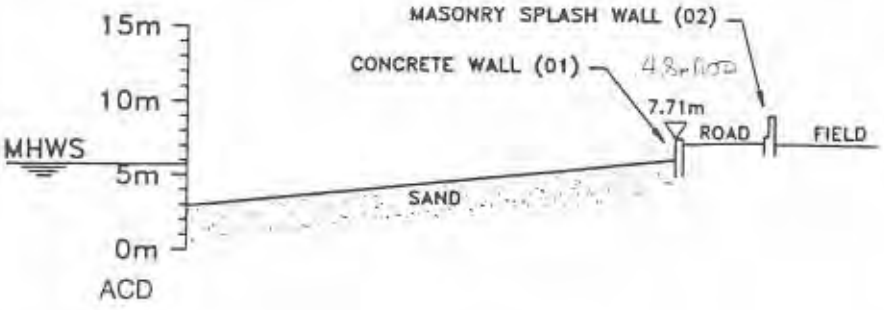
PORTH HELLICK
690/8901
(1:500)



PORTH MINNICK
690/8902
(1:500)



OLD TOWN
690/8903
(1:500)



Note

1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

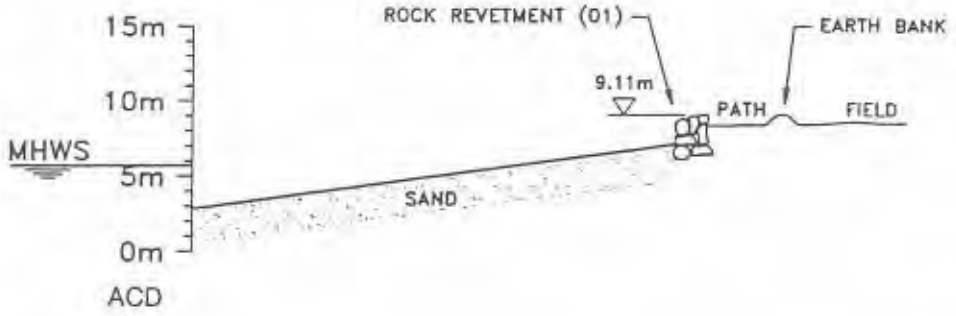
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

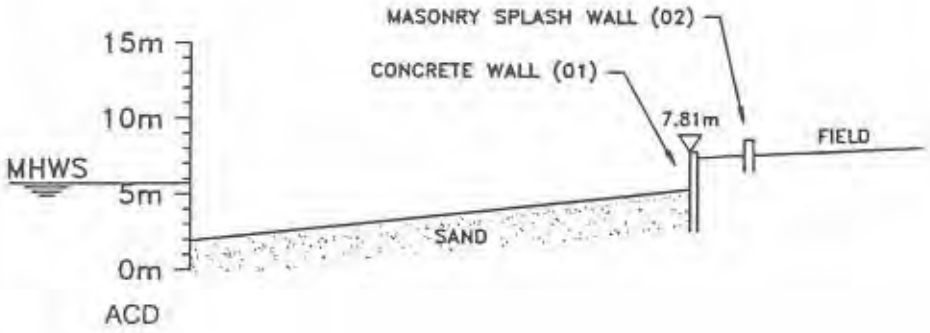
Prepared | Checked

Issue 1: Rev 1

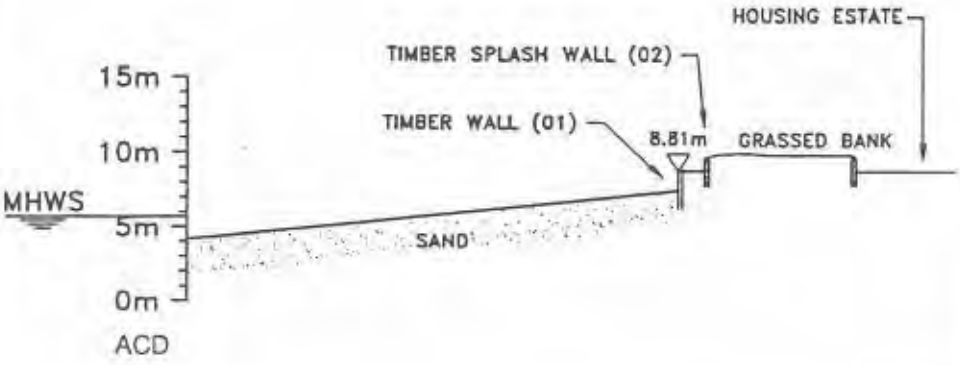
OLD TOWN
690/8904
(1:500)



OLD TOWN
690/8905
(1:500)



PORTH CRESSA
690/8906
(1:500)



Note

1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

Mouchel
LGMouchel & Partners Ltd

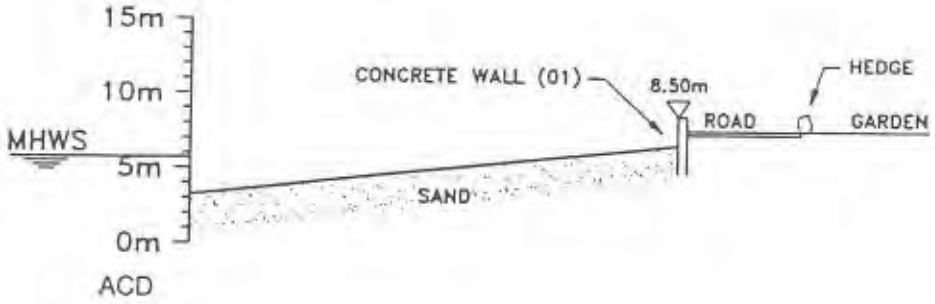
ISLES OF SCILLY

Prepared

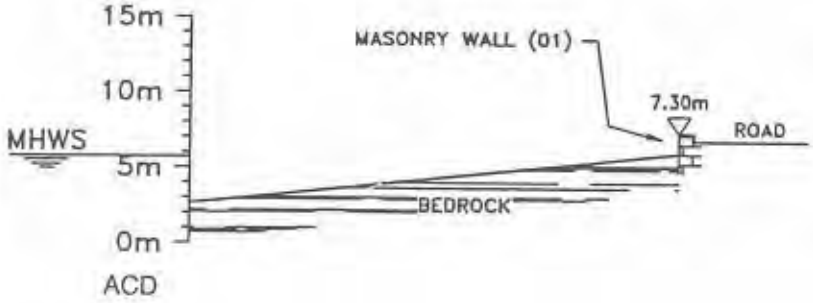
Checked

Issue 1: Rev 1

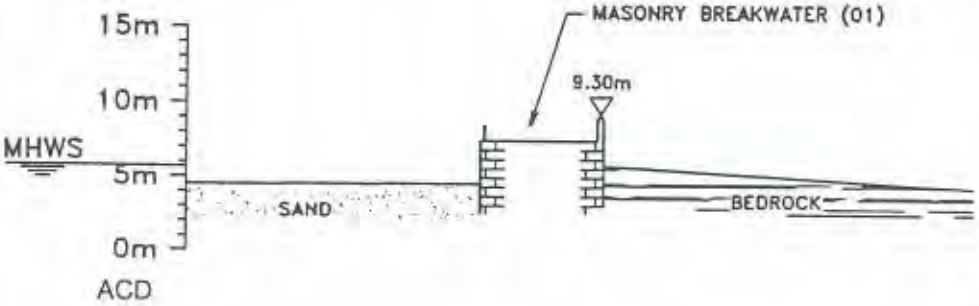
PORTH CRESSA
690/8907
(1:500)



HUGH TOWN QUAY
690/8908
(1:500)



HUGH TOWN
690/8909
(1:500)



Note

1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

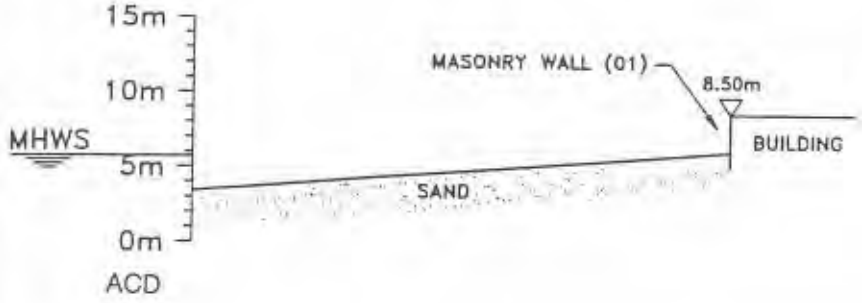
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

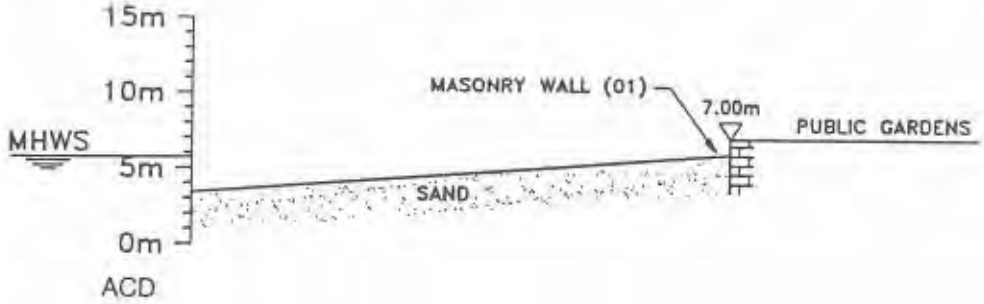
Prepared | Checked

Issue 1: Rev 1

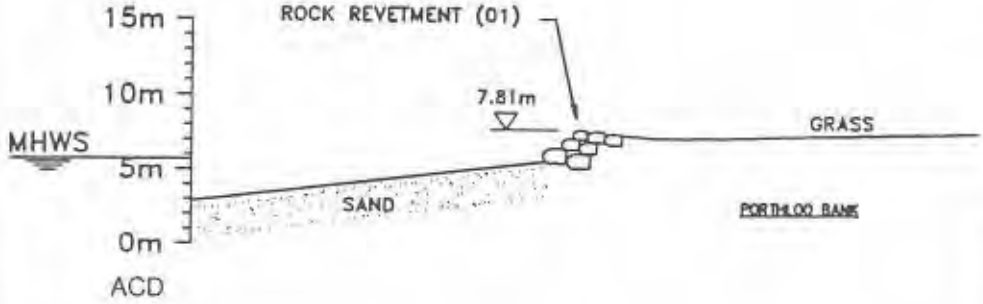
HUGH TOWN
690/8910
(1:500)



HUGH TOWN
690/8911
(1:500)



PORTHLOO
690/8912
(1:500)



Note

1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

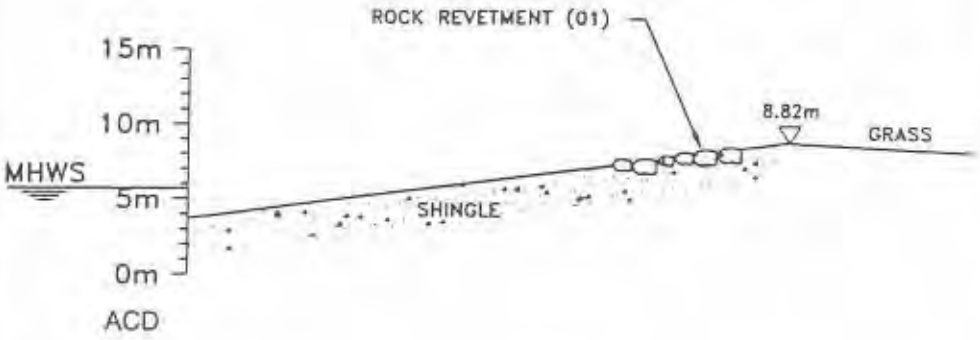
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

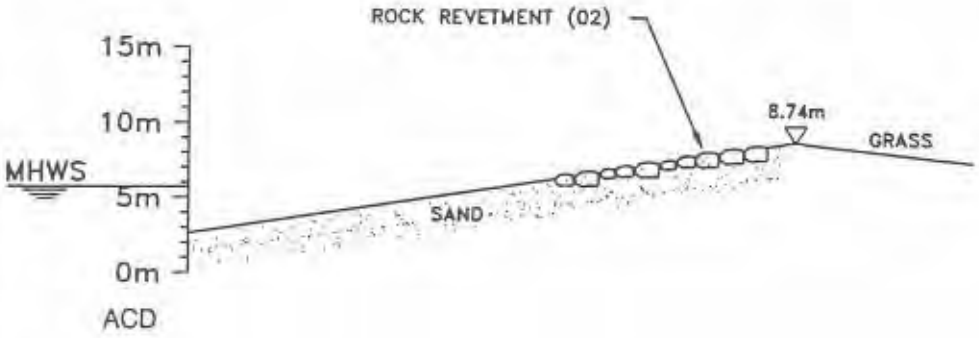
Prepared | Checked

Issue 1: Rev 1

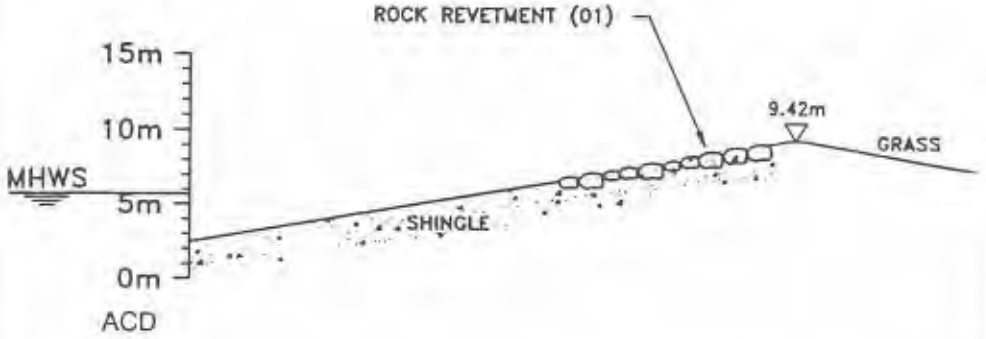
PERIGLIS
690/8913
(1:500)



PORTH COOSE
690/8914
(1:500)



PORTH KILLIER
690/8915
(1:500)



Note
1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

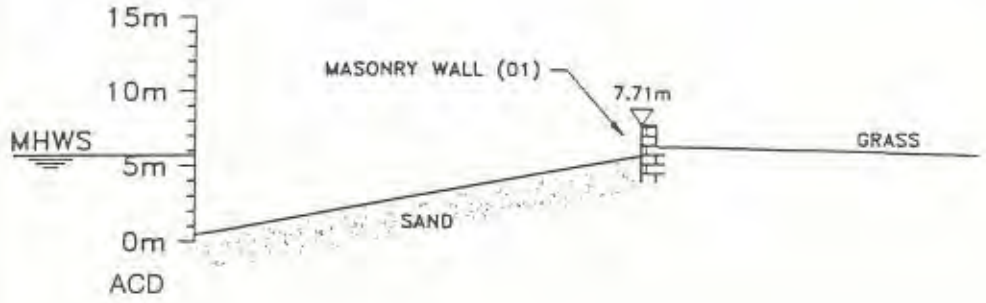
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

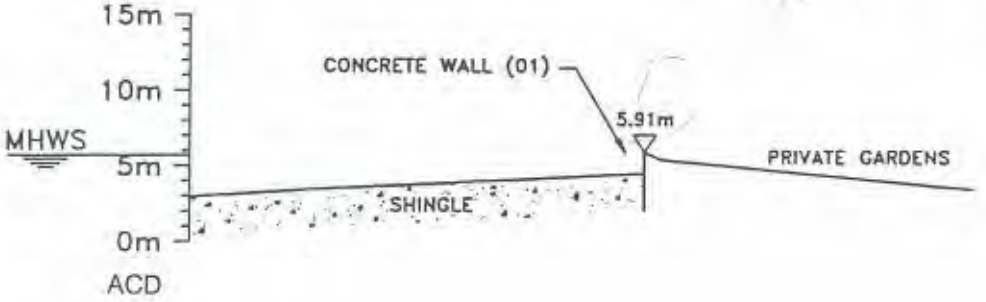
Prepared | Checked

Issue 1: Rev 1

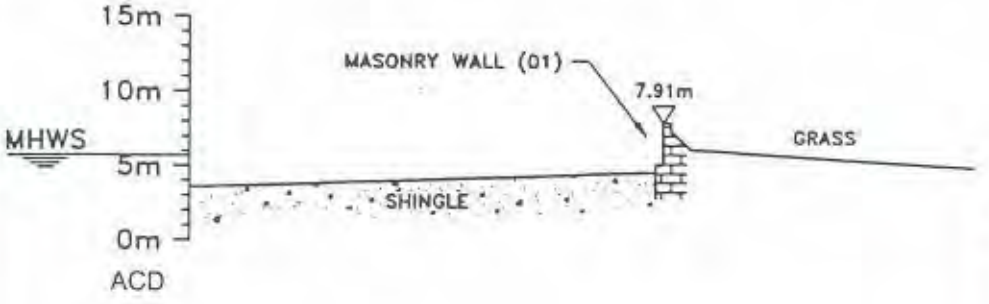
BRYER GREEN BAY
690/8916
(1:500)



BRYER GREAT PORTH
690/8917
(1:500)



BRYER
690/8918
(1:500)



Note
1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

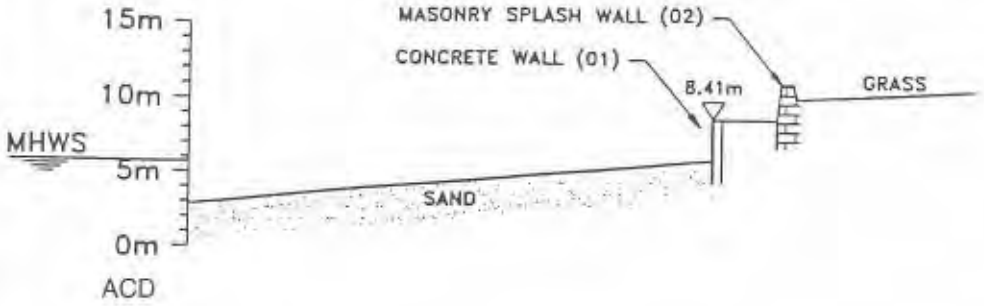
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

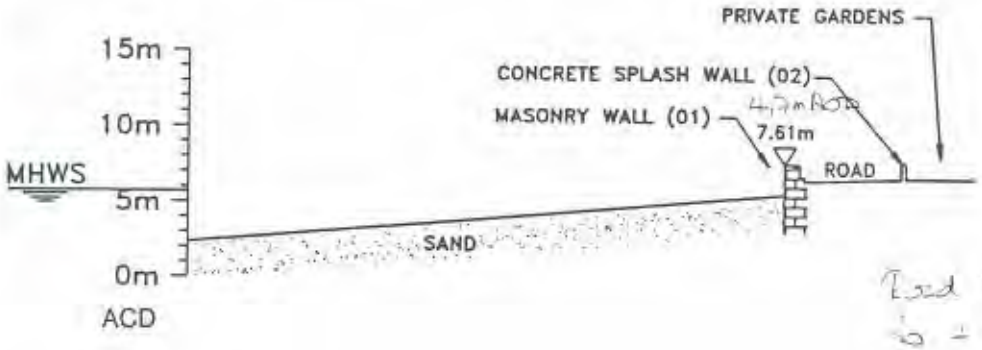
Prepared | Checked

Issue 1: Rev 1

APPLE TREE BAY
690/8919
(1:500)



NEW GRIMSBY
690/8920
(1:500)



Road is at +2.7m AOD
to +4.3m AOD at Trading
Corner

Note
1 All levels indicated are above Chart Datum (ACD)
Chart Datum is Local Datum - 2.91m

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared | Checked

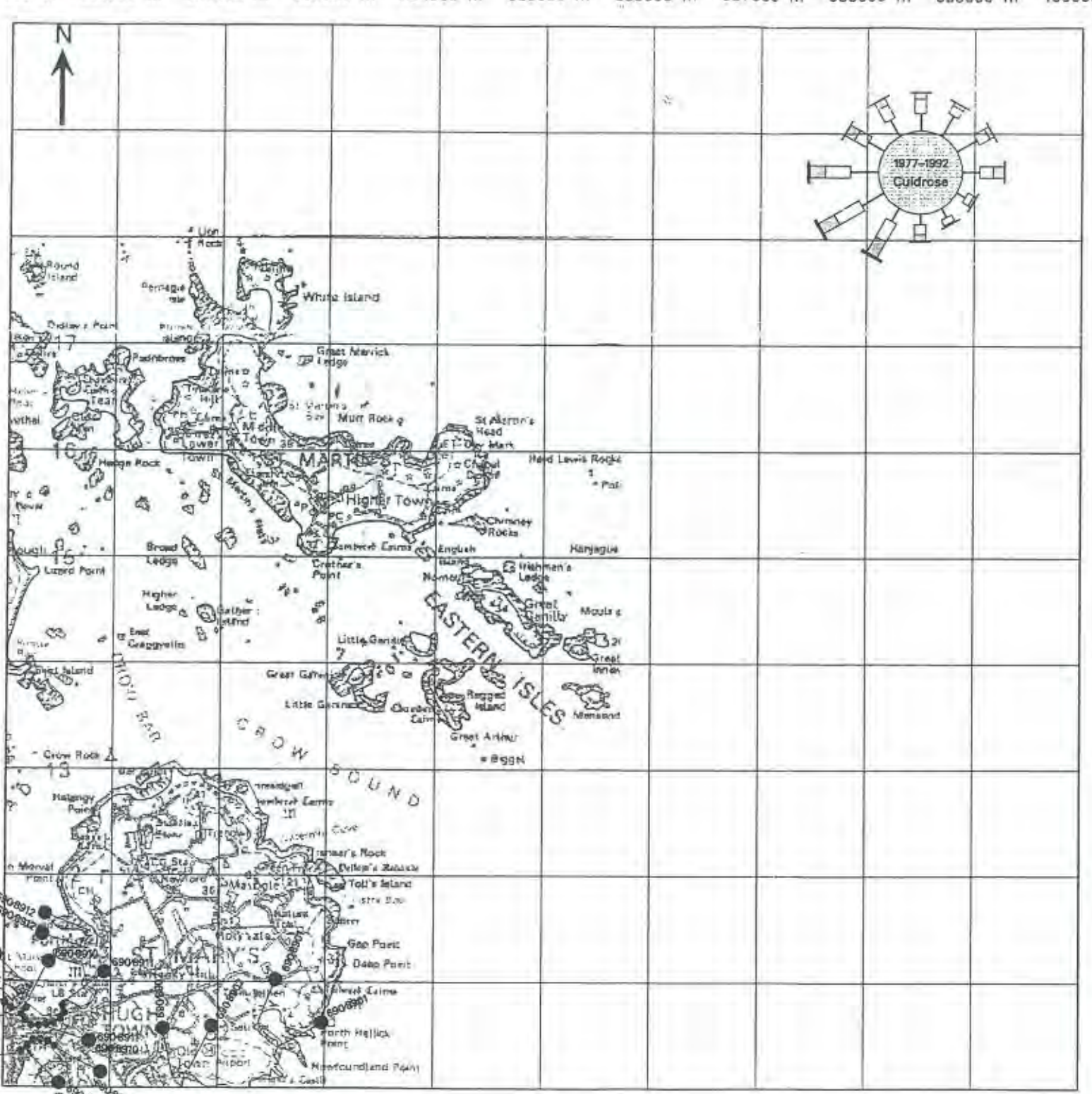
Issue 1: Rev 1

Defence Code	Sub Cod	OS Grid Start / Finish	Def Len	Structure / Geology/ Sediment	Material / Angle of Slope	Condition / Cliff Appearence	Foreshore Type	Foreshore Condition	Foreshore Level	Foreshore Dependancy	Year Constructed	Residual Life yrs	Maintenance	Priority	Urgency	Photo
690/8901 01		SV92601035 SV92421054	0.18	Embankment	Rock	Class 3	Sand	Eroding	High	High	1930	5 - 10	IOS	3	2	yes
BANK PRINCIPALLY TO PROTECT AGAINST FLOODING AND TO PROTECT WATER SUPPLIES.																
690/8902 01		SV91581000 SV91751006	0.18	Embankment	Rock	Class 2	Sand	Stable	High	High	1930	5 - 10	IOS	3	2	yes
ROCK BANK PRINCIPALLY TO STOP FLOODING TO HINTERLAND.																
690/8903 01		SV91251020 SV91361018	0.13	Wall	Concrete	Class 2	Sand	Stable	High	High	1980	> 10	IOS	4	3	yes
PROVIDES PROTECTION TO MAIN COAST ROAD. SHORT SECTION ADJACENT TO QUAY CONSTRUCTED IN STONE.																
690/8903 02		SV91251020 SV91361018	0.13	Splash Wall	Masonry	Class 2	Sand	Stable	High	Low	1980	> 10	IOS	4	3	yes
690/8904 01		SV91171014 SV91251020	0.09	Revetment	Rock	Class 2	Sand	Stable	High	High	1970	> 10	PRIVATE	4	3	yes
PROVIDES PROTECTION TO COAST PATH AND ISOLATED PROPERTIES.																
690/8905 01		SV91151003 SV91171014	0.10	Wall	Concrete	Class 3	Shingle	Stable	High	High	1960	> 10	PRIVATE	4	3	yes
PROTECTION TO COAST PATH AND WAR MEMORIAL. PREVIOUS SECTION HAS FAILED BY BEING UNDERCUT AND REBUILT. PART OF SECTION HAS STONE UPPER SECTIONS.																
690/8905 02		SV91151003 SV91171014	0.10	Splash Wall	Masonry	Class 3	Shingle	Stable	High	Low	1960	> 10	PRIVATE	4	3	yes
690/8906 01		SV90271045 SV90481041	0.13	Wall	Timber	Class 4	Sand	Stable	High	High	1960	< 5	IOS	1	1	yes
REBUILT AFTER 89 STORMS BY FILLING BEHIND WITH COMPACTED INCINERATOR ASH AND SAND.																
690/8906 02		SV90271045 SV90481041	0.13	Splash Wall	Masonry	Class 4	Sand	Stable	High	Low	1960	< 5	IOS	1	1	yes
690/8907 01		SV90151038 SV90261044	0.14	Wall	Masonry	Class 2	Sand	Stable	High	High	1930	> 10	IOS	3	3	yes
WALLS IN GOOD CONDITION. DID NOT SUFFER IN 89 STORMS.																
690/8908 01		SV90041072 SV90141072	0.10	Wall	Stone	Class 3	Bed Rock	Stable	Low	Low	1850	> 10	IOS	3	3	yes
WALLS PROTECT MAIN VEHICULAR ACCESS TO QUAY.																
690/8909 01		SV90261097 SV90141072	0.31	Breakwater	Masonry	Class 3	Bed Rock	Stable	Low	Low	1850	> 10	IOS	3	1	yes
BREAKWATER OWNED BY DUTCHY OF CORNWALL. MAJOR REMEDIAL WORKS PROPOSED ON END DUE TO LOSS OF HEARTING. OTHERWISE APPEARS SOUND.																

Defence Code	Sub Cod	OS Grid Start / Finish	Def Len	Structure / Geology/ Sediment	Material / Angle of Slope	Condition / Cliff Appearence	Foreshore Type	Foreshore Condition	Foreshore Level	Foreshore Dependancy	Year Constructed	Residual Life yrs	Maintenance	Priority	Urgency	Photo
690/8910 01		SV90591074 SV90411059	0.34	Wall	Masonry	Class 2	Sand	Eroding	High	Low	1900	> 10	PRIVATE	2	3	yes
COLLECTION OF PRIVATE WALLS FORMING FOUNDATIONS TO PROPERTIES. CREST LEVELS NOT APPLICABLE.																
690/8911 01		SV90591074 SV90411059	0.30	Wall	Masonry	Class 2	Sand	Eroding	High	Low	1930	> 10	IOS	2	3	yes
WALLS PROTECTED BY OUTER QUAY BREAKWATER.																
690/8912 01		SV90881141 SV90801120	0.22	Revetment	Rock	Class 4	Sand	Eroding	High	Medium	1930	< 5	PRIVATE	2	1	no
PROTECTION TO COAST ROAD AND ROAD PROTECTION TO PROPERTIES BEHIND.																
690/8913 01		SV87710854 SV87730833	0.24	Revetment	Rock	Class 3	Shingle	Stable	High	High	1930	5 - 10	PRIVATE	4	2	yes
EMBANKMENT PROVIDES FLOOD PROTECTION TO ISOLATED PROPERTIES BEHIND, BUT LIKELY TO RECEIVE C.P. GRANT AID.																
690/8914 01		SV87650855 SV87700854	0.05	Groynes	Rock	Class 3	Shingle	Stable	High	High	1960	5 - 10	PRIVATE	4	2	no
GROYNE REDUCES SCOUR BETWEEN PORTHGOOSE AND PERIGLIS. PROTECTING PROPERTY. CONSTRUCTED OF STONE SECTIONS CONTAINING ROCKS.																
690/8914 02		SV87710855 SV87780864	0.12	Revetment	Rock	Class 3	Sand	Stable	High	High	1930	5 - 10	PRIVATE	4	2	yes
EMBANKMENT PROVIDES FLOOD PROTECTION TO ISOLATED PROPERTIES, BUT LIKELY TO RECEIVE C.P. GRANT AID.																
690/8915 01		SV87950852 SV88120846	0.22	Revetment	Rock	Class 3	Shingle	Stable	High	High	1930	5 - 10	PRIVATE	4	2	yes
PROVIDES FLOOD PROTECTION TO ISOLATED PROPERTIES, BUT LIKELY TO RECEIVE C.P. GRANT AID. ORIGINAL STONE WALL NOW LARGELY BOLDER REVETMENT.																
690/8916 01		SV87941456 SV88091485	0.50	Wall	Masonry	Class 4	Sand	Eroding	High	High	1950	< 5	PRIVATE	2	1	yes
PROTECTION TO COAST PATH AND GARDEN TO ISOLATED PROPERTIES.																
690/8917 01		SV87451468 SV87501472	0.04	Wall	Concrete	Class 3	Shingle	Stable	High	High	1975	> 10	PRIVATE	3	3	yes
WALL PROTECTING ISOLATED PROPERTY AND ACCESS TO PROPERTY.																
690/8918 01		SV87401498 SV87351496	0.07	Wall	Masonry	Class 3	Shingle	Stable	High	High	1900	5 - 10	PRIVATE	3	2	yes
WALL PROTECTED BY PROMONTORY OPPOSITE WHICH IS ITSELF VULNERABLE. FLOOD PROTECTION TO HOTEL AND PROPERTY.																
690/8919 01		SV89101402 SV89001413	0.12	Wall	Concrete	Class 4	Sand	Stable	High	Medium	1960	< 5	PRIVATE	2	1	yes
PROVIDES PROTECTION TO COAST ROAD AND TRESCO GARDENS. ROAD HAS BEEN REALIGNED SO URGENCY MAY NOT BE SO HIGH.																
690/8919 02		SV89101402 SV89001413	0.12	Splash Wall	Masonry	Class 4	Sand	Stable	High	Low	1960	< 5	PRIVATE	2	1	yes

Defence Code	Sub Cod	OS Grid Start / Finish	Def Len	Structure / Geology/ Sediment	Material / Angle of Slope	Condition / Cliff Appearence	Foreshore Type	Foreshore Condition	Foreshore Level	Foreshore Dependancy	Year Constructed	Residual Life yrs	Maintenance	Priority	Urgency	Photo
690/8920	01	SV88881513 SV88691529	0.29	Wall	Masonry	Class 4	Sand	Stable	High	High	1970	5 - 10	PRIVATE	3	2	yes
COAST PROTECTION TO ROAD AND SEA DEFENCE TO PROPERTIES BEHIND. PRIVATE ISLAND.																
690/8920	02	SV88881513 SV88691529	0.29	Splash Wall	Concrete	Class 4	Sand	Stable	High	Low	1970	5 - 10	PRIVATE	3	2	yes

Defence Code	Sub Cod	OS Grid Start / Finish	Def Len	Structure / Geology/ Sediment	Material / Angle of Slope	Condition / Cliff Appearence	Foreshore Type	Foreshore Condition	Foreshore Level	Foreshore Dependancy	Year Constructed	Residual Life yrs	Maintenance	Priority	Urgency	Photo
690/8920 01		SV88881513 SV88691529	0.29	Wall	Masonry	Class 4	Sand	Stable	High	High	1970	5 - 10	PRIVATE	3	2	yes
COAST PROTECTION TO ROAD AND SEA DEFENCE TO PROPERTIES BEHIND. PRIVATE ISLAND.																
690/8920 02		SV88881513 SV88691529	0.29	Splash Wall	Concrete	Class 4	Sand	Stable	High	Low	1970	5 - 10	PRIVATE	3	2	yes



Ministry of Agriculture Fisheries and Food

Flood and Coastal Defence Div

COAST PROTECTION SUR OF ENGLAND 1993

Associate Consultant Commission
Taunton Area

Isles of Scilly

OS Sheet SV91

SV82	SV92	SW02
SV81	SV91	SW01
SV80	SV90	SW00

- Wall
- Embankment
- Revetment
- Groynes
- Gabions
- Shore
- Breakwater
- Other

Mean low water

Mean wate

Marker between defence lengths

Net d direc

Marker between defence elements

×××× Sche Bour

573/3905 Defence code 1 Subc

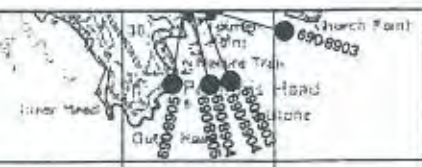
Wind Rose (All m Hourly Mean

Wind data supplied by the Met. Office, Bracknell

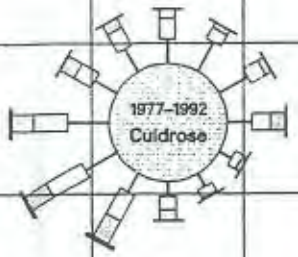
1km 2km

091000 m 092000 m 093000 m 094000 m 095000 m 096000 m 097000 m 098000 m 099000 m 100000 m

010000 m
009000 m
008000 m
007000 m
006000 m
005000 m
004000 m
003000 m
002000 m
001000 m
000000 m



N



MAFF

Ministry of Agriculture Fisheries and Food

Flood and Coastal Defence Divisio

COAST PROTECTION SURVE OF ENGLAND 1993

Associate Consultant Commission
Taunton Area

Isles of Scilly

OS Sheet SV90

SV81	SV91	SW01
SV80	SV90	SW00

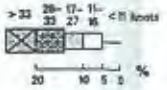
Wall
Embankment
Revetment
Groynes
Gabions
Shore
Breakwater
Other

Mean low water
Mean hi water

Marker between defence lengths
Net drift direction

Marker between defence elements
×××× Schedul Bounda

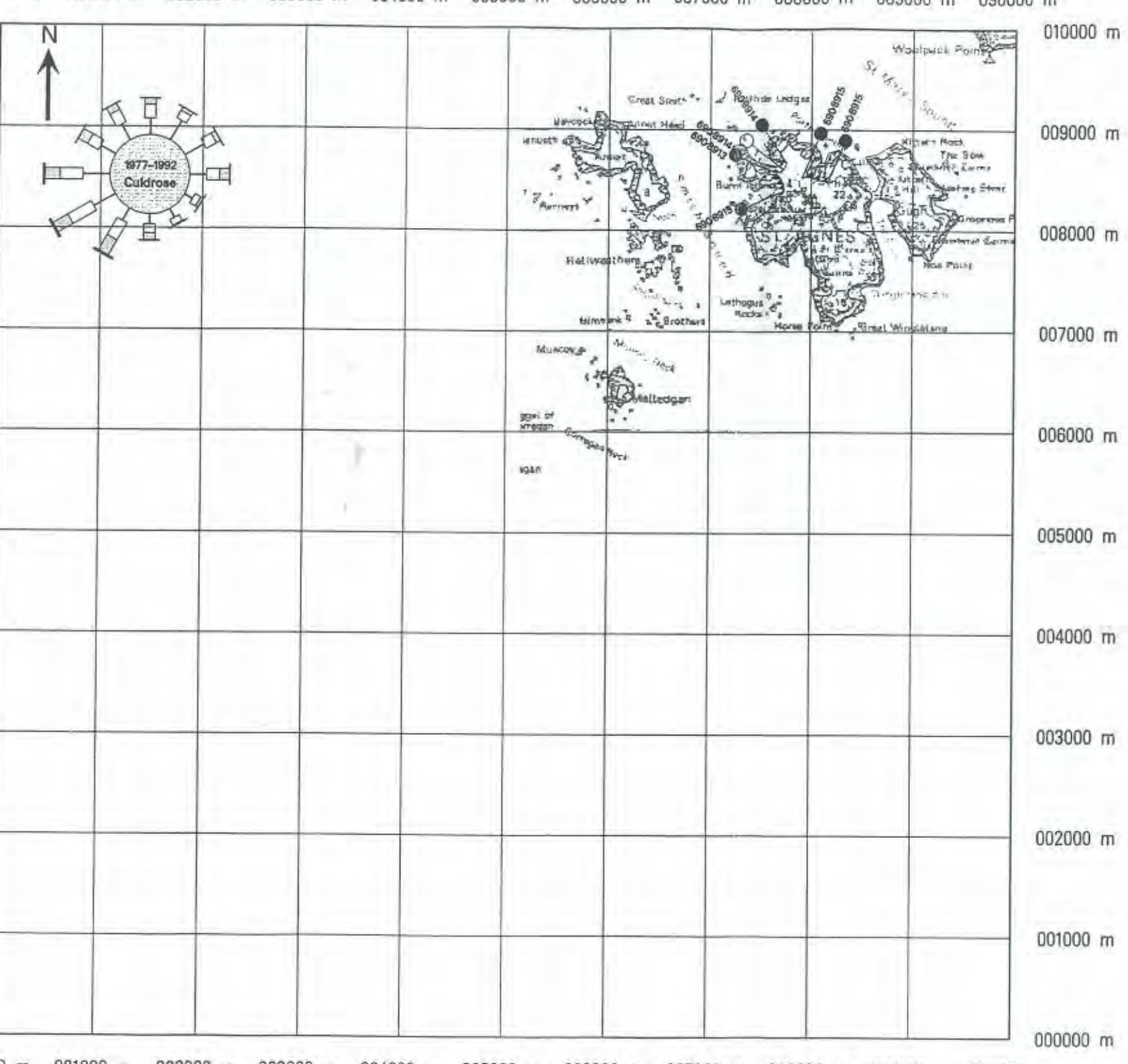
5733905 Defence code
1 Subcode



Wind Rose (All mon Hourly Mean

Wind data supplied by the Met. Office, Bracknell

1km 2km 3k



MAFF

Ministry of Agriculture Fisheries and Food

Flood and Coastal Defence Divis

COAST PROTECTION SURV OF ENGLAND 1993

Associate Consultant Commission
Taunton Area

Isles of Scilly

OS Sheet SV80

SV71	SV81	SV91
SV70	SV80	SV90

- Wall
- Embankment
- Revetment
- Groynes
- Gabions
- Shore
- Breakwater
- Other

Mean low water

Mean water

Marker between defence lengths

Net dri direct

Marker between defence elements

×××× Sched Bound

5733905 Defence code 1 Subcod

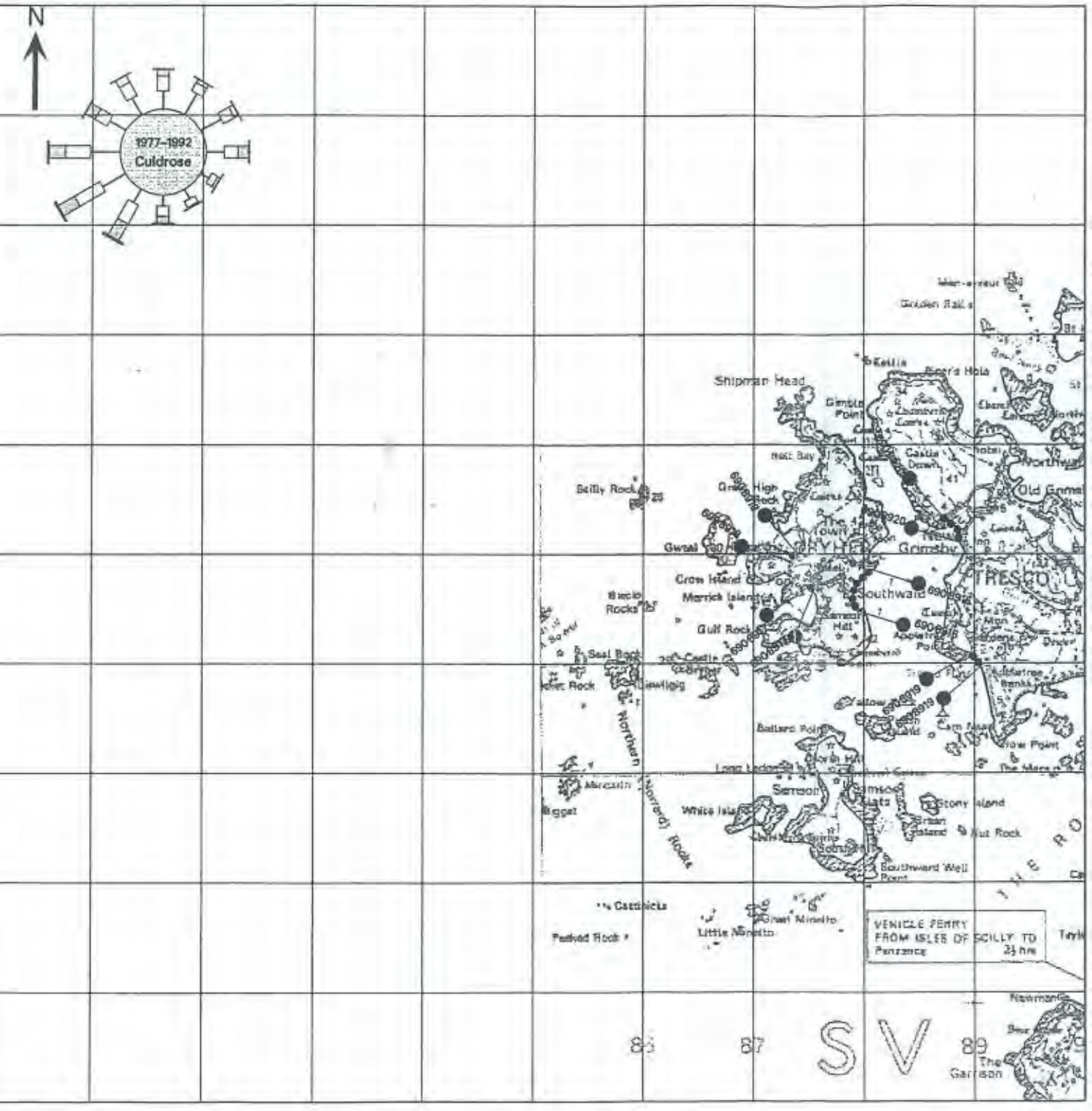
Wind Rose (All mo Hourly Mean

Wind data supplied by the Met. Office, Bracknell

1km 2km 3

081000 m 082000 m 083000 m 084000 m 085000 m 086000 m 087000 m 088000 m 089000 m 090000 m

020000 m
019000 m
018000 m
017000 m
016000 m
015000 m
014000 m
013000 m
012000 m
011000 m
010000 m



MAFF

Ministry of Agriculture Fisheries and Food

Flood and Coastal Defence Divisio

COAST PROTECTION SURVE OF ENGLAND 1993

Associate Consultant Commission
Taunton Area

Isles of Scilly

OS Sheet SV81

SV72	SV82	SV92
SV71	SV81	SV91
SV70	SV80	SV90

- Wall
- Embankment
- Revetment
- Groynes
- Gabions
- Shore
- Breakwater
- Other

Mean low water

Mean hi water

Marker between defence lengths

Net drift direction

Marker between defence elements

×××× Schedul Boundar

573/3905 Defence code 1 Subcode

Wind Rose (All mon Hourly Mean

Wind data supplied by the Met. Office, Bracknell

1km 2km 3k

PORT CRESSA BEACH–
ST MARYS
690/8907 – 01

HUGH TOWN –
ST MARYS
690/8908 – 01

HUGH TOWN –
ST MARYS
690/8909 – 01

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared | Checked

HUGH TOWN –
ST MARYS
690/8910 – 01

HUGH TOWN –
ST MARYS
690/8911 – 01

PORTH LOO
690/8912 – 01

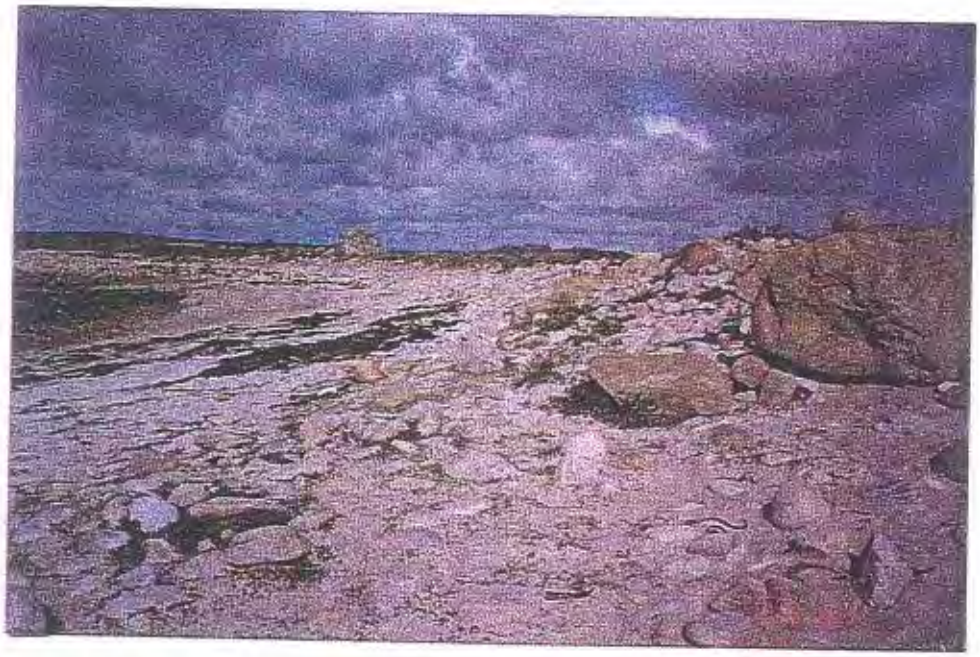
Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared

Checked

PERIGLIS –
ST AGNES
690/8913 – 01



PORTH COOTH –
ST AGNES
690/8914 – 02

PORTH KILLIER –
ST AGNES
690/8915 – 01

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared

Checked

BRYER
690/8916 - 01

BRYER
690/8917 - 01

BRYER
690/8918 - 01

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared

Checked

APPLE TREE BAY – TRESCO
690/8919 – 01 & 02

NEW GRIMSBY – TRESCO
690/8920 – 01 & 02

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared

Checked

PORT HELLICK –
ST MARYS
690/8901 – 01

PORT MINNICK –
ST MARYS
690/8902 – 01

OLD TOWN –
ST MARYS
690/8903 – 01
& 02

Mouchel
LGMouchel & Partners Ltd

Authority

ISLES OF SCILLY

Prepared

Checked

OLD TOWN –
ST MARYS
690/8904 – 01

OLD TOWN –
ST MARYS
690/8905 – 01
& 02

PORT CRESSA BEACH
ST MARYS
690/8906 – 01
& 02

Mouchel
LGMouchel & Partners Ltd

Authority
ISLES OF SCILLY

Prepared

Checked

Appendix D

Chapter 7 of the 1997 Shoreline Management Plan on Coastal Defences and Structures

7COASTAL DEFENCES AND STRUCTURES

7.1Objectives of Coast Defence for the Isles of Scilly

The primary objectives of coast defence have been stated quite simply[1] by the government to be the reduction of risks to people and the developed and natural environments from flooding and coastal erosion. The government states furthermore that the safeguarding of lives must clearly be of the highest priority.

In meeting the primary objectives, and in order to qualify for grant funding, the defences must fulfil three standard criteria defined by the principal UK funding agency for coast protection (i.e. the protection of the land from erosion and encroachment by the sea) which is the Ministry of Agriculture, Fisheries and Food (MAFF). The criteria are:

·technical feasibility;
·economic viability;
·environmental sensitivity.

The first two criteria are stringent and clear-cut and relatively easily understood and managed by engineers and lay people alike. The last may be open to some interpretation (for example, aesthetics) and may best be resolved in discussion and collaboration with the local population and other main statutory consultees. It should be noted that the notional environmental sensitivity of schemes might also be considered against wider criteria established by the UK government following the Rio Convention on Biological Diversity in 1992.

A variety of secondary criteria may also be stated:

·the conservation of internationally important environmental sites;
·the preservation of archaeological and historical remains;
·the enhancement of amenity for all coast users and, generally,
·the improvement of the environment.

The satisfaction of these criteria is important but only as supplementary conditions to the principal objectives of individual schemes. Grant aid made available under the relevant Coast Protection and Sea Defence legislation is directed expressly at satisfying the primary objectives of individual schemes.

---

[1] *Strategy for Flood and Coastal Defence in England and Wales*, PB1471, Ministry of Agriculture, Fisheries and Food, London, 1993

7.2Existing Defences and Structures

The existing defences of the Isles of Scilly were surveyed by MAFF Flood and Coastal Defence Division in 1993 as part of the Coast Protection Survey of England (CPSE)[(2)]. The relevant extracts of the CPSE are reproduced in Appendix 4. The plans show the extent of the defences on the main island of St Mary's and the so-called "off-islands" of St Agnes, Bryher and Tresco; there are apparently no coastal defences on St Martin's. There is a high level defence against erosion by splashing to the garden of the *Turk's Head* on St Agnes which is not mentioned in the CPSE. This defence is understood to be suffering minor damage as is the neighbouring (albeit abandoned) slip.

The existing defences have been constructed over the years on an *ad hoc* basis as erosion and overtopping problems have become evident. They are comprised of a variety of structural types varying from rubble mounds to stone walls, timber cribwork and mass and reinforced concrete structures. The protection afforded by the individual schemes usually has a low return period owing to the relatively great expense, to a formerly subsistence level community, of building anything more substantial. The structures have, to a greater or lesser extent, served their purpose over the years although many have now reached the ends of their lifetimes. The structures do not generally meet accepted design criteria.

Following the severe storms of 1989/1990, all five inhabited islands reported damage. Appendix 1 reproduces the original damage assessments made by the Council[(3)]. DHV were subsequently appointed Consultants to the Council of the Isles of Scilly for the appraisal of coast protection and sea defences on all the inhabited islands of the archipelago.

Existing defences and problem sites were inspected in September 1991 following which preliminary designs were made for the construction of new works and for remedial works to existing coastal defences. Benefit/cost assessments of the proposed works were undertaken and priorities for future work defined. The appraisal report[(4)] was presented to the Council and the Ministry of Agriculture, Fisheries and Food (MAFF) in April 1992.

[(2)] *Coast Protection Survey of England, Summary Survey Report, PB1667*, Ministry of Agriculture, Fisheries, and Food , London, 1994

[(3)] *Storm Damage Reports*, Council of the Isles of Scilly, December 1989

[(4)] *Report on Existing Sea Defences and Proposals for Remedial and Additional Works*, DHV Burrow-Crocker Consulting, Bristol, April 1992

Subsequent to the publication of the CPSE, new coast defence structures have been constructed at three locations on Bryher and at Porth Cressa, Porth Minick and Old Town on St Mary's, and three locations around Big Pool on St Agnes.

7.2.11995 Coast Protection on Bryher

Bryher was separated into two project areas forming the Popplestones/Great Pool cell to the north-west and the Great Porth South/Stony Porth cell in the south-west of the island.

The Popplestones/Great Pool cell was partially protected by an old and dilapidated seawall as described in the CPSE[(1)] (Drawing 690/8918). This structure had marginal stability and was threatened by an increasingly severe wave climate as Popplestone Brow to its north continued to be dramatically eroded (it reportedly lost 3.5 m in height during the storms of 1989/90 and a further 0.5 m in the storms of Easter 1994). The old seawall at Great Popplestones cracked in Easter 1994 during the design of its replacement and 10 m of its eastern end was lost during storms in early 1995. The wall was protected by a new rock revetment (W_{50} = 1.5 Tonnes) of imported Cornish Armorican granite which was overlain at its flanks by existing boulder beaches.

Erosion at the north edge of the dune system near Little Popplestones threatened to breach during severe conditions with potential flooding and contamination of the island's fresh water supply as a consequence. The transition zone between the boulder tombola, in the lee of Little Popplestone, and the sand dune system itself was reinforced with a short rock revetment buried beneath the sand. This would only be exposed under severe wave conditions and natural processes would be expected to re-bury it during subsequent calmer conditions.

The old seawall (CPSE Drawing 690/8917) at the north of Great Porth protected the garden of *Old School House*. The wall was built in the early 1960's using local labour and materials provided by the Duchy of Cornwall and had a rather ugly appearance having been constructed using corrugated iron sheeting as formwork. Timber piles into the beach lending stability to the mass concrete wall were rather dilapidated. The existing wall was supplemented in 1995 by a rock armour revetment (W_{50} = 1.35 Tonnes) which was constructed to extend east and south of the existing seawall to protect the low-lying and vulnerable part of the beach.

The length of new revetment that it was possible to build at Great Porth was restricted by the low benefit of the area but it was possible to supplement it by repositioning existing large boulders to form an extended revetment. The existing seawall was retained to stop water penetration into the garden of the *Old School House* but the action of excavating for the new revetment has

enabled water to percolate under the old wall. This has since been alleviated by the construction of a diaphragm wall. The inhabitants of *Old School House* report that the effect of the new revetment is the replacement of the previous shingle beach by a higher beach of sand.

7.2.21995 Coast Protection at Porth Cressa, St Mary's

Hugh Town, the main settlement of the Isles of Scilly, is situated on the sand isthmus between Buzza and Garrison Hills. On the southern side of the isthmus is Porth Cressa beach which is a sandy beach and one of the more important tourist beaches on the isles. It was formerly protected at its crest by a timber bulkhead (CPSE Drawing 690/8906) surmounted by a two metre wide footpath at +6.0 mAOD which was concreted for a limited length at the west. The timber cribwork defence was constructed in 1963 following storm damage in 1962 which threatened to break through the sand dunes, then the only defence, and engulf the town.

A stone-faced reinforced concrete wall was constructed during early 1995 approximately two metres south of the timber cribwork which was partially removed (the sub-structure remaining) on completion of the replacement seawall. The concrete seawall is 1.6 m high with its crest at +6.0 mAOD (the same as the previous promenade) and has its toe protected against undermining by an *Armorflex* cable-tied concrete block revetment. The apron revetment is buried under the beach and will only be exposed under storm conditions. The concrete wall is piled with pile caps at six metre centres. The total length of seawall is approximately 225 m and a new slipway orientated at an angle to the wall (i.e. roughly south-south-west) was constructed at the eastern end to replace the previous timber Buzza Street slip. South of the slip, for a distance of approximately 90 m, a rock revetment (W_{50} = 3.5 Tonnes) was built to protect the exposed ram cliff from further fretting. The new slip has been designed to allow a 22 Tonne 360 degree excavator, purchased by the Council for coast protection purposes, access to the beach for maintenance of the rock revetment.

7.2.3 1996 Coast Protection at Big Pool SSSI, St Agnes

The island of St Agnes is sparsely populated and is partly dependent for its fresh water supplies on an aquifer with boreholes abstracting supplies from the Big Pool Site of Special Scientific Interest (SSSI). The Big Pool area is protected by low, small volume dunes which are slowly eroding. Breaches in the existing dune defence system would cause the Big Pool to become saline which would not only affect a substantial portion of the island's fresh water supplies but also the flora and fauna. Migrating birds currently using the site on passage would

no longer visit if the Big Pool were to become saline which would severely affect the island tourist industry with further effects on tourism on St Mary's.

A low-lying headland containing the Big Pool SSSI juts out of the main body of the island with its centreline orientated in a north-north-westerly direction. To its east is the embayment of Porth Killier, to its north-west is the embayment of Porth Coose and to its west is the embayment of Periglis. Periglis and Porth Coose are separated by an eroding spit of land (reinforced around the early 1960's by a cribwork of old railway lines containing boulders sourced from the beach) connecting westwards to the rocky promontory of Ginamoney Carn, itself attached further west by a drying bank to the Burnt Island rocks.

The dune backing Porth Coose has proven particularly vulnerable to erosion in the past and is considered by the islanders to be the weakest link in the natural defences to the Big Pool. In the "do nothing" scenario, it is considered that it could breach at any time. Erosion there has been estimated to range from virtually nothing to 40 m^3/yr. Porth Killier is similarly vulnerable and its volumetric rate of erosion has been estimated in the order of 10-35 m^3/yr. The patterns of erosion and accretion determinable in Periglis from maps have apparently changed in response to the state of repair of the old lifeboat slipway. Since no severe problems are reported from Periglis, this embayment may well be exhibiting medium term stability.

The St Agnes scheme was finished in July 1996 and was principally an (*Armorflex* or similar) cable-tied concrete block revetment system buried into the existing dune and beaches at Porth Killier and Porth Coose, such that its visual impact was minimised, with (*Enkamat* or similar) erosion control matting reinforcing a graded and "bulked-out" shallower back face. A small (85 m long) granite-faced mass concrete seawall protects the east end of Porth Killier where the cliff is vertical and there are internationally important archaeological remains which need protecting.

Transition zones between different structural types and at the ends of the concrete block revetments is protected with imported Cornish Armorican granite armour rock (W_{50} = 500 kg). The rock armour stone which reinforces the existing stone and rail groyne between the Porth Coose and Periglis beach and Ginamoney Carn was also sourced from the same quarry.

The Periglis Bank has been raised slightly where there was a local depression and erosion control matting was used on the rear face.

7.2.41997 Coast Protection at Porth Minick, St Mary's

Porth Minick is an embayment situated to the south-east of Old Town which is the second largest settlement on St Mary's. Low lying land behind the small embankment at the back of the sand and boulder beach has been flooded by past breaches which are considered to have reduced the return period at which they may be affected in the future. Council and Duchy of Cornwall owned housing estates are located at the limit of the area flooded by the last breach.

The preferred scheme is that of a cable-tied concrete block revetment (*Armorflex* or similar) fixed at a crest elevation of +6.0 mAOD and extending down the beach for approximately six metres at the centre of the bay and somewhat longer at the flanks to where, in normal circumstances, it will be overlain by one or more metres of sand. It will be necessary over a short length to build up the crest of the beach to attain the minimum desirable crest level. Material was won from the volume displaced by the concrete block mattress throughout the length of the protection.

There is already well established vegetation around much of the beach crest and one objective of the works was the re-establishment of this cover over the new revetment. Vegetation cover serves two purposes in that it hides the artificial revetment and also, in storm conditions, resists erosion and therefore delays the onset of removal of beach cover. The concrete block revetment serves to provide the in-depth defence once erosion of the beach has started to occur. The block revetment will be protected at its flanks by rock armour shoulders. These rock structures have the necessary flexibility to adjust to minor erosion around them and may be simply adjusted during maintenance operations by the labour force and equipment available on the island.

7.2.51997 Coast Protection at Old Town, St Mary's

During late 1996, the original seawall at the north-east corner of Old Town Bay (date unknown, but probably built at the same time as the seawall at St Mary's which was constructed in 1930) began to fail significantly. Large cracks began to develop and the lower stones dropped; arching action temporarily prevented the upper courses from dropping. The cause of the failure was undermining as the wall had no foundations as such and the structure was built directly on the beach. Sea level rise and beach loss have jointly reached a point such that the wall would get increasingly unstable.

The opening up of cracks in the seawall enabled the loss of fines from the road behind it occasionally resulting in damage to the road and presenting a real threat to traffic and pedestrians. The risk would increase in time. A breach of the seawall which would enable the low-lying hinterland to the north to be flooded was threatened and the Council instructed a replacement of this sea defence as a matter of urgency before this scenario developed.

The existing seawall was replaced by a masonry-faced mass concrete vertical seawall of generally similar appearance to its predecessor with foundations allowing erosion of one metre of beach levels. Although the degree of protection offered is no more than previously, it is more resistant to breaching. It can be expected to overtop in extreme conditions.

7.3Current Proposals for New Coast Defences

The Council has a rolling programme for the provision of coast protection to areas which have been identified as being at particular risk. Projects under consideration for construction from the financial year 1997/98 onwards are for the *Island Hotel* (Tresco), and Porth Loo and Town Beach (St Mary's). Some of the more definite proposals are discussed below.

*7.3.1*Island Hotel*, Tresco*

Tresco has been developed over the last twenty years or so to cater to the all-important tourist industry. Part of that development has been brought about by the construction of the heliport in the grounds of the Abbey which has enabled easier and faster access to the island. Improved accessibility has increased tourist demand to which the island has responded with an expansion in tourist accommodation including the five star *Island Hotel*.

An extension to the hotel has been built within the last ten years which has brought the dining room within a few paces of a ram cliff which is rapidly eroding. Owing to the proximity of the dining room to the cliff, the options for coast protection are limited and the likely solution will be a mass concrete seawall faced with masonry and with a rock armour toe protection. Surveys and studies have been commissioned by the Council for this work to proceed in the spring of 1998.

7.3.2South Beach (Crab's Ledge), Tresco

Tresco is eroding at several locations around the island and has lost stretches of footpaths and roads in very recent times. The present crisis point is the road south of Great Rock between Sea Carn and Skirt Island which, for reasons of safety, has had to be closed to traffic and pedestrians owing to erosion. Cornwall Archaeological Unit (CAU) have been involved in monitoring archaeological remains at the site and have noted in a letter to the Council's Chief Planning Officer dated 25 September 1995 that "... it is clear that the rate of erosion on the beach varies from year to year and ... the peat appears to have become more exposed as a result of the extraction previously of building sand from the adjacent sand dune."

It is interesting to note that South Beach was not identified by the 1992 DHV Burrow-Crocker report[3] as being a problem area and the firm's engineers had at that time inspected "those areas where damage had been suffered in the 1989/90 storms or where potential damage had already been identified by the Council." It is clear therefore that South Beach was not recognised as being a problem or potential problem three years ago. The excavation of sand for building purposes is reported to have ceased within the last couple of years.

Planning permission for a 200 m length of new coast protection ranging from 100 m east to 300 m east of Sea Carn was granted by the Council to the Tresco Estate in October 1995. The proposed protection consisted of cleft log fencing dug into the beach and strapped together at the top. Marram would be encouraged to re-establish. CAU expressed reservations about the scheme as there had been no consideration within it of changes to patterns of erosion and accretion and because no Environmental Statement had been produced. They further noted in their letter of 25 September 1995 their understanding "... that the scheme presently proposed is intended as a temporary measure ..."

CAU were presumably referring to a potential permanent structure to be funded by the Council as the coastal authority. However, the Council had at October 1995 expressed no commitments or plans for coast defences at this location. It is understood, furthermore, that following the 1995/96 storms the proposal for temporary coast protection by Tresco Estate was abandoned.

7.3.3Town Beach, St Mary's

The seawall at Town Beach was the subject of an investigation in March 1997[5]. The seawall is in a serviceable condition north of the steps at the extreme east end of Town Beach (chainages 0 m to -63.1 m) but requires remedial work, including pressure pointing and possibly some grouting, within the next five years to reinstate it. The toe needs further protection in places by extension of the apron seawards and downwards and the posts and railing are in need of immediate replacement or removal.

The CPSE in 1989 (i.e. some eight years ago) considered that the Town Beach seawall had a residual life in excess of ten years. The evidence seen from the seawall west of the Rechabite Slipway is that that part of the wall is fast approaching the end of its life and is in need of extensive repair and upgrading or, indeed, total replacement in the next few years.

Since the wall east of the slip is in a better condition than that west of the slip, it may be reasoned that this section of wall has a somewhat longer residual life. It must be considered, however, that the seawall at this location is probably of identical construction to that at the west. In similar weather, it would probably suffer a similar fate to the western stretch of wall if the extent of beach lowering during storms were the same. Considering that this stretch of seawall is less sheltered, its exposure would consequently be worse and damage incurred during storms would be expected to be greater notwithstanding its better present condition.

The Council is planning to undertake remedial work probably following completion of the *Island Hotel* coast protection project.

7.4Areas of Risk

The Council's damage assessment following the December 1989 storms highlighted areas which had suffered damage at that time and also raised concerns about other areas which had appeared vulnerable. Subsequent to the storms of 1989/1990 the Council commissioned DHV to investigate "... areas of potential damage identified by the Council ..." in addition to those that had suffered actual damage in the 1989/90 storms. Areas of risk identified in that report may be summarised as being the following:

•St Mary's
· Porth Cressa

•Tresco
· Appletree Beach

[5] *Town Beach Seawall, St Mary's - Report of Visual Inspection*, Report Nr F4116, Aspen Burrow Crocker, Bristol, April 1997

· Old Town Bay
· Porth Minick
· Porth Hellick
· Porth Loo
· Town Beach

· Timothy's Corner
· Island Hotel, Old Grimsby
· Old Grimsby

•St Martin's
· Higher Town Bay
· Lawrence's Bay
· Neck of the Pool

•Bryher
· Great Popplestones
· Great Porth
· Stony Porth
· Green Bay

•St Agnes and Gugh
· Porth Killier
· Porth Coose
· Periglis
· Blanket Bay
· The Bite
· Cove Vean
· St Warna's Cove
· Bergecooth

Findings of DHV Burrow-Crocker's 1992 Report[3] are summarised below.

7.4.1St Mary's

- ***Porth Cressa Beach***

During the December 1989 storm, the timber cribwork wall, footpath and mound suffered considerable damage which was repaired by replacing timbers and filling behind the wall with sand and stones wrapped in geotextile and *Tensar* geogrid.

This defence has been replaced in 1995 by a new stone-faced reinforced concrete wall and extended to the south east by a rock revetment.

- ***Old Town Bay***

The 1964/65 seawall was reportedly eroded at its eastern end but this was rapidly reinstated by the sea itself. A stonework revetment failed over 9 m^2 at the western end of the bay where it may have been weakened by a tree. A road and estate of houses lie beyond the reinforced concrete seawall.

The masonry eastern end of the seawall, between the 1964/65 reinforced concrete seawall and the slip, began to fail in late 1996 and was replaced as a matter of urgency outside the planned works (see Table 7.1) and extended slightly south eastwards in early 1997. The new structure is a stone-faced mass concrete seawall.

- ***Porth Minick***

The dune at the crest of the beach was breached permitting flooding of the bulb fields behind. Flooding reached the houses of the housing estate behind but did not flood them. Some repairs have been carried out to the bank but the defence is now weaker than previously.

A cable-tied *Armorflex* concrete block revetment with flanking rock shoulders was constructed concurrently with the Old Town seawall in early 1997.

- ***Porth Hellick***

The main source (70% by volume) of St Mary's fresh water. Its defences were intact after the storms of 1989/90 having suffered little or no damage but the Council is concerned about its long-term security.

- ***Porth Loo***

A road and a terrace of six houses was threatened during the 1989/90 storms by overtopping and extensive flooding and erosion of the ram cliff. Royal Marines effected repairs using boulders from the beach. A monitoring programme was instituted in March 1997.

- ***Town Beach***

Town Beach formerly flooded on spring high tides from the slip by the *Atlantic Hotel*. This was cured by the fitting of stoplogs. However, occasional flooding of the road still occurs via the road gulleys and the stormwater drainage system.

Only the eastern half of Town Beach (from Holgate's Green to Carn Thomas) has a formal seawall. General dilapidation including incipient collapse near Holgate's Green was noted in March 1997 and a report prepared for the consideration of the Council[5].

7.4.2Tresco

- ***Appletree Beach***

The beach accreted by some 2 m during the storms but the roadway, supported on beams off the top of the reinforced concrete seawall, was destroyed. The seawall has moved down the beach and rotated during storm activity. Builder's rubble is being dumped near the wall. The roadway has now been abandoned and the road diverted further inland. The High Water mark at this point has reportedly retreated by some 6-9 m over the period 1987-1992.

- ***Timothy's Corner, New Grimsby***

The extension of the dry stone wall protecting New Grimsby at Timothy's Corner is rather less substantial than the main wall and has been partially demolished by sea action over time with erosion removing the reserve between the road and

the cliff (4 m in 40 years). Four two-bedroomed cottages and a road containing the main sewer and water main are threatened by continued erosion.

- ***Island Hotel, Old Grimsby***

There are signs of an old seawall some 7 m seaward of the existing ram cliff. Erosion of the ram cliff seriously threatens a recent extension to the hotel. The present rate of erosion has been estimated at 0.6 m in four years.

- ***Quay, Old Grimsby***

There is a low point at the root of the quay in Raven's Porth which was flooded.

7.4.3St Martin's

- ***Higher Town Bay***

A dune system some 700 m long protects disused (in 1991) bulb fields, a well and a popular cricket field. The dune system is reportedly dynamically stable.

- ***Lawrence's Bay***

The bay is 600 m long and is composed of dune for one half and ram cliff for the other. The cliff has eroded but is backed only by disused (in 1991) bulb fields.

- ***Neck of the Pool***

The dune system here is 600 m long and there are indications of possible erosion (6 m is mentioned but no timescale is indicated). The dunes protect a well and a campsite.

7.4.4St Agnes and Gugh

- ***Porth Killier***

A ram cliff contains internationally important prehistoric remains and was partially protected by a 1931 cobble and concrete wall. Additional protection was provided by boulders deposited nearby by the farmer who owns the nearby *Lower Town Farm*. There was evidence of the steepening of the beach and fretting of the dune. A new defence was constructed in 1996.

- ***Porth Coose***

A low dune separates the beach from the Big Pool SSSI and was vulnerable to erosion and breaching. Royal Marines and islanders placed 20 Tonnes of boulders retrieved from Periglis in the weakest sections of the dune following the storms of 1989/90. A new defence was constructed in 1996.

A rail and boulder groyne connects Porth Coose and Ginamoney Carn together. This is in poor condition and has lost about 60% of its filling. This defence was strengthened in 1996.

- ***Periglis***

The defences consist of a shallow dune which occasionally overtops. The beach is apparently stable although the shape of the high and low water marks had changes over time in response to structures being built and demolished around the bay.

- ***Big Pool SSSI***

The Big Pool has no man-made features which are immediately at risk but the threat of any breach to the natural defences is to the water supply to the Lower Town area and to so-called eco-tourism dependent on migrating birds flocking to the existing fresh water supply.

Coastal protection works at bays around the SSSI comprising mass concrete sea wall, concrete block revetment, rock armour and erosion control matting are now in place. Construction finished in July 1996.

- ***The Bite***

The sand dune vegetation comprises marram grass and mesembryanthemum. Some erosion was reported after the December 1989 storms but nothing of any value was apparently threatened.

- ***Cove Vean***

This is a sheltered cove facing south east with a sandy beach at its upper end. Some cliff damage was reported after the storms.

- ***St Warna's Cove***

St Warna's Cove is rocky with rock outcrops onto the beach. Some cliff falls were evident after the storms.

- ***Bergecooth***

The ram cliff backs a beach consisting of boulders varying in size from 2-3 Tonnes at the low water mark to 300 mm diameter at the foot of the cliff. Troy Town well and a camp site lie behind the well.

7.4.5Bryher

- ***Popplestones Bay***

The December 1989 storm eroded some 1,000 Tonnes of rock from Popplestones Brow which has been sheltering a 70 year old wall at Great Popplestones within the bay. The old structure needed emergency repairs and there was concern that it would fail in the future due to its now increased exposure to storms from the north-north-west. Overtopping at Little Popplestones threatened the island's water supply.

- ***Great Porth***

The neck between Great Porth and the Great Pool has been inundated and there were concerns that this would breach leading to a medium-term threat particularly to the *Hell Bay Hotel* but also to two cottages which would be cut off from the remainder of the island.

- ***Stony Porth***

The beach has reportedly recently receded 9 m - mostly in the December 1989 storm. More recent investigation[6] has shown this claim to be exaggerated but there is no doubt that the beach continues to erode. The land behind is a Site of Special Scientific Interest, designated, amongst others, for a rare dwarf pansy.

- ***Green Bay***

Although in a sheltered location, a stone wall which had previously kept out high waters was damaged by the storms. The banks are covered with exotic plants (mesembryanthemum and agapanthus) which form good ground cover and resistance to erosion. Several low-lying cottages are around the bay although not immediately threatened.

Subsequent to the 1992 DHV Burrow-Crocker report being published, works were undertaken to the island. These were composed of rock revetments at Great and Little Popplestones and at the north end of Great Porth with sand fences at the south of the island.

7.4.6Crab's Ledge, Tresco

[6] *Bryher Coast Protection, Engineer's Report*, DHV Burrow-Crocker, Bristol, May 1994

Planned coast defence works at Crab's Ledge on Tresco (see Section 7.3.2) have come about as a response to an erosion problem which was not identified in 1992. The problem appears, at least in part, to be a response by Nature to over-exploitation of the beach for building sand. The Works at Crab's Ledge are said to be temporary in nature and it is possible that other works may need to be designed for this location in the longer term.

7.4.7Pentle Bay, Tresco

Pentle Bay was mentioned by Tresco Estates as being a particular cause for concern owing to evidence of continuing steady erosion along the margins of the bay. A preponderance of south-easterly winds throughout the early winter 1995/96 was said to be the reason for this. In early January 1996 a series of marker pegs were placed along South Beach and Pentle Bay. The most dramatic erosion occurred on spring tides in late January 1996 when the navigation cable marker in the middle of Pentle Bay, which was formerly some 4.5 m away from the dune cliff, was washed away together with a further 3 m of land behind it.

Further to the erosion at Pentle Bay, it is believed that much of the eroded material is being taken a short distance offshore to form a bank at the north of the bay between the Great Pentle Rock and Lizard Point.

The 1995/96 Capital Expenditure Profile submitted by the Council of the Isles of Scilly to MAFF has set their short-term priorities for the financial years 1996/97 to 1998/99. These are shown in Table 7.1. No longer term objectives have, at the time of writing (September 1996), specifically been defined.

7.5Strategic Coastal Defence Options

Prior to any consideration being given to the types of coastal defences that could be provided, there are four generic strategic options which should be considered for each management unit (MU) which are[(7)]:

·do nothing;
·hold the existing defence line by maintaining or changing the standard of protection;
·advance the existing defence line;
·retreat the existing defence line.

[(7)] *Shoreline Management Plans - A Guide for Coastal Defence Authorities*, PB2197, Ministry of Agriculture, Fisheries and Food, London, 1995

Each strategic option should be considered in relation to its likely effect on adjacent MUs and the sediment cell as a whole. Furthermore, any strategic option must be sustainable and compatible with the objectives set for adjacent MUs and the processes at work within the sediment cell.

The strategic options are considered in tabular form in Section 6. Having been identified, the preferred strategic coastal defence option is to be referred to all interested organisations. In the present Shoreline Management Plan consultation has been undertaken by the circulation of the draft document from September 1996 to March 1997 to the parties shown in Table 7.2. Their comments and observations have been incorporated into the text of this final version of the SMP.

7.6Design Considerations

7.6.1Standards of Protection

The Ministry of Agriculture, Fisheries and Food has published indicative standards of protection (stated as return periods) for various land uses in tidal and non-tidal situations (see Table 7.3 for a synopsis).

Owing to the low density of population and the relatively poor quality and low productivity of farmland on the Isles of Scilly, there are few locations where an indicative standard of protection with a high return period would be justified (see Table 7.3). Hugh Town on St Mary's is probably the only location in the Scillies where a return period of the order of 50-150 years could be justified based on indicative standards. Old Town, also on St Mary's, could probably justify an indicative standard of 50 years but all other locations would probably vary between 5 and 20 years.

Scillonian coast defence projects incur large overheads compared to equivalent schemes on the mainland owing to two problems: the logistical difficulties in bringing plant and material across the sea and the necessity, owing to the heavy dependence of the islands' economy on tourism, of having to undertake the works at times of the year when the weather is least benign - incurring downtime particularly in marine transport.

The high costs of constructing projects in the islands coupled with the generally low level of tangible benefits combine to yield low benefit/cost ratios. This criterion is one of three on which projects are considered by MAFF to be eligible for grant aid. With the exception of Porth Cressa, it has been necessary on the schemes for Bryher, St Agnes and Porth Minick (St Mary's) to design for low return periods. The schemes considered by the Council of the Isles of Scilly to be most urgent have been completed and were designed for return periods of 5-10 years. Remaining schemes will probably have similarly low benefit/cost

ratios and it is recommended therefore that **the design sea level and wave height are to the once in five year return period**. One or two individual schemes with high benefits may warrant the consideration of a longer return period where appropriate.

MAFF emphasise that the indicative standards quoted above do not represent either an entitlement to protection or a minimum level at which protection should be aimed - they are the starting point from which benefit/cost assessments may be commenced. MAFF's decision rule as to which coast defence project should be selected from a range of options considered states that it is that scheme with the greatest average benefit/cost ratio in excess of unity meeting or exceeding the indicative standard.

The consequence of designing for low return periods is that there would be more damage incurred to coast defences when events with higher return periods occur. The burden of maintenance would, therefore, be expected to be higher than for coast defence works designed to a higher standard.

An additional consideration on the Isles of Scilly is the fact that the islands are remote from ready sources of heavy plant (although a 22 Tonne excavator is owned by the Council, having been purchased specifically for coast defence works, and is kept on St Mary's). Should emergency repairs be needed which require the use of heavy plant on one of the off-islands, it would be necessary to move it by means of floating plant.

Since emergencies requiring repairs to the defences almost inevitably arise during storms, the easy movement of small floating plant, such as landing craft (the *Mojo* based at Penzance is used frequently for transport of occasional items of heavy plant to and from the islands and requires winds to be less than Beaufort Force 4/5), which are suitable for access to the small bays and coves on the islands would be precluded until such time as the sea/weather abates. As this process can take some time, the Council ideally wishes that the maintenance requirement for future defences is minimised as far as is possible.

7.6.2Design Still Water Level

Because of the length of time for which coastal defence structures are designed (50 and 60 years being common periods), they must be capable of maintaining the design level of protection throughout their lifetimes. Over a fifty year period, for example, the still water level will increase by 250 mm. Table 7.4 gives a summary of design still water levels for typical structure lifetimes.

Notwithstanding the recommendation above that the design still water level (SWL) be the once in five year return period, any structures designed will be in place for

design lives of 50-60 years. The design SWL, taking account of the increase in sea levels due to global warming expected in this time period will be as shown in Table 7.4. **A design SWL of +3.6 mAOD is therefore recommended.**

7.6.3Design Significant Wave Height

Much of the interior of the archipelago is inward facing which generally restricts the wave climate to that which can be generated by waves across the limited fetches (generally less than 5,000 m) available. Wave development is further restricted by the shallow water depths prevailing within the sheltered confines where average bed levels are of the order of Chart Datum owing to the presence of extensive drying banks. Water depths are therefore restricted to around 6.5 m on the peak spring tides.

Taking the wind condition as that of a Force 10 blowing directly across the fetch onto the shore of concern, the fully developed significant wave height determined from the modified depth-limited Sverdrup-Munk-Bretschneider (SMB) curves[8] is generated in around 30 minutes and is slightly less than one metre in height with a period of the order of 3 s. Cross-checking against the deep water SMB predictions produces very little difference.

The above design wave condition for the interior of the archipelago needs to be treated with some caution as there are certainly more vulnerable areas where the deep water channels permit more damaging longer period ocean waves to penetrate within the archipelago. There are four main channels into the centre of the island group which are described further below.

New Grimsby and Old Grimsby Channels both run approximately north-south to the west and east of Tresco respectively (see Drawing 1) and permit the penetration of what are locally termed ground seas to travel along them into the flats between the islands. Since the directions of the two Grimsby Channels do not point directly towards land, the waves penetrating along them generally dissipate their energy in refraction and diffraction in the large open spaces of the Tresco and St Martin's Flats into which they then move.

The channel between Bryher and Samson points from the open sea south-west of Bryher more-or-less directly towards Appletree Point on Tresco. Wave orthogonals north and south of the channel are refracted to north and south respectively while those centred on the channel continue with a combined refraction and shoaling index at chart datum just offshore Appletree Point of the order of 0.5 for 9 s period waves. Inshore wave heights derived from the

[8] *Shore Protection Manual*, US Army Coastal Engineering Research Center, US Government Publishers, Washington DC, 1984

combined refraction and shoaling index probably slightly overstate the wave size that can be expected as diffraction (lateral transfer of wave energy) and friction effects (normally assumed to be zero) have been conservatively assumed to be zero.

Crow Sound is orientated approximately north-west to south-east and permits the penetration of long period waves into Pentle Bay. Combined refraction and shoaling effects at this location are slightly lower (i.e. not so effective in wave height reduction) than at Appletree Point. Although the offshore significant wave heights generated from the south-east are lower than those generated from the south-west, the higher combined refraction and shoaling index allows an inshore wave height of approximately the same height as at Appletree Point in the same water depth.

Although other inward facing parts of the islands can be attacked by waves generated offshore, they are in general protected by rocky outcrops and shoals and refraction and shoaling attenuates the magnitude of offshore wave attack.

Outward facing shores are obviously the most exposed and have suffered from damage in the past. Even relatively sheltered and deep bays such as Porth Cressa are affected. Where shorelines of concern are affected by wave attack they fall broadly into two categories:

·those with high level beaches fronting them (Figure 7.1) such that erodible land is landward of the still water level and attack is in the form of bore of water generated by wave uprush;

·those with lower level beaches where erodible land is seaward of the still water level (Figure 7.2). Depending on water depths, this type of shore is vulnerable to the higher waves that can be supported in larger water depths.

It is recommended in Section 7.5.2 that the five year return period is used as the starting point for design and the offshore significant wave heights at this level are given in Table 2.5.

7.6.4Overtopping

Overtopping is always a consideration in design, particularly where the terrain behind the defences is liable to flooding such as Old Town and Porth Minick on St Mary's. In many locations on the islands, however, overtopping of natural or man-made defences in itself is not a problem and causes little difficulty (e.g. overtopping into the Big Pool area of St Agnes) Indeed, overtopping onto Rushy Bay Green on Bryher was considered by English Nature to have been

generally beneficial in the spread of the nationally rare dwarf pansy (*Viola kitaebeliana*).

The problem for these locations is the erosion of forward defences (e.g. beaches and dunes) and the consequences of resultant flooding or increased overtopping that that would have for the hinterland including in many instances the security of water supplies (e.g. Bryher and St Agnes). The prevention of overtopping, although an inconvenience, is therefore not always essential. Loss of fresh water supplies is a significant risk since Samson was abandoned in recent history (about 100 years ago) owing to the loss of its fresh water supply.

Apart from technical feasibility, the other two of the three criteria on which any potential scheme will be assessed will be the environmental suitability of what is proposed and the result of its benefit/cost assessment. In order to achieve schemes that dramatically reduce the amount of overtopping experienced, it will be essential to increase the height or magnitude of such defences so that they interfere with their perceived visual and general environmental acceptability.

The Scillies are essentially a rural/semi-rural environment set within a Heritage Coast and the large defences that would be needed to greatly diminish overtopping are probably inappropriate in terms of aesthetics and general environmental sensitivity. It is sensible to examine the return periods for which coast defence designs are made and this has been done. However, reducing the return periods for which defences are designed makes little significant difference to the defence height (certainly in terms of cost) that would be needed to reduce overtopping volumes below a defined level.

Owing to the significant logistical overhead that any scheme on the Scillies bears compared to an equivalent project on the mainland, the benefit/cost analyses, certainly in terms of tangible assets, are usually marginal on the lower end of the sensitivity range tested. It is therefore necessary to design schemes for a lower return period than might be possible for an equivalent scheme on the mainland.

7.7Potential Structural Types

The Scillies are an extremely sensitive environmental area as recognized in the definition of Heritage Coast and designation as an Area of Outstanding Natural Beauty (AONB). Care must be taken when selecting coast protection types such that they are not only appropriate on technical and economic grounds but that they will harmonise insofar as possible with the surrounding townscapes and natural landscapes. The above consideration swiftly discounts such alternatives as plain concrete walls (although textured concrete utilising exposed granite aggregates or facings of stone may be acceptable) and exposed revetments of linked concrete armour blocks or

asphalt. Potential alternatives are discussed below with outline sketches included in Appendix 11.

7.7.1Offshore Breakwaters

The use of offshore breakwaters is appropriate in certain circumstances in dissipating wave forces before waves reach vulnerable shorelines. The energy shadow created in their lees can result in the reduction of the longshore transport current and the accretion of a protective beach from material which would otherwise continue to be carried in suspension.

Natural offshore breakwaters are in evidence throughout the archipelago, such as in Porth Cressa (Porth Cressa Brow) on St Mary's and in Pentle Bay (Great Pentle Rock) on Tresco, although these have limited value as protection owing to their restricted heights. Some of the islets close to the main islands are taller and more extensive than the rocks mentioned above and provide good protection to the adjacent shorelines; Toll's Island on St Mary's, which has accumulated a substantial tombola in its lee, is a good example albeit much bigger than an offshore breakwater would be.

During the early stages of design of the coast protection scheme for Bryher there were objections voiced by English Nature to the potential use of offshore breakwaters. These structures would be very noticeable as they would be high (rising of the order of 4 m above the seabed) and, in the early years following construction before they have weathered and accumulated coatings of seaweed and lichens, they would be more visible than in later years owing to the harsh appearance of freshly quarried rock.

English Nature have stipulated that any rock proposed for use in coast protection schemes on the Scillies should be Armorican/Hercynian granite quarried from Cornwall. A suitable quarry was named by English Nature as being Carnsew, near Falmouth. The beds at Carnsew used to produce armour rock and facing stone for the schemes on Bryher and St Mary's have furnished high quality armour stone but it is from a rock which is light grey in appearance compared to the light brown of the native rock. The imported stone will mellow in time when colonised by lichens and intertidal seaweeds and when natural marine debris (seaweed, etc.) begins to accumulate. The appearance of the pre-cast concrete panels of the reconstructed quay head on St Mary's are a perfect example since they were originally light grey and have mellowed appreciably in the two years since their construction and installation.

7.7.2Beach Replenishment

Beach replenishment is a way to increase the volume of the beach and to raise its height such that wave energy is dissipated on the beach before reaching the defences proper. It would have the advantage, at locations such as Porth Cressa, of increasing the amenity value of the existing beach while providing structural benefit to the shoreline defence in terms of reduced wave forces.

The Scillies have been declared a voluntary nature reserve and it is therefore not possible to obtain a supply of material for beach replenishment locally. Dredged material would have to be obtained from further afield and problems are presented by changes in marine legislation which now require that an existing licensed dredging site would have to be closed before another could be opened. This action therefore places a premium on the supply of dredged fill.

English Nature have indicated previously that English China Clays (ECC) in Cornwall produce sand as a by-product from their operations which they (English Nature) consider would be suitable for use in beach replenishment in the Isles of Scilly. While the ECC sand is quartz, with high mica and clay fractions, rather than the naturally occurring silica sand found in the Scillies, English Nature consider it to be acceptable in terms of its mineral composition. The ECC sand, once all clay traces had been washed out would be whiter than the native sand but neither English Nature nor the Countryside Commission would object to this colour difference.

Discussions with ECC reveal that their sand cannot be cleaned sufficiently to remove all traces of the clay fraction. Grading curves of "tip sand" presented by ECC show that only 65% of the material is sand coarser than 600 microns with fully 25% of the total grading being clay. ECC estimate that it would take of the order of two to five years before natural washing by the sea removed the silts and clays. During this time there would be some staining present in the sea. Moreover, calculations indicate that the cost of having to import sand from Cornwall make it uncompetitive compared to other alternatives. Recent (but unexceptional) gales which eroded large parts of the coastline on Tresco show the vulnerability of this type of material to loss which would create an unacceptably costly maintenance commitment on Scilly for reasons stated above.

In most instances on the Isles of Scilly, beach recharge in itself would not be sufficient. The use of beach recharge, while reducing the degree of run-up and magnitude of wave attack, does not address the problem of elderly and insufficient structures higher up the beach and supplementary shore works would still be required. This requirement in most, if not all, instances places a high financial penalty on beach replenishment as an option owing to the high mobilisation charges for all construction forms.

7.7.3Armoured Revetments

Armoured revetments are a suitable construction type for use at many locations throughout the islands and have been used most recently at Bryher and St Mary's. They can be constructed from many materials, typically concrete blocks (often cable tied), open stone asphalt and the more traditional rock or concrete armour units. Thomas and Hall[9] give a suitable review of sloping porous walls which form revetments; pertinent findings of which are summarised below.

- ***Open Stone Asphalt***

Open stone asphalt is a system of loose rock continuously or pattern-grouted using asphalt. It is suitable for use in mild to moderate wave climates (i.e. wave heights less than 4 m) and, as such, would be suitable throughout the Isles of Scilly. Its main drawback in a sensitive environment is the visual impact of the black asphalt in the joints (although this may become less severe with weathering). It may, however, be suitable for use in certain applications such as within the working harbour of St Mary's.

Open stone asphalt is stated to have only fair durability and maintenance would therefore be a considerable problem owing to the total lack of material, specialist equipment and trained personnel on the islands for dealing with not only with the material itself but with its specialist application in the marine environment. Notwithstanding the above, the potential use of open stone asphalt in the Scillies would most likely be on the upper beach and therefore somewhat easier to deal with.

- ***Concrete Blocks***

Concrete blocks are available in a variety of shapes and sizes and often are part of patent systems. Wave run-up and hence overtopping would be greater with the smoother concrete block system than with an equivalent rock revetment but in most locations within the islands, the occasional overtopping may not be a problem.

The visual appearance of a concrete block system is obviously that of a fabricated man-made structure and so the locations at which their use is proposed would have to be selected carefully. A patent system (*Armorflex*) has been used (1995) at Porth Cressa to protect the toe of the new stone-faced reinforced concrete seawall from undermining and, at the time of writing, a similar system has been constructed on St Agnes at Porth Coose and Porth Killier to reinforce the natural dune system (1996). As with the system at Porth Cressa, it is the

[9] *Seawall Design*, R.S. Thomas & B. Hall, CIRIA, Butterworth Heinemann, Oxford, 1992

intention that the beach and dune is the main protection but that the concrete block system forms a longstop during extreme conditions. During the winter 1995/96, a prolonged and relatively unusual run of persistent south-east gales drove much sand from the eastern end of south-facing beaches to the west. At Porth Cressa, the new toe protection became exposed for a length of 20-30 m but gradually accreted sand over itself as expected.

Flexible armoured revetment systems are only suitable in mild wave climates (that is, wave heights less than about 1.5 m). They would therefore be useful defence elements within the Isles of Scilly in many inward facing shores where water depths are shallow and fetch lengths restricted to the order of 3,000 m. Experience of the recent construction in Porth Cressa, which employed the *Armorflex* cable-tied concrete block revetment system, and which required adjacent mats to be meshed together and the cables to be rethreaded and crimped showed that maintenance issues are not a problem and can be dealt with locally.

- ***Concrete/Rock Armour***

Where the exposure of stretches of coastline is greater than the more sheltered inward-facing shores, it will be necessary to look to more substantial structures to provide the necessary protection. Rock or concrete armour units can do this. For a given wave climate, smaller concrete armour units would provide the requisite protection compared to the equivalent rock armour unit but they are generally economical only where the unit size, depending on the quarry yield curve for the rock alternative, is above about ten tonnes.

Apart from technical and economic considerations, the aesthetics of a concrete armour protected slope are not as sympathetic to the needs of a Heritage Coast as is the alternative of rock. The visual impact of rock would be more acceptable given the visually broadly similar collections of rock around the margins of the islands bay.

Where defences formed of rock or concrete armour units would present problems would be in restricting access to the beach for pedestrians, boats, etc. although slips/access ramps, for example, set back into the structure could relatively easily be accommodated.

Rock revetments have now been provided at Bryher and Porth Cressa and it is likely that rock will further provide, if not the entire protection system, then elements of coast protection schemes elsewhere within the islands. It is within the nature of rock armour that individual elements are susceptible to being moved by the elements and that maintenance of some degree will be required from time to time.

Since the islands form a small community operating an agricultural/tourist economy supported by some light industry, they have a major drawback compared with mainland communities in that suitable items of heavy plant are not readily available. One of the major concerns of the Council therefore has been in providing for maintenance of their coastal structures. To this end, they have acquired a 22-tonne 360◦ tracked backactor equipped with a rock grab through the rolling programme of coastal schemes. This machine is adequate for most maintenance purposes utilising rock armour up to a mean weight of 3.5 tonnes (i.e. individual stones of 5 tonnes). There will always remain the problem of moving the machine between islands as needed to repair storm damage.

7.7.4Seawalls

Seawalls can be constructed using concrete, stone, timber or steel and examples of the use of all materials are seen throughout the islands. Concrete, for example, has been used on Tresco (Appletree Point) and dressed stone is in evidence on Tresco (New Grimsby) and St Mary's (Town Beach). Timber was used for the construction of the bulkhead on Porth Cressa beach (St Mary's) in 1963 but was replaced in 1995 after earlier storm damage; some timber uprights are in evidence on Tresco although they have been ineffective. Steel has not been used widely on the Scillies owing to the need for and high cost of specialist plant (piling hammers and cranes) for its installation but it has been used for the strengthening of the Quay on St Mary's where the sheet steel piles have been faced with precast concrete panels to give the appearance of large dressed stones.

As has been emphasised time and again throughout this document, aesthetics are an important consideration for the design and construction of new coastal structures. The example quoted above for the facing to the strengthened Quay is important since it has been followed by the design of the new seawall at Porth Cressa. This wall incorporated stone blocks to create the appearance of random stone walling to harmonise with the background of stone buildings in the nearby Hugh Town.

Nowadays, the use of vertical seawalls is avoided wherever possible owing to their propensity to become undermined because of their generally high wave reflection characteristics. This property is readily evident at many locations within the archipelago but probably most prominently at Appletree Point at Tresco where the erosion has reached such a degree that the seawall has failed and is in urgent need of replacement. The use of vertical, or near vertical, seawalls is still justifiable such as at locations where ram cliffs have been created with roads close by and where there is really no feasible alternative. Seawalls form a useful secondary purpose in providing platforms

for promenades - witness the popularity of the previous (1963) and present (1995) seawalls at Porth Cressa.

Some form of toe protection would, however, have to be provided to protect against the eventuality of undermining. Toe structures are frequently of steel sheet piling but alternatives such as the flexible *Armorflex* type apron provided at Porth Cressa could be provided in appropriate applications. This type has the benefit of allowing free movement of tidal and ground water and dissipation of excess pore pressures under the superstructure while having the flexibility to accommodate some differential movement. The use of any type of toe protection, and indeed superstructure, will be governed by the prevailing ground conditions.

Appendix E

Environment Agency NFCDD
Record of Defences

NFCDD defences, St Marys

Environment Agency

Legend

Defence_polyline

1:13,666

NFCDD defences, Tresco & Bryher

Legend

Defence_polyline

1:14,810

ASSETREFER	ASSETTYPE	MAINTAINER	ASSETPROTE	ASSETCOMME	ALTERNATIV	ASSETDESCR	ASSETLOCAT	DESIGNTYPE	CONSENTNUM	ASSETLENGT
690/8913/01	coastal protection (man-made)	local authority	coastal	891301 EMBANKMENT PROVIDES FLOOD PROTECTION TO ISOLATED PROPERTIES BEHIND, BUT LIKELY TO RECEIVE C.P. GRANT AID.: 1997 - northern 40m of embankment rear face slope reduced and embankment deepened	CPSE-690/8913/01	Embankment	SV87710854, SV87730833			100.00
690/8915/02	coastal protection (man-made)	local authority	coastal	891501 1997 - mass concrete wall faced in stone constructed 1996, significant archaeology behind	CPSE-690/8915/02	Wall	SV88050850, SV88130846			80.00
690/8902/01	coastal protection (man-made)	local authority	coastal	890201 ROCK BANK PRINCIPALLY TO STOP FLOODING TO HINTERLAND.	CPSE-690/8902/01	Embankment	SV91581000, SV91751006			180.00
690/8905/02	coastal protection (man-made)	private	coastal	890502	CPSE-690/8905/02	Splash Wall	SV91151003, SV91171014			100.00
690/8905/01	coastal protection (man-made)	private	coastal	890501 PROTECTION TO COAST PATH AND WAR MEMORIAL. PREVIOUS SECTION HAS FAILED BY BEING UNDERCUT AND REBUILT. PART OF SECTION HAS STONE UPPER SECTIONS.	CPSE-690/8905/01	Wall	SV91151003, SV91171014			100.00
690/8903/01	coastal protection (man-made)	local authority	coastal	890301 PROVIDES PROTECTION TO MAIN COAST ROAD. SHORT SECTION ADJACENT TO QUAY CONSTRUCTED IN STONE.	CPSE-690/8903/01	Wall	SV91251020, SV91361018			130.00
690/8903/02	coastal protection (man-made)	local authority	coastal	890302	CPSE-690/8903/02	Splash Wall	SV91251020, SV91361018			130.00
690/8903/03	coastal protection (man-made)	local authority	coastal	1997 - a new defence to the survey.	CPSE-690/8903/03	Wall	SV91321020, SV91361020			0.00
690/8901/01	coastal protection (man-made)	local authority	coastal	890101 BANK PRINCIPALLY TO PROTECT AGAINST FLOODING AND TO PROTECT WATER SUPPLIES.	CPSE-690/8901/01	Embankment	SV92601035, SV92421054			180.00
690/8907/01	coastal protection (man-made)	local authority	coastal	890701 WALLS IN GOOD CONDITION. DID NOT SUFFER IN '89 STORMS.	CPSE-690/8907/01	Wall	SV90151038, SV90261044			140.00
690/8906/03	coastal protection (man-made)	local authority	coastal	890602	CPSE-690/8906/03	Wall	SV90271045, SV90481041			220.00
690/8906/02	coastal protection (man-made)	local authority	coastal	890602	CPSE-690/8906/02	Splash Wall	SV90271045, SV90481041			130.00
690/8910/01	coastal protection (man-made)	private	coastal	891001 COLLECTION OF PRIVATE WALLS FORMING FOUNDATIONS TO PROPERTIES. CREST LEVELS NOT APPLICABLE.	CPSE-690/8910/01	Wall	SV90591074, SV90411059			340.00
690/8911/01	coastal protection (man-made)	local authority	coastal	891101 WALLS PROTECTED BY OUTER QUAY BREAKWATER.	CPSE-690/8911/01	Wall	SV90591074, SV90411059			300.00
690/8908/01	coastal protection (man-made)	local authority	coastal	890801 WALLS PROTECT MAIN VEHICULAR ACCESS TO QUAY.	CPSE-690/8908/01	Wall	SV90041072, SV90141072			100.00
690/8919/01	coastal protection (man-made)	private	coastal	891901 PROVIDES PROTECTION TO COAST ROAD AND TRESCO GARDENS. ROAD HAS BEEN REALIGNED SO URGENCY MAY NOT BE SO HIGH.	CPSE-690/8919/01	Wall	SV89101402, SV89001413			120.00
690/8919/02	coastal protection (man-made)	private	coastal	891902	CPSE-690/8919/02	Splash Wall	SV89101402, SV89001413			120.00
690/8916/01	coastal protection (man-made)	private	coastal	891601 PROTECTION TO COAST PATH AND GARDEN TO ISOLATED PROPERTIES.	CPSE-690/8916/01	Wall	SV87941456, SV88091485			500.00
690/8921/01	coastal protection (man-made)	local authority	coastal	892101 Bryher - little Popplestones.	CPSE-690/8921/01	Embankment	SV87501519, SV87521513			60.00
690/8920/02	coastal protection (man-made)	private	coastal	892002	CPSE-690/8920/02	Splash Wall	SV88881513, SV88691529			290.00
690/8920/01	coastal protection (man-made)	private	coastal	892001 COAST PROTECTION TO ROAD AND SEA DEFENCE TO PROPERTIES BEHIND. PRIVATE ISLAND.	CPSE-690/8920/01	Wall	SV88881513, SV88691529			290.00
690/8923/01	coastal protection (man-made)	local authority	coastal		CPSE-690/8923/01	Cliff / Scarp	SV89401586, SV89351594			100.00

NFCDD defences, St Agnes

Environment Agency

Legend

Defence_polyline

1:9,632