REPORT (FINAL)

Slapton Sands Beach Management Plan

Prepared for

Slapton Line Partnership

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Contents

Beach Management Plan Partners and Consultees

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Environment Agency	Devon County Council
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Executive Summary

This Beach Management Plan (BMP) covers the coastline from Torcross in the south, to Strete Gate in the north. The central section of the BMP study area, which separates the freshwater lake, Slapton Ley lagoon, from Start Bay is locally referred to as 'The Line' and supports a section of the A379 road. The open coast area covered by this BMP is the responsibility of South Hams District Council (SHDC), whilst the Torcross seawall is the responsibility of the Environment Agency. In addition, Plymouth Coastal Observatory (PCO) undertakes coastal monitoring of the area as part of the South West Strategic Regional Coastal Monitoring Programme (SWRCMP).

The aim of this BMP, which has been developed utilising best practice contained in the CIRIA Beach Management Manual (CIRIA, 2010), is to identify the management activities that could be undertaken to reduce the flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years whilst recognising and managing the environmental and amenity implications of doing so.

The specific objectives of the SLP in developing the BMP are:

- To review and better understand the coastal processes which contribute to change along the study boundary.
- To assess the performance of the existing coastal defences.
- To assess the local economic benefit of future management options.
- To appraise each short listed option against technical, economic, environmental and social criteria and identify the preferred management approach.
- Present a monitoring and intervention plan to sustain the A379 for the next 20 years.
- To develop and implement more sustainable longer-term solutions with consideration of the current 'Shoreline Management Plan'.
- To consider immediate and long-term changes to both funding and local policy.
- Consider that impact of any management solution on the Slapton Line which is in a National Nature Reserve and SSSI designated for vegetated shingle, freshwater lakes and wetlands, geomorphologic features and rare plants and birds.

The Slapton frontage is at risk of both coastal flooding and erosion. To reduce these risks, various coastal defences have been constructed along the frontage over the years, with the existing defences consisting of a concrete seawall and sheet piling, rock revetment, block armour work, and periodic beach recycling. These coastal defences protect a number of assets, including:

- Up to 48 properties at risk of flooding at Torcross. The discounted Present Value (PV) of these properties is estimated to be £1,162,000 (over a 20-year appraisal period): and,
- The A379 road (operated and maintained by Devon County Council, DCC), which is at risk of flooding and collapse via erosion of the underlying shingle barrier and beach during storms. The A379 provides an important transport link to the area for both local traffic and tourists. Sea level rise predictions and increased storminess will continue to increase the vulnerability of beach and shingle barrier and its associated infrastructure to damage. The discounted Present Value (PV) (over a 20-year appraisal period) of damages arising from the impact of temporary and permanent closure of the A379 on local/tourist traffic and tourism revenue is estimated to be £30,550,000.

As estimated for the BMP, approximately £1,778k of FCERM-GiA from the Environment Agency could be available to protect the £31,712,000 of benefits, which, as described above, is based on 48

properties being at risk of flooding and damages arising from the impact of temporary and permanent closure of the A379 on local/tourist traffic and tourism revenue.

The BMP sets out the plan for management and monitoring of the coastal defence assets, road infrastructure and access, and the beach to ensure they continue to provide adequate flood and coastal erosion risk management to BMP frontage in the immediate future, whilst also identifying measures to support development and implementation of more sustainable longer-term solutions to the management of these issues. This monitoring and intervention plan has been developed in the context of providing a technically, economically, environmentally and socially sustainable management approach for the next 20 years in line with the long-term strategic flood and coastal erosion risk management approach developed alongside this BMP.

In summary, the preferred solution/option for the long-term strategic flood and coastal erosion risk management approach along the BMP frontage (which is to be developed and implemented as soon as possible) is a combination of:

- **Maintenance of the existing seawall at Torcross** for the next 20 years at a PV cost of £376,244 (refer to Options Appraisal Report, Appendix F). Future maintenance of the existing seawall will be undertaken by the Environment Agency as part of their asset maintenance programme. The timing and scale of future maintenance, improvements and upgrades of the structure should be informed by ongoing monitoring completed as part of the defence inspections completed for the BMP frontage.
- **Maintain, improve and upgrade the existing defences adjacent to the Torcross seawall** to prevent outflanking and cutback of the coastline, including:
    - Maintain the existing 23m concrete seawall along landward edge of slipway.
    - Maintain the existing 60m sheet pile wall at Torcross.
    - Upgrade and improve existing 60m concrete seawall at Torcross. The estimated costs to undertake these works could be in the region of £250k (see Appendix F).
    - Upgrade and improve existing 700m of rock revetment at Torcross. The estimated costs to undertake these works could be in the region of £500k (see Appendix F).

  It is anticipated that funding to improve the existing concrete seawalls and rock revetment could be sought from the Environment Agency via Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM-GiA) and SHDC/DCC (Highways). Maintenance of the existing sheet pile wall, and recovery and re-profiling of the rock in conjunction with concrete seawall improvements (as described above) may attract some FCERM-GiA contribution. However, if undertaken in isolation it is less likely to achieve FCERM-GiA funding. Therefore, in order for this option to be implemented, it is recommended that funds are identified via SHDC to support any FCERM-GiA that may be available.
- **Management of the A379 addressed through reactive management** with the view that all necessary works relating to planning and approvals are put in place to ensure a quick and smooth implementation. Reactive realignment works could have a PV cost anywhere from £892,875 to £1,590,128 depending on the length of realignment required, with funding sourced via FCERM-GiA funding and DCC (Highways) (see Appendix F).
- **Beach recycling** as an option that could be considered in the future, but requires preliminary studies to determine its suitability, the volumes that could be re-placed, and over what time-scales. Beach recycling could have a PV cost of £1,278,200 depending on the length of realignment required, with funding sourced via FCERM-GiA funding, SHDC, and DCC (Highways) (see Appendix F).
- **Formally recognising the BMP study area as a Coastal Change Management Area (CCMA)**, which is key to addressing the long-term inevitability of the potential loss of the barrier and with that the A379 along 'The Line'.

These preferred options were selected as they provide the best balance between technical viability, environmental acceptability and economic case. However, further work is still needed in the immediate future (within the next 6 months) to fully confirm the level of funding contribution that can be delivered to robustly evidence this in the business case when it is eventually submitted to the Environment Agency's National Project Assurance Service. It is possible that a change to the preferred option could occur if, as a result of that further work, it is shown that a greater level of funding contribution can be confirmed as being deliverable. This funding work can be progressed alongside initial work to develop the detailed appraisal of the currently defined preferred option, with the scope able to be changed if additional partnership funding is made available.

The plan for management of the coastline between Torcross and Strete Gate for the next 20 years is formalised within a BMP Action Plan and includes details of the activities to be completed with dates for action.

SECTION 1

Introduction

1.1 Background

This Beach Management Plan (BMP) has been prepared for the Slapton Line Partnership (SLP) and their partners South Hams District Council (SHDC), the Environment Agency and Devon County Council (DCC). The BMP study area covers the Slapton Sands coastline from Torcross in the south, to Strete Gate in the north, as shown in Figure 1.1. The central section of the BMP study area, which separates the freshwater lake, Slapton Ley lagoon, from Start Bay is locally referred to as 'The Line' and supports a section of the A379 road.

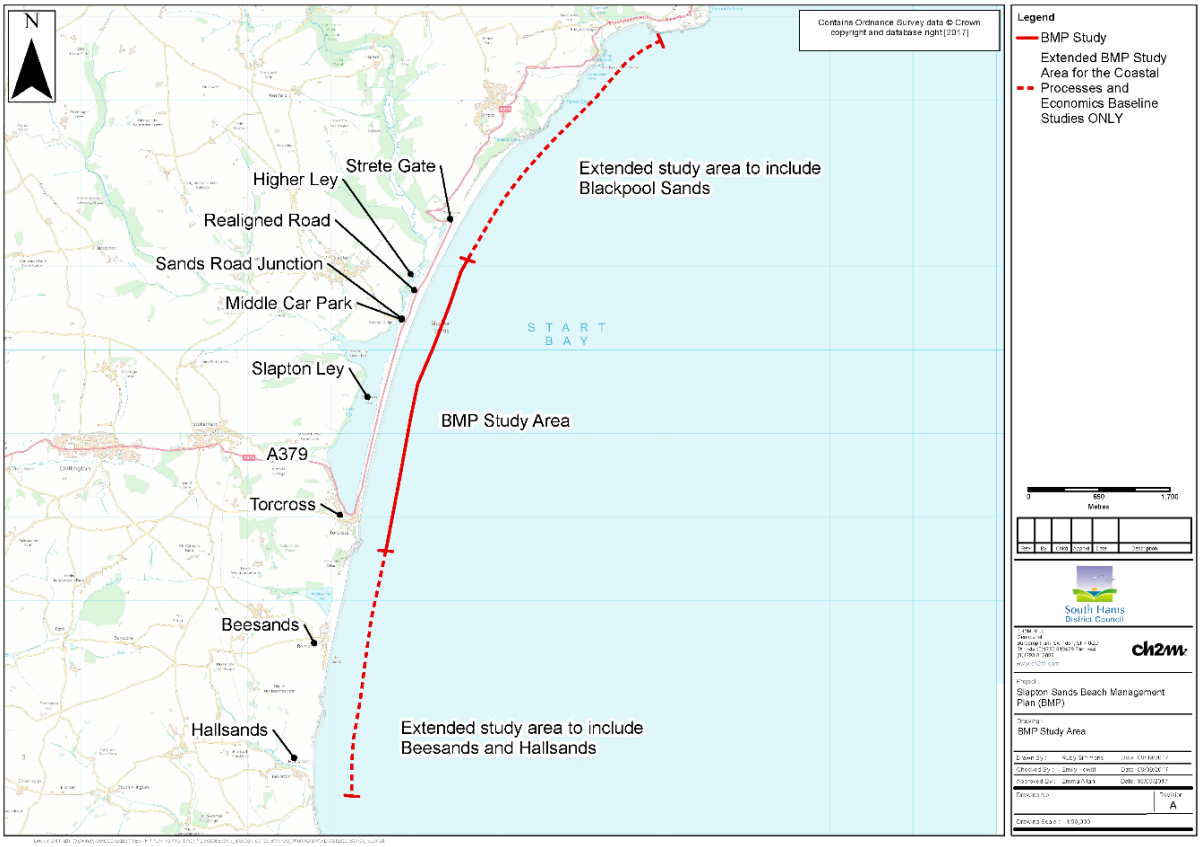

Figure 1-1 Slapton Sands BMP extent

An explanation of the extended study area is provided in Section 1.3

The Slapton Sands coastline is at risk of both coastal flooding and erosion; for example, the storms of 1979; 2001/2002, which resulted in significant damage and closure of the A379 road; 2014/2015; and February 2016, which resulted in significant damage to, and failure of, the concrete seawall at Torcross. To reduce these risks, various coastal defences have been constructed / emergency works completed along the frontage over the years, with the existing defences consisting of a concrete seawall and sheet piling, rock revetment, block armour work, and periodic beach recycling. These coastal defences protect a number of assets, including:

- Up to 48 properties at risk of flooding at Torcross. The discounted Present Value (PV) of these properties is estimated to be £1,162,000: and,
- The A379 road (operated and maintained by DCC), which is at risk of flooding and collapse via erosion of the underlying shingle barrier and beach during storms. The A379 provides an important transport link to the area for both local traffic and tourists. Sea level rise predictions and increased storminess will continue to increase the vulnerability of beach and

shingle barrier and its associated infrastructure to damage. The discounted Present Value (PV) of damages arising from the impact of temporary and permanent closure of the A379 on local/tourist traffic and tourism revenue is estimated to be £30,550,000.

This BMP has been prepared to address these issues and provide a way forward to manage flood and coastal erosion risk between Torcross and Strete Gate, allowing for the present-day funding limitations and technical constraints and opportunities.

The BMP provides an update to the Slapton Coastal Zone Management Study (SCZMS), which was prepared by Scott Wilson in 2006 (described in Section 1.7.2) and established a robust long-term coastal zone management strategy for Slapton Sands. The SCZMS recommended that a review of the recommended management strategy is undertaken at intervals of no less than every five years. This was recognised in the Environment Agency's Management Investment Programme 2015 – 2021. However, following the 2015 storms and the significant damage that they caused, a decision was made by the SLP to advance the review of the 2006 recommended management strategy in the SCZMS and bring it forward to 2016/2017. This update has now been undertaken and presented within the Slapton Sands BMP.

Since the completion of the SCZMS, there have been a number of changes that determine the way in which flood and coastal erosion risk management is defined and this needed to be reflected in the SCZMS update (and therefore the BMP accordingly). These changes are summarised below:

1. Changes to the governmental funding system and the way in which expenditure is allocated to flood and coastal erosion risk management; and
2. 10 more years of beach profile, providing a better understanding of coastal processes and shoreline interaction taking place along the Slapton Sands coastline.
3. Advance in the development of Beach Management Plans, with the release of the CIRIA Beach Management Manual, 2nd Edition in 2010, and the production of numerous BMPs since then.

The recommendations made by the SCZMS are generally similar; both including reactive realignment, beach recycling, development of an adaptation plan, ongoing beach monitoring and ensuring ecological data is kept up-to-date; however, recommendations to maintain/improve/upgrade the defences at Torcross are included within the BMP.

1.2 Aim and Objectives of the Beach Management Plan

The purpose of the BMP is to identify the management activities that could be undertaken to reduce the flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years whilst recognising and managing the environmental and amenity implications of doing so.

The specific objectives of the SLP in developing the BMP are:

- To review and better understand the coastal processes which contribute to change along the study boundary.
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- To develop and implement more sustainable longer-term solutions with consideration of the current 'Shoreline Management Plan' (as set out in Table 1.1).
- To consider immediate and long-term changes to both funding and local policy.

- Consider that impact of any management solution on the Slapton Line which is in a National Nature Reserve and SSSI designated for vegetated shingle, freshwater lakes and wetlands, geomorphologic features and rare plants and birds.

1.3 Development of the BMP

The BMP has been developed utilising best practice contained in the *CIRIA Beach Management Manual, 2nd Edition* (CIRIA, 2010). It has been prepared in six stages, with ongoing communications with stakeholders throughout. A diagram showing the staged approach to preparing the BMP is presented in Figure 1-2.

- Stage 1 – Desktop Review: The purpose of this stage was to review the suitability of the existing and available data, identify any critical data gaps, and refine the scope of works for Stage 2 of the BMP. The findings of the review were recorded within a Baseline Scoping Report (refer to Appendix A).
- Stage 2 – Technical Updates: The purpose of this stage was to update the existing baseline information on coastal processes, coastal defences, environment and economics, which underpins the BMP options development and decision-making process (see Stage 4). The findings of the work were recorded within four reports; Coastal Processes Baseline, Environmental Baseline, Defence Baseline, and Economics Baseline (refer to Appendix B to E respectively).

  As indicated in Figure 1-1, the study area was extended to include Blackpool Sands, Beesands and Hallsands for two of the four baseline reports prepared for BMP; including the Coastal Processes Baseline Report (Appendix B) and the Economics Baseline Report (Appendix E). The reasons for this are outlined below:

  - The Coastal Processes Baseline inherently covers the wider coastal processes operating to the north and south of the study area, however, the study area was extended to include new high-level trends analysis for the wider coastline at Blackpool Sands, Hallsands and Beesands. This ensured that the options appraisal process is underpinned by the best possible evidence and analysis of coastal processes and shoreline change. This information will also be available for use in any future studies.
  - The Economics Baseline Study was extended to include damages arising from erosion risk at Blackpool Sands and Hallsands and flood risk at Beesands in lieu of the potential benefits that may arise from works that could be undertaken in the future or alongside those at Slapton and to inform any future studies.
- Stage 3 – Stakeholder Engagement and Funding: Stakeholder engagement was integral to the options appraisal process and the definition of a preferred option. Consultation with the SLP took place during the BMP development to seek local knowledge/information and to help guide the selection of beach management options. In addition, public consultation on the long-list options was conducted in July 2017. All comments made have informed the options development (see Stage 4).
- Stage 4 – Options Development and Economics: The options development stage identified and appraised the different management activities that could be implemented to manage flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years. The options appraisal was completed in accordance with best practise guidance and followed a staged approach to ensure that the decision-making process was transparent and auditable. Section 4 of this BMP describes the preferred approach resulting from this stage. The full Options Appraisal Report (refer to Appendix F) provides full details of this stage, the appraisal process and rationale to the decisions made.
- Stage 5 – Community Engagement: In additional to the main BMP report, the findings of the BMP will be disseminated via a non-technical summary, suitable for a wide range of readers.

- Stage 6 – BMP Development: This stage involves the production of the main BMP document and Options Appraisal Report. In line with the aims and objectives, the BMP identifies the measures to develop and implement more sustainable longer-term solutions along the BMP frontage and sets out a plan to maintain and monitor the beach. Going forward, the BMP will then be used by SHDC, the SLP, Environment Agency and DCC to inform, guide and assist them when making decisions on how to best manage the coast going forward. The BMP also includes recommendations for further studies and investigations to refine the preferred long-term option and inform its implementation.

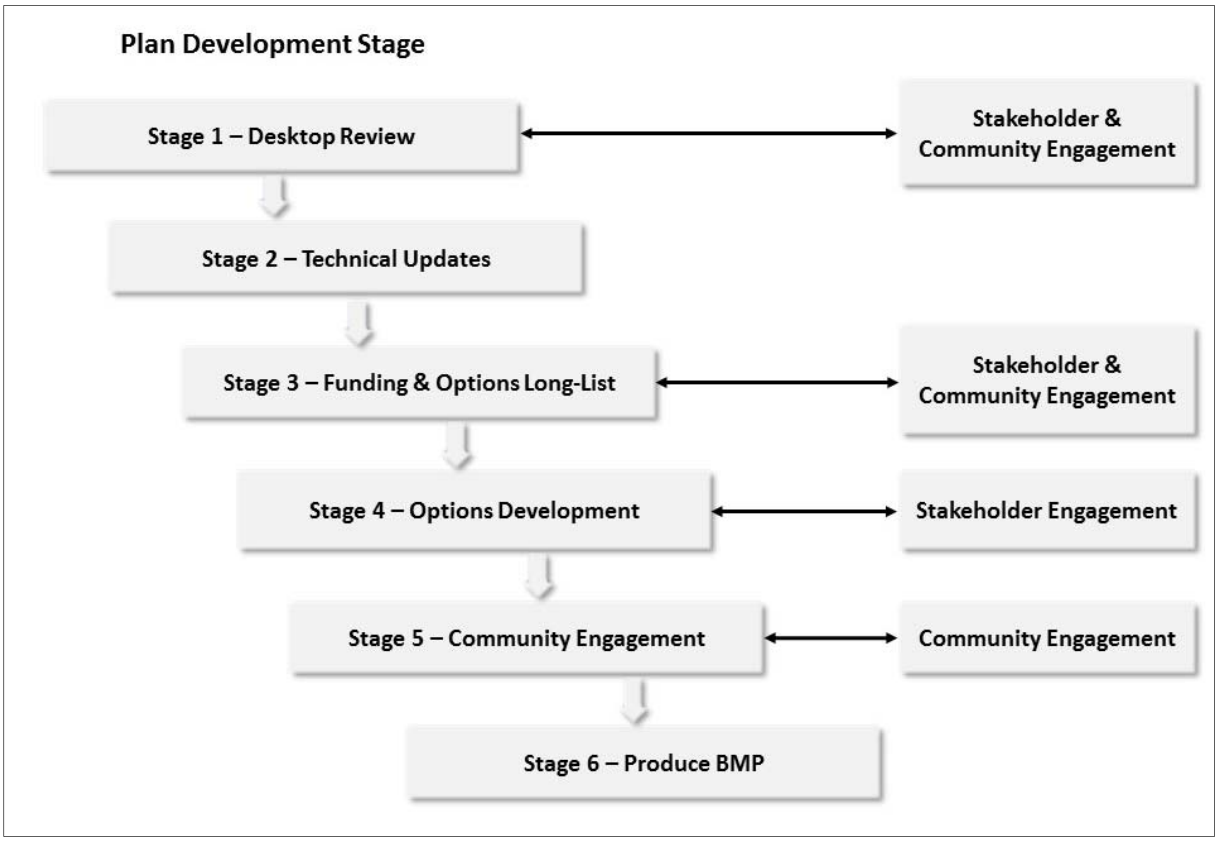


Figure 1-2 Beach Management Plan development process

1.4 The BMP Study Area

1.4.1 Physical Setting

Slapton Sands is a southeast facing gravel (or 'shingle') barrier beach in Start Bay, on the south coast of Devon, UK. To the northeast of Slapton Sands lies Strete and Blackpool Sands, and to the southwest lies Beesands and Hallsands beaches. The barrier is approximately 4.5 km long, and extends continuously between headlands at its southwestern (Torcross) and northeastern (Strete) extents. The gravel barrier at Slapton Sands is between 50 and 100 m wide at high tide and widens between Torcross and the northeast extent of the barrier. The central section of Slapton Sands separates the freshwater lake, Slapton Ley lagoon, from Start Bay. Referred to as 'The Line', this stretch of the barrier supports a section of the A379 road, which provides an important transport link between Torcross and Strete.

Signpost!

Full details of the physical setting, coastal processes and shoreline interactions are provided in Section 2 of this report, and in the **Coastal Processes Baseline Report**, which is provided in Appendix B.

1.4.2 Environmental Setting

Slapton Sands is located within an area of considerable ecological importance; designated for its environmental, landscape, geological and geomorphological value. The environmental and nature conservation designations within the BMP study area are described below. Further, the South West Coastal Path runs along 'The Line' and the area has several local small businesses and settlements where tourism makes up a major source of income.

- 'The Line' is located within a Site of Special Scientific Interest (SSSI), nationally designated for its biological and geomorphological features.
- 'The Line' and Ley are also located within a nationally designated Geological Conservation Review (GCR) site (no. 1840) and a Regionally Important Geological and Geomorphological Site (RIGS)in recognition of the key scientific elements of the Earth heritage of Britain that it shows and regionally/locally important earth science.
- The Slapton Ley is the largest freshwater lake in southwest England and is a nationally designated National Nature Reserve (NNR).
- For its landscape setting, the area is located within the nationally designated:
    - South Devon Area of Outstanding Natural Beauty (AONB); and
    - South Devon Heritage Coast.
- In the vicinity of the BMP study area, situated from mean high water at the southern tip of the BMP study area, is the nationally designated Skerries Bank and Surrounds Marine Conservation Zone (MCZ). The MCZ is a large area that covers 24,969 ha of marine subtidal and intertidal habitat.
- In the vicinity of the BMP study area, situated to the north/north-east of Blackpool Sands, is the internationally designated Lyme Bay and Torbay SCI; recognised for reefs and submerged or partially submerged sea caves.
- The nearby area also includes several conservation areas as well as many listed buildings, scheduled monuments and a number of designated and non-designated archaeological/cultural heritage sites.

These designated sites are important in the consideration of options for beach management, with many having legislative requirements to ensure they are not adversely impacted by human actions.

Signpost!

Full details on amenity value, land ownership and highways, services and utilities are presented in Sections 1.4.4, 1.4.5 , and 1.4.6 respectively, along with environmental considerations in Section 1.5.3 and license, approvals and consents in Section 1.6.3. Details of the environmental designations, conservation sites and features are provided in Section 2.7 of this report. The full **Environmental Baseline Report** is provided in Appendix C.

1.4.3 Coastal Defences

1.4.3.1 Coastal Defence and Management History

The construction of coastal defences between Torcross and Strete Gate dates to the early 1900's. Full details, including a chronological summary, photos and technical drawings and defence ownership, are provided in Appendix D (Section 2), whilst the following provides a brief synopsis of the defences constructed over the past ~100 years:

- 1917: Concrete seawall (143m) constructed north of Torcross.
- 1979: Rock revetment (795m) constructed between Torcross and the middle car park.

- 1979 / 1980: Torcross seawall constructed.
- Late 1980s: Concrete 'Armourflex' blockwork (330m), installed in front of the middle car park.
- 2000: Torcross seawall modified.
- 2002: A 250m section of the A379, adjacent to the Higher Ley, was reinstated 20m inland. The new two-way length of carriageway replaced a temporary single road which was built after storm damage in 2001.
- 2003: Beach redistribution.
- 2005: Bastions constructed.
- 2009: Bastion replenishment works.
- 2015: Construction of six shingle bastions and beach recycling, including the movement of 17,041m^3 of material from Pilchard Cove to Torcross (3,855m^3) and at the location of the 6 bastions (13,186m^3).
- 2016: Former concrete seawall damaged by storms in February 2016 replaced by 4m deep sheet piling with rock/concrete crest protection and intermittently placed rock armour at the toe of the structure.
- 2016 / 2017: Sheet piling and reinforced concrete capping beam added to the site along the Torcross seawall frontage.

1.4.3.2 Existing Defences

The existing coastal defences are shown in Figure 1-3, with further details provided in Section 3.

Figure 1-3 Existing coastal defences along the Slapton Sands BMP frontage

1.4.3.3 Existing Defence Condition

As part of developing this BMP, a coastal defence visual inspection and condition assessment was undertaken in accordance with the Environment Agency's Condition Assessment Manual (Environment Agency, 2012a).

In summary, the majority of defences along the western and central end of the BMP frontage, are in fair or good condition. The seawall and sheet pile wall are in good or fair condition with a residual life of 35-40 years, due to recent emergency works completed by the Environment Agency, SHDC and DCC completed in 2016. The rock armour protection that runs along a large extent of 'The Line' appears in reasonable condition, however, it is no longer in its 1979 structural form and thus as a coastal defence is not fully serving its intended function. The concrete seawall (constructed in 1917) and the Concrete 'Armourflex' blockwork were both assessed to be in poor condition, with significantly reduced performance.

Signpost!

Full details of the history of defences, visual inspection and condition assessment are provided in Section 3 of this report, and in the **Defence Baseline Report**, which is provided in Appendix D.

1.4.4 Amenity Value

Slapton Sands is a popular tourist destination and as such the local economy is heavily dependent on this source of revenue. As an important tourism designation, there are several established local businesses servicing the area. These include self-catering holiday accommodation, guest houses, touring caravan and campsites, a seafront with defences, and dining options (pubs, cafes and restaurants) and shops selling local produce.

It is a picturesque and popular area noted for its high-quality landscape and natural heritage. The barrier protects two important wetland areas and freshwater lagoons; Slapton Ley is the largest freshwater lake in southwest England. This is a major tourist attraction for bird watchers, wildlife enthusiast and naturalists.

Slapton Ley Field Study Centre was set up in the 1950's to manage the 214 hectares' nature reserve as an "outdoor laboratory" for education and conservation. The is a base for educational courses and research, which integrate with the reserve management. The centre caters wildlife courses and events for amateur day trippers and holiday visitors as well as residential field courses for professionals, and large groups of university, college and school students. Facilities include accommodation, dining facilities, leisure facilities and class rooms.

A major draw to the area is the South West Coastal Path. The South West National Trail runs through the area from Start Point and onwards to Dartmouth attracting walkers and ramblers.

The long wide beach of Slapton Sands provides recreational opportunities for families, walkers and dog walkers, wildlife watching, geology, beach fishing and naturism (north Strete section within the summer months) whilst slipways and beach access provide local sea going activities and water sports such as boating and sea fishing, canoeing, sailing, surfing and windsurfing. There is disabled access to the beach and lifeguards during the summer (May – September) and a small number of privately owned boat lifts present. Several tourist businesses are present along the Torcross promenade (recent emergency repair works (2016/17) have been completed to its sea defences), including a, pub, café, chip shop, restaurant and holiday accommodation (many are historic, listed buildings). Other village businesses are located nearby in easy access from the beach via the A379.

Within the BMP study area, there are a number of WWII coastal defensive structures. A Tank and War Memorial at Slapton and Torcross bears testament to the part that Slapton played in the War including the large numbers of lives lost during one beach landing exercise.

The Slapton Line Partnership Tourism Strategy, is aimed at enhancing the sustainable tourism potential of the Slapton Line Area.

1.4.5 Land Ownership

The land ownership along the BMP frontage varies from that owned by the Local Authority to private land ownership. It is understood the key land ownership is as follows:

- Slapton Ley is leased from the owner Whitley Wildlife Conservation Trust which promotes education and conservation through its ownership of Slapton Ley and Paignton Zoo Environmental Park.
- Slapton Ley National Nature Reserve is managed by the Field Studies Council in partnership with the owners Whitley Wildlife Conservation Trust, Natural England and South Hams District Council.
- Slapton Ley is a Site of Special Scientific Interest (SSSI) and was declared a National Nature Reserve (NNR) in 1993. Natural England is the government body responsible for managing advising on the management of SSSIs and NNRs.
- The shingle ridge, including beach and car parks, is sub-leased to the South Hams District Council.
- There are a small number of privately owned boat lifts at Torcross promenade and along 'The Line' to Strete Gate.
- Blackpool Sands beach (above MHWS) is privately owned and managed by the Newman family.

1.4.6 Highways, Services and Utilities

1.4.6.1 Highways

Along the shingle barrier ridge runs the A379. Built in 1854, the road connects the surrounding historic villages of Frogmore, Chillington, Stokenham, Tocross, Strete, and Stoke Fleming along the road and Slapton, Hallsands and Beesands by rural lanes linked to it. The road is operated and maintained by DCC.

The midway section of the A379 is set along 'The Line' of the Slapton BMP study area, and links with Kingsbridge and Dartmouth. Several local villages including Torcross, Strete, Frogmore, Chillington, Stokenham and Stoke Fleming run along from the A379 section of the BMP study area and Slapton, Hallsands and Beesands are accessed via local roads from it.

Public and private transport companies operate along the A379, serving local communities and the tourist industry. Carpark facilities within the BMP study area serve cars and coaches.

There are public car parks with toilet facilities at Torcross, Street Gate and the Memorial Car Park (midway along 'The Line' at Slapton Bridge). With 600 car parking spaces available, it is thought that up to 40,000 people use these carparks during the year (Slapton Line Partnership, 2009).

1.4.6.2 Services and Utilities

There is a river/stream intersection at Torcross Point and an emergency or storm overflow.

1.5 Issues and Considerations

1.5.1 Flood and Coastal Erosion Risk

The BMP study area, and in particular 'The Line', is primarily at risk of erosion with an increasing vulnerability to breach. Over the years', the shingle barrier has become constrained by the installation of short lengths of coastal defences and by the A379 road itself. The road has a significant influence on the barrier, preventing gravel thrown landwards of the beach crest from forming a new crest further landward (i.e. rolling back). Instead, gravel is cleaned off the road after a storm and deposited back on the seaward side. These effects, however, only play a role at the sections of the beach where the road is close to the active beach crest. Here and elsewhere, wave-

attack, overtopping and overwashing, is resulting in a reduction in beach volume, cut-back and undermining.

Estimates of future erosion have been made by the South Devon and Dorset Shoreline Management Plan and most recently for the current BMP; this is discussed further in Section 2.6.3 and in Appendix B (Section 4).

1.5.2 Coastal Processes Considerations

As noted in Section 1.4.1, a detailed review of coastal processes was undertaken as part developing this BMP. This is presented in full in Appendix B, with key information for beach management decisions summarised in Sections 2.1 to 2.6 of this BMP.

Conceptually, short-term, medium-term, and long-term coastal processes in Start Bay are relatively well understood. There is little uncertainty about which are the key processes acting on the beaches and barrier, where these processes are having the greatest effect, or, conceptually, how the processes will interact over the long-term to shape the future coastline. However, there is uncertainty:

- On the effect that different wave and water level combinations would have on beach/barrier morphology and coastal flooding; and
- In predicting when significant events will occur, or what magnitude and sequence of hydrodynamic forcing would be required to cause significant coastal change. These uncertainties relate to:
    - Future emission levels are unknown, and there is therefore uncertainty in predicting the future rate of sea level rise (refer to Appendix B; Section 3.7) and barrier retreat (refer to Appendix B; Section 4).
    - The timing and sequencing of future storm wave events is unknown, and therefore the resulting beach configuration cannot yet be predicted into the future.
    - Increasing storminess due to climate change is not well understood, and the effect that this will have on the probability (return period) of extreme storm waves is presently unclear.
    - It is very unclear how climate change will affect Atlantic weather system and thus the North Atlantic Oscillation and West Europe Pressure Anomaly, which we now understand to be critically important in driving storms in Start Bay.

There is a need to understand the vulnerability of different sections of Start Bay, and the impact that would arise from certain combined events. For instance, there is a need to quantify the probability of overtopping (some gravel on the road), overwashing (a lot of gravel on the road), and breaching (catastrophic failure of road/breaching of the lagoon) of the Slapton barrier under different future wave events, levels of beach depletion, and sea level.

Monitoring of data and numerical modelling could be undertaken to overcome these uncertainties and are discussed in more detail in Section 5.2.2.

1.5.3 Environmental Considerations

The following environmental considerations for beach management activities at Slapton Sands have been identified:

- Unexploded ordnance (UXO) risk will require upmost consideration by BMP options, particularly if options require any deep excavation or whereby storms damage to the road may result in the requirement for emergency works and the potential to expose UXO's.
- Construction works above the Mean High Water Spring (MHWS) require planning authority permission to be sought. Construction works proposed below the MHWS mark will require an application for a marine licence.

- Any alterations that may be required to the highway culvert from the lake into the sea by Torcross Point, anything that would require Land Drainage Consent from Devon County Council would require consent alongside or following planning permission
- Impact of beach management activities on internationally and nationally designated sites – need to avoid disturbance to notable and protected habitats and species. Potential requirement for Habitats Regulations Assessment to assess impacts of beach management activities on the integrity of the international conservation sites. Early consultation with Natural England during the development of any follow-up work will be required.
- It would be beneficial for any new and current survey data to be collectively mapped (for example Devon Biodiversity Records Centre data obtained during the development of this BMP). This mapped information will provide a firm basis for location of the following important ecological features within the BMP study area, which can be referred back to when seeking to implement the preferred management options for Torcross to Strete Gate. This is acknowledged in the BMP Action Plan (see Section 6; Action FSR_001).

1.6 Management and Legislative Framework

1.6.1 Responsibilities for Management of the Coastline

Responsibility for the management and operation of activities within the BMP study area varies depending upon the activity and ownership. Relevant roles and responsibilities are summarised in Table 1-1.

Table 1-1 Assigned responsibilities for flood and coastal erosion risk management activities

Coastal Defence / Management Activity	Ownership	Assigned Responsibility
Torcross seawall (including structural inspection and maintenance of)	Environment Agency	Environment Agency
Sheet pile wall (including structural inspection and maintenance of)	Whitley Wildlife Conservation Trust	SHDC / DCC / Environment Agency
Concrete seawall (including structural inspection and maintenance of)	Whitley Wildlife Conservation Trust	SHDC / DCC / Environment Agency
Rock revetment (including structural inspection and maintenance of)	Whitley Wildlife Conservation Trust	SHDC
Concrete 'Armourflex' blockwork	SHDC	SHDC
Ownership and maintenance of the A379	DCC	SHDC (via a sub-lease)
Clearance of shingle from Torcross promenade	DCC	DCC
Clearance of shingle from A379 road	DCC	DCC
Monitoring of beach and other coastal processes	n/a	South West Regional Coastal Monitoring Programme
Flood warning	n/a	Environment Agency
Flood incident response actions	n/a	Environment Agency and SHDC
Emergency planning	n/a	Environment Agency, SHDC and DCC

1.6.2 Funding

Funding for flood and coastal erosion risk management can be achieved via a number of sources, some examples are provided below, with full details provided in Appendix E; Section 4.4.

- Environment Agency via FCERM-GiA. FCERM-GiA funding must be used to provide measures that protect against flood and erosion damages and realise the 'benefits'. Any business case submitted to the Environment Agency National Projects Assurance Services must demonstrate 'confidently' that the problem of flooding/erosion would be 'solved' and not need further protecting for the duration of the 'benefits' claimed.
- Environment Agency funding streams (as identified in Operational instruction 492_09, Environment Agency, 2017), including:
    - Capital budgets – allocated to the construction, provision, purchase and replacement of assets owned and managed by the Environment Agency. This is expenditure that leads to the creation of tangible and intangible assets which are included on the Environment Agency asset register. Capital assets must have a value greater than the £5k.
    - Capital Works Expensed in a Year (CWEiY) – this is budget allocated to works on assets that are not included on the Environment Agency asset register and includes works to replace an existing asset or structure / significantly improve the useful life of the existing asset or structure beyond its original design. CWEIY is treated by Defra as part of the grant in aid capital allocation.
    - Revenue Budgets – allocated as operating expenditure. This includes the likes of maintenance of existing structures of the structure that is not below target or useable condition; or capital works valued to be less than £5k).
- Directly via the assets owner / responsible authority, such as SHDC via local levy, or Devon County Council.
- Third party funding, such as utilities companies, local landowners and residents.

As estimated for the Economics Baseline Report (refer to Appendix E), approximately £1,778k of FCERM-GiA could be available to protect £31,712k of benefits, which is based on 48 properties being at risk of flooding and damages arising from the impact of temporary and permanent closure of the A379 on local/tourist traffic and tourism revenue.

Signpost!

Full details of the economics assessment are provided in the **Economics Baseline Report**, which is provided in Appendix E.

1.6.3 License, Approvals and Consents

In order to undertake any future beach recycling or other capital scheme along the BMP frontage as described in Section 4, a range of licences, approvals and consents would be required, including:

- Marine Licence under the Marine and Coastal Access Act 2011 (see Section 1.6.3.1).
- Habitats Regulations Assessment Screening exercise (see Section 1.6.3.2).
- SSSI Assent from Natural England (see Section 1.6.3.3).
- Planning Application under the Town and Country Planning Act 1990 (see Section 1.6.3.4).
- Land owner permissions from the Whitley Wildlife Conservation Trust, and the Newman Family, private landowners of Blackpool Sands beach (as described in Section 1.4.5).

The following sections summarise the required consents and the processes to obtaining them.

Discussions should be held with the relevant consenting organisations in a timely manner to ensure that all requirements of licence/consent applications are confirmed and addressed in order to minimise the risk of delays in being able to implement works. These discussions should also assess

the applicability of progressing a licence application through the streamlined process defined in the Coastal Concordant for England published in November 2013 (Defra, 2013).

1.6.3.1 Marine License

At present no Marine Licence is held to facilitate any potential future beach management works. Therefore, to implement any beach recycling along the BMP frontage (as described in Section 4.2.2.1), the Marine Management Organisation (MMO) will need to be engaged to determine if a Marine Licence or Licences is needed, and if so, obtain the necessary approvals.

It should be noted that the MMO guidance has previously advised that beach recycling activities within the same sediment cell are exempt from the need for a marine licence. However, there is still a need to notify the MMO of a licence exempt activity notified via the MMO website (see https://www.gov.uk/guidance/make-a-marine-licence-application). Should the MMO not agree with the exemption they will notify the applicant (usually within a week).

It is therefore recommended that initial consultation is undertaken with the MMO to notify them of any proposed beach recycling works along the BMP frontage to determine whether or not a Marine Licence is required. The notification should include details of the period over which it will take place (20 years), the location of movement along the beach and cross the beach, whether movement will be above/below MHWS, and likely volumes.

The time-scale involved to obtain a Marine Licence is typically 14 weeks, so it is recommended that a Marine Licence from the MMO is obtained in good time to enable beach management works to be implemented when it becomes required, rather than having a 14-week delay at a time when such a delay may increase risk of failure of the seawall, etc. Any Marine Licence should be kept up-to-date so there is no lapse. It may be pertinent to seek a Marine Licence in the immediate future that would facilitate undertaking emergency works prior to the any planned works that are to be developed in further detail in the near future.

As part of the process of obtaining a Marine Licence or Licences for undertaking beach recycling or other capital works, consideration of the Marine Work Regulations 2017 (as amended) is required. Through an Environmental Impact Assessment (EIA) screening exercise in consultation with the Marine Management Organisation, the need to produce an EIA will be determined.

A Water Framework Directive Assessment may also be required to support the Marine Licence application. The scope of any such assessment would require consultation with the Environment Agency.

1.6.3.2 Habitats Regulations Assessment Screening

Consideration of areas designated under the Conservation of Habitats and Species Regulation 2010, namely Lyme Bay and Torbay Special Area of Conservation (SAC), and those within or within close proximity (<2km) is required for any proposed works to coastal defence assets or recycling works area. This will be undertaken initially through a Habitat Regulation Assessment Screening exercise, in which the potential for likely significant effects to the designated features of the SAC will be established in consultation with the Competent Authority and Statutory Nature Conservation bodies. The Competent Authority for this would be the MMO.

The BMP frontage is also located approximately 4km from the boundary of the Skerries Bank and Surrounds Marine Conservation Zone. Due consideration should also be applied to the risk of impacts from the works and operation of a scheme to the features of this designated area. This will be undertaken in in consultation with the Competent Authority and Statutory Nature Conservation bodies. The Competent Authority for this would be the MMO.

1.6.3.3 SSSI Assent

All works in the SSSI must seek 'assent' from Natural England. Therefore, if beach recycling works are to occur along the BMP frontage without a Marine Licence and/or planning permission in place, consent will be needed from Natural England each time works are carried out in the SSSI area.

1.6.3.4 Planning Application

Any capital scheme will also require some form of planning consent from SHDC. It is recommended that the local planning officer be consulted at the time when a capital scheme is being developed to determine the most appropriate route for planning consent.

Above the MHWS the planning authority would act as the Competent Authority and planning permission would be sought. An application under these circumstances would also require consideration under the Town and County Planning (Environmental Impact Assessment) regulations 2011. In this regard, SHDC would likely act as the Competent Authority.

1.7 Linkages to Other Relevant Documents

1.7.1 Shoreline Management Plan (SMP2) (2011)

The current Shoreline Management Plan (SMP) which includes the BMP study area was adopted in June 2011 (Halcrow, 2011). The BMP study area is located within policy units 6a75 and 6a76 'Strete to Limpet Rocks'; an extract from the policy statement is provided below and a summary of the SMP policies for the BMP frontage is provided in Table 1-2.

> *'The coastline is characterised by vegetated sea cliffs, freshwater lagoons and shingle ridges. These features have formed over geological timescales as a result of a shingle barrier migrating landwards, in response to rising sea levels, and have become progressively segmented by emerging headlands. There are a number of shingle beaches along the coastline, with the longest stretch being Slapton Sands (Policy Unit 6b75) which is an important tourist attraction. At the southern end of this area is the seaward portion of the village of Torcross (Policy Unit 6b76).*
>
> *This area is of outstanding environmental, landscape and geological/geomorphological value and therefore a key driver of policy is conservation of this asset through allowing natural processes to occur whilst undertaking measures to ensure the sustainability of the shingle ridge. However, the A379, an important link road, runs along the crest of the Slapton Sands barrier beach and the village of Torcross also lies to the south. The A379 has recently suffered damage as a result of beach cutback and is also affected by the natural rollback of the shingle barrier, which will continue in response to sea level rise. It is therefore unsustainable in its current location. However, it is recognised that the road is also an important transport route and is of economic and social value for the area and Devon County Council are committed to maintaining the highway whilst it is technically feasible and cost effective to do so. However, there is acceptance that it will not be possible to do this indefinitely and whilst some upgrading of small inland routes is possible, these would not be sufficient to adequately replace the A379. Investigations into how the long term social and economic structure of the area could adapt to the situation when this road link is no longer viable are currently underway.*
>
> *The long-term vision for this coastline is to allow the beach-barrier to evolve naturally and thereby ensure its integrity and geomorphological and environmental value is maintained through to the next century. The main implication of this will be the long-term loss of road access across Slapton Sands; which will become increasingly difficult to sustain in its current form. Plans therefore need to be developed now such that future transport provision is addressed in good time. In the short and medium-term the policy is to allow the barrier to retreat naturally whilst enabling local measures to be put in place to allow localised realignment of the road as required.*
>
> *In the long-term sea level rise and increased storminess will impact upon the sustainability of continuing to defend the seaward part of Torcross. In addition, as the rest of Slapton Sands to the north will roll back landwards this could potentially lead to significant outflanking of defences here. The beaches fronting the defences along the Torcross frontage will narrow and steepen as a result of coastal squeeze resulting from sea level rise. All of these processes*

will increase exposure of the defences on the seaward part of Torcross to wave action and so make it increasingly technically and economically difficult to sustain defences in this position.

In the long term, realignment of these defences in some form will be required. This may involve constructing much larger defences around the more seaward part of Torcross and extending them across the southern part of the Ley towards the west. If this is not economically viable to implement, then abandoning the seaward part of Torcross will need to be considered, taking a new defence line along the western (landward) shore of Slapton Ley. However, there are a number of socio-economic assets that will be at risk under this approach and therefore the immediate future defences will be maintained as long as possible within existing economic justification, whilst adaptive measures are put in place to manage this risk and mitigate the displacement of people and loss of property and facilities.'

Table 1-2 Summary of the SMP policies that apply to the BMP study area

Policy Unit	Short Term (to 2025)	Medium Term (to 2055)	Long-term (to 2105)
6b75 - Strete to Torcross North (Slapton Sands)	Allow the barrier to retreat, through Managed Realignment, with local beach management as necessary to support localised realignment of the A379.	Allow the barrier to retreat, through Managed Realignment, with local beach management as necessary to support localised realignment of the A379. Studies to investigate implementation of No Active Intervention.	Allow the barrier to retreat, with localised beach management as necessary through Managed Realignment, with No Active Intervention once the road is abandoned.
6b76 - Torcross North to Limpet Rocks	Continue to maintain existing defences through a Hold the Line policy.	Maintain the existing defences for as long as technically possible, through a Hold the Line policy.	Build new defences in a more sustainable set-back position, through Managed Realignment.

1.7.2 Slapton Coastal Zone Management Study (2006)

The Slapton Coastal Zone Management Study, undertaken by Scott Wilson (2006) on behalf of the SLP, provided a long-term coastal zone management strategy for the Slapton Sands and included evaluation of existing issues. This report has provided the basis from which this new BMP has been developed.

1.7.3 Vulnerability Assessment (2016)

A Vulnerability Assessment was undertaken by SHDC on behalf of the SLP to achieve a high-level understanding of the vulnerability of different sections of the A379 to damage. This was achieved through quantitative analysis of different vulnerability factors located both seaward and landward of the A379.

1.7.4 South West Inshore Marine Plan (in Progress)

The BMP study area lies within the South West Inshore Marine Plan area. This Marine Plan is currently being developed by the Marine Management Organisation (MMO) in parallel to the South West Offshore Marine Area. Once published and adopted, the Marine Plan will be a statutory planning document used to guide licence and consent decisions within the marine environment up to the Mean High Water mark including beach management activities. Marine planning for the South West began spring 2016; finalisation, adoption and publication of the plans are expected winter 2019.

1.7.5 Plymouth and South West Devon Joint Local Plan 2014 – 2034 (in Progress)

The Plymouth and South West Devon Joint Local Plan (JLP) is a joint plan between Plymouth City Council, South Hams District Council and West Devon Borough Council. The (JLP) looks ahead to 2034 and sets a shared direction of travel for the long-term future of the area, within the context of wider integrated strategic plans. The JLP integrates with and completes work that was previously being undertaken separately on the 'Plymouth Plan' (Plymouth City Council and its strategic partners), 'West Devon: Our Plan' (West Devon Borough Council) and 'South Hams: Our Plan' (South Hams District Council). The JLP was submitted to the Planning Inspectorate for examination on 31 July 2017 and is still awaiting approval.

Pertinent policies to the BMP study area include:

- Policy DEV25 - Undeveloped Coast and Heritage Coast.
- Policy DEV38 - Coastal Change Management Areas: included within the JLP is a commitment to take full account of coastal flood risk in the consideration of development proposals and within areas designated as a Coastal Change Management Area.

1.7.6 South Devon Catchment Flood Management Plan (CFMP) (2012)

The South Devon Catchment Flood Management Plan (CFMP) acknowledges sources of flooding from rivers in the South Devon Catchment. There is no reference to issues from river flooding within the BMP study area.

1.7.7 River Basin Management Plan (2016)

The South West River Basin Management Plan (Environment Agency, 2016a) was prepared under the Water Framework Directive (WFD) as an update to the original programme produced in 2009 as part of a series of six-year planning cycles. It contains actions to improve the ecological status of water bodies in river basin catchments, including coastal waters from mean low water up to 1 nautical mile from shore. The BMP study area lies within one such protected WFD Coastal Water Body and so activities need to comply with the requirements of this plan.

1.7.8 National Mapping Programme Survey (2014) Rapid Coastal Zone Assessment (RCZA) (2016)

Historic England commissioned a Rapid Coastal Zone Assessment (RCZA) for the South Devon Coastline, which includes a Desk-Based Archaeological (DBA) assessment and a National Mapping Programme survey (NMP). The DBA assessment was published in 2014 and the NMP survey in 2014.

Implementation of the management approach for the BMP study area will require a detailed search to ensure that the environmental information is updated with the findings of the RCZA, which is acknowledged in the BMP Action Plan (see Section 6; Action FSR_001).

SECTION 2

Supporting Information – Physical Environment

This Section provides details of the physical environment of the BMP study area, including information on coastal processes and shoreline interactions and environmental features. The information presented here builds on that presented in Section 1.4.1 and 1.4.2 and draws from the Coastal Processes and Environmental Baseline Reports prepared in support of the BMP (refer to Appendix B and Appendix C). This information is pertinent to the options appraisal process and has been used to inform the technical and environmental assessment of different options (as described in Section 1.3).

2.1 Waves

2.1.1 Typical Waves

In Start Bay, wave conditions arrive from both a southerly direction and an easterly/south-easterly direction. The southerly waves originate in the Atlantic Ocean, and refract into Start Bay as they propagate up the English Channel, whereas the easterly waves originate from local storms occurring in the Channel itself. Wave data is available via two key data sources, as shown in Figure 2-1 and outlined in more detail in Figure 2-1; with plots of the data shown in Figure 2-2.

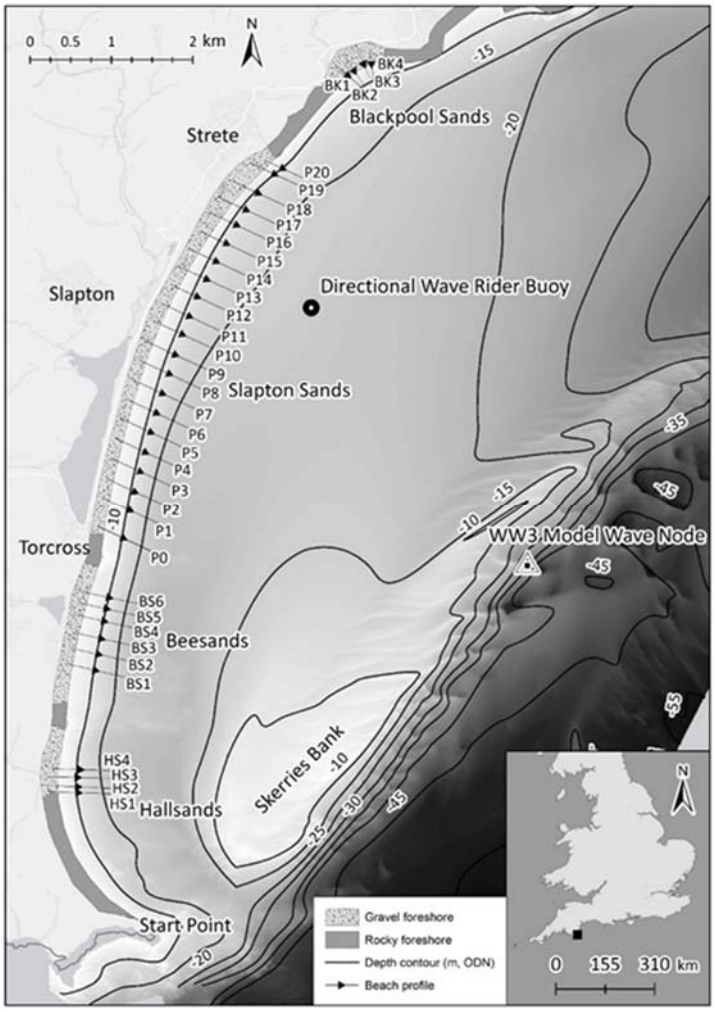


Figure 2-1 Map showing locations of wave data collection points
(Start Bay Directional Wave Rider Buoy and WW3 Model Wave Node)

Table 2-1 Wave data sets relevant to Slapton Sands BMP study area

Name	Location	Details	Period of Measurement
Start Bay Directional Wave Rider Buoy	Directly offshore of Slapton Sands; and situated in approximately 10m depth	Operated as part of the SWRCMP	Measured data for 10 years between April 2007 to April 2017
The Met Office WaveWatch 3 hindcast wave model	Just outside of Start Bay and seaward of Skerries Bank, approximately 35m depth	Met Office hindcast wave data which used the WaveWatch 3 hindcast model	Hindcast data for a 33-year period between January 1980 and December 2016

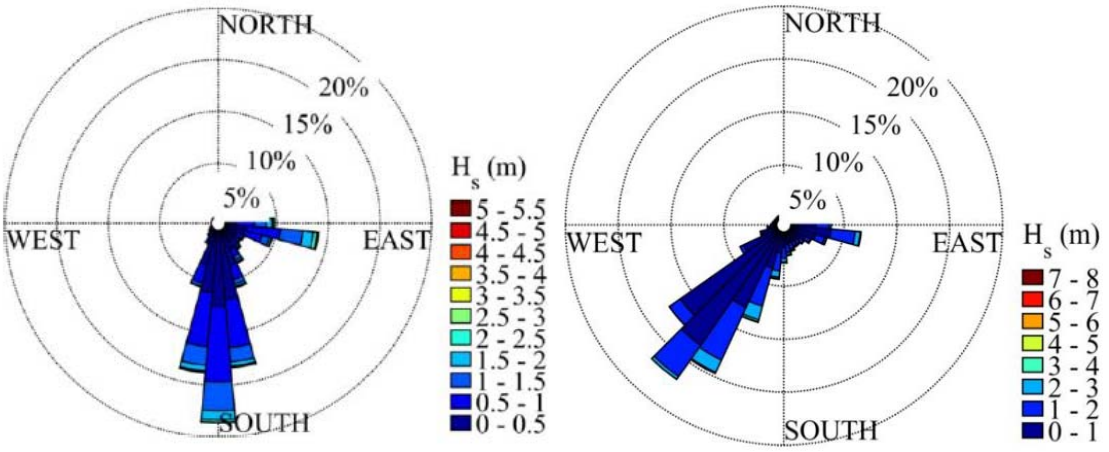


Figure 2-2 Directional wave roses of Significant Wave Height

Left - Start Bay wave buoy between 01-Apr-2007 and 30-Apr-2017; and Right WW3 model hindcast in Start Bay 01-Jan-1980 to 31-Dec-2016

2.1.2 Extreme Waves

New extreme wave analysis was completed for the BMP (refer to Appendix B; Section 3.3). Extreme Value Analysis (EVA) performed on the WaveWatch 3 (WW3) model hindcast data and the Start Bay wave buoy data. The results are presented in Table 2-2.

From the Met Office WW3 extreme wave heights, there is little variation in the heights of waves with return periods of 20, 50, and 100 years. However, extreme waves from the south (ranging from 5.99 m to 6.60 m) are predicted to be larger than extreme waves from the east (ranging from 4.28 m to 4.76 m). Interestingly, extreme waves from the east are predicted to lose less of their energy as they propagate into Start Bay, with the 100-year wave height reducing by only 11% between the depths of 35 m and 15 m, compared to a 20% reduction for a 100-year wave height from the south. This is likely to be due to the effects of refraction and shoaling, as waves arriving from a south-southwest direction propagate across Skerries Bank.

Table 2-2 Extreme significant wave heights for southerly waves (145° – 270°), and easterly waves (35° – 145°)

Return period	Met Office WW3, 35 m depth		Start Bay wave buoy, 15 m depth	
	Southerly waves, H_s (m)	Easterly waves, H_s (m)	Southerly waves, H_s (m)	Easterly waves, H_s (m)
1-in-20 year	5.99	4.28	4.85	4.01
1-in-50 year	6.36	4.57	5.13	4.14
1-in-100 year	6.60	4.76	5.31	4.23

2.2 Water Levels

2.2.1 Tidal Information

The mean spring and neap tide ranges in Start Bay are 4.70 m and 2.20 m, respectively. This is based on data collected from Devonport in Plymouth, which is the nearest tide gauge to Slapton Sands. Tide levels for Devonport are presented in Table 2-3.

Table 2-3 Tide levels (in mOD) for Devonport, Plymouth; the nearest tide data point to Slapton Sands
Source: UKHO, 2014

Tidal Reference	Water Level Elevation (m CD)	Water Level Elevation (m ODN)
Highest Astronomical Tide (HAT)	5.90	2.68
Mean High Water Spring (MHWS)	5.50	2.28
Mean High Water Neap (MHWN)	4.40	1.18
Mean Sea Level (MSL)	3.31	0.08
Mean Low Water Neap (MLWN)	2.20	-1.02
Mean Low Water Spring (MLWS)	0.80	-2.42
Lowest Astronomical Tide (LAT)	0.00	-3.22

2.2.2 Extreme Water Levels

New extreme wave analysis was completed for the BMP (refer to Appendix B; Section 3.5). The analysis used a combination of observed water level data and skew surge data calculated from the Devonport tide gauge. The results of the analysis are presented in Table 2-4.

These values indicate that water levels could reach 3.21 m above ODN during a 100-year event, and that storm surge could super-elevate the water level more than 1 m above the predicted highest tide level once in a 100-year period. When compared with exiting data, the extreme storm surge event that occurred on the 14th of February 2014 had a return period of around 50 years.

Table 2-4 Extreme Water Levels for Devonport, Plymouth; the nearest tide data point to Slapton Sands

Return Period	Extreme Water Level Elevation (m ODN)	Extreme skew surge magnitude (m)
1 in 20 year	3.15	0.85
1 in 50 year	3.19	0.96
1 in 100 year	3.21	1.04

2.3 Joint Probability Extreme Waves and Water Levels

Consideration of the possibility of a combination of extreme water level and extreme wave conditions is particularly important at Slapton Sands. Wave run-up can add many meters of elevation to the still water level and this can affect the likelihood and amount of overtopping that may occur along 'The Line'.

A joint probability analysis assessing the combinations of extreme wave and water levels has been undertaken for Start Bay as part of the Environment Agency's State of the Nation Project. The results of the analysis are presented in Appendix B (Section 3.6).

In summary, the joint probability analysis demonstrates that:

- Large wave conditions combined with an average water level, can have the same probability of occurrence as small wave conditions combined with a very high water level.
- The chance of overtopping from these two different events could be very different, given that there would be a substantial difference in the wave run-up.

2.4 Climate Change and Risk

Climate change poses two major risks to the coastal environment:

- The first is the gradual raising of sea levels, which increases the chances of coastal flooding, and elevates the action of erosive and energetic waves higher up the coastal profile, which consequently causes the shore and coastline to migrate landwards (Nicholls and Cazenave, 2012).
- The second climate-induced risk to the coastal environment is an increase in storminess caused by global warming, which may increase the magnitude and frequency of storms arriving at our coast (Harley *et al.*, 2006). UKCP09 does not directly project the magnitude and frequency of storms or storm wave conditions in the future, so their effect on coastal processes is harder to quantify.

Climate model projections suggest that the global average rate of sea level rise will increase in the 21st Century. A general assumption is that any increase in mean sea level is likely to cause an equal increase in all other water levels, including extreme water levels.

Relative sea level in southwest England is controlled by both sea-level rise and large-scale subsidence of the land in southern England caused by isostatic rebound following de-glaciation. The average historic rate of relative sea-level rise in South Devon is on the order of 1.1 mm/year, but the contemporary rate is likely to be higher.

Projections of future relative sea-level rise are provided by the United Kingdom Climate projections 2009 (UKCP09) database1, and are dependent on global greenhouse gas emissions occurring now and in the future. UKCP09 provide projections based on three scenarios: low, medium, and high emissions. From these projections, the rate of relative sea-level rise around Start Bay since 1990 is expected to have been between 2.9 and 3.9 mm/year. The UKCP09 predictions of relative sea level rise at Start Bay under the range of scenarios are presented in Figure 2-3.

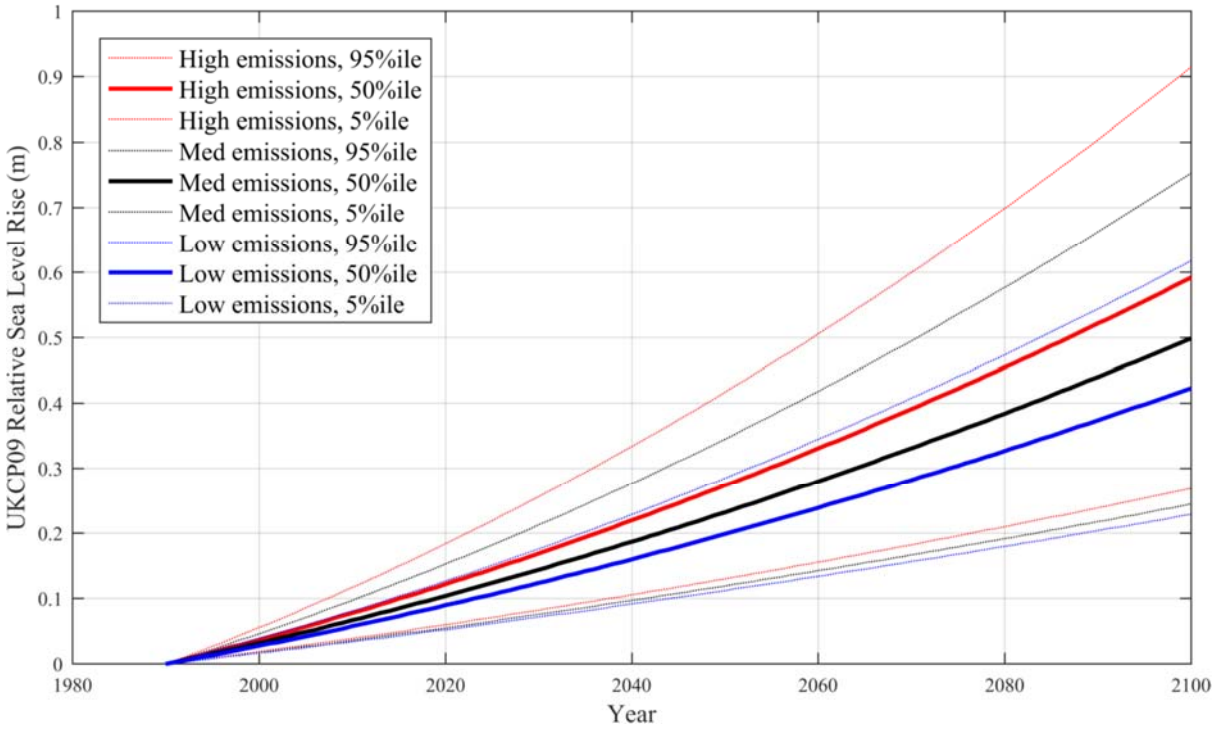


Figure 2-3 UKCP09 predictions of relative sea-level rise at Start Bay

Under high, medium, and low emissions scenarios (from http://ukclimateprojections.metoffice.gov.uk). Lower (5th percentile), median (50th percentile), and upper (95th percentile) predictions are shown for each scenario, indicating the magnitude of uncertainty, determined from an ensemble of UKCP09 model predictions

2.5 Sediment Transport

2.5.1 Sediments

There are very limited contemporary inputs of shingle to the BMP frontage. The sediment that forms these beaches was originally sourced from periglacial deposits which are now exhausted or lie in deep waters offshore, beyond the influence of waves and currents. Beach material at Slapton Sands is predominantly granules and small pebbles and has a pronounced alongshore grading with coarser beach material towards Torcross, and finer material to the north. There is a reversal of alongshore sediment grading along Slapton Sands at different times of the year, indicating a change in the direction of longshore transport (see Section 2.5.2).

2.5.2 Sediment Transport Mechanisms

Net alongshore sediment transport in Start Bay is from south to north, driven by Atlantic waves arriving from the south of the bay. Drift reversals occur from north to south, when waves originating in the English Channel arrive from the east, usually under storm conditions.

Southerly waves have the potential to drive significant alongshore sediment transport to the north, which results in beach narrowing to the south, widening to the north and resultant beach rotation in a clockwise direction. This leaves the coast to the south of Strete vulnerable to waves from the east, which can cause further profile cut-back and overwashing. This is believed to have been the cause of the 2001 road collapse.

Storms incur coastal changes through the action of energetic waves eroding and transporting sediment within the bay, and/or causing wave run-up and overwashing. Locally generated storms can additionally super-elevate sea-levels through storm surge.

2.6 Shoreline Movement

2.6.1 Shoreline Evolution

Shoreline movement in Start Bay is influenced by the long-term effects of long-term sea-level rise, including barrier roll back and shoreline retreat, acting over decades to centuries; medium-term alongshore transport, acting over weeks to years; and short-term storm impacts, which act over a matter of days (refer to Figure 2-6).

- Over long time-scales, relative sea-level rise gradually increases the vertical reach of waves; this increasingly allows for short-term events (storm waves) to cut-back the upper beach profile and for wave run-up to overtop/overwash the crest of the beach.
- Meanwhile, alongshore-oriented waves cause beach rotation over medium time-scales, which intermittently reduces the sediment volume along certain stretches of Start Bay. Those sections are then vulnerable to short-term wave attack and overwashing.
- Short-term storm wave attack results in vulnerable sections of Start Bay being cut-back even further, and allows wave run-up to overtop and overwash sections of the beaches.
- These episodic, short time-scale overwashing events are the mechanism for long-term barrier roll-back, and allow the barrier to retreat in response to sea level rise.
- Eventually, the decreasing cross-sectional area of Slapton barrier, caused by the lengthening of the shoreline as it retreats, will make the barrier increasingly vulnerable to breaching. Once significant breaching occurs, the barrier could begin to break down into a series of tidal inlets.

Because of the decreasing trend in easterly storm waves over the last 30 years or more, alongshore sediment transport to the south is becoming less prevalent. This means that the southern part of Start Bay (between Hallsands and Strete) is suffering from a gradually decreasing sediment supply from the north, and is increasingly vulnerable to storm wave attack, overtopping, and barrier retreat.

2.6.2 Beach Profile Analysis

New beach profile analysis has been completed for the BMP and is presented in the Coastal Processes Baseline Report (refer to Appendix B; Section 5.3).

- At Blackpool Sands, all four profiles gained sediment over the last 10 years, with profiles gaining up to 6 m of elevation in places.
- At Slapton Sands, profiles P1 – P13 situated along the southern half of the beach, all lost sediment over the last 10 years.
- At Beesands, there has been relatively little net profile change at profiles BS4 – BS6 at the north end of the beach over the last 10 years. In contrast, profiles BS1 – BS3 at the southern half of the beach have all shown a decrease in profile elevation, with parts of those profiles losing more than 2 m of elevation.
- At Hallsands all four of the monitored profiles show a net decrease in profile elevation of up to 2 m, indicating net erosion at this beach over the last 10 years.

2.6.2.1 Erosional Hot Spots

Erosional hot-spots in Start Bay can be identified as areas of beach that have the combination of a low mean sediment volume, and a large variance in sediment volume. This combination indicates that regular erosion of the profile occurs, and that there is limited sediment available to provide resilience against such erosion. From examination of the volume statistics, a number of erosional hot-spots have been identified within Start Bay (listed from north to south and shown in Figure 2-4):

1. Middle of Slapton Sands (profiles P8 – P11). These profiles have, on average, 150 – 200 m^3/m of sediment, and have had as little as 100 m^3/m in the last 10 years.
2. South end of Slapton Sands (profile P0 – P3). These profiles have, on average, 75 – 200 m^3/m of sediment, and P0 in front of Torcross village has had as little as 50 m^3/m in the last 10 years.
3. North end of Beesands (profile BS6). This profile has, on average, around 150 m^3/m of sediment, and has had as little as 100 m^3/m in the last 10 years.
4. South end of Beesands (profile BS1). This profile has, on average, around 180 m^3/m of sediment, and has had as little as 150 m^3/m in the last 10 years.
5. All of Hallsands (profiles HS1 – HS4). Profile HS4 at the north of Hallsands has had, on average, around 200 m^3/m of sediment, and has had as little as 150 m^3/m in the last 10 years. Profile HS1 at the south of Hallsands has had, on average, around 100 m^3/m of sediment, and has had as little as 50 m^3/m in the last 10 years.

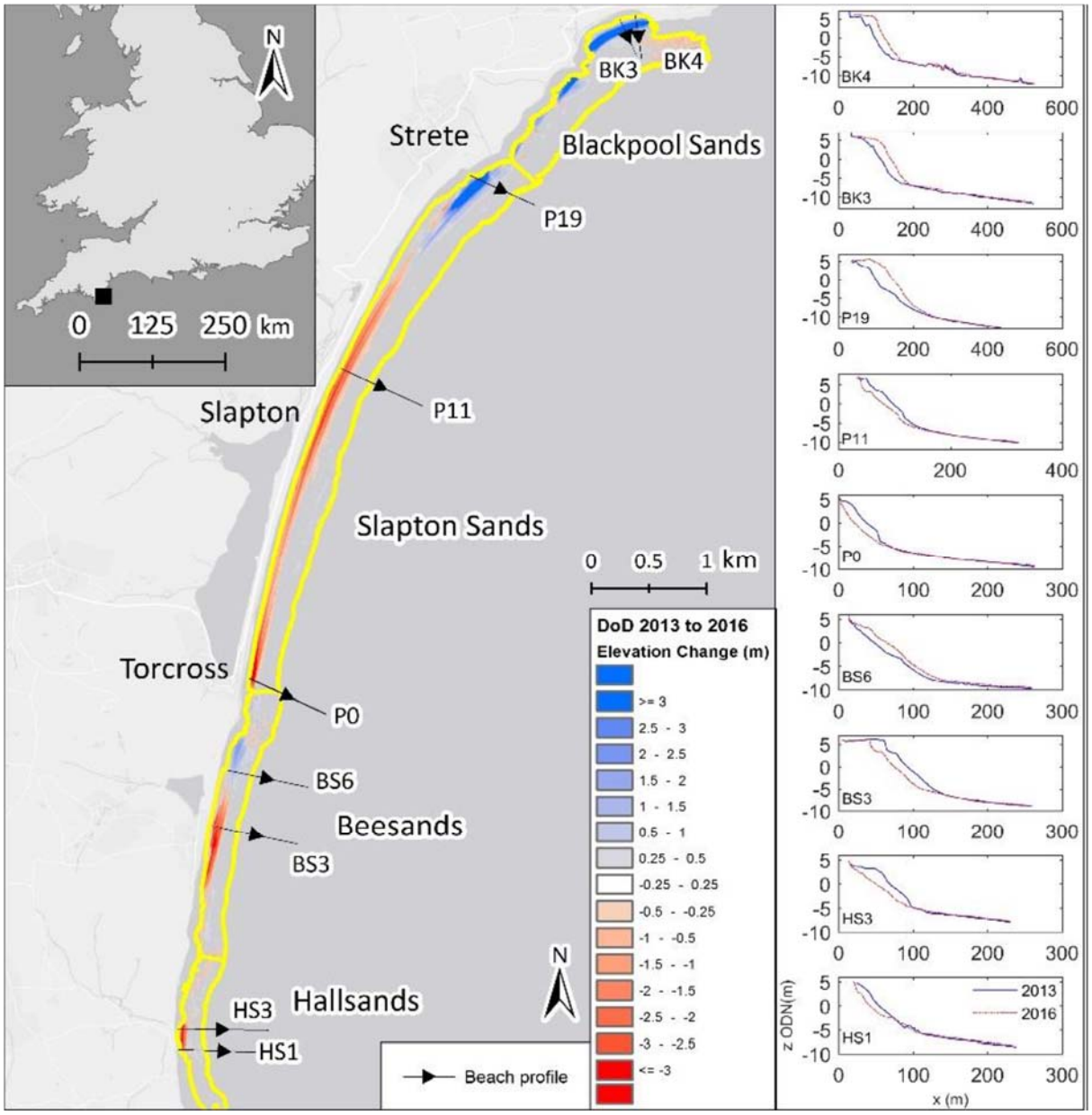


Figure 2-4 Digital elevation model of difference of Start Bay from 2013 to 2016, including subaerial and subtidal extents

2.6.2.2 Beach Storm Response

From the erosional hot-spots discussed in Section 2.6.2.1, it can be concluded that the most vulnerable/ least resilient sections of coast in Start Bay to storm impacts are at the south of Hallsands beach and at the south of Slapton Sands in front of Torcross village, due to their low sediment volumes and long term erosional trend.

The middle of the Slapton barrier (around the location of the 2001 road collapse) is shown to be the most vulnerable section of the barrier to overwashing of sediment, and to potential future undermining of the road, or even breaching of the barrier. Further modelling is required in order to better understand the vulnerability of each section of Start Bay to future potential storm events. This is discussed in Section 5.2.2.3 and acknowledged in the BMP Action Plan (see Section 6; Action MON_008).

2.6.3 Predictions of Future Shoreline Change

Over time scales of years to centuries, the effects of sea-level rise drive shoreline and barrier retreat. Estimates of potential future shoreline change, which includes the BMP study area, have been developed for the South Devon and Dorset Shoreline Management Plan (as shown in Figure 2-5).

New estimates of potential barrier retreat were undertaken for the present BMP (refer to Appendix B; Section 4.3 and Appendix A-C within Appendix B). Allowing for acknowledged uncertainties and years under all emissions scenario, it is concluded that the barriers position is likely to migrate inland over the next 100. It is predicted that, on average, the Slapton barrier will naturally attempt to migrate landward 3.4 – 4.5 m by the year 2036, 9.6 – 12 m by the year 2065, and 22 – 28 m by the year 2117. These migration rates may be exceeded due to increasing storminess in the future, and due to a reducing cross-sectional area as the barrier retreats, or lowered where human interventions (engineered sea defences and post-storm sediment re-charges) act to stop sediment from migrating from the front of the barrier to the back of the barrier.

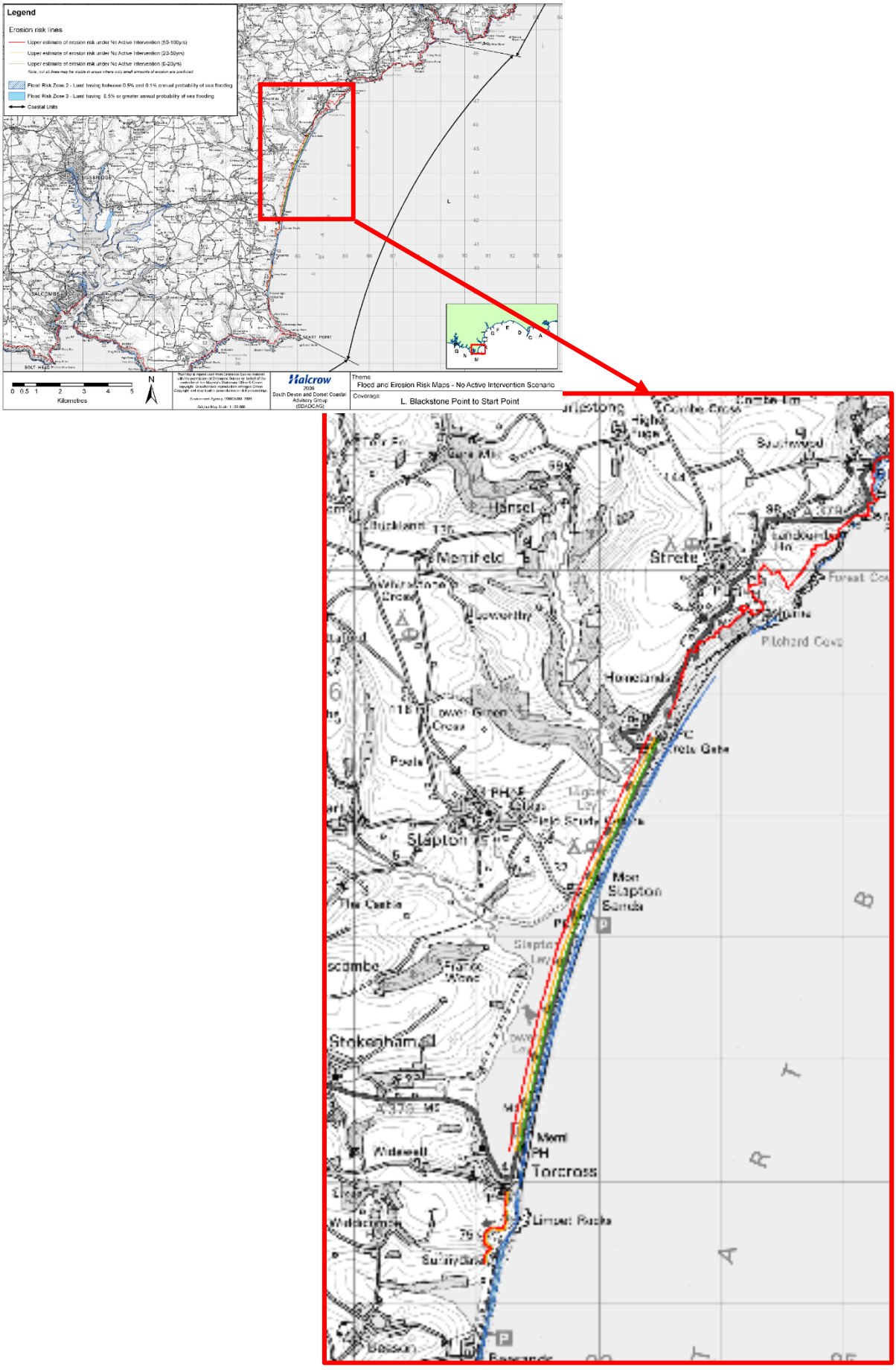


Figure 2-5 Predicted coastal erosion for the next 100 years (red box shows BMP study area)
Source: Halcrow, 2011

2.6.4 Conceptual Model

These interacting coastal processes cause a number of coastal management challenges (Figure 2-6). In the short-term, storm wave attack is the main concern to coastal management, as this can cause coastal flooding and undermining of the A379 road, storm defences, and other engineered structures. Over medium time-scales, the alongshore supply of sediment and resulting vulnerability of the different sections of Start Bay is a concern for coastal management. Over the long-term, the retreat of Slapton barrier will potentially expose Torcross village to the sea, and will require consideration to be given to the future of the Slapton line section of the A379 road.

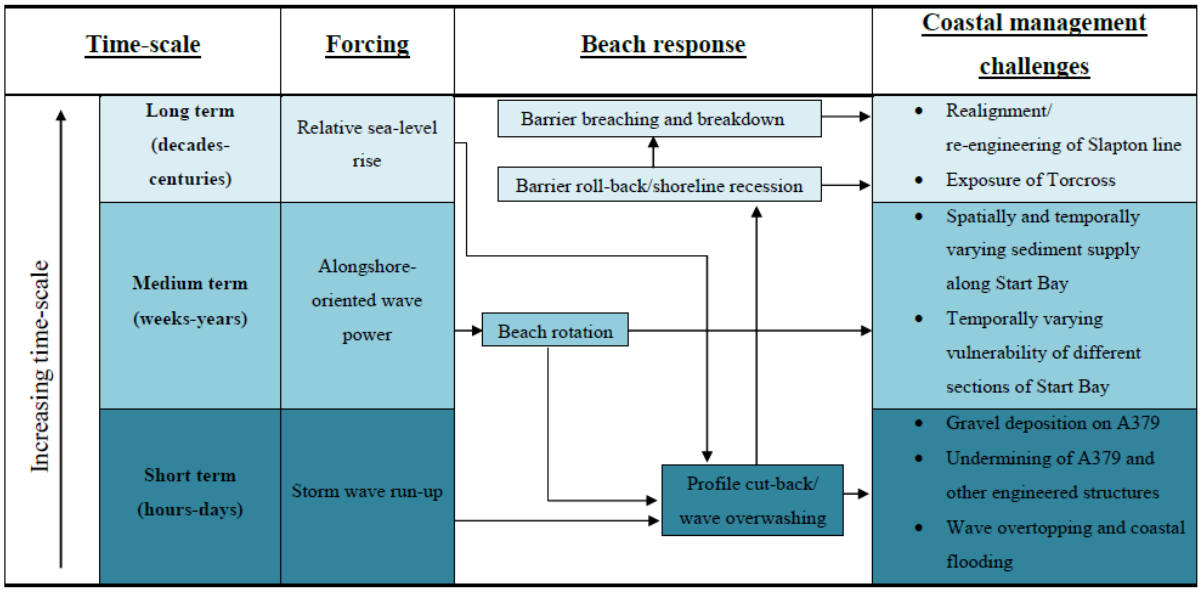


Figure 2-6 Conceptual model of key coastal processes and related management challenges in Start Bay

2.7 Environmental Characteristics

This section builds on the information on Environmental Setting in Section 1.4.2 and provides an overview of the key environmental characteristics and features within the BMP study area, which have been used to inform environmental assessment of options. The section is structured around a number of environmental topics presented within the Environmental Baseline Report (refer to Appendix C), which follow the recommended structure contained in the Beach Management Manual (CIRIA, 2010). As included within Section 1.5.3, several recommendations have been made for future study within the Environmental Baseline and these have been carried forward within the BMP Action Plan (refer to Section 6).

2.7.1 Sediment Quality

Sediment quality data for beach locations is not readily available unless dredge material has been sourced from a location for capital or maintenance dredging, as noted in CIRIA (2010).

2.7.2 Water Quality

There are important water quality designations within the BMP study area (see Figure 2-7).

There are five WFD designated waterbodies (South West river basin district) within the BMP study area.

The Slapton Sands BMP is situated within the South Hams Designated Bathing Waters area. The Bathing Water quality profile is tested from two different Environment Agency sampling stations within the BMP study area.

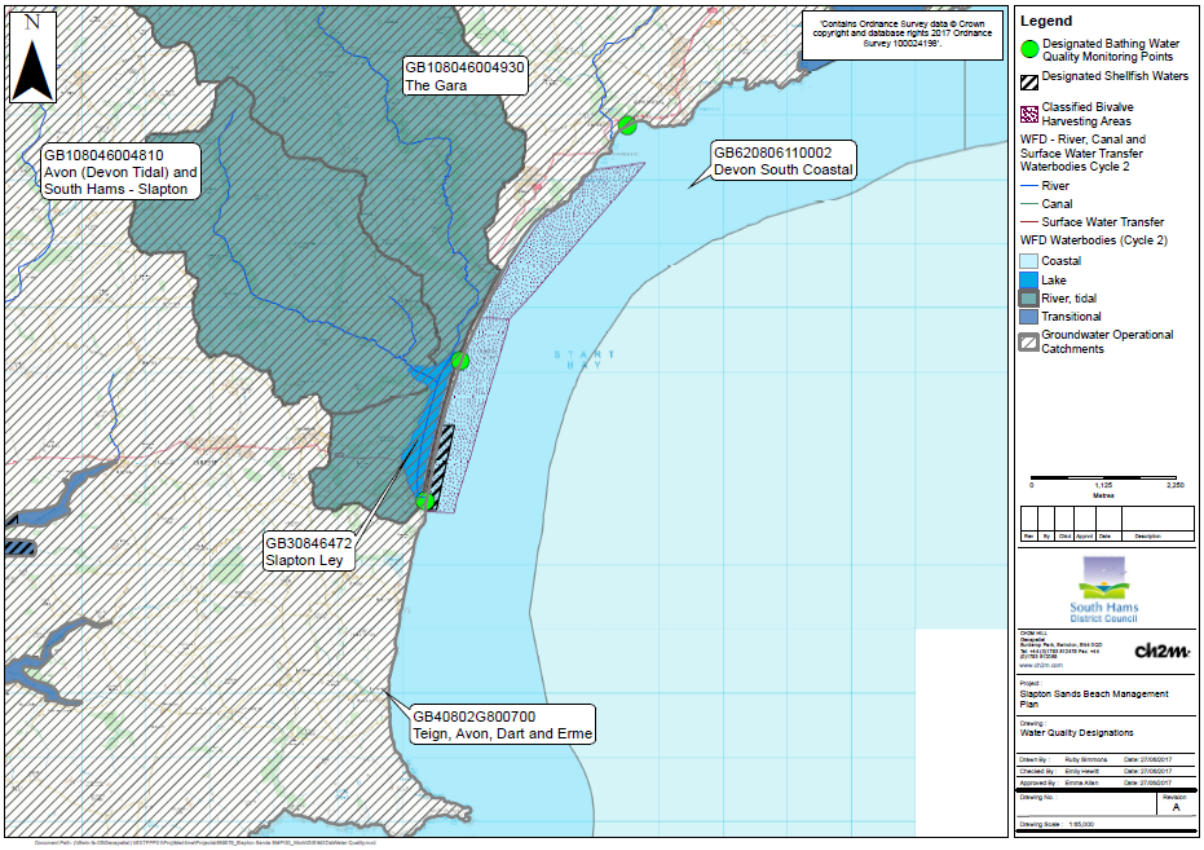


Figure 2-7 Water quality designations in the BMP study area

2.7.3 Ecology

2.7.3.1 Designated Nature Conservation Sites

Designated and non-designated nature conservation sites within the BMP study area include biological and geological protected features (see Figure 2-8).

- **Lyme Bay and Torbay Site of Community Importance (SCI)** is located within 3km and SCI features may be present within the BMP study area. The site was designated in 2010 under Annex 1 of the EC Habitats Directive for supporting Annex I; relevant features include 1170 - reefs and 8330 - submerged or partially submerged sea caves (Natural England, 2012).
- **Slapton Ley SSSI** covers an area of approximately 254.72 ha**.** The area is designated for its coastal geomorphology (shingle barrier beach enclosing a lagoon) and the following habitats: open water (the lagoon is the largest freshwater lake in southwest England); vegetated shingle (covering approximately 26 ha, the largest area of its kind in Devon); and approximately 50 ha of reed-bed, tall-herb fen and fen woodland mosaic habitat. The SSSI is an important area for birds and affords protection to a breeding bird assemblage of 'Lowland open waters and their margins' (with large populations of sedge warbler (*Acrocephalus schoenobaenus*) and reed warbler (*A.scirpaceus*), the most important in South Devon; breeding Cetti's warbler (nationally important numbers); and non-breeding passage birds (migrating swallows (*Hirundo rustica*) and sand martins (*Riparia riparia*) regurlary peaking at 10,000 and 500 individuals respectively. The site is also designated as a nationally important site for wintering bittern. Slapton Leys vascular plant assemblage includes the schedule 8 protected plant strapwort (*Corrigiola litoralis*) and only known location in the UK; and the nationally scarce plant toadflax-leaved St John's-wort (*Hypericum linariifolium*). The SSSI is also designated for its rich lichen assemblage (associated with the fen and woodland habitats) which includes IUCN Red List threatened species (Natural England, 2004).

- **Slapton Ley NNR** comprises 192 ha of Slapton Ley SSSI. Managed by the Field Studies Council on behalf of the Whitley Wildlife Conservation Trust the NNR is designated for the largest natural freshwater lake in South West England; shingle barrier (a nationally important example of a bay bar); one of the best British sites to display the links between seabed features and shoreline landforms; reedbeds and rich fen and willow carr vegetation supporting highly diverse flora and fauna and one national rarity; 2000 species of macro and micro fungi including newly described species to science and its important staging post for wintering and in-passage birds (Scott Wilson, 2006).
- **Skerries Bank and Surrounds MCZ** was designated in November 2013**.** The MCZ is a large area that covers 24,969 ha of marine subtidal and intertidal habitat. Situated from mean high water at the southern tip of the BMP study area. The landward boundary runs along the mean high water mark from Torcross around the coast to Leek Cove at Limebury Point. The seaward boundary aligns with the boundaries of the eastern portion of the South Devon Trawling and Crabbing Chart, known locally as the Start Point Inshore Potting Agreement (IPA). MCZ features include the following designated habitat: High energy intertidal and infralittoral rock, Moderate energy Intertidal, Infralittoral and Circalittoral rock, Intertidal and Subtidal coarse sediment, Intertidal mixed sediment, Intertidal sand and muddy sand; Subtidal sand, Subtidal Mud, and designated species: Pink sea-fan (*Eunicella verrucosa*) and Spiny lobster (*Palinurus elephas*) (Natural England, 2015)
- **Stokenham SSSI** The site is situated within the grounds of Widdicome House inland, west of the BMP study area. The site comprises a row of mature trees and an adjacent boundary wall which together support an exceptionally rich lichen flora which includes several nationally rare species (Natural England, 1986). The BMP is not likely to impact on these designated habitat features. The SSSI features are immobile habitats protected by physical barriers within the grounds of Widdicome house, and no potential to be impacted by BMP options.

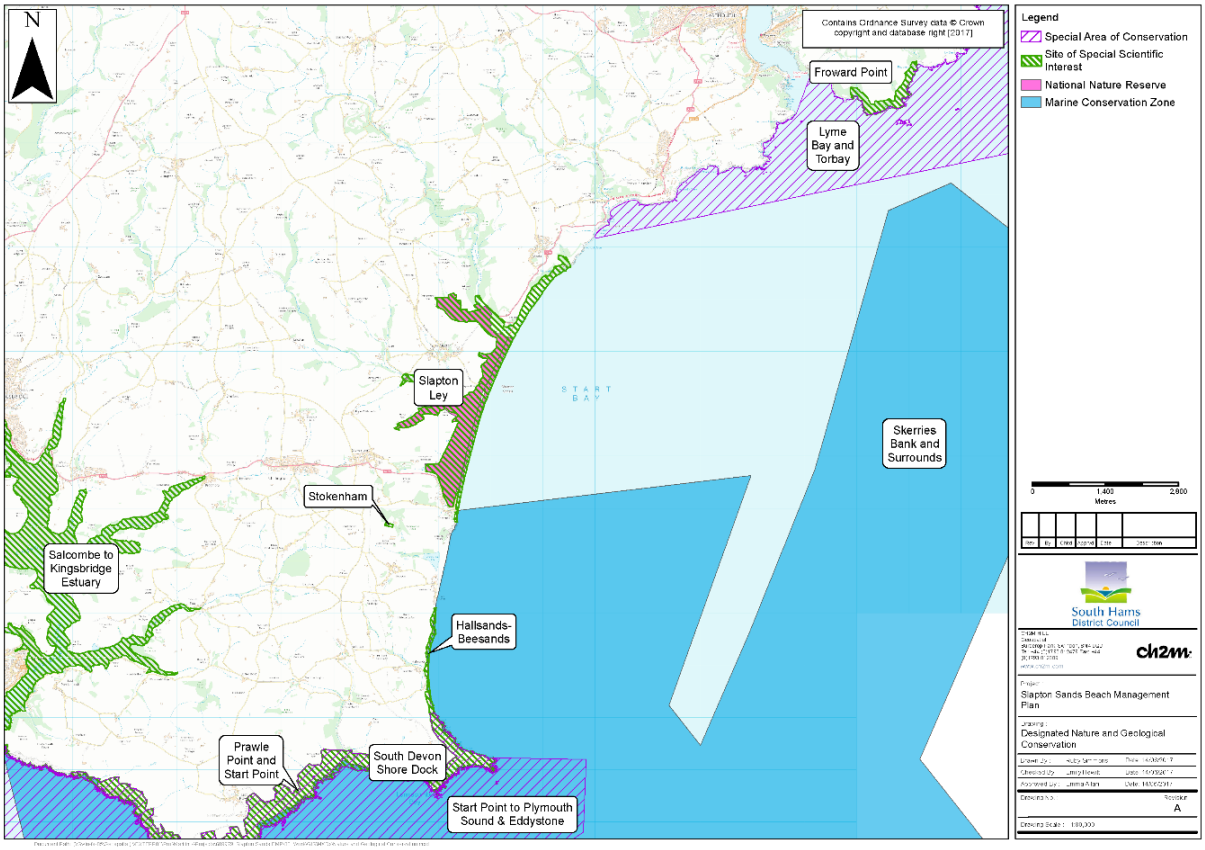


Figure 2-8 Nature conservation designations in the BMP study area

2.7.3.2 Priority Habitats

Priority habitats will require consideration of options for the beach management plan. The following Priority Inventory habitats are likely present within the BMP study area or in close proximity:

- Coastal vegetated shingle (establishing/mapping the exact extent would be beneficial).
- Subtidal sands and gravels (within Start Bay) - also an MCZ designated Habitat Feature of Conservation Importance (FOCI) (see section above Skerries Bank and Surrounds MCZ).
- Maritime cliff and slope.
- Reedbeds.
- Ancient & Semi-Natural Woodland.
- Deciduous woodland.
- Good quality semi-improved grassland.

2.7.4 Protected Species

There are records of protected terrestrial and marine species within 3km of the BMP study area which require consideration planning and implementing flood and coastal erosion risk management activities along the BMP frontage. These features are described in this section, with full details provided in Appendix C (Section 3.4.4).

2.7.4.1 Terrestrial Species

Birds

- Cetti's Warbler (SSSI feature and listed under Schedule One of the Wildlife and Countryside Act 1981).
- Cirl Bunting (UK and Devon BAP priority species and listed under Schedule One of the Wildlife and Countryside Act 1981).
- Linnet (UK and Devon BAP priority species).
- Bittern (Slapton Ley NNR feature and listed under Schedule One of the Wildlife and Countryside Act 1981)

Mammals

- Badger.
- Bat (foraging habitat, no bat roost habitat has been identified).
- Dormouse (Dormouse habitat has been identified in the past, however, there has been no evidence of Dormouse in the scrub adjacent to the Lower Ley since 2014 and the Slapton Field Studies Centre are confident that there is no Dormouse present between Torcross and Slapton Bridge (*Pers. Comms*., County Archaeologist, DCC Highways, 2018).
- Otter.
- The Slapton Coastal Zone Management Study (Scott Wilson, 2006) described old records of Water Vole within the Slapton NNR, however there are no available Devon Biodiversity Records Centre records to support this. Latest information suggests that there have been no sightings of water vole within the Slapton NNR, and the shores of the Higher and Lower Ley are not considered to be suitable for such species (*Pers. Comms*., County Archaeologist, DCC Highways, 2018).

Invertebrates

41 key species that have been noted on Slapton shingle beach to date (*Pers. Comms*., County Archaeologist, DCC Highways, 2018 referring to DC Boyce, September 2017). As noted in the

Environmental Baseline Report (appendix C), of these, 11 were recorded in 2016, which included four beetles of particularly high conservation status:

- Rove beetle *Actocharis readingii* (RDBK).
- *Ocypus fortunatarum* (IUCN Near Threatened).
- Malachite beetle *Clanoptilus marginellus* (IUCN Near Threatened).
- Pollen beetle *Brachypterolus antirrhini* (RDBK).

The most important areas of the site for invertebrates are the stands of short-sward shingle grassland with patches of bare substrate.

Notable Plants

- SSSI Shingle ridge community species:
  - yellow horned poppy (*Glaucium flavum*).
  - Sea kale (*Crambe maritima*).
  - Viper's bugloss (*Echium vulgare*).
  - Sea radish (*Raphanus maritimus*).
- Coastal Species:
  - Sea spurge (*Euphorbia paralias*).
- Within close proximity to the study area:
  - Wildlife and Countryside Act Schedule 8 protected species:
    - Strapwort (*Corrigiola littoralis*) (western shore of the Lower Ley).
    - Bluebell (*Hyacinthoides nonscripta*) (thought to be common throughout the reserve).
    - Toadflax-leaved St John's-wort (*Hypericum linariifolium*) is present on cliff tops.

Reptiles

- Slow worm, grass snake, common lizard and adder are known to occur in suitable habitat within the BMP study area. Includes winter and breeding habitat. Mapping reptile habitat within the BMP study area would be beneficial.

Fungi, mosses liverworts

- There are thought to be some 2,344 featured SSSI/NNR species of fungi, important slime molds, 195 species of mosses and liverworts within the Slapton Ley area (DCC, 2016). It is unknown if any of these are Wildlife and Countryside Act Schedule 8 protected species may be present, or if any notable species are present with the BMP study area. It is recommended that the presence of notable fungi, mosses liverworts within the BMP study area are mapped going forward.

2.7.4.2 Marine Species

Marine Mammals

Several species of dolphin and porpoise frequent Start Bay from time to time (Brereton *et al.*, 2010), there are no seal colonies within Start Bay, however it is thought they may forage within the vacuity of the shellfish beds from time to time (CEFAS, 2015). During spring 2017 a humpback whale was present within Start Bay over a few days. The well documented event (by national and local media) is thought to be a rare event.

2.7.5 Fish Ecology

2.7.5.1 Freshwater

The Ley is currently dominated by perch at the expense of the roach and rudd populations, with pike and eel found at reasonable densities (Fishtek Consulting, 2015).

2.7.5.2 Marine

Fish nursey and spawning areas are within the BMP study area. The Centre for Environment Fisheries and Aquaculture Science (CEFAS – UK) report 'Spawning and nursery grounds of selected fish species in UK waters' (Ellis *et al.*, 2012) reported the following species in the surrounding waters of the BMP study area:

Spurdog *Squalus acanthias*	Low intensity nursery area
Thornback ray *Raja clavata*	Low intensity nursery area
Spotted ray *Raja montagui*	Low intensity nursery area
Whiting *Merlangius merlangus*	Low intensity spawning area Low intensity nursery area
Anglerfish *Lophius piscatorius*	Low intensity nursery area
Sandeels *Ammodytidae*	Low intensity spawning area
Mackerel *Scomber scombrus*	High intensity nursery area
Sole *Solea*	Low intensity spawning area

Start Bay is designated Shellfish Waters under the Shellfish Directive a Classified Bivalve Mollusc Harvesting Area for the wild grown production and harvesting of surf clams (*S. solida*).

2.7.6 Fisheries

2.7.6.1 Commercial Fishing

Start Bay is Designated Shellfish Waters and a Classified Bivalve Mollusc Harvesting Area.

Start Bay is also designated Shellfish Waters under the Shellfish Directive (for protection from pollution) and a Classified Bivalve Mollusc Harvesting Area under EC regulation No. 854/2004 (hygiene legislation of live food for human consumption). The exact locations of these areas are shown in Figure 2-7 and described below:

- Designated Shellfish Waters are situated from mean high water within the intertidal/subtidal area off Torcross; and
- Classified Bivalve Mollusc Harvesting Area are situated within across the entire BMP frontage of Slapton Sands within the intertidal/subtidal area from Torcross to Forest Cove at Strete.

Both areas are protected under the Shellfish Directive for the wild grown production of surf clams (*S. solida*).

Start bay is shallow, with a maximum depth of about 16 m relative to chart datum. The naturally occurring stocks of surf clams are present along a narrow subtidal strip between the 5 and 10 m depth bands (see Figure 2-9). These stocks are thought to be exploited by one harvester on a part time basis. The areas fished are rotated on a four-year cycle with animals of four years or older retained in the bay to ensure that the fishery remains sustainable. There is no closed season for harvesting. The clams are harvested by dredging methods. The use of mobile demersal gear (bottom trawling of the seabed) is permitted within the waters off Slapton Sands, and permanently closed to dredging within the southern half and top northern section of Start Bay (CEFAS, 2015).

The main boating centre near the shellfishery is the Dart Estuary. Fishing fleets operate from Dartmouth and Salcombe, which between them have 47 resident fishing vessels (CEFAS, 2015).

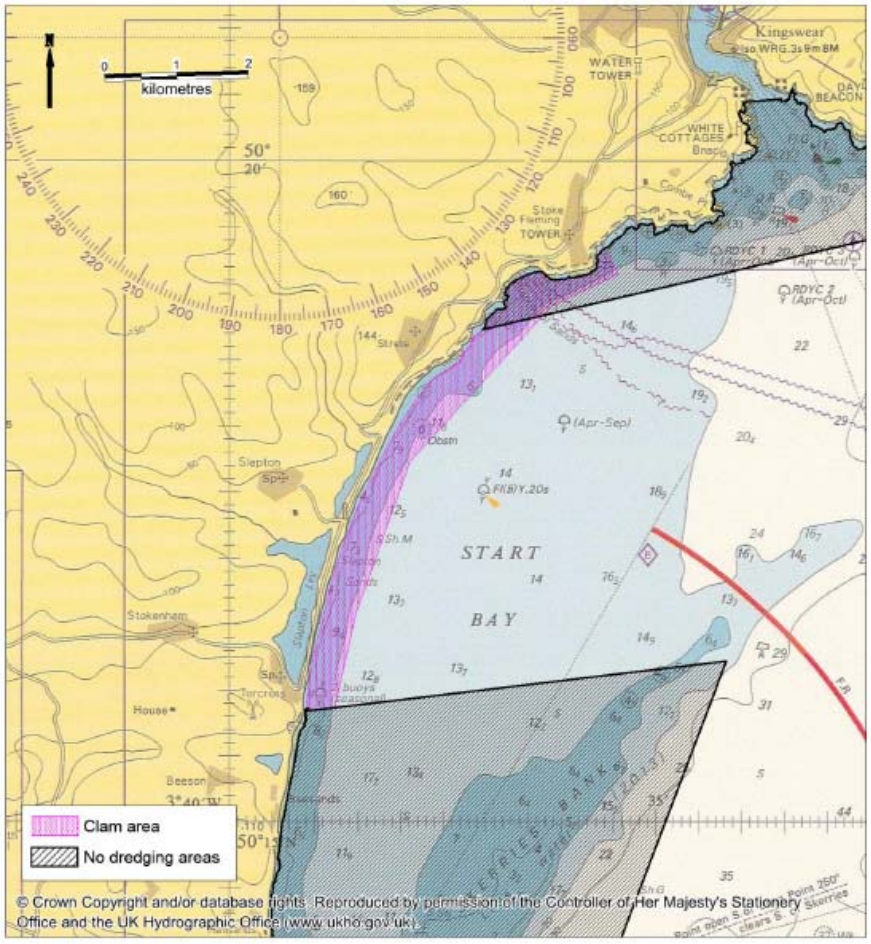


Figure 2-9 Approximate extent of the surf clam fishery and prohibited dredging areas (CEFAS, 2015)

2.7.6.2 Recreational Fishing

The Ley has been fished since medieval times, but fishing has not been allowed within the Ley since 2005 to prevent the potential of disturbance to birds and breeding birds afforded protection under the Slapton Ley SSSI designation (SLFC, 2012).

Beach fishing is popular across the entire frontage of the BMP study area. Fish caught ranges from Cod, Lesser Spotted Dog fish and whiting in the winter to bass, mackerel, pollack and flat fish from spring to autumn (Devon Angling Centre, 2017).

2.7.7 Navigation

2.7.7.1 Road Transportation

The midway section of the A379 is set along 'The Line' of the BMP frontage, and links with Kingsbridge and Dartmouth. Several local villages including Torcross, Strete, Frogmore, Chillington, Stokenham and Stoke Fleming run along from the A379 section of the BMP study area and Slapton, Hallsands and Beesands are accessed via local roads from it.

Public and private transport companies operate along the A379, serving local communities and the tourist industry. Carpark facilities within the BMP study area serve cars and coaches.

Further information regarding highways is presented in Section 1.4.6.

2.7.7.2 Marine Navigation

There is significant boat traffic within the Start Bay area, including yachts and fishing vessels, but there are no harbours, marinas or ports. Boat traffic in the area consists of potentially large numbers

of pleasure craft on transit to and from the Dart Estuary, and smaller numbers on the anchorages at the northern and southern ends of Start Bay (CEFAS, 2015).

Within the BMP study area, there are slipways and lifting areas utilised by pleasure craft.

2.7.8 Landscape

The importance of landscape to the Slapton Sands Area is recognised by the following nationally and regionally important designations. These are important in the consideration of options for the beach management plan (see Figure 2-10).

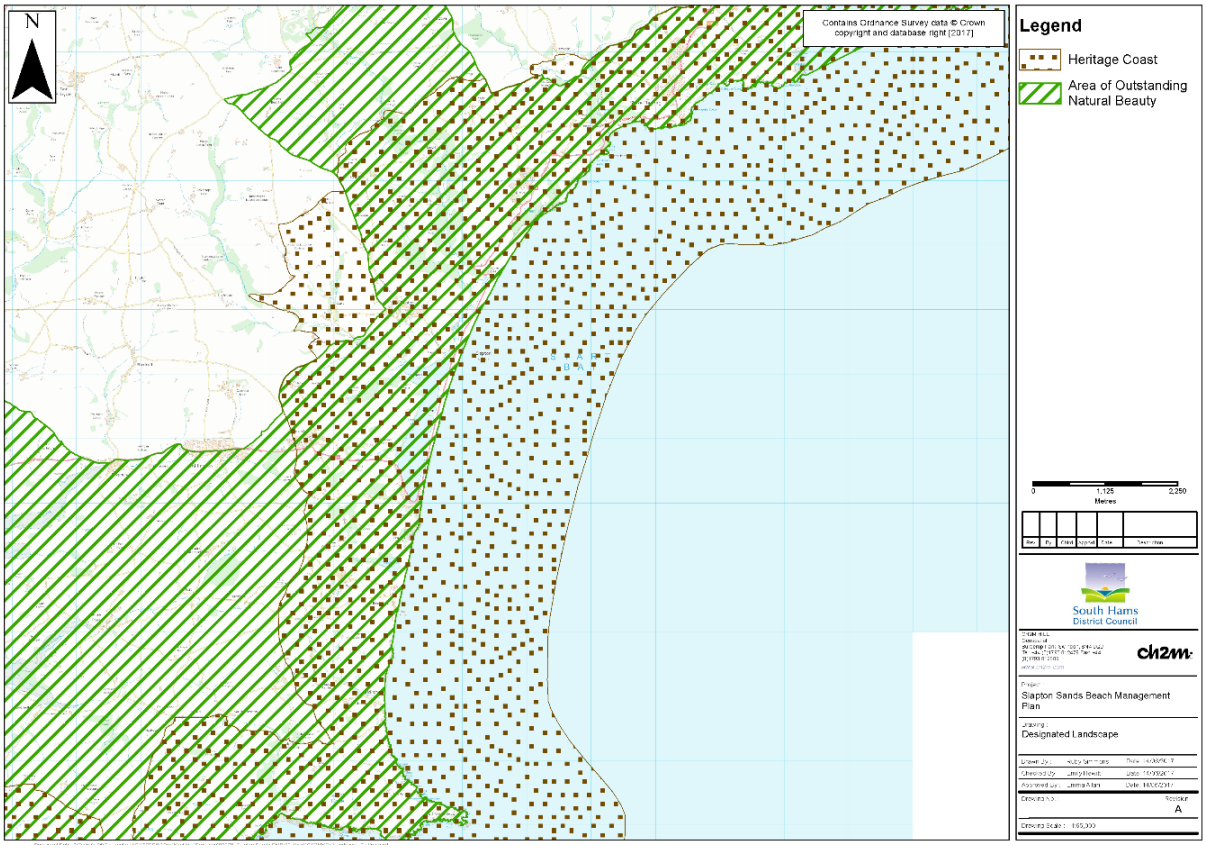


Figure 2-10 Landscape designations in the BMP study area

2.7.8.1 National Landscape Designations

South Devon Area of Outstanding Natural Beauty

South Devon Area of Outstanding Natural Beauty (AONB) is one of several protected landscapes in the UK.

South Devon Heritage Coast

Heritage coasts are 'defined' rather than designated, established to conserve the best stretches of undeveloped coast in England. A heritage coast is defined by agreement between the relevant maritime local authorities and Natural England (Natural England, 2015).

2.7.8.2 Regional Landscape Designations

Conservation Areas

Conservation Areas (CA) are areas of special architectural or historic interest which the Local Planning Authority designates under the Listed Buildings and Conservation Areas Act 1990 with aim to preserve or enhance. Slapton CA and Stokenham CA are located in close proximity to the BMP study area.

2.7.8.3 Landscape Character

The Devon County Council Landscape Character Planning Strategy affords the Start Bay Coastal Hinterland to protect the high scenic quality associated with the South Devon AONB. From this strategy, the Slapton BMP study area and surrounds are described below:

- National Character Area 151: South Devon
- Landscape Character Types of Devon (updated 2010)
    - 4B: Marine Levels.
    - 3B: Lower Rolling Farmed and Settled Valley Slopes.
    - 5A: Inland Elevated Undulating Plateau.
    - 4D: Coastal Slopes and Combes.
- Distinctive Character Areas (updated 2015):
    - Elevated land with a rolling topography underlain by Meadfoot Beds dropping gently to the coast with its distinctive open shingle bay.
    - Inland plateau that slopes eastwards towards the sea and is drained by series of small steams creating shallow combes.
    - Higher ground sparsely wooded with grown-out wind-sculpted beech hedge-banks and some pine shelterbelts.
    - Small woodland copses on valley sides, often emphasising landform; tree-lined streams and wet woodlands common in valleys and combes.
    - Mixture of regular modern and Parliamentary fields of small to medium scale, with smaller curving fields of medieval origin remaining on valley slopes.
    - Mixed farming on plateau and areas of pasture on steeper slopes within valleys.
    - Extensive freshwater lake, swamp and coastal grassland and scrub habitats; farmland with bird interest; ancient semi-natural and broadleaved woodlands; and areas of neutral grassland and wet woodland fringing streams.
    - Iron Age hillfort, castle and Civil War features on promontories and elevated locations in commanding positions; ancient settlement remains also lend strong time-depth.
    - Historic villages clustered at road crossings and bridging points; often centred on a square-towered church; farmsteads scattered throughout, nestled in dips with shelterbelts.
    - Strong local vernacular of stone buildings with slate roofs and red brick detailing, with some cream cob/ render cottages, often thatched.
    - Strong overarching perceptions of tranquillity and remoteness in many areas.

Special Qualities and Features:

- High scenic quality reflected in the inclusion of coastal areas and the Gara valley and combe in the South Devon AONB.
- Outstanding open views along the length of Slapton Sands – sometimes bleak depending on weather conditions – and notable views out to sea with large skies.
- Sense of isolation, remoteness, enhanced by natural qualities of the coast; tranquillity that is higher than many other coastal areas of South Devon.
- Slapton Ley – largest natural freshwater lagoon in south-west England and important habitat for migratory and wintering birds – SSSI and NNR.

- Slapton Sands associated with Second World War – used to practice the D-Day landings, now commemorated by a Torcross Tank which sits at the southern end of the beach.

Overall Start Bay Coastal Hinterland Strategy:

To protect the high scenic quality associated with the South Devon AONB, and to sustain the area's important nature conservation sites, and historic settlement. The shingle beach, and freshwater lagoon are well managed and their resilience to climate change is enhanced where feasible. Recreation is encouraged, but a good balance between recreation and conservation is retained.

Specific guidelines relevant to the Slapton BMP are noted as:

- Protect the open character of the inland plateau and Slapton sands and Views to and along the sea.
- Protect the undeveloped character of Slapton Bay (beach, and freshwater lagoon and surrounding combes and hills) ensuring that any limited new development in the area respects the scale and horizontal emphasis of the landscape.
- Plan for future impacts of climate change (particularly the effects of sea level rise and coastal erosion), allowing natural process to take place where possible, whilst ensuring that local communities are involved in making decisions about their future landscape.

2.7.9 Archaeology and Cultural Heritage

The importance of historic and cultural heritage to the Slapton Sands and the surrounding area is recognised by the following national and regional designations.

2.7.9.1 Designated Archaeology and Cultural Heritage

The BMP will need to consider the following archaeology and cultural heritage designations (refer to Figure 2-11).

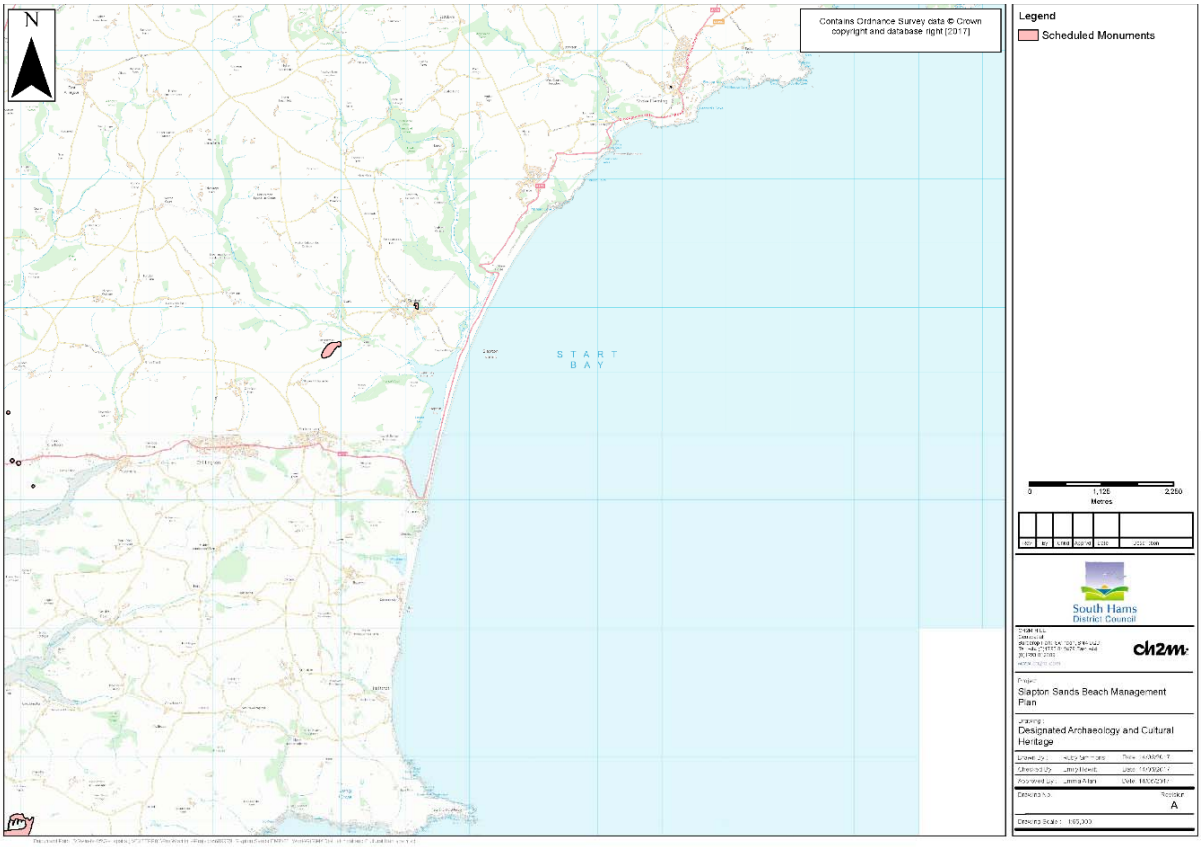


Figure 2-11 Designated historical and cultural heritage in the BMP study area

Scheduled Monuments

There are two designated scheduled monuments within close proximity of the BMP study area. Slapton chantry college, is present within Slapton Village; and Slapton Castle Hillfort further inland southwest.

Listed Buildings

Listed buildings are present within, and in close proximity of the BMP study area, at Torcross, Strete Gate (see Figure 2-12).

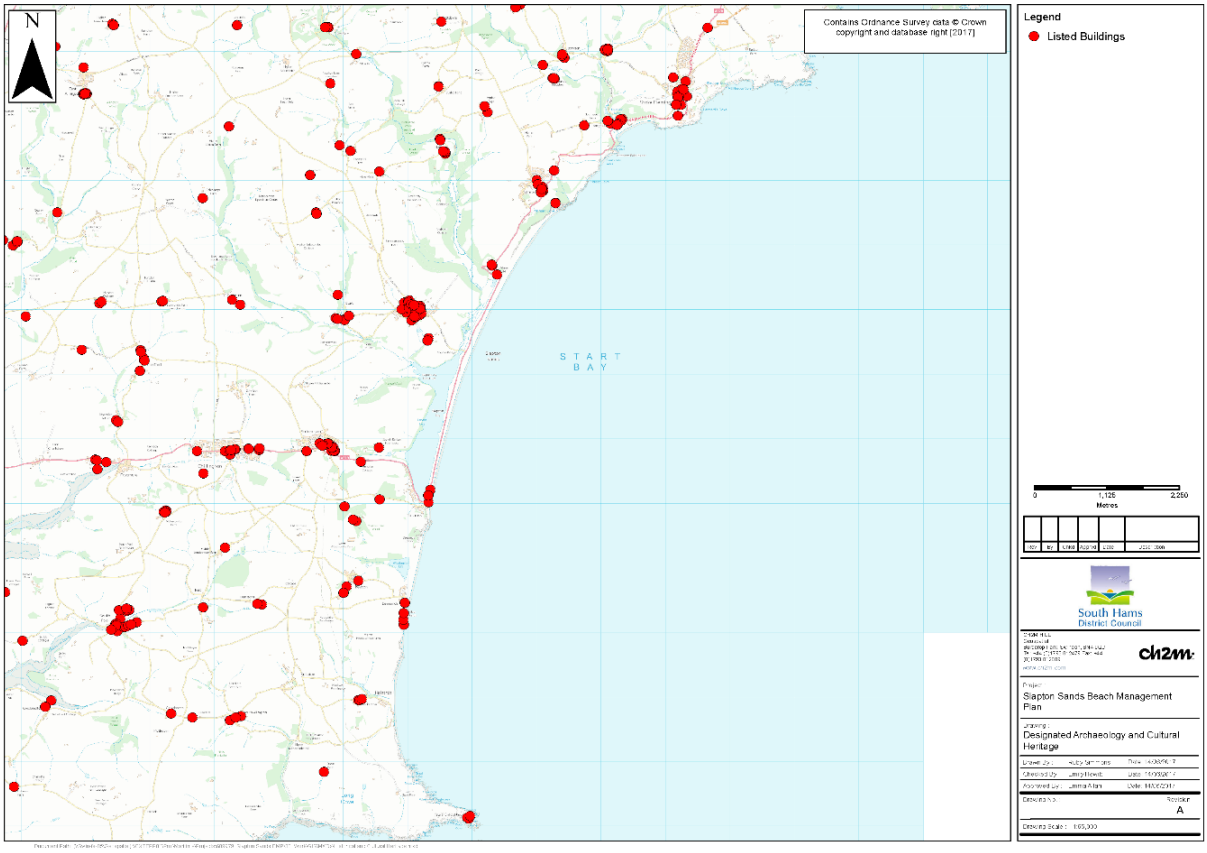


Figure 2-12 Listed buildings in the BMP study area

2.7.9.2 Non-Designated Archaeology and Cultural Heritage

Within the study area, there are non-designated archaeological features and features of cultural heritage interest:

- Within the study area are a number of WWII coastal defensive structures. A Tank and War Memorial at Slapton and Torcross bears testament to the part that Slapton played in the War including the large numbers of lives lost during one beach landing exercise.
- A comprehensive baseline search of the non-designated archaeological and cultural heritage sites within a 3km radius of the centre of the study area is provided within Chapter 6 Archaeology and Cultural Heritage Baseline of the Slapton Coastal Zone Management Study (Scott Wilson, 2006).

2.7.10 Unexploded Ordnance (UXO)

Due to the importance of Slapton during WWII, there is a high risk of unexploded ordnance (UXO) that may be encountered within the BMP study area. As part of the Pre-Construction Information for the emergency works to repair the seawall at Torcross over 2016 - 2017, BMMJV undertook a Preliminary and Detailed Unexploded Ordnance Risk Assessment. The report concluded that the likelihood that a UXO may be found on site to be high. Information relating to UXO should also be

sourced from the latest RCZA (refer to Section 1.7.8); this is acknowledged in the BMP Action Plan (see Section 6; Action FSR_001).

2.7.11 Air Quality

There are no Air Quality Management Areas in the BMP study area.

2.7.12 Noise

No baseline data on existing background noise level has been sourced for this baseline report. This may be required prior to any beach construction/management works depending on their scale and scope to produce elevated noise. The 2016 - 2017 Torcross emergency works to repair the seawall required piling works and heavy plant movement, for which a risk assessment was undertaken to mitigate construction noise and vibration, included monitoring at the start and during the works. It is recommended that this approach is taken should the scale and scope of any flood and coastal erosion risk management activities be deemed to produce elevated noise.

SECTION 3

Scheme Design (Existing Coastal Defences)

As described in Section 1.4.3, the coastal defences between Torcross and Strete Gate have been constructed over many years, starting in 1917 and most recently in 2017. This Section provides details of the existing coastal defences within the BMP study area, which was also used to determine the standard of protection afforded by the present defences (see Section 3.12). The information presented here draws from the Defence Baseline Report (refer to Appendix D) prepared in support of the BMP.

3.1 Concrete Seawall (1917)

In 1917, a wall capped with a concrete top (143m) was constructed north of Torcross.

3.2 Rock revetment (1979)

In 1979, a 795m-long rock revetment was constructed running north of Torcross.

3.3 Torcross Seawall – Phase 1 of 3 (1979 to 1980)

The Torcross seawall was first constructed in 1979, with three principle elements; 6m steel sheet piled toe with concrete capping beam (toe level at 3.00m ODN); 5m wide revetment with rock cast in concrete (1 in 2.5 slope); and a recurved seawall (crest level at 6.25m ODN). A design drawing of structure is shown in Figure 3-1 . Natural geomorphological change covered the rock revetment with beach material for approximately 30 years.

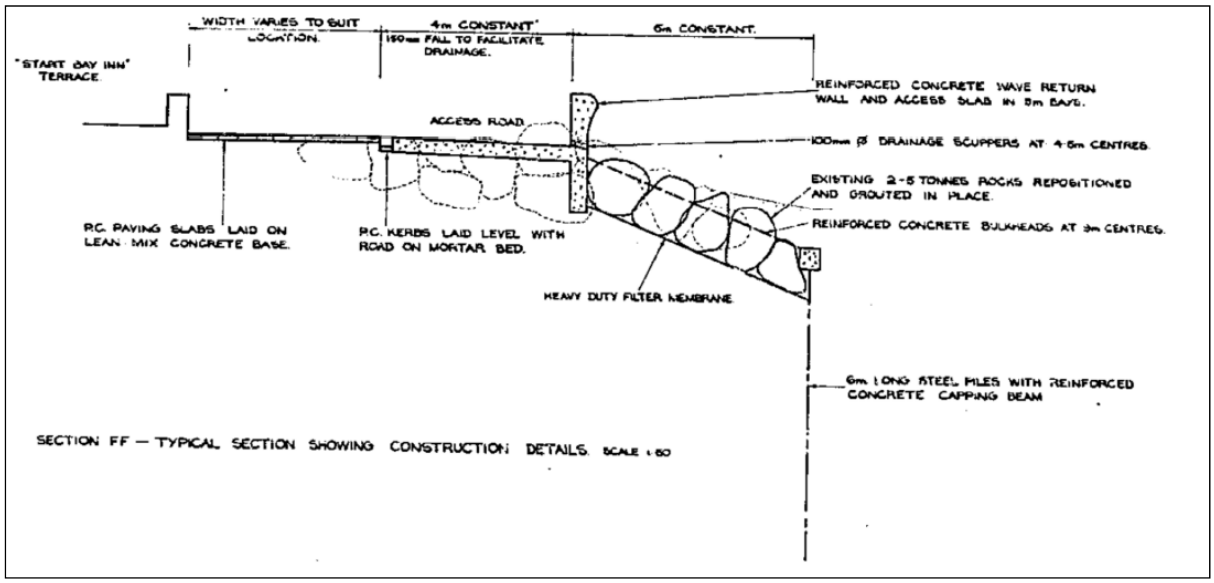


Figure 3-1 1979 as-built drawing of the Torcross seawall
Source: Environment Agency, 2016b

3.4 Concrete 'Armourflex' Blockwork (1980s)

In the late 1980s, 330m of concrete 'Armourflex' blockwork was installed in front of the middle car park. In 2001, the blockwork suffered from storm damage (see Figure 3-2), and today, the blockwork is in poor condition.

Figure 3-2 2001 Storm damaged 'armour flex' blockwork protection

3.5 Torcross Seawall – Phase 2 of 3 (2000)

The seawall was later modified by the Environment Agency in 2000.

3.6 Reactive Road Realignment (2001 to 2002)

Severe storms in January 2001 caused a reduction in the crest width of 5m over a length of 1,000m (see Figure 3-3). The erosion undermined a 200m length of the A379, north of the junction with Sands Road, resulting in the temporary closure of the road.

Shingle and debris washed onto the A379

Damage and undermining of the A379

Figure 3-3 2001 storm damage to the A379

In 2002, a 250m section of the A379 adjacent to the Higher Ley had to be reinstated 20m inland. The new two-way length of carriageway replaced a temporary single road which was built after storm damage in 2001 (see Figure 3-4).

Two-lane highway realigned inland of the temporary single lane road

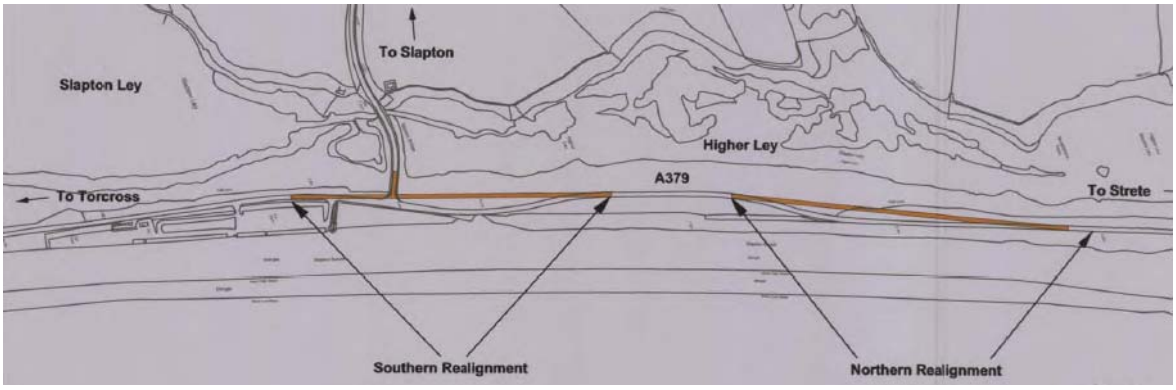
Realigned highway behind the beach

Satellite image of the realigned highway

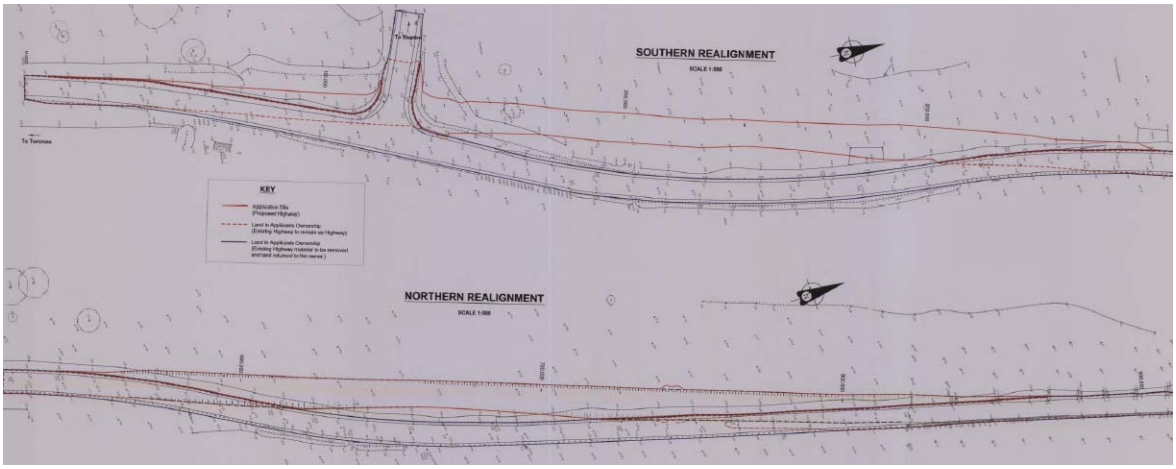
Figure 3-4 New section of road set back 21m from the existing storm damaged section

In 2006, a planning permission was sought to replace and realign two sections of the A379 highway between Slapton and Torcross, considered to be the most vulnerable lengths of road to storm damage. The two lengths are to the east and west of the new road constructed in 2002 (and described above). Location plans of the southern and northern sections of realignment are shown in Figure 3-5 and Figure 3-6.

Figure 3-5 Diagram showing location of proposed A379 realignments
Source: DCC, 2006



Location of the proposed sections of realignment



Proposed southern and northern realignment

Figure 3-6 2006 realignment location proposal

3.7 Beach Recycling (2003)

In 2003, beach material was moved along the beach at Slapton Sands.

3.8 Bastions (2005 and 2009)

In 2005, a number of bastions were installed along the back of the beach to protect the car park and monument area with the placement of beach material over the bastions (shown in Figure 3-7). Further bastion replenishment works were undertaken in 2009.

Figure 3-7 Beach material being redistributed over bastion

3.9 Bastion Construction and Beach Recycling (2015)

After the 2014 storms, the beach levels in front of the Torcross defences did not recover as quickly as was anticipated. A shingle recycling project was undertaken by SHDC along the Slapton line, including the deposition of shingle from Strete gate at Torcross and the construction of six shingle bastions (see Figure 3-8). 17,041m^3 of material was excavated from Pilchard Cove with 3,855m^3 deposited at Torcross Point and 13,186m^3 deposited at six the bastions.

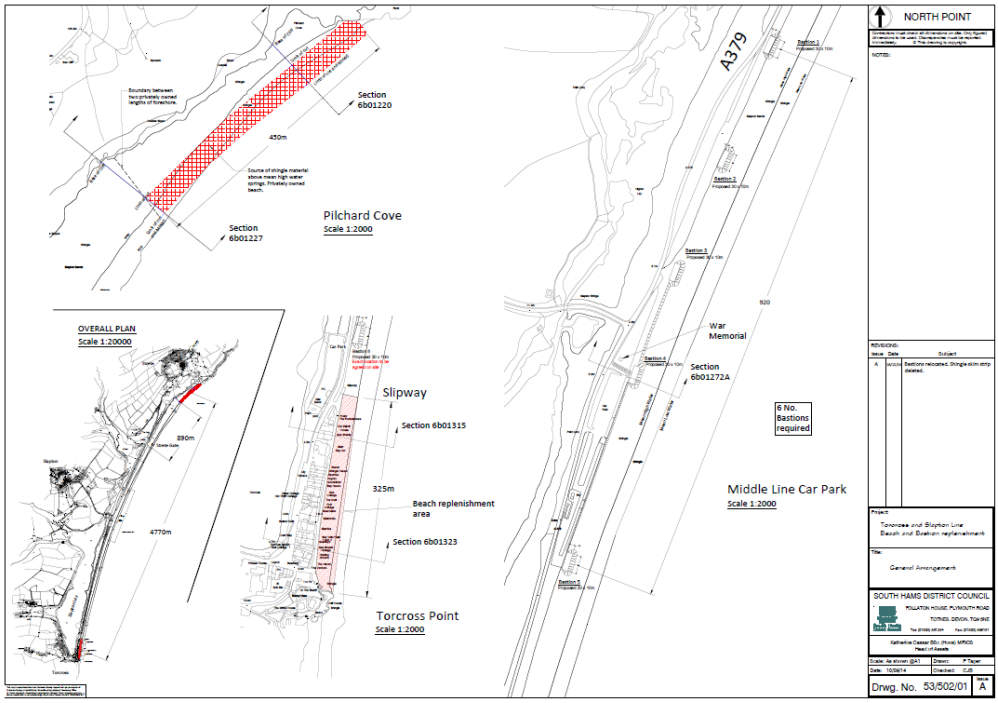


Figure 3-8 2015 Torcross beach and bastion replenishment
Source: SHDC, 2015

3.10 Concrete Seawall Repairs (2016)

Following storms in the winter of 2015/2016, a section of the concrete seawall, north of the slipway, was severely damaged and collapsed (see Figure 3-9). Emergency repair works were implemented along ~60m of the wall in 2016, which included the installation of a sheet pile wall and replacement of the concrete seawall crest with rock/concrete crest protection (see Figure 3-10). Rock armour was also intermittently placed at the toe of the structure.

Where not replaced in 2016, the old concrete seawall on the landward side of the slipway is showing signs of cracking and loss of structural concrete at the crest, and the concrete seawall to the north of the sheet pile wall is showing significant signs of vertical and lateral cracking (particularly along the bull-nose), large areas of spalling and minor displacement, and undermining.

**It should be noted that the 4m piles were selected on the basis of what was available at the time and the 6m piles that made up the Torcross seawall have since been replaced with 12m piles as the original piles were not deemed deep enough. There is therefore potential to increase the depth of the piles at this location to prevent toe erosion and collapse of the defences when beach levels are low.*

Figure 3-9 Collapse of a section of the concrete seawall running north of Torcross in February 2016

Figure 3-10 Repaired ~60m section of concrete seawall, showing sheet piles, rock/concrete crest protection and rock armour at the toe

Photograph taken during coastal defence condition assessment on 27th April 2017, looking north-east

3.11 Torcross Seawall – Phase 3 of 3 (2000)

In 2016 / 2017, piling and reinforced concrete capping beam added to the site along the Torcross seawall frontage. The works were completed in March 2017.

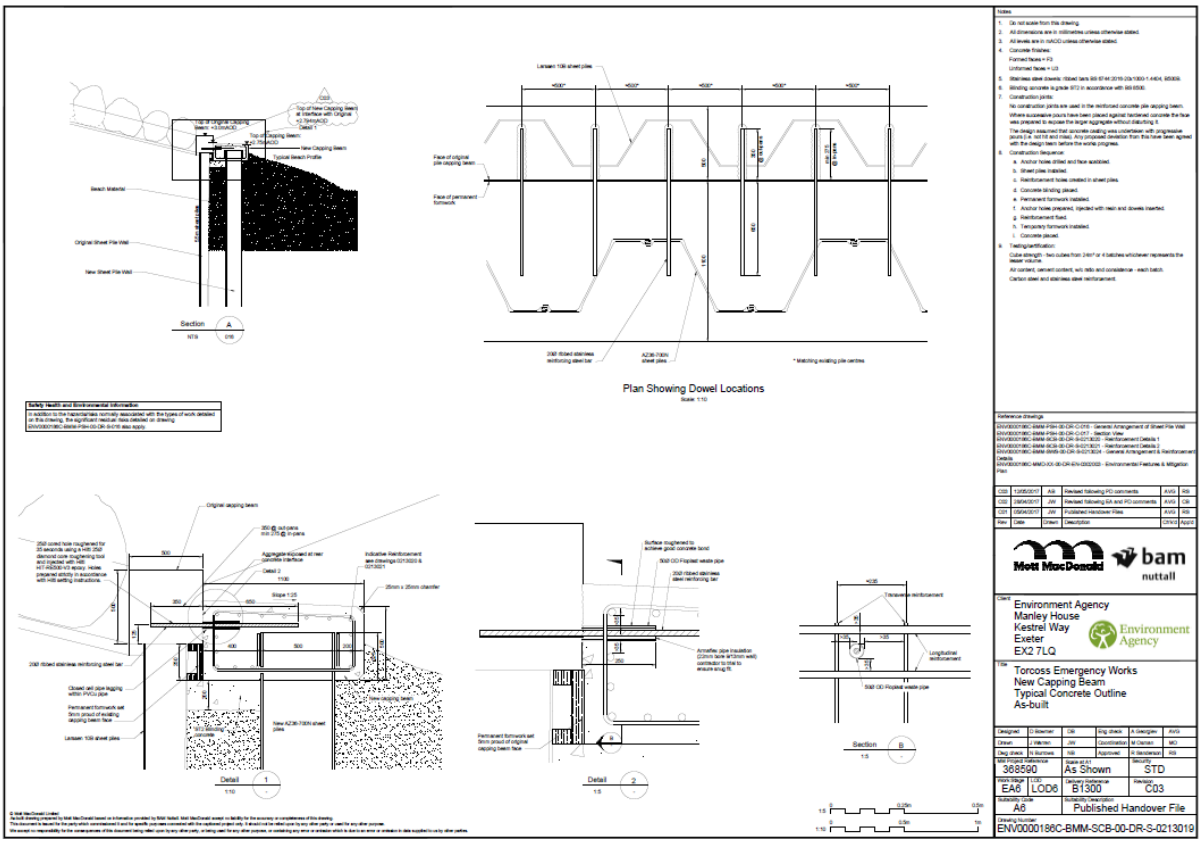


Figure 3-11 2016/2017 Torcross seawall emergency work as-built

Mott MacDonald and BAM, 2017

Fixing of the sheet piles

Reinforced concrete capping beam

Figure 3-12 2016/2017 Torcross seawall emergency works photos

3.12 Existing Standard of Protection

3.12.1 Overtopping Analysis

One of the key performance criteria of coastal defence assets and the A379 road is the wave overtopping discharge permitted by the structures. In line with the aims and objectives of the BMP to assess the performance of the existing defences, and to define a management approach to reduce the risk of flood and coastal erosion, there was a need to better understand the flood/breach risk to Torcross and the beach fronting the A379 road.

Following a review of existing data and information for the defence history (summarised in Section 3, with full details presented in Appendix D; Section 2), there was little existing information on standard of protection against wave overtopping for the BMP frontage. However, during the development of the BMP, new wave overtopping analysis was being completed by JBA on behalf of the Environment Agency for the State of the Nation (SoN) project, but the results for the BMP study area were not programmed in-line with the development of the BMP. Therefore, ahead of the release of the JBA work, and at the request of the SLP, new overtopping analysis was completed for the present study, with a view to compare the results of the new analysis and JBA work as it became available.

Wave overtopping analysis was completed to determine the level of protection that the current defences afforded to wave overtopping in 2017, and how it may change in the future. Full details of the overtopping analysis undertaken, including the data used, methodology and results, is presented in Appendix D; Section 4. The key findings of the analysis are:

- **Under present-day conditions**, the analysis indicates that the area at most significant risk of flooding by overtopping of coastal defences is the area between the Torcross slipway and the northern beach adjacent to the Higher Ley. This length of coast is characterised by a gravel beach acting as the primary flood defence, with only small structures at the crest of the beach area. The limit for public safety and vehicle safety is exceeded in this area for all the present-day and future conditions examined.
- The overtopping analysis indicates relatively large overtopping rates, creating a risk to pedestrians and vehicles for all return periods examined. The large overtopping rates are also likely to exceed the design structural stability limits throughout this stretch (assumed to be 0.1 l/s/m), as much of the area behind the defence is grassed bank. The high overtopping rates are also suggestive that pedestrians and vehicles will be at risk during more frequent extreme events.
- The high overtopping rates generated by the tested conditions also suggest a high likelihood that the A379 would be closed due to debris being transported to the road, or damage to the roadway. This view is further supported by the results of the wave run-up assessment, which indicated the 2% run-up limit will exceed the beach/structure crest level for the worst case of all return periods examined. This indicates that the beach might roll back and flatten, transporting sediment on to the road and affecting access.
- The flood defences at Torcross generally provide a much higher standard of protection than the adjacent beach area further north. Pedestrian safety behind the Torcross flood defences is variable, but falls below the 5% AEP (1 in 20-year) event in two places. The vehicle safety threshold (5 l/s/m) is broadly not exceeded until the 0.2% AEP (1 in 500-year) event, with one exception at the section of steel sheet pile at the crest of the shingle beach. The threshold for vehicle safety is the same as the likely damage threshold for the flood defences at Torcross (5 l/s/m). As such, the most likely area of damage during future extreme events will be at the stretch of steel sheet piling.
- **Wave overtopping discharge rates significantly increase at future dates**. For the return periods examined, the results at Year 50 indicate little change in the risk to pedestrians or vehicles behind the flood defences. It is likely that pedestrian safety may be exceeded during lower

return period events. The increased discharge rates along the main beach section will lead to more significant damage to the upper beach and road area.

- For the return periods examined, the results at Year 100 indicates a marked change in the risk to pedestrians and vehicles behind the defence. The most noted area of changes are at Torcross, where the flood defences fall below the 0.5% AEP (1 in 200-year) design level, and at Strete Gate, where damage, overwash, and potential breach of the beach might be expected for events with 0.2% AEP (1 in 500-year).

The JBA work has since been completed in draft and a comparison of the results showed that there were some key differences in the methodology and methods of analysis, which returned slightly different results. The comparison indicates that the overtopping values calculated for the BMP were generally lower than the equivalent values produced by JBA. The exception to this is at very high return periods for profile 6b01313 (sheet pile wall, see Section 3.1), where the BMP overtopping rates indicate a substantial increase in discharge rate, exceeding the rate estimated by JBA. Overall the differences in results produced in this report and by JBA are not unexpected, due to the sensitivity of the analysis to changes in some parameters. It is recommended that the overtopping analysis completed for the BMP is sense checked against the final JBA overtopping results as and when they become available.

3.12.2 Undermining / Scour Risk

Draw down in the level of the beach in front of the coastal defence assets, such as a seawall, can lead to its exposure and result in undermining leading to slumping, collapse and failure of the defence. An assessment of undermining/scour of the existing coastal defences was included within the visual inspection completed for this BMP (refer to Appendix D; Section 3.2).

In summary, this assessment concluded that the seawall at Torcross and the adjacent defences are not experiencing damage resulting from scour and undermining. The existing seawall at Torcross has been constructed with a 6m steel sheet piled toe with concrete capping beam (toe level at 3.00m ODN) and the risk of undermining / scour is considered to be low.

However, the displaced rock (armour and bastions) (described in Sections 3.2 and 3.8 and 3.9) along the length of ‘The Line’, suggests undermining and scour to some degree. The displaced rock is being considered for remedial works in the short term as part of the management approach to reduce flood and coastal erosion risk for the next 20 years (refer to Section 4.2.1.1(b)(i)).

The armour flex blockwork (described in Section 3.4) and the middle car park embankment/ bastions (described in Sections 8 3.8 and 3.9), are markedly experiencing undermining and failing as a result. Works to the armour flex blockwork, middle car park embankment and bastions do not form part of the proposed management approach and their relative merits would need to be reviewed by SHDC/DCC as part of their ongoing coastal defence asset maintenance programme. However, for completeness, an action has been included within the Action Plan (see Section 6).

SECTION 4

Maintenance Programme

4.1 Management Approach, Key Activities and Programme

In line with the aims and objectives of the BMP (outlined in Section 1.2), the following sets out the management approach to reduce the flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years.

The approach to managing the coastline between Torcross and Strete Gate was developed via a robust options appraisal process and ongoing stakeholder engagement (see also Section 1.3). The selection of a preferred management approach for the BMP frontage was undertaken via a staged approach, which rationalised a long-list of options to a short-list of options, from which a preferred option(s) was selected. This is shown in Figure 4-1.

The options appraisal is underpinned by the information and evidence presented in the four baseline reports:

- Coastal Processes Baseline: coastal processes, shoreline interactions and shoreline evolution (presented in Appendix B).
- Environmental Baseline: environmental setting and features (presented in Appendix B).
- Defence Baseline: coastal defence assets, condition and performance (presented in Appendix D).
- Economics Baseline: economic basis (i.e. the economic benefits) for both ongoing and future beach management and coastal flood and erosion risk management activities (presented in Appendix D).

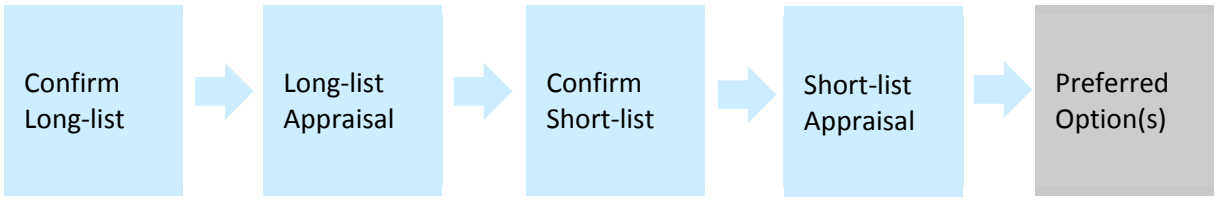


Figure 4-1 Options appraisal process – staged approach to option selection

Signpost!

Full details of the options appraisal are presented in the **Options Appraisal Report**, which is provided in Appendix F.

An outline summary and programme of the key activities that form the preferred management approach is presented in Table 4-1, with full details of the activities presented in the following sections.

The overall strategy going forward is to recognise that reactive work should be done, but only to patch and mend the defences and road as required over the next 20 years. This is in line with funding available via FCERM-GiA. Further options do exist but their implementation is wholly dependent on the availability of third-party funds. Preparations should be made for the next 50 years, and not to leave a legacy of unmanageable and unaffordable solutions to future generations.

Table 4-1 Programme of management activities to reduce the flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years

Key Activity Number	Key Activity Description	Programme of Activities				
		Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022
1	Maintain the existing seawall at Torcross.					
2	Maintain existing 23m concrete seawall along landward edge of slipway.					
3	Maintain existing 60m sheet pile wall at Torcross.					
4	Upgrade and improve existing 60m concrete seawall at Torcross.					
5	Upgrade and improve existing 700m of rock revetment at Torcross.					
6	Undertake periodic beach recycling, guided by ongoing monitoring and possibly new modelling.					
7	Undertake reactive realignment.					
8	Formally recognise the BMP study area, including 'The Line', within the Coastal Change Management Area (CCMA) and update the Local Plan. Produce a CCMA Adaptation Plan.					
9	Undertake beach management works instigated by alarm and crisis trigger levels. This includes shingle clearance, more frequent and focused beach monitoring, beach recycling, emergency works to the A379 road, and reactive realignment.					

4.2 Management Activities

4.2.1 Structure Maintenance and Modification

4.2.1.1 Maintain, Upgrade and Improve the Existing Seawalls at Torcross

(a) Maintain the Existing Seawall at Torcross

The purpose of this activity is to ensure that the existing seawall at Torcross continues to provide a robust defence for the properties at Torcross against flooding via wave overtopping and protection of the A379 road behind from erosion. It is not anticipated that the seawall is upgraded and made higher due to landscape issues.

The Torcross seawall is currently owned and maintained by the Environment Agency. Future maintenance of the existing seawall will be undertaken by the Environment Agency as part of their asset maintenance programme. The timing and scale of future maintenance, improvements and upgrades of the structure should be informed by ongoing monitoring completed as part of the defence inspections completed for the BMP frontage (see Section 5.1).

(b) Existing Defences Adjacent to Torcross Seawall

Works to maintain or improve/upgrade the existing defences adjacent to the Torcross seawall should be undertaken to provide a more robust line of defence and protect the seawall from outflanking and in turn protect the road from erosion. There are four elements to this work, as outlined below.

(i) Maintain Existing 23m Concrete Seawall Along Landward Edge of Slipway

Works to the maintain the existing 23m of concrete seawall that runs along the landward edge of the slipway to be undertaken to address signs of cracking and loss of structural concrete at the crest and to ensure that a consistent line of defence is provided between the northern end pf the Torcross seawall and the adjacent defences. The timing and scale of future maintenance should be informed by ongoing monitoring completed as part of the defence inspections completed for the BMP frontage (see Section 5.1).

(ii) Maintain Existing 60m Sheet Pile Wall at Torcross

Following emergency works in 2016, the sheet pile wall should be maintained. Future maintenance will be undertaken by SHDC as part of their asset maintenance programme. The timing and scale of future maintenance, improvements and upgrades of the structure should be informed by ongoing monitoring completed as part of the defence inspections completed for the BMP frontage (see Section 5.1).

(iii) Upgrade and Improve Existing 60m Concrete Seawall at Torcross.

Improvements to the existing condition and level of protection provided by 60m long concrete seawall should include upgrading the wall to the same standard as the adjacent sheet pile wall to the south.

(iv) Upgrade and Improve 700m of Rock Revetment at Torcross

Repairs to approximately 700m of rock revetment that has become displaced along the barrier. At present, some of this rock is providing some degree of protection to the barrier from wave attack. Works are to include recovery and re-profiling of the rock, in line with the SMP2 Policy.

It is anticipated that funding to improve the existing concrete seawalls and rock revetment could be sought from the Environment Agency via Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM-GiA) and SHDC/DCC (Highways). Maintenance of the existing sheet pile wall, and recovery and re-profiling of the rock in conjunction with concrete seawall improvements (as described above) may attract some FCERM-GiA contribution. However, if undertaken in isolation it is less likely to achieve FCERM-GiA funding. Therefore, in order for this option to be implemented, it recommended that funds are identified via SHDC to support any FCERM-GiA that may be available.

The next steps to implement this activity would be to prepare and submit a project proposal to the Environment Agency for consideration.

4.2.2 Beach Management

4.2.2.1 Undertake Periodic Beach Recycling

Strategic movement of beach material could be undertaken to bolster areas along the beach where levels are low. Material would be moved from areas of accretion to areas of erosion periodically to raise beach levels to a healthier level and thereby provide some buffer to wave energy at Torcross

and along the length of 'The Line'. Beach recycling would not provide protection to the full length of the eroding frontage.

There are many uncertainties and risks associated with recycling, including the volumes required, frequency of movement, the likelihood that the beach material will stay in place and provide a sufficient level of protection. There is no guarantee the material will stay in place, and in the absence of control structures this material could be removed in one storm. and, as the appraisal process has identified, there are pros and cons to implementing such structures.

Therefore, any planned movement would need to take consideration of observed weather patterns and their influence on beach erosion/accretion and be informed and guided by the latest beach monitoring data. Such uncertainty could also be further reduced by undertaking modelling of the beach under various weather conditions.

Beach recycling may attract some FCERM-GiA contribution if supporting measures to address outflanking of the Torcross seawall. However, if undertaken to protect the road, it is less likely to achieve FCERM-GiA funding. Therefore, in order for this option to be implemented, it recommended that funds are identified via SHDC and/or DCC (Highways) to support any FCERM-GiA that may be available.

The next steps to implement this activity would be to define better areas of accretion and erosion of the beach using the latest monitoring data and if possible reduce uncertainty through the completion of numerical modelling. Once a better understanding has been achieved, then funding could be sought.

4.2.3 Public Access / Amenity / Safety

4.2.3.1 Undertake Reactive Realignment

The A379 road should be managed as an emergency measure in response to failure as and when it occurs. The activity can be assisted by ensuring that any necessary preliminary studies, consents and planning works are undertaken and in place, so emergency works can be undertaken as quickly and smoothly as possible.

An existing planning application has been submitted to realign the road to the north of the junction of the A379 and the road to Slapton village in anticipation of future storm damage to the road. Any further works required to implement the northern realignment should be undertaken as per the existing planning application, and as much preparatory work relating to consents, planning and funding should be undertaken from the remainder of the A379 along 'The Line' to facilitate a prompt realignment should the need arise.

Should storm damage result in failure of the road to a state that is repairable within budgets available at the time, it is anticipated that funding will be made available for reactive realignment through FCERM-GiA and DCC (Highways).

The next steps to implement this activity would be to undertake any necessary preparatory work relating to consents, planning and funding.

4.2.4 Coastal Change Management and Adaption

It is evident from undertaking the Slapton Sands BMP that funding for the management of flood and coastal erosion risk at Slapton Sands is limited and that there is little that can be done to combat the effects of ongoing coastal change. Over time, the road may become irreparable and even breach. It is therefore important to formally recognise this in the immediate future and define 'The Line' as a Coastal Change Management Area (CCMA) in order to drive future coastal change adaptation efforts in the area.

Recommendations to address coastal change adaptation include:

- Update the Plymouth and South West Local Plan (PSWLP) to include the BMP study area and the associated areas at risk from flooding and erosion within the CCMA (*as defined by Policy Dev38*

and shown on SUB3 Policies Map: Thriving Towns and Villages Policy Area (South Hams), plymouth.gov.uk). This should be completed in accordance with the Coastal Change Planning Guidance (CH2M, 2015) and will need to be mapped as a 'zone', for which specific planning policies will need to be defined.

- Prepare a Coastal Change Adaptation Plan (CCAP) for the BMP study area. The CCAP could take the form of a Supplementary Planning Document to be appended to the PSWLP as well as the BMP. The CCAP should include details of the measures that can be taken to adapt to coastal change, including:
    - Incorporate and add to the recommendations made by the PSWLP; in turn update the PSWLP. Investigate adaptive solutions and make provisions to 'roll back' properties and assets at risk, including defining a plan for compensation, changes to planning restrictions, relocation etc.
    - Make plans for and undertake high quality education and engagement – communicate with the public about the changing processes, landscape, funding opportunities and potential failure of the A379 in the future and the realities of this.
    - Wider use of local land charges registers for getting this information out there.
    - Prepare for eventuality of road failure including any required pre-existing planning and EIA work.
    - Preparing for the eventually of a breach and the need for a new road link – identify a suitable inland road network and make movements to improving it. To assist with the BMP project, work is being undertaken by DCC (Highways) to estimate costs associated with improving and upgrading inland routes.
    - Prepare for eventuality of road failure and on a more local level, look to make changes to the existing infrastructure.
        - Investigate adaptive solutions and make provisions to 'roll back' properties and assets at risk, including defining a plan for compensation, changes to planning restrictions, relocation etc.
        - Recommendations made via the stakeholder engagement meetings during the development of the BMP included actions such as relocating car parks landward and consideration of options to cease maintenance of the tarmac road, but allow the top of the barrier to be used as a carriageway as a gravel road.

4.2.5 Works Determined by Trigger Levels

When beach levels reach a specific elevation or 'trigger level', an action may be taken. The guidance within *Toe Structures Management Manual* (Environment Agency, 2012b) recommends estimation of the trigger level consistent with times when the probability of structural failure reaches thresholds that are deemed important. The trigger levels of a beach will often coincide with the point at which beach levels threaten a probability of exposure/damage, stability failure or an unacceptable rate of overtopping. Multiple trigger levels can be adopted for a beach which will reflect different risk levels or points at which action is required.

Works to the existing coastal defence assets and the A379 road along the length of the BMP frontage, resulting from low beach levels will be triggered by defined alarm and crisis levels described in Sections 4.2.5.1 and 4.2.5.2 below. To the north of the 60m concrete seawall, following overtopping/over washing events, beach material can be deposited on the A379 road, and depending on the volume, lead to road closure. Further to this, the rock revetment has been displaced and the armour flex and car park are subject to undermining, even at present beach levels. This indicates that in the first instance, maintenance/improvement works are required immediately,

and secondly this section of the BMP frontage could benefit from trigger levels to prompt future management/raise awareness of potential road failure.

4.2.5.1 Alarm Trigger Levels

To prompt works along the BMP frontage as described above, the alarm trigger levels are defined in Table 4-2 below.

Table 4-2 Alarm Trigger Levels

Alarm Trigger Reference	Alarm Trigger Description	Alarm Trigger Action
Alarm Trigger 1	Deposition of shingle on the road as a result of wave overtopping / overwashing.	Clear the road and place shingle back on the beach.
Alarm Trigger 2	High beach levels leading to increased risk of deposition of shingle on the road as a result of wave overtopping / overwashing.	More frequent beach monitoring to determine if low beach levels are a temporary or persistent trend occurring over several weeks. Details of the monitoring requirements are described in detail in Section 5.2.3.
Alarm Trigger 3	Low beach levels leading to exposure/damage of the Torcross seawall, undermining and increased risk of overtopping and breach particularly in storm events.	More frequent beach monitoring to determine if low beach levels are a temporary or persistent trend occurring over several weeks. Details of the monitoring requirements are described in detail in Section 5.2.3.

4.2.5.2 Crisis Trigger Levels

To prompt immediate works along the BMP frontage as described above, the alarm trigger levels are defined in Table 4-3 below.

Table 4-3 Crisis Trigger Levels

Crisis Trigger Reference	Crisis Trigger Description	Crisis Trigger Action
Crisis Trigger 1	Partial loss of part or parts of the A379 resulting from erosion and storm damage.	Put into place contingency plan for A379 Slapton Line closure (Fewings, 2017). Reinstate the A379 road. This may require emergency works or reactive -realignment of the road, as described in Section 4.2.3.1.
Crisis Trigger 2	Full loss of part or parts of the A379 resulting from erosion and storm damage.	Instigate alternative inland route. This is discussed in more detail in Section 4.2.4.
Crisis Trigger 3	Persistent (over several weeks) high beach levels poses an increased risk of beach overtopping, overwashing and breach during storm events. This will be informed by the increased beach monitoring instigated in response to Alarm Trigger 2.	Consider if appropriate and if so undertake beach recycling activities, including movement of beach material along the BMP frontage from areas of high beach levels/accretion to areas of low beach levels/erosion. *This alarm trigger would only ever be implemented should further studies indicate that beach recycling is a suitable management approach for the BMP frontage (as discussed in Section 4.2.2.1).*
Crisis Trigger 4	Persistent (over several weeks) low beach levels poses an increased risk of damage, undermining and failure of the Torcross seawall / backshore, A379, overtopping and breach during storm events. This will be informed by the increased beach monitoring instigated in response to Alarm Trigger 3.	If appropriate implement works to address Torcross seawall defects. Consider if appropriate and if so undertake beach recycling activities, including movement of beach material along the BMP frontage from areas of high beach levels/accretion to areas of low beach levels/erosion. *This alarm trigger would only ever be implemented should further studies indicate that beach recycling is a suitable management approach for the BMP frontage (as discussed in Section 4.2.2.1).*

4.3 Implementation of Management Activities

In the event that the management activities described in Section 4.2 are implemented, then it is important to ensure that any works utilise appropriate methods and materials in order to maximise effectiveness and extend the structures life as long as possible into the future.

4.3.1 Plant Requirements and Access

The plant required to undertake modification of the existing coastal defence assets / beach recycling activities will depend upon the nature of the works and should be considered by the designer and contractor at the time when any such works are to occur. Consideration should be given to beach access, including access points for plant and any constraints occurring due to the tidal working window.

4.3.2 Public Access, Amenity and Safety

Coastal defence and beach works, when they are required, should avoid the peak holiday season, weekends and public holidays where possible. This will minimise the impact of works on beach users and will reduce the minor risk to public safety that such work would pose. In order to ensure the safety of the public whilst works are being carried out, restrictions on public access to the areas of the beach being worked on should be implemented, with alternative routes provided if possible.

Information boards should be displayed whilst the works are being carried out to explain what is being done and why. This will also serve to improve public education. Appendix G contains a best practice guide on how to communicate with the public and local businesses when undertaking beach maintenance works.

4.3.3 Environmental Impacts

As part of the works to apply for funding, planning and design of future works to the concrete seawall, rock revetment and beach recycling, a review of the impacts on the environment should be undertaken. This should include mapping of new and current ecological, archaeological, and UXO survey data, as acknowledged in the BMP Action Plan (see Section 6; Action FSR_001). These activities should also be completed alongside consultation with Natural England.

4.3.4 Notifying Others

In addition to communicating effectively with the public, it is recommended that explicit notification of any works, and contact details should there be any queries, be provided to the following organisations/groups as appropriate depending upon the location where works are occurring:

- The Slapton Line Partnership.
- The Crown Estate.
- The Marine Management Organisation.
- The National Trust.
- South West Water.
- Local fishermen and those people who have a day to day interest in what is happening along the frontage where works are to occur, i.e. any businesses that may be affected.
- Local residents directly affected by any road or access closures along the frontage when works occur.
- Natural England (in relation to nature conservation and coastal access interests).

SECTION 5

Monitoring Programme

In support of the management approach set out in Section 4 to reduce the risk of flooding and coastal erosion between Torcross and Strete Gate over the next 20 years, an ongoing comprehensive monitoring programme is required. The monitoring activities provide a greater level of quantitative field data to:

1. Provide information on the condition of the existing coastal defence assets.
2. Aid an improved understanding of the coastal processes operating along the Slapton Sands BMP frontage and wider coastal area.
3. Inform future management decisions.

For completeness, the monitoring programme includes the ongoing monitoring undertaken by the Plymouth Coastal Observatory (PCO) as part of the South-West Regional Coastal Monitoring Programme (SWRCMP).

- Data collected by the SWRCMP includes two annual beach profile surveys, post-storm surveys when needed, a five-yearly bathymetry survey, aerial LiDAR, aerial photography on a frequent basis; and wave data.
- The data is analysed and reported on within an annual survey report; the relevant report to the BMP study area is 'Dawlish Warren to Start Point' and the survey units that cover the BMP study area include 6bSU25-2 (Blackpool Sands), 6bSU26-1 (Slapton Sands), 6bSU26-2 (Beesands) and 6bSU26-3 (Hallsands).
- The report and data is available through the PCO website (www.coastalmonitoring.org) from 2007 onwards (when PCO was established).

An outline summary and programme of the key monitoring activities is presented in Table 5-1, with full details of the activities presented in the following sections.

Table 5-1 Programme of monitoring activities for Slapton Sands BMP study area (Torcross and Strete Gate)

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022
1	Undertake an annual visual inspection of the coastal defence assets along the BMP frontage.					
2	Undertake post-storm visual inspections of the coastal defence assets along the BMP frontage as and when required.					
3	Undertake defence monitoring as and when required.					
4	Undertake detailed inspection of the existing coastal defence assets every five years.					
5	SWRCMP to continue with current monitoring including routine/bi-annual surveys, post-storm surveys, bathymetric surveys, aerial LiDAR and aerial photographs and annual reporting.					

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022
6	Plymouth University to continue with monthly beach monitoring of beach between Torcross and Strete.					
7	Real time beach monitoring using semi-permanent video cameras or laser scanners.					
8	Undertake numerical and morphodynamic modelling.					
9	Undertake more frequent monitoring in response to Alarm Trigger Levels.					
10	Ensure records are kept of any beach recycling works and complete a pre- and post-beach recycling survey for the first one or two beach recycling campaigns.					
11	SWRCMP to continue to monitor and analyse wave data sourced from the Slapton Sands wave rider buoy.					
12	Develop a storm event record with details of the storm conditions (waves, winds and water levels), pre/post-storm surveys and effects/impacts of the event. The recorded should be updated following every storm.					
13	Record additional information on the offshore wave climate from other data sources such as near real time data from the National Data Buoy Centre (www.ndbc.noaa.gov/) and the CEFAS Wavenet (www.cefas.co.uk/data/wavenet.aspx) websites.					
14	Flood warning and response to be continued by Environment Agency practice.					
15	Continue with current pollution incident practices.					
16	Environmental monitoring will be required at the scoping stage of any beach recycling activities / works to coastal assets and subsequently to monitor the status of the environment post -works.					
17	Continue with bathing water quality monitoring undertaken by the Environment Agency. Additional monitoring may be required after the placement of recycled material.					
18	Data capture and storage that is collected outside of the SWRCMP					

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018	Year 2 2019	Year 3 2020	Year 4 2021	Year 5 2022
	should be stored within one location for ease of reference and consistency.					

5.1 Structure Monitoring

5.1.1 Annual Visual Inspection

There are a number of coastal defence assets along the BMP frontage. The existing defences were visually inspected as part of the current BMP and the results of the inspection are presented in the Defence Baseline Report (refer to Appendix D).

The existing coastal defences should be re-inspected regularly to ensure that they remain in good-condition and, where not, used to inform an ongoing maintenance works to improve their condition. The visual inspections should take place once every year and utilise the inspection proforma presented in Appendix H to ensure each visual inspection is recorded in a consistent way.

Inspection reporting should follow the format presented within the Defence Baseline Report (refer to Appendix D; Section 3) to allow a direct comparison to be made with the latest inspection results. The inspections should occur during the spring of each year to allow time for any issues to be identified and rectified through the completion of any maintenance works prior to the busy summer period, thus avoiding impacting on the amenity use of the beach.

5.1.2 Post-Storm Visual Inspection

Visual inspections to monitor the coastal defence assets after storms should also be undertaken since damage to the structures is most likely to occur during storms.

The following items should be checked as part of these inspections:

- Visual checking of the beach level in front of the seawall at Torcross and the defences adjacent to ensure that the trigger levels defined in Section 4.2.4 are not reached.
- Visual checking of access ramps, steps, hand rails, etc. to ensure that these are in a safe condition of public use. This should be carried out in accordance with the Environment Agency's public safety risk assessment operational instruction.
- Visual identification and checking of any defects (e.g. cracks in the seawall; timber groyne planking, etc.) and overall defence condition in accordance with the Condition Assessment Manual (Environment Agency, 2012a).

For completeness, reporting should make reference and draw comparison to the assessment of the coastal defence asset made in the Defence Baseline Report (refer to Appendix D).

5.1.3 Defect Monitoring

When either routine inspection (such as the annual visual inspection) or rapid assessment (such as the post-storm visual inspection) identifies a defect in the coastal defence asset, be it a crack in the defence or damage to public safety aspects of the defence (e.g. buckled hand railings or trip hazards, etc.) then the following steps are to be followed:

1. Increased defect monitoring – should any defects be identified then it may be appropriate to implement an increased level monitoring rather than immediately undertaking remedial works. This could also involve the use of additional monitoring devices such as crack gauges. This step would only occur if the identified defect is not considered an immediate safety risk (i.e. this step is optional and may or may not occur prior to Step 2 below).

2. Remedial works – once an identified defect is considered to be in need of remedial work, then the design of remedial works should be undertaken and an appropriate repair specification generated. To ensure consistent information on repairs undertaken is recorded, a defence repair works proforma is provided in Appendix I.

For completeness, reporting should make reference and draw comparison to the assessment of the coastal defence assets made in the Defence Baseline Report (refer to Appendix D).

5.1.4 Detailed Inspection

Over a less frequent interval, approximately every five years, it is recommended that a full structural inspection of the coastal assets along the BMP frontage is undertaken.

In addition to the items assessed during an annual visual inspection, the full structural inspection should also include, not exclusively, the items listed below. As with the annual visual inspections, to ensure a complete and consistent set of data is recorded, the inspection proforma presented in Appendix H should be used.

- Non-intrusive investigations, such as estimate of sheet-pile thickness, depth of sheet pile at the structure of the toe.
- Intrusive investigations if required, such as core samples to test concrete strength.
- Inclusion of analysis of beach level at the structure toe.
- A full photographic record of the assets at the time of the inspection and these should be kept with the inspection records for future reference.

5.2 Beach Monitoring

Beach monitoring is primarily undertaken by two parties, Plymouth Coastal Observatory via the South-West Regional Coastal Monitoring Programme and the Plymouth University. Beach profile data along the length of the Slapton Sands was collected by the Slapton Field Studies Centre over the period 1972 to 2003. However, these profiles were only sporadically collected and are no longer monitored. The data was analysed as part of the current BMP (refer to Appendix B).

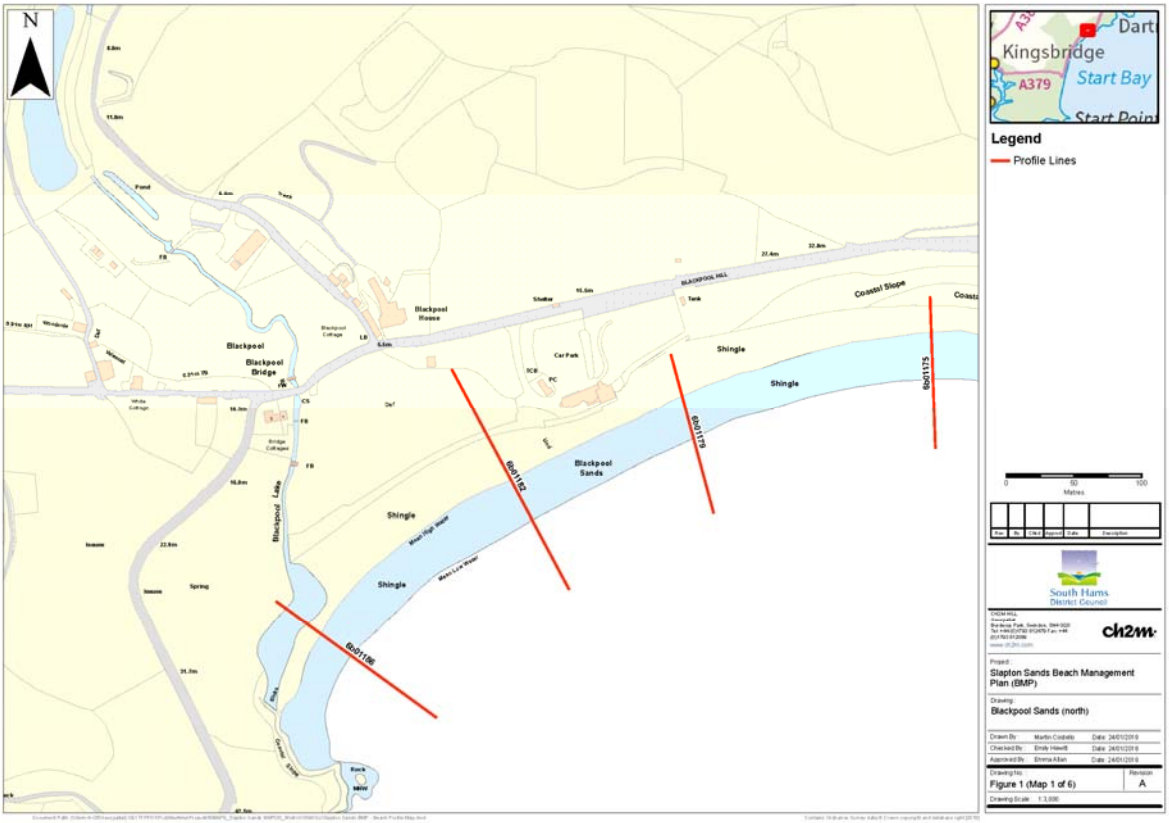
5.2.1 South-West Regional Coastal Monitoring Programme

5.2.1.1 Routine Annual/Bi-Annual Surveys

Topographic beach profile surveys are undertaken by Plymouth Coastal Observatory (PCO) as part of the South-West Regional Coastal Monitoring Programme (SWRCMP) every spring and autumn at pre-defined locations along the BMP frontage, and to the extended study area to the north at Blackpool Sands and south at Beesands and Hallsands (see Figure 5-1).

A summary of the beach profile locations is provided in Table 5-2, and includes origin co-ordinates and dates of first and most recent surveys. It also shows which profiles are currently surveyed twice per year, and which of those are also currently used to capture additional post-storm survey profiles (NB: these currently used profiles have not always been used for this purpose; in the past other profiles were used).

SECTION 5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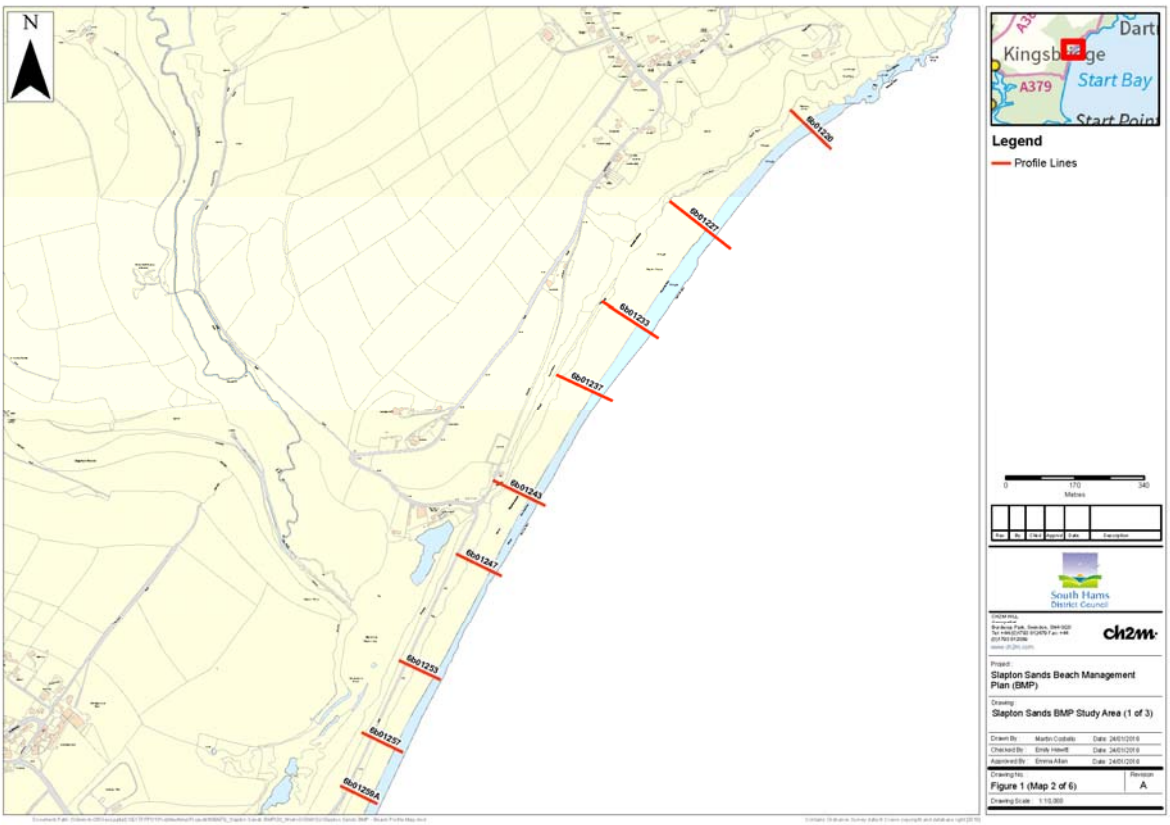
6b01186
Kingsbridge
A379
Start Bay
Legend
Profile Lines
South Hams District Council
ch2m
Slapton Sands Beach Management Plan (BMP)
Blackpool Sands (north)
Figure 1 (Map 1 of 6)
A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A379
Start Bay
Legend
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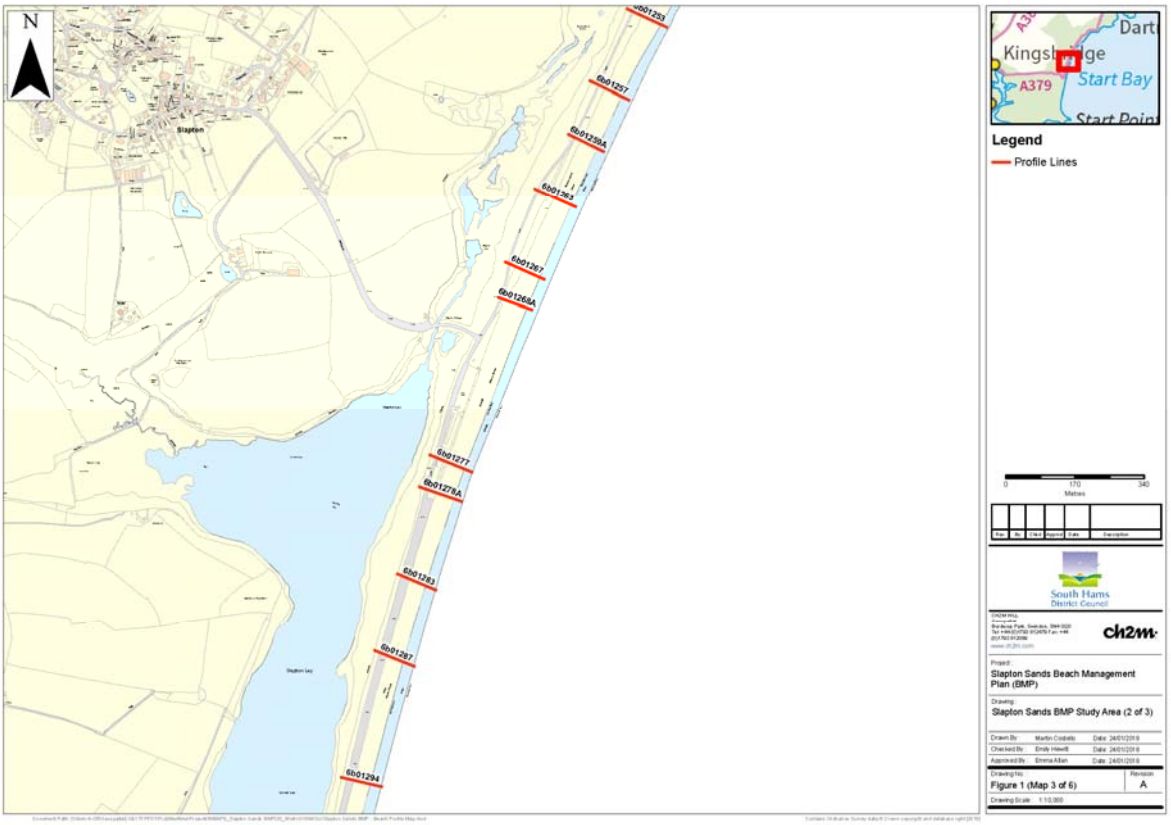
Slapton Sands Beach Management Plan (BMP)
Slapton Sands BMP Study Area (1 of 3)
Figure 1 (Map 2 of 6)
A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6b01283
6b01287
6b01294
Kingsbridge
A379
Start Bay
Legend
Profile Lines
0
170
340
Metres
South Hams District Council
ch2m
Slapton Sands Beach Management Plan (BMP)
Slapton Sands BMP Study Area (2 of 3)
Figure 1 (Map 3 of 6)
A


N
6b01294
6b01298
6b01302
6b01306
6b01310
6b01315
Torcross
6b01319
6b01323
Kingsbridge
A379
Start Bay
Legend
Profile Lines
0
170
340
Metres
South Hams District Council
ch2m
Slapton Sands Beach Management Plan (BMP)
Slapton Sands BMP Study Area (3 of 3)
Figure 1 (Map 4 of 6)
A

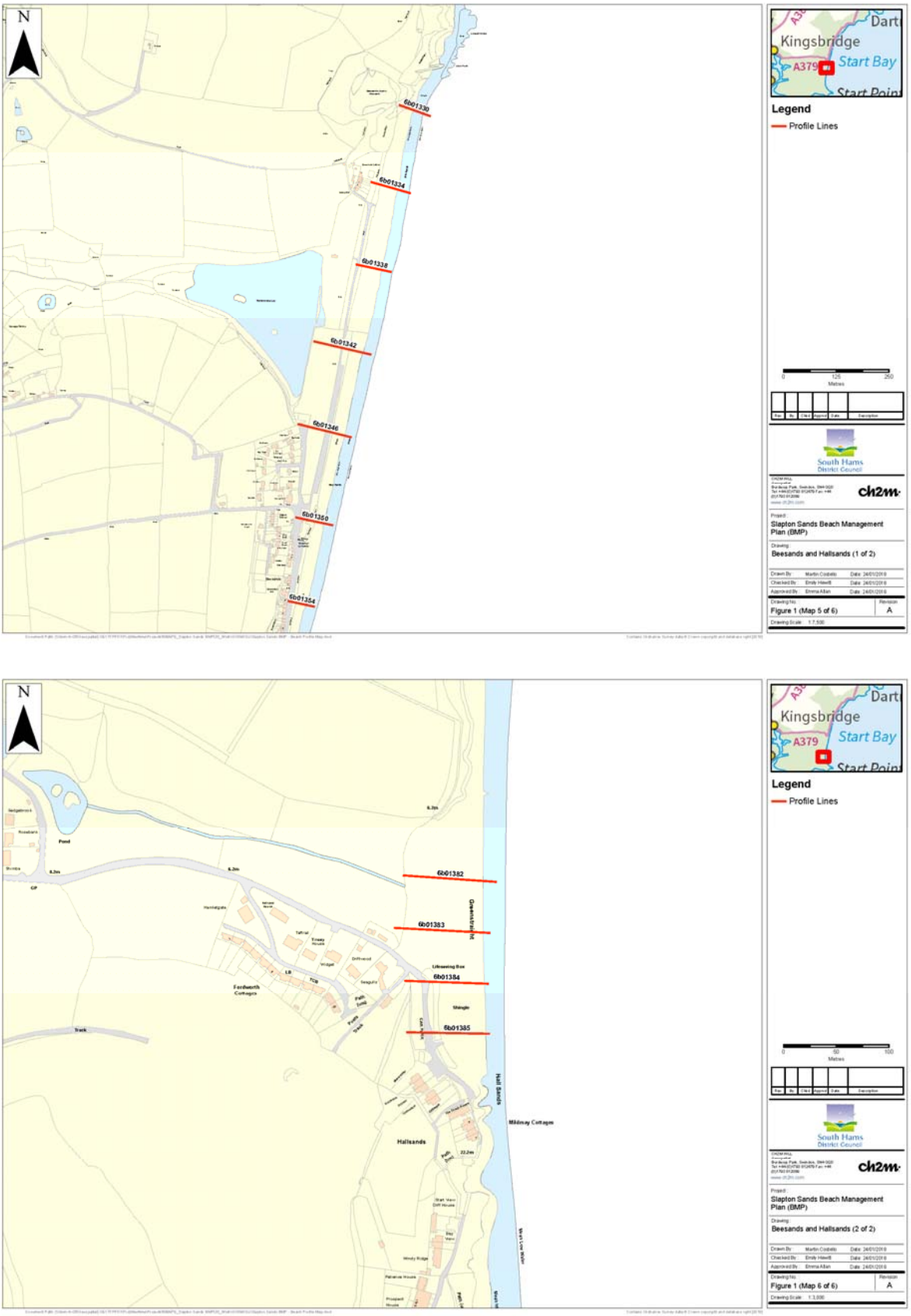

Figure 5-1 PCO beach profile survey locations

Table 5-2 PCO beach profile survey locations within the BMP study area and extended study area

(NB: Profiles in bold are also currently surveyed as post-storm profiles, see Section 5.2.1.2)

Profile	Origin Easting	Origin Northing	Date of First Survey	Date of Most Recent Survey (at time of reporting)
Blackpool Sands				
6b01175	285729.932547	47978.997594	30.09.2007	16.11.2016
6b01179	285530.961956	47939.989539	30.09.2007	16.11.2016
6b01182	285387.936883	47877.965977	30.09.2007	16.11.2016
6b01186	285228.074125	47740.102923	30.09.2007	16.11.2016
Slapton Sands				
6b01220	**284067.022009**	**46675.023334**	**27.09.2007**	**15.11.2016**
6b01227	**283816.925644**	**46380.905632**	**27.09.2007**	**15.11.2016**
6b01233	283661.939229	46111.906738	30.09.2007	15.11.2016
6b01237	**283578.829786**	**45899.637053**	**30.09.2007**	**15.11.2016**
6b01243	283469.021206	45616.044139	30.09.2007	15.11.2016
6b01247	**282899.496896**	**45669.972225**	**30.09.2007**	**15.11.2016**
6b01253	283064.460353	45251.849994	30.09.2007	15.11.2016
6b01257	**282988.333257**	**45071.687185**	**30.09.2007**	**15.11.2016**
6b01259A	**283138.651728**	**44841.442365**	**06.12.2010**	**15.11.2016**
6b01263	**282862.116054**	**44793.260779**	**30.09.2007**	**15.11.2016**
6b01267	**282826.333987**	**44595.754176**	**30.09.2007**	**15.11.2016**
6b01268A	282956.945266	44443.044888	06.12.2010	15.11.2016
6b01272A	**282870.316404**	**44282.986221**	**06.12.2010**	**15.11.2016**
6b01277	**282506.187313**	**44167.464563**	**30.09.2007**	**15.11.2016**
6b01278A	**282774.546058**	**43971.299412**	**06.12.2010**	**15.11.2016**
6b01283	282167.907232	43991.54553	30.09.2007	15.11.2016
6b01287	**282317.974557**	**43706.487943**	**30.09.2007**	**15.11.2016**
6b01294	282237.00568	43338.024371	30.09.2007	15.11.2016
6b01298	282141.011805	43155.052968	30.09.2007	15.11.2016
6b01302	282053.986653	42969.943911	30.09.2007	15.11.2016
6b01306	**281757.115759**	**42854.431099**	**30.09.2007**	**15.11.2016**
6b01310	281876.94454	42614.79428	30.09.2007	15.11.2016
6b01315	**282366.997324**	**42238.978127**	**30.09.2007**	**15.11.2016**
6b01319	282335.998604	42041.987028	30.09.2007	15.11.2016
6b01323	**282250.999715**	**41849.991903**	**30.09.2007**	**15.11.2016**
Beesands				
6b01330	282030.962383	41576.897656	30.09.2007	16.11.2016

Profile	Origin Easting	Origin Northing	Date of First Survey	Date of Most Recent Survey (at time of reporting)
6b01334	**282118.997986**	**41333.993877**	**30.09.2007**	**16.11.2016**
6b01338	281945.002683	41167.013786	30.09.2007	16.11.2016
6b01342	**281725.988844**	**41012.950452**	**30.09.2007**	**16.11.2016**
6b01346	281984.009896	40749.038256	30.09.2007	16.11.2016
6b01350	**281979.986629**	**40525.940135**	**30.09.2007**	**16.11.2016**
6b01354	281954.005887	40330.028891	30.09.2007	16.11.2016
Hallsands				
6b01382	281699.000097	38982.005852	28.09.2007	16.11.2016
6b01383	281696.000486	38932.010777	28.09.2007	16.11.2016
6b01384	281693.000461	38882.000504	28.09.2007	16.11.2016
6b01385	281690.999733	38832.006076	28.09.2007	16.11.2016

5.2.1.2 Post Storm Surveys

In addition to undertaking routine beach profile surveys, PCO also undertake post-storm surveys although not always along the same profiles each time (see Table 5-2).

In order to capture post-storm surveys in the future, a number of local authority staff who are regularly on-site should be encouraged to report to a key contact in SHDC and/or the Environment Agency as to when a storm event has occurred and resulted in notable change in the beach levels. The key contact in SHDC and/or the Environment Agency can then call-out post-storm surveys via PCO. To support this, some basic training should be provided to the staff who are regularly on-site so they know what to look for. This could be based upon the Environment Agency's Condition Assessment Manual (Environment Agency, 2012a). The arrangements for this, once confirmed, should be captured in a formal communication document so that the role can be communicated to others in the future.

Once a greater amount of post-storm survey data is gathered, it will be possible to review data and determine if the post-storm profiles surveyed by PCO are the correct ones to be surveying in these circumstances (i.e. are the post-storm profiles representative of storm driven changes in the beaches).

5.2.1.3 Bathymetric Survey, Aerial LiDAR and Aerial Photography

Bathymetric survey data, aerial LiDAR and aerial photography should continue to be collected via and in line with the schedule set by the SWRCMP.

- A bathymetric survey is due to be completed every 5 years. The latest bathymetric survey was completed in 2008/2009, however, the next survey is scheduled for some time in the next funding phase.
- Aerial LiDAR surveys are to continue to be flown every five years, with some repeat sites flown every two years, although Slapton is not included. The latest survey was completed in 2017 and the next survey is scheduled for some time in the next funding phase.
- Aerial photography is taken at a different time to the aerial LiDAR surveys, with a view to repeat the photography every five years. The last aerial photography was taken in 2017, so the next survey will be undertaken sometime in the next funding phase. *With regards to the aerial photography, it is recommended that these continue to be delivered as high-quality aerial photo*

surveys – similar to those collected in recent years – and that when undertaken, the survey specification should state the need to achieve a RMSE of better than +/-10cm.

5.2.2 Plymouth University

5.2.2.1 Monthly Beach Monitoring

Since November 2006, Plymouth University have undertaken monthly surveys of the beach at Slapton between Torcross and Strete. The location of the profiles, numbered P0 to P20 are shown in Figure 5-2.

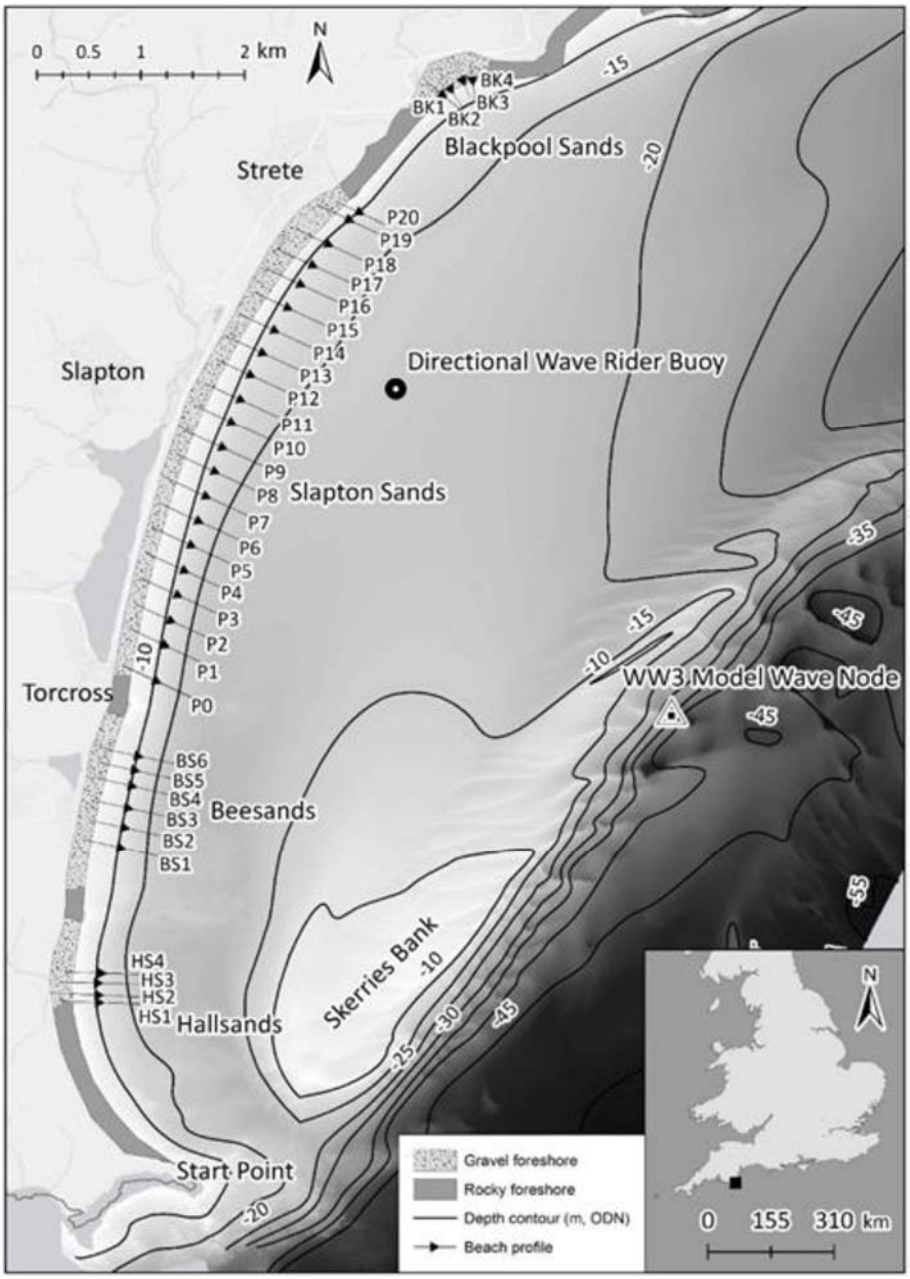

Figure 5-2 Plymouth University beach profile monitoring locations

5.2.2.2 Real Time Beach Monitoring

Real-time monitoring of beach levels (especially those in front of sea defences at Torcross, Beesands, and Hallsands) using either semi-permanent video cameras or laser scanners installed at each beach, would provide coastal managers with some warning about beach levels and imminent undermining of the engineered structures in Start Bay.

5.2.2.3 Morphodynamic Modelling

In addition to the beach monitoring activities undertaken by PCO for the SWRCMP and monthly surveys completed by Plymouth University, it is recommended that two linked modelling exercises are undertaken to help reduce the uncertainties in the existing data and better inform the analysis and interpretation of monitored data. Ultimately, this information will help to inform the assessment on whether beach recycling is a suitable option for the BMP frontage (discussed in Section 4.2.2.1).

1. Detailed numerical modelling: this is required in order to better understand the inshore wave conditions along the length of Start Bay under different scenarios. This can then feed into detailed alongshore transport modelling which will enable the quantification of alongshore transport rates and sediment gains/losses along the bay under different wave scenarios.

2. Process-based morphodynamic modelling: this is required to fully assess the vulnerability of the barrier system, and hence the A379 road, to overwash and breaching under different wave and sea-level scenarios.

5.2.3 Alarm Trigger Level Monitoring

As described in Section 4.2.5.1, Alarm Trigger Levels have been set for the BMP frontage, to determine when increased beach monitoring will be required. If Alarm Trigger Level 2 (high beach levels) or Alarm Trigger Level 3 (low beach levels) is reached, the primary response will be to undertake more frequent monitoring of the beach levels.

This should be undertaken on a weekly to monthly basis. Analysis and review of the data will determine if this is an ongoing-trend of high beach levels/beach lowering or if it is merely a temporary occurrence as a result of naturally dynamic beach level fluctuations. This ensures that (i) the changes are observed in a timely manner and not missed by less frequent planned beach profile surveys, and (ii) subsequently, action (for example beach recycling*) can be taken to rectify the high/low beach levels and reduce the risk of overtopping, overwashing and potential breach during storm events.

**Note on beach recycling; consideration should be given to recycling beach sediment along the BMP frontage. Any decision to undertake recycling in this situation will need to be based upon an assessment at the time of the beach volume distribution along the BMP frontage, and need to consider if recycling of material from one area to another will adversely affect beach levels, and so Standard of Protection, in the source area.*

5.2.4 Beach Recycling Logs

Whenever beach recycling works occur in the future (as described in Sections 4.2.2.1 and 4.2.5.2), then beach recycling logs are to be maintained by those undertaking the works, with the records then being passed to SHDC and PCO. This information will allow future analysis of beach volume changes to more accurately account for the effects of beach recycling work and will enable the underlying natural beach movements to be identified.

To support this, a template beach recycling log to be used is provided in Appendix J. It is to be completed in a simple manner, by tallying the number of truck or dumper loads (of known capacity) transported along the beach during a recycling event.

This could be supported by completing a pre- and post-beach recycling survey for the first one or two beach recycling campaigns to provide actual data against which the recycling logs can be validated.

5.3 Physical Condition Monitoring

5.3.1 Wave and Water Levels

Wave climate is monitored by a wave buoy located offshore of Slapton Sands in a water depth of approximately 10m water depth (refer to Section 2.1.1). The Slapton Sands wave buoy is maintained by PCO as part of the SWRCMP and recorded data is available through the PCO website (www.coastalmonitoring.org). There is currently only a relatively short-period of data available. The continuation of data capture by these wave buoys is vital to improving the amount of information available for future assessment of typical and extreme wave climate in the area, and validating numerical models.

Tide level data is recorded by a tide gauge located at Devonport in Plymouth, which is the nearest tide gauge to Slapton Sands.

5.3.2 Storms

The movement of material along the BMP frontage, and the risk of beach lowering leading to increased wave overtopping and/or undermining of the coastal defences and backshore, is significantly increased during storms as a result of increased wave action, particularly when storms waves combine with high tide levels.

A storm event record should be developed with details of the storm conditions (waves, winds and water levels), pre/post-storm surveys and effects/impacts of the event. The recorded should be updated following every storm. The data recorded can be analysed and interpreted in support of the post-storm profile surveys (discussed in Section 5.2.1.2). to understand the effect of storm events upon the beach response. Data from the Slapton Sands wave buoy and the tide gauge at Devonport should also be used for obtaining details of the wave and water level conditions at the time of the storm event.

Additional information on the offshore wave climate should also be recorded from other data sources such as near real time data from the National Data Buoy Centre (www.ndbc.noaa.gov/) and the CEFAS Wavenet (www.cefas.co.uk/data/wavenet.aspx) websites. These websites provide data for a number of locations between the Atlantic and the English Channel that are relevant to the BMP frontage, and recording of this information will allow assessment of any linkages between offshore and nearshore wave climate to be made once a sufficient data set is collected.

5.4 Warning and Emergency Procedures

5.4.1 Flood Warning and Response Procedures

Flood warnings and responses are co-ordinated by the Environment Agency's Flood Incident Management Duty Officer based in Exeter. The Duty Officer procedures are available through the Environment Agency's South West Incident Management (SWIM) website (www.imflooding.co.uk) – note this is a secure site for approved Environment Agency users only and all duty officers have access to the SWIM website. Up-to-date hard copies of the procedures are held in the Environment Agency Area Incident Room in Exeter.

5.4.2 Pollution Incidents

Pollution incidents can occur at varying scales. Minor pollution such as litter and small debris are typically dealt with by SHDC.

Larger pollution incidents are dealt with by a range of organisations including SHDC, Devon County Council and the Environment Agency. The responses to large pollution incidents are guided the Devon County Council Coastal Pollution Plan (June 2008).

5.5 Environmental Monitoring

The study area covered by this BMP is within the vicinity of a number of environmental designations, including international and European nature conservation features, designated bathing waters, and local landscape designations (refer to Section 1.4.2 and Section 2.7).

Future beach recycling, and/or the maintenance/improvement of existing coastal defence structures along the BMP frontage has the potential to impact upon the some of these environmentally important sites and so detailed investigation will be needed before any sediment is relocated or any construction occurs.

If beach recycling occurs in the future, or if new coastal defence structures are constructed, there will be a need to undertake regular water quality monitoring to assess the impacts (if any) of moving/placing material along the shoreline and/or altering the coastal defence arrangement. Bathing water quality monitoring is undertaken by the Environment Agency at several locations along the BMP study area (refer to Section 2.7.2). This data is considered sufficient to provide a robust baseline for future Water Framework Directive (WFD) assessment that would be needed as part of any potential future beach recycling that may occur. Post-implementation monitoring could be delivered to ensure the WFD objectives are not compromised by any future works along the frontage.

5.6 Data Capture

Having collected the beach monitoring data, it is important that all of the information is stored and analysed to allow decisions to be made with respect to ongoing maintenance and future management of the beaches and coastal defence assets along the BMP frontage for flood and coastal erosion risk management purposes.

Following each scheduled twice-yearly beach profile survey, the information collected is uploaded for storage and analysis to a database system that operated by the South West Regional Coastal Monitoring Programme at PCO. Additional survey data that is to be collected as per the requirements set out in this BMP, should be collected, stored and analysed in accordance with PCO quality standards and be compatible with PCO's database system (if PCO are not used to undertake the additional survey work).

Additional monitoring data, obtained from sources such as annual visual inspection of coastal defence assests (see Section 5.1.1), beach monitoring data collected by Plymouth University (see Section 5.2.2.1) or beach recycling logs (see Section 5.2.4), should also be stored in the same location.

SECTION 6

Action Plan

The Slapton Sands BMP Action Plan (presented in Table 6-1) provides a detailed list of actions that are required to take forward the recommendations made within the management approach to reduce the flood and coastal erosion risk between Torcross and Strete Gate over the next 20 years (see Section 4) and the monitoring programme (see Section 5).

The actions have been divided into a series of broad action 'types' relating to Beach Management and Planning, Maintenance (including maintenance of coastal assets), Monitoring, and Future Studies / Research. It is recognised that there is some inter-relationship between these broad action types.

The Action Plan is designed to be a working document and should be used to monitor the progress of each item. To assist with this, each action has been assigned an owner (responsible for undertaking/implementing the action) and a deadline for completion. The status column can be used to record progress; it is suggested that the Action Plan is re-visited and maintained frequently.

Table 6-1 Slapton Sands BMP action plan

**Note: Current status shaded in 'amber' indicates continuation of an item already ongoing / items started but not completed. Items, once completed, should be shaded green.*

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
Beach Management and Planning						
BMP_001	Undertake a review of the BMP in 5 years' time.	SHDC	January 2018	January 2023	General	Not started
BMP_002	It is strongly recommended that a Scoping Opinion be sought from the MMO in the immediate future to clarify this and determine whether or not a Marine Licence is required for ongoing beach recycling covering a period of ten years or so (in advance of any new scheme being implemented) and, if needed and given the time-scale involved in obtaining a Marine Licence (typically 14 weeks), obtain a Marine Licence from the MMO in good time to enable beach management works to be implemented when it becomes required.	SHDC	January 2018	July 2018	General	Not started
BMP_003	If beach recycling works are to occur within the BMP study area, without a Marine Licence and/or planning permission being in place, then consent will always be needed from Natural England each time works are carried out in the SSSI area.	SHDC	January 2018	As required	General	Not started
BMP_004	Prepare an Outline Business Case and submit to the Environment Agency's National Project Assurance Services to progress the preferred options. This will include work to refine the economic case and confirmation of funding contributions.	SHDC	January 2018	With immediate effect	General	Not started
Maintenance						
MAI_001	Maintain the existing seawall at Torcross.	Environment Agency	January 2018	Ongoing	Section 4.2.1.1(a)	Not started
MAI_002	Maintain existing 23m concrete seawall along landward edge of slipway.	SHDC	January 2018	January 2020	Section 4.2.1.1(b)(i)	Not started
MAI_003	Maintain existing 60m sheet pile wall at Torcross.	SHDC	January 2018	January 2020	Section 4.2.1.1(b)(ii)	Not started
MAI_004	Upgrade and improve existing 60m concrete seawall at Torcross.	SHDC	January 2018	January 2020	Section 4.2.1.1(b)(iii)	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
MAI_005	Upgrade and improve existing 700m of rock revetment at Torcross.	SHDC	January 2018	January 2020	Section 4.2.1.1(b)(iv)	Not started
MAI_006	Undertake periodic beach recycling, guided by ongoing monitoring and possibly new modelling (refer to Actions MON_008 and FSR_002).	SHDC	January 2018	If suitable and as required	Section	Not started
MAI_007	Undertake reactive realignment as and when/where needed.	SHDC	January 2018	As and when required	Section 4.2.3.1	Not started
MAI_008	Formally recognise the BMP study area, including 'The Line', within the Coastal Change Management Area (CCMA) and update the Local Plan. Produce a CCMA Adaptation Plan.	SHDC	January 2018	December 2018	Section 4.2.4	Not started
MAI_009	Undertake beach management works instigated by alarm and crisis trigger levels. This includes shingle clearance, more frequent and focused beach monitoring, beach recycling, putting contingency plan for A379 Slapton Line closure into place, emergency works to the A379 road, and reactive realignment.	SHDC	January 2018	As and when required	Section 4.2.5	Not started
MAI_010	If appropriate, undertake repair works to failing defences, including an armour flex blockwork, middle car park embankment and bastions as part of SHDCs ongoing coastal defence asset maintenance programme. Note that works to the armour flex blockwork, middle car park embankment and bastions do not form part of the proposed management approach and would need to be addressed by SHDC as part of their ongoing coastal defence asset maintenance programme. However, for completeness, an action has been included within the Action Plan.	SHDC	January 2018	With immediate effect	Section 3.12.2	Not started
Monitoring						
MON_001	Undertake an annual visual inspection of the coastal defence assets along the BMP frontage.	Environment Agency / SHDC	January 2018	Ongoing	Section 5.1.1	Not started
MON_002	Undertake post-storm visual inspections of the coastal defence assets along the BMP frontage as and when required.	Environment Agency / SHDC	January 2018	As and when required	Section 5.1.2	Not started
MON_003	Undertake defence monitoring as and when required.	Environment Agency / SHDC	January 2018	Ongoing	Section 5.1.3	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
MON_004	Undertake detailed inspection of the existing coastal defence assets every five years.	Environment Agency / SHDC	January 2018	January 2023	Section 5.1.4	Not started
MON_005	SWRCMP to continue with current monitoring including routine/bi-annual surveys, post-storm surveys, bathymetric surveys, aerial LiDAR and aerial photographs and annual reporting.	SWRCMP	January 2018	Ongoing	Section 5.2.1	Started (current phase funded to 2021)
MON_006	Plymouth University to continue with monthly beach monitoring of beach between Torcross and Strete.	Plymouth University	January 2018	Ongoing	Section 5.2.2.1	Started
MON_007	Real time beach monitoring using semi-permanent video cameras or laser scanners.	SHDC / SWRCMP / Plymouth University	January 2018	December 2018	Section 5.2.2.2	Not started
MON_008	Undertake numerical and morphodynamic modelling.	SHDC / SWRCMP / Plymouth University	January 2018	December 2018	Section 5.2.2.3	Not started
MON_009	Undertake more frequent monitoring in response to Alarm Trigger Levels.	SHDC	January 2018	As and when required	Section 5.2.3	Not started
MON_010	Ensure records are kept of any beach recycling works and complete a pre- and post-beach recycling survey for the first one or two beach recycling campaigns.	SHDC / Environment Agency	January 2018	As and when required	Section 5.2.4	Not started
MON_011	SWRCMP to continue to monitor and analyse wave data sourced from the Slapton Sands wave rider buoy.	SWRMP	January 2018	Ongoing	Section 5.3.1	Started
MON_012	Develop a storm event record with details of the storm conditions (waves, winds and water levels), pre/post-storm surveys and effects/impacts of the event. The recorded should be updated following every storm.	SHDC	January 2018	With immediate effect	Section 5.3.2	Not started
MON_013	Record additional information on the offshore wave climate from other data sources such as near real time data from the National Data Buoy Centre (www.ndbc.noaa.gov/) and the CEFAS Wavenet (www.cefas.co.uk/data/wavenet.aspx) websites.	SHDC	January 2018	With immediate effect	Section 5.3.2	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
MON_014	Flood warning and response to be continued by Environment Agency practice.	Environment Agency	January 2018	Ongoing	Section 5.4.1	Started
MON_015	Continue with current pollution incident practices.	SHDC, Devon County Council and the Environment Agency	January 2018	Ongoing	Section 5.4.2	Started
MON_016	Environmental monitoring will be required at the scoping stage of any beach recycling activities / works to coastal assets and subsequently to monitor the status of the environment post -works.	SHDC/Natural England	January 2018	As and when required	Section 5.5	Not started
MON_017	Continue with bathing water quality monitoring undertaken by the Environment Agency. Additional monitoring may be required after the placement of recycled material.	Environment Agency / SHDC	January 2018	As and when required	Section 5.5	Started
MON_018	Data capture and storage that is collected outside of the SWRCMP should be stored within one location for ease of reference and consistency.	SHDC / Plymouth University	January 2018	With immediate effect	Section 5.6	Not started
Future Studies / Research						
FSR_001	Collectively map new and current ecological, archaeological, and UXO survey data (for example form the Devon Biodiversity Records Centre data obtained during the development of this BMP and the latest RCZA). This mapped information will provide a firm basis for location of the following important ecological features within the BMP study area, which can be referred back to when seeking to implement the preferred management options for Torcross to Strete Gate.	SHDC	January 2018	July 2018	Section 1.5.3 and Section 1.7.8	Not started
FSR_002	Specific study to determine suitability of beach recycling along the BMP frontage and if so, potential volumes and frequencies of movement.	SHDC	January 2018	As and when required	Section 4.2.2.1	Not started
FSR_003	Update overtopping analysis with final JBA overtopping analysis.	SHDC	January 2018	As and when available	Section 3.12.1	Not started

SECTION 7

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SECTION 8

Glossary

Term	Definition
Accretion	Accumulation of sediment due to the natural action of waves, currents and wind.
Alarm level	A Trigger Level. The level before Crisis Level. This is usually a predetermined value where the monitored beach parameter falls to within range of the Crisis Level, but has not resulted in systematic failure of the function being monitored, e.g. recession of a beach crest eroding to within 10m of an asset, where it has been predetermined that an extreme storm event could result in recession of 5m. The Alarm Level in this example is therefore a 5m buffer. Increased monitoring would be required when an Alarm Level is compromised and intervention undertaken if deemed necessary. Managing Alarm Levels can be planned in advance.
Amenity	The tangible or intangible elements of a location that contribute to a perceived positive character of the area for the enjoyment of those that use it.
BAP	Biodiversity Action Plan. A strategy for conserving and enhancing wild species and wildlife habitats in the UK.
Bathymetry / Bathymetric (survey)	The measurement of depths of water in oceans, seas and lakes. Also, the information derived from such measurements.
Beach	A deposit of non-cohesive material (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively 'worked' by present day hydrodynamic processes (i.e. waves, tides and currents) and sometimes by winds.
Beach profile	Cross-section perpendicular to the shoreline. The profile can extend seawards from any selected point on the landward side or top of the beach into the nearshore.
Beach recycling/re-profiling	The movement of sediment along a beach area, typically from areas of accretion to areas of erosion, and shaping the beach profile to have a desired crest height, width and slope.
BMP	Beach Management Plan. It provides a basis for the management of the beach and defence asset system for flood and coastal erosion risk management purposes, taking into account coastal processes and the other uses of the coastal environment.
Breach	Failure of the beach / backshore allowing flooding by tidal action.
CIRIA	Construction Industry Research and Information Association.
Coastal Change Management Area (CCMA)	An area identified in Local Plans as likely to be affected by coastal change (physical change to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion). See related policy in paragraphs 105 to 108 of the National Planning Policy Framework.
Climate change	Long-term changes in climate. The term is generally used for changes resulting from human intervention in atmospheric processes through, for example, the release of greenhouse gases to the atmosphere from burning fossil fuels, the results of which may lead to increased rainfall and sea level rise.
Coastal change	Physical change to the shoreline, i.e. erosion, coastal landslip, permanent inundation and coastal accretion.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by a fixation of the high water mark.
Crest (in relation to beach)	Highest point on a beach face, breakwater or seawall.
Crest level/height	The vertical level of the beach relative to mOD.
Crest width	The horizontal distance of the beach measured from the seaward edge of the promenade to the point where the beach slope angle drops down towards the sea.

Term	Definition
Crisis level	A Trigger Level. The level at which the function being monitored, such as the stability of the beach and/or any structures (seawall/promenade/groyne), could be compromised and emergency remedial action becomes necessary, e.g. as in the case described under Alarm Level above, the beach crest recedes to within 4m of an asset that requires protection, where it has been predetermined that an extreme event could result in 5m of recession.
Defra	Department for Environment, Food and Rural Affairs (formerly known as MAFF).
EA	Environment Agency. UK non-departmental government body responsible for delivering integrated environmental management including flood defence, water resources, water quality and pollution control.
Erosion	Wearing away of the land, usually by the action of natural forces.
Flood and Coastal Erosion Risk Management (FCERM)	FCERM addresses the scientific and engineering issues of rainfall, runoff, rivers and flood inundation, and coastal erosion, as well as the human and socio-economic issues of planning, development and management.
FCERM GiA	FCERM Grant in Aid. The mechanism by which central Government funding for coastal flood defence and erosion protection works is accessed by operating authorities to deliver schemes.
Flood zone	A geographical area officially designated subject to potential flood damage. The Environment Agency uses Flood Zone 2 and Flood Zone 3.
Geomorphology/ morphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
GIS	Geographical Information System.
Groyne	Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain beach material. Most groynes are of timber or rock, and extend from a seawall, or the backshore, well onto the foreshore and rarely even further offshore.
Hard defence	General term applied to impermeable coastal defence structures of concrete, timber, steel, masonry, etc, which reflect a high proportion of incident wave energy.
Hold the Line	An SMP policy to maintain or change the level of protection provided by defences in their present location.
H_s	Significant wave height
Joint probability	The probability of two (or more) things occurring together.
Joint Probability Analysis (JPA)	Function specifying the joint distribution of two (or more) variables.
Joint return period	Average period of time between occurrences of a given joint probability event.
LiDAR	Light Detection and Ranging. This is an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground.
Listed building	A building or other structure officially designated as being of special architectural, historical or cultural significance.
Locally generated (wind) waves	Locally generated short period and irregular waves created by the flow of air over water.
Longshore transport	Movement of material parallel to the shore, also referred to as longshore drift.
mCD	metres Chart Datum. Approximately the lowest astronomical tidal level, excluding the influence of the weather.
mOD	metres Ordnance Datum. A universal zero point used in the UK, equal to the mean sea level at Newlyn in Cornwall.
Managed Realignment	An SMP policy, allowing the shoreline to move backwards or forwards, with management to control or limit movement. This includes reducing erosion or building new defences on the landward side of the original defences.

Term	Definition
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean High Water Springs (MHWS)	The average height of the high waters of spring tides.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Low Water Springs (MLWS)	The average height of the low waters of spring tides.
Met Office	UK Meteorological Office.
Monitoring	Systematic recording over time
Marine Management Organisation (MMO)	Marine Management Organisation. An executive non-departmental public body established and given powers under the Marine and Coastal Access Act 2009. Responsible for managing activities in the marine environment including marine licensing and marine planning.
Natural England	A non-departmental public body of the UK government responsible for ensuring that England's natural environment, including its land, flora and fauna, freshwater and marine environments, geology and soils, are protected and improved. It also has a responsibility to help people enjoy, understand and access the natural environment.
Nearshore	The zone that extends from the swash zone to the position marking the start of the offshore zone, typically to water depths of about 20m.
No Active Intervention	An SMP policy that assumes that existing defences are no longer maintained and will fail over time or undefended frontages will be allowed to evolve naturally.
Offshore	The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the seabed on wave action has become small in comparison with the effect of wind.
Overtopping	Water carried over the top of a coastal defence due to wave run-up exceeding the crest height.
Partnership Funding	A mechanism that provides funding in full or in part (alongside a proportion of total funding need from FCERM GiA) for coastal flood defence and erosion protection from multiple sources (including those that benefit directly from such measures).
Plymouth Coastal Observatory (PCO)	Plymouth Coastal Observatory. Based at the University of Plymouth, responsible for the South-West Strategic Regional Coastal Monitoring Programme (SWRCMP).
Present Value (discounted)	The value of a present of a sum of money, in contrast to some future value when it has interest earning potential and could therefore be worth more (a discount value of 3.5% was used for this study).
Policy Unit	A Policy Unit relates to the policy area defined by the Shoreline Management Plan (SMP).
Ramsar	Designated under the, “Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.” 1971. The objective of this designation it to stem the progressive encroachment onto, and loss of wetlands.
Return Period	A statistical measurement denoting the average probability of occurrence of a given event over time.
Rock armour	Wide-graded quarry stone normally bulk-placed as a protective layer to prevent erosion of the seabed and or other slopes by current and/or wave action.
Rock revetment	A sloping surface of rock or stone used to protect a shoreline against erosion.
SAC	Special Area of Conservation: this designation aims to protect habitats or species of European importance and can include Marine Areas. SACs are designated under the EC Habitats Directive (92/43/EEC) and will form part of the Natura 2000 site network. All SACs

Term	Definition
	sites are also protected as Site of Special Scientific Interest, except those in the marine environment below the Mean Low Water (MLW).
Scheduled Monument	Scheduled Monument: formerly referred to as Scheduled Ancient Monuments. Scheduled Monuments are nationally important archaeological sites which have been awarded scheduled status in order to protect and preserve the site for the educational and cultural benefit of future generations. The main legislation concerning archaeology in the UK is the Ancient Monuments and Archaeological Areas Act 1979. This Act, building on legislation dating back to 1882, provides for nationally important archaeological sites to be statutorily protected as Scheduled Monuments.
Scour	Removal of underwater material by waves or currents, especially at the toe of a shore protection structure.
Sea level change	The rise and fall of sea levels throughout time in response to global climate and local tectonic changes.
Seawall	Massive structure built along the shore to prevent erosion and damage by wave action.
Sediment transport	The movement of a mass of sedimentary material by the forces of currents and waves.
Significant wave height	The average height of the highest of one third of the waves in a given sea state.
SMP	Shoreline Management Plan. It provides a large-scale assessment of the risks associated with coastal processes and presents a policy framework to manage these risks to people and the developed, historic and natural environment in a sustainable manner.
SPA	Special Protection Area. These are internationally important sites, being set up to establish a network of protected areas for birds.
Spit	A long, narrow accumulation of sand or shingle, generally lying in-line with the coast, with one end attached to the land the other projecting into the sea or across the mouth of an estuary.
SSSI	Sites of Special Scientific Interest. These sites, notified by Natural England, represent some of the best examples of Britain's natural features including flora, fauna, and geology. This is a statutory designation.
Standard of Protection (SoP)	The level of return period event which the defence is expected to withstand without experiencing significant failure.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Sustainability (in flood and coastal erosion risk management)	The degree to which flood and coastal erosion risk management options avoid tying future generations into inflexible or expensive options for flood defence. This usually includes consideration of other defences and likely developments as well as processes within catchments. It will take account of long-term demand for non-renewable materials.
Swash	The area onshore of the surf zone where the breaking waves are projected up the foreshore.
Swell waves	Remotely wind-generated waves (i.e. Waves that are generated away from the site). Swell characteristically exhibits a more regular and longer period and has longer crests than locally generated waves.
SWL	Still water level. The level that the sea surface would assume in the absence of wind and waves.
SWRCMP	South-West Strategic Regional Coastal Monitoring Programme. Based at the University of Plymouth with Teignbridge District Council as lead authority (see also PCO).
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Toe level	The level of the lowest part of a structure, generally forming the transition to the underlying ground.

Term	Definition
Trigger level	This is usually a predetermined value where the monitored beach parameter falls to within range that results in management action being required (see also Action Level and Crisis Level).
UKCP09	UK Climate Projections 2009. Research giving predictions of how future climate change may affect the UK.
UKHO	United Kingdom Hydrographic Office.
Wave climate	Average condition of the waves at a given place over a period of years, as shown by height, period, direction, etc.
Wave direction	Direction from which a wave approaches.
Wave height	The vertical distance between the crest and the trough.
Wave hindcast	In wave prediction, the retrospective forecasting of waves using measured wind information.
Wave period	The time it takes for two successive crests (or troughs) to pass a given point.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.
Wave reflection	The part of an incident wave that is returned (reflected) seaward when a wave impinges on a beach, seawall or other reflecting surface.
WSC	West Somerset Council. Coastal Operating Authority as defined under the Coast Protection Act 1949 with permissive powers to provide defence against coastal erosion.
WFD	Water Framework Directive. A European Directive that aims to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater.

Appendix A
Baseline Scoping Report

Appendix B
Coastal Processes Baseline Report

Appendix C
Environmental Baseline Report

Appendix D
Defence Baseline Report

Appendix E
Economics Baseline Report

Appendix F
Options Appraisal Report

Appendix G
Environment Agency Guide to Engagement

Appendix H
Defence Inspection Proforma

Appendix I
Defence Repair Works Proforma

Appendix J
Beach Recycling Log Template