REPORT (FINAL)

Seaton Beach Management Plan

Prepared for

East Devon District Council

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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.

Term	Definition
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.
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.
Outflanking	Waves or rising sea levels going around the end of a defence, causing erosion or flooding behind it.
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).
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.

Term	Definition
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 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).

Term	Definition
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.
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.

Executive Summary

This Beach Management Plan (BMP) covers the coastline from Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge. The open coast area covered by this BMP is the responsibility of East Devon District Council (EDDC), whilst the Seaton 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 to reduce the flood and coastal erosion risk between Seaton Hole, in the west, and Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 years, whilst recognising and managing the environmental and amenity implications of doing so. The BMP defines a maintenance and monitoring programme for the next 5 years to implement those identified activities, all within in the context of the long-term (100 year) policy intent for this area (as defined by the Shoreline Management Plan (SMP).

The specific objectives of the BMP are:

1. Ensure Seaton's coastal defences provide an appropriate standard of service.
2. Determine an appropriate management regime for Seaton spit.
3. To compliment Seaton Town Council's vision for the Seafront.
4. To carry out (1), (2) and (3) in an integrated, justifiable and sustainable way.

The Seaton coastline is at risk of both 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 primarily a rock revetment and a number of walls/seawalls. These coastal defences protect a number of assets, including:

- Up to 28 properties (and 8 flats) at risk of erosion at West Seaton. The discounted Present Value (PV) of these properties is estimated to be £4,843,131.
- Highways and utilities on the cliff top at West Seaton. Included with this is a section of the alternative and important local coastal route is also at risk (at the junction Old Beer Road and the B3172). The discounted Present Value (PV) is estimated to be £664,454 (which includes costs that would be incurred to manage changes to the junction).
- Up to 67 residential and 27 non-residential properties at Seaton. The discounted Present Value (PV) of these properties is estimated to be £571,000 (at present-day, not accounting for the effects of climate change and sea level rise).
- Up to 6 properties at risk of erosion on the east bank of the Axe Estuary harbour. The discounted Present Value (PV) of these properties is estimated to be £357,761.

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

The BMP sets out the plan for management and monitoring of the coastal defence assets and 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 20-30 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 along the BMP frontage (which is to be developed and implemented as soon as possible) is a combination of:

- Maintain and improve the existing defences between Seaton Hole and the West Walk Promenade.
- Maintaining the West Walk Promenade and Seaton seawalls.
- Do-nothing on the spit.
- Manage flood risk along the west bank Axe Estuary with the construction of a new scheme.
- Monitor and maintain the harbour walls on the east bank of the Axe Estuary.
- 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.
- Formally recognising the BMP area as a Coastal Change Management Area (CCMA), which is key to addressing the long-term inevitability of cliff erosion at West Seaton.

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.

A five-year programme for the management of the coastline between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20 - 30 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 and BMP Area

This Beach Management Plan (BMP) has been prepared for East Devon District Council (EDDC), and their partner, the Environment Agency. The BMP area covers the coastline from Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge, as shown in Figure 1-1.

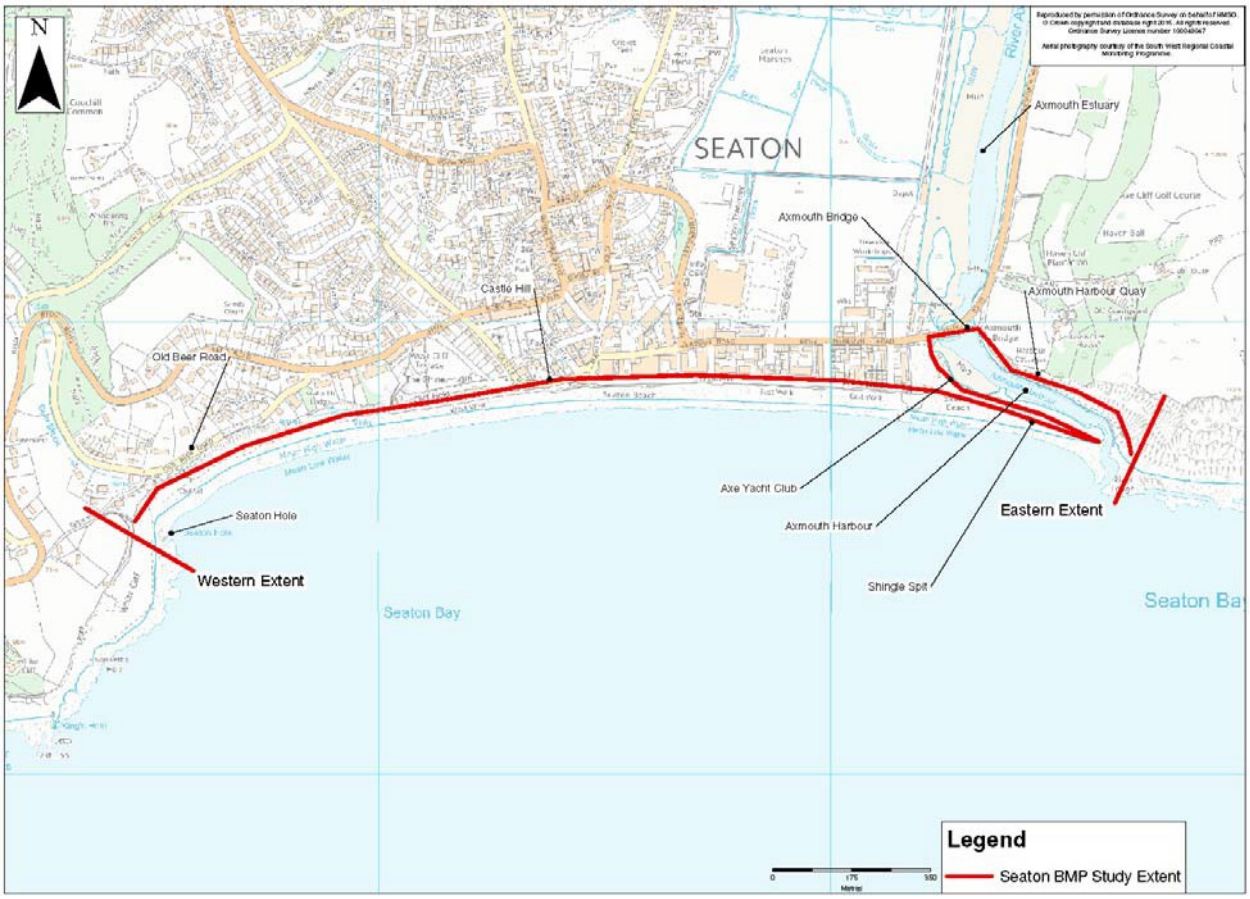

Figure 1-1 Seaton BMP area

The Seaton coastline is at risk of both 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 primarily a rock revetment and a number of walls/seawalls. These coastal defences protect various assets, including:

- Up to 28 properties (and 8 flats) at risk of erosion at West Seaton. The discounted Present Value (PV) of these properties is estimated to be £4,843,131.
- Highways and utilities on the cliff top at West Seaton. Included with this is a section of the alternative and important local coastal route is also at risk (at the junction Old Beer Road and the B3172). The discounted Present Value (PV) is estimated to be £664,454 (which includes coststhat would be incurred to manage changes to the junction).

- Up to 67 residential and 27 non-residential properties at Seaton. The discounted Present Value (PV) of these properties is estimated to be £571,000 (at present-day, not accounting for the effects of climate change and sea level rise).
- Up to 6 properties at risk of erosion on the east bank of the Axe Estuary harbour. The discounted Present Value (PV) of these properties is estimated to be £357,761.

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

1.2 Purpose of the Beach Management Plan

The purpose of the BMP is to identify the management activities to reduce the flood and coastal erosion risk between Seaton Hole, in the west, and Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 years, whilst recognising and managing the environmental and amenity implications of doing so. The BMP defines a maintenance and monitoring programme for the next 5 years to implement those identified activities, all within in the context of the long-term (100 year) policy intent for this area (as defined by the Shoreline Management Plan (SMP) and outlined in Section 1.7.1).

The specific objectives of the BMP are:

1. Ensure Seaton's coastal defences provide an appropriate standard of service.
2. Determine an appropriate management regime for Seaton spit.
3. To compliment Seaton Town Council's vision for the Seafront.
4. To carry out (1), (2) and (3) in an integrated, justifiable and sustainable way.

1.3 The BMP Area

1.3.1 Physical Setting

Seaton is a small seaside town and residential area within Seaton Bay in East Devon. The present-day coastline is a result of varying geology laid down over time, major geological earth movements and subsequent changes in sea level that has given rise to differential erosion.

At the very western limit of Seaton Bay, at White Cliff, the cliffs are high and steep and formed of sandstone, limestone and chalk that is largely resistant to erosion. Adjacent, the cliffs at Seaton Hole are high and comprised of sandstone overlying softer mudstone, but they reduce in height towards Seaton and the low-lying land of the Axe Valley as the overlying sandstone is replaced by the softer mudstone (Halcrow, 2011). A rock platform extends into the nearshore at White Cliff and Seaton Hole and there is also a small outcrop of rock in the vicinity of the Hideaway Café. The rock platform is understood to be made of mudstone (Posford Duvivier, 1994).

The Axe Estuary is fed by the River Axe and River Coly. Large areas of saltmarsh and mudflat have formed by the accumulation of silt brought down by the rivers over a long period of time, however, today much of the original saltmarsh and mudflat has been reclaimed.

To the east of the Axe Estuary, the high cliffs are characterised by a complex coastal slope that is the result of long-sustained processes and products of landsliding (SCOPAC, 2012). Such landsliding can be triggered by a combination of: prolonged intensive rainfall; ground water levels and the effect on rock structure; and marine toe erosion. Along the eastern limits of the study area, a rock platform extends

seawards from the Haven Cliffs, at the mouth of the Axe Estuary; this is generally covered by beach deposits, but is occasionally exposed.

The cliffs and valley are fronted by a shingle barrier beach, comprised of a mix of boulder and gravel fractions (chert) in the vicinity of Seaton Hole, and flint and gravel (chert) between Seaton Hole and the Axe Estuary (SCOPAC, 2012). Eastwards of the Axe Estuary, the barrier is comprised of an increasing mix of coarse gravel and boulders fed by landslide debris (SCOPAC, 2012).

At the eastern end of the BMP area, the barrier beach extends eastward from the foot of the cliffs at Seaton Hole and across mouth of the Axe Estuary, where it forms a spit (Seaton spit) and diverts the river mouth to the east.

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 A.

1.3.2 Environmental Setting

The Seaton Bay area is of considerable ecological importance, designated both internationally and nationally for its high environmental, landscape and geological value. The environmental and nature conservation designations within the BMP area are summarised below and described in more detail in Section 2.6.

- For its nature and geological importance:
  - Dorset and East Devon World Heritage Site (WHS).
  - Lyme Bay and Torbay Site of Community Importance (SCI).
  - Sidmouth to West Bay Special Area of Conservation (SAC).
  - Sidmouth to Beer Coast Site of Special Scientific Interest (SSSI).
  - Axmouth to Lyme Regis Under Cliffs SSSI/National Nature Reserve (NNR).
  - Axe Estuary Recommended Marine Conservation Zone (rMCZ).
  - Geological Conservation Review (GCR) sites.
  - Scheduled Monuments and Listed Buildings.
- For its landscape setting:
  - East Devon Area of Outstanding Natural Beauty (AONB).
  - East Devon Heritage Coast.
- For its water quality:
  - Water Framework Directive (WFD) Protected sites.
  - Seaton designated Bathing Water.

Designated sites within approximately 2km of the BMP area also require consideration when managing the coastline.

- Nature and geological conservation:
  - Beer Quarry and Caves SAC/SSSI.
  - River Axe SAC/SSSI.

- Spring Head - Axmouth SSSI.
- Exe Estuary Special Protection Area (SPA).
- East Devon Heaths Special Protection Area (SPA).
- Seaton Marshes Local Nature Reserve (LNR).

- Historical and cultural heritage:
  - Listed buildings and three Scheduled Monuments.
- Landscape setting:
  - Conservation Area.
- Water:
  - Water Framework Directive (WFD) Protected sites and Sensitive Habitat Features.
  - Beer designated Bathing Water.

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 1.3.4, 1.3.5, and 1.3.6 respectively, along with environmental considerations in Section 1.4.3 and license, approvals and consents in Section 1.6. Details of the environmental designations, conservation sites and features are provided in Section 2.6 of this report. The full **Environmental Baseline Report** is provided in Appendix B.

1.3.3 Coastal Defences

1.3.3.1 Defence History

The construction of coastal defences between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge dates to the early 1900's. The following provides a brief synopsis of the defences constructed over the past ~100 years with some additional key information of current defences provided in Section 3 of this report. Full details, including a chronological summary, photos and technical drawings, defence ownership and visual inspection / condition assessment, are provided in Appendix C (Section 2).

- Prior to 1915: A promenade extended between Seaton and Seaton Hole, following significant storm damage in 1915 was not replaced.
- Prior to the 1960s: Construction of West Walk Promenade along the base of the cliffs between Seaton and the café close to the Check House Wall (today the Hideaway Café). Remedial works were undertaken in 1993, with addition of the concrete/stone blockwork facing in 1996/1997.
- 1970: Seaton Hole concrete encased revetment constructed from scree material collected from base of White Cliff and sometime later encased in concrete.
- 1970's: Commencement of modifications to Seaton spit and western bank of the Axe Harbour, including maintenance dredging, disposal of dredge material within the spit, construction of defences in the lee of the spit on the west bank of the Axe Harbour including secondary fencing, rock armouring, bag works and a geotextile curtain (concrete mattressing). Issues relating to the

disposal of dredge material and management of defences are now recognised and discussed further in Section 1.4.3.

- 1978: Construction of the original harbour arm as a mass concrete gravity structure surrounded by sheet piling. In 1985 the harbour wall was refurbished, and again in 1998 and 2001, with the addition of a new 20m harbour arm extension in 2001 consisting of a lower level cellular structure, backfilled with concrete and supported by timber fendering and breastwork. Remedial works to the harbour arm were undertaken in in 2003 along with treatment to small areas of Accelerated Low Water Corrosion (ALWC).
- 1980: Construction of a 780m long concrete seawall and wave return wall by the South West Water Authority (now property of the Environment Agency) in response to severe flooding and damage following storms in 1979.
- Prior to 1990's: Construction of 60m long concrete gravity wall, known as Check House Wall. Remedial works were undertaken in 1995/1996 and 2005.
- Prior to 1994: 64m long rock revetment constructed at Seaton Hole (referred to as 'old revetment' herein).
- 1998 / 1989: 410m long rock revetment constructed between Seaton Hole (old revetment) and 'The Pillar'.
- 2002 / 2003: Gabions/concrete filled sandbags constructed around Seaton Hole outfall in response to landslip and debris fall in Autumn 2000. Remedial works were completed in 2005.
- 2003: At 'The Pillar', construction of gabion baskets infilled with concrete sand bags, with later addition of stone-filled gabion baskets.

1.3.3.2 Existing Defences

The existing coastal defences are shown in Figure 1-2, with further details provided in Section 3.

Figure 1-2 Existing coastal defences along the Seaton BMP frontage

1.3.3.3 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 the defences are in good condition. Check House Wall, the defences on the in the lee of the spit on the west bank of the Axe Harbour, and the sheet pile wall that forms part of the harbour walls on the east bank of the Axe Harbour were assessed as 'fair', whilst the concrete encased revetment at Seaton Hole, parts of the rock revetment between Seaton Hole and 'The Pillar', and the gabion baskets at 'The Pillar' were assessed as 'poor'.

Signpost!

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

1.3.4 Amenity Value

Seaton's two main functions are as a residential base, popular with retired people and commuters, and as a traditional seaside resort, supporting many small shops, restaurants and cafés (EDCC, 2013).

The Seaton Jurassic visitor centre is the newest attraction to the area and Devon Wildlife Trust's first flagship visitor centre. Seaton Marshes LNR wetland wildlife site is also an important a recent addition to

the area and is managed and financed by EDDC. Both attractions are important tourist, community and education developments in Seaton.

The Axe Estuary is a popular area for wildlife watching, particularly bird watching over the estuary and adjacent marshes. There are viewing platforms and hides along the western bank of the estuary, provided as part of EDDC's management of the Seaton Marshes LNR. There is an existing programme of education events at the Axe Estuary, managed by EDDC, and run from the Seaton Marshes LNR Field Studies Base Wetlands Classroom (capacity: 50 people). This includes indoor and outdoor events and open days for the public and schoolchildren (Seaton Bay, 2012 via Finding Sanctuary, 2012). The Council's work on the Axe Wetlands Project has, over recent years, had huge impact, raising the biodiversity value and the public's understanding and appreciation of this special area (EDDC, 2013).

Recreational assets include the Axe Valley Museum, which is situated within Seaton Town Hall, and a Sea Discovery Centre located on the eastern side of the river, which displays the local sea life of Seaton Bay. In the summer, there are vintage open-air trams that run along the bank of the River Axe beside the marshes, across the river and then up to the medieval market town of Colyton. Redevelopment of the Harbour Road Victorian tramway terminus is due for completion in Easter 2018. Works include demolition of the existing terminus building, raising the site and track levels, construction of a new terminus building on the site to shelter additional tramway platforms, café, gift shop, storage areas and construction of an additional length of track (EDDC, 2015).

The South West Coastal Path currently runs along the BMP frontage, and from west to east, follows the cliffs at Seaton Hole, the beach and seafront along the Esplanade leading to the B3172 Harbour Road, and across the estuary via the Old Axmouth Bridge. Following cliff erosion and collapse of the Old Beer Road, an alternative route is available avoiding the eroding cliffs. Natural England has recently stated that the coastal path may be relocated inland at Seaton, due to cliff erosion, and allow its continuation as an important tourist attraction (Natural England, 2017a).

Seaton Beach front is a popular walking and running route. Seaton's weekly community 5km parkrun takes place every Saturday morning at the Esplanade attracting runners of all ages and abilities averaging 140 runners per week (Parkrun, 2017).

Seaton's pebble beach provides recreational opportunities for families, walkers and dog walkers (although certain areas are closed to dogs between May 1st to September 30th), wildlife watching, geology, beach fishing and access for swimming and surfing whilst the harbour slipways provide estuary and beach slipway access for local sea-going activities and water sports including, sailing and windsurfing. Seaton is home to a small harbour and port.

A number of EDDC owned beach huts are present on the beach at East Walk (mid-section of the BMP area), and placed on the promenade itself, at the far end of West Walk. These are leased to individuals on an annual basis, although often leased for many years. Huts are put up at the start of the season and taken down at the end.

To note: no change to the existing beach hut 'situation' is expected as part of the recommended management approach to reduce the flood and coastal erosion risk between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 years. Future management of the beach huts, including annual beach levelling and response to damage from storms, will be managed by EDDC via existing revenue funding.

1.3.5 Land Ownership

The land ownership within the BMP area is understood to be largely EDDC with exception to the western extent, where there are a large number of private landowners, who are currently dealing with serious erosion issues and loss of land with likely future loss of property:

Axmouth Harbour is owned by EDDC, who in turn lease the harbour to the Axmouth Harbour Management Company Limited (AHMC). AHMC has an independent Chair and Treasurer/Secretary together with representation from the Axe Yacht Club (AYC) and East Devon Fishermen's Association (EDFA)

AHMC leases the western side of the harbour to the AYC and the Eastern side of the Harbour to EDFA. There is also a sub-lease from AYC to Axe Vale Canoe Club. (www.axeyachtclub.co.uk).

1.3.6 Highways, Services and Utilities

1.3.6.1 Highways

There are no motorways or major A-roads within the BMP area, only local roads, which are discussed in Section 2.6.7.1.

1.3.6.2 Services and Utilities

At the far western end of the BMP area, there is an emergency/storm overflow from the pumping station at Beer Brook and Seaton Hole, that discharges 600m northeast of Beer beach (Environment Agency, 2017a). The outfall is referred to herein as the Seaton Hole outfall (refer to Section 3.1.1).

The Seaton sewerage treatment works outfall discharges to the River Axe Estuary (discharge is disinfected and designed to protect bathing water quality).

The storm/emergency overflow from the Harbour Road pumping station discharges to the Axe Estuary.

1.4 Issues and Considerations

1.4.1 Flood and Coastal Erosion Risk

The coastline at Seaton has a long-history of flooding. As documented by Posford Duvivier (1994), storm events have resulted in flooding at Seaton several times in the past including November 1924, January 1925, December 1978 and February 1979. The flooding that occurred in February 1979 was severe and in response a new seawall was constructed, however, more flooding occurred following a storm in December 1989, when the seawall was overtopped. A number of flood events along the Seaton frontage have occurred since, including in 2006 when insufficient warning to close the flood gates resulted in overflow through the gates and flooding of the seafront, and in 2014, when the seawall was once again overtopped. It was also noted during the project site visit on the 25th May 2017, that the Axe Yacht Club boat yard is regularly flooded by storm waves that enter through the estuary.

Future anticipated flood risk can be determined by taking account of the presence of coastal defences, the height of shoreline and the hydrodynamic conditions being considered, i.e. extreme still water levels, return period and the inclusion of wave run-up and wave overtopping. Flood risk mapping completed by the Environment Agency (presented in Figure 1-3) shows the predicted areas of land that could be inundated by coastal water in the absence of defences/channel improvements and under two scenarios:

- Flood zone 3: shows the area that could be affected by flooding from the sea by a flood that has a 1 in 200 year return period (or a 0.5% chance of being exceeded in any year); or from a river by a flood that has a 1 in 100 year return period (or a 1% chance of being exceeded in any year).
- Flood zone 2: shows the area that could be affected by extreme flooding from the sea and rivers, with a 1 in 1000 year return period (or a 0.1% change of being exceeded in any year).

It should be noted that the flood zones are a projection of still water level, and do not include wave run-up or wave overtopping. However, recent work completed for the Lyme Bay Coastal Flood Forecasting

Phase 2 project (refer to Section 1.7.5) shows the present-day flood risk from wave overtopping of coastal defences under a range of extreme return period events (refer to Figure 1-4). The analysis and results that inform the overtopping estimates are also discussed in Section 3.4.1.

Also, to note, is that the Lyme Bay Coastal Flood Forecasting Phase 2 project, included modelling of a range of return periods for the present day, but only included a limited assessment of climate change for a sub-set of these return periods, which is insufficient for a full economics appraisal of future flood damages. It is recommended that if a 'scheme' for Seaton is going to be progressed, a more detailed assessment of flood risk/damages that assesses climate change impact for a full range of return periods is undertaken to determine a more accurate assessment of benefits and damages now and in the future, which can then be used to better determine the viability of options for the frontage. This is acknowledged in the BMP Action Plan (refer to Action FSR_001).

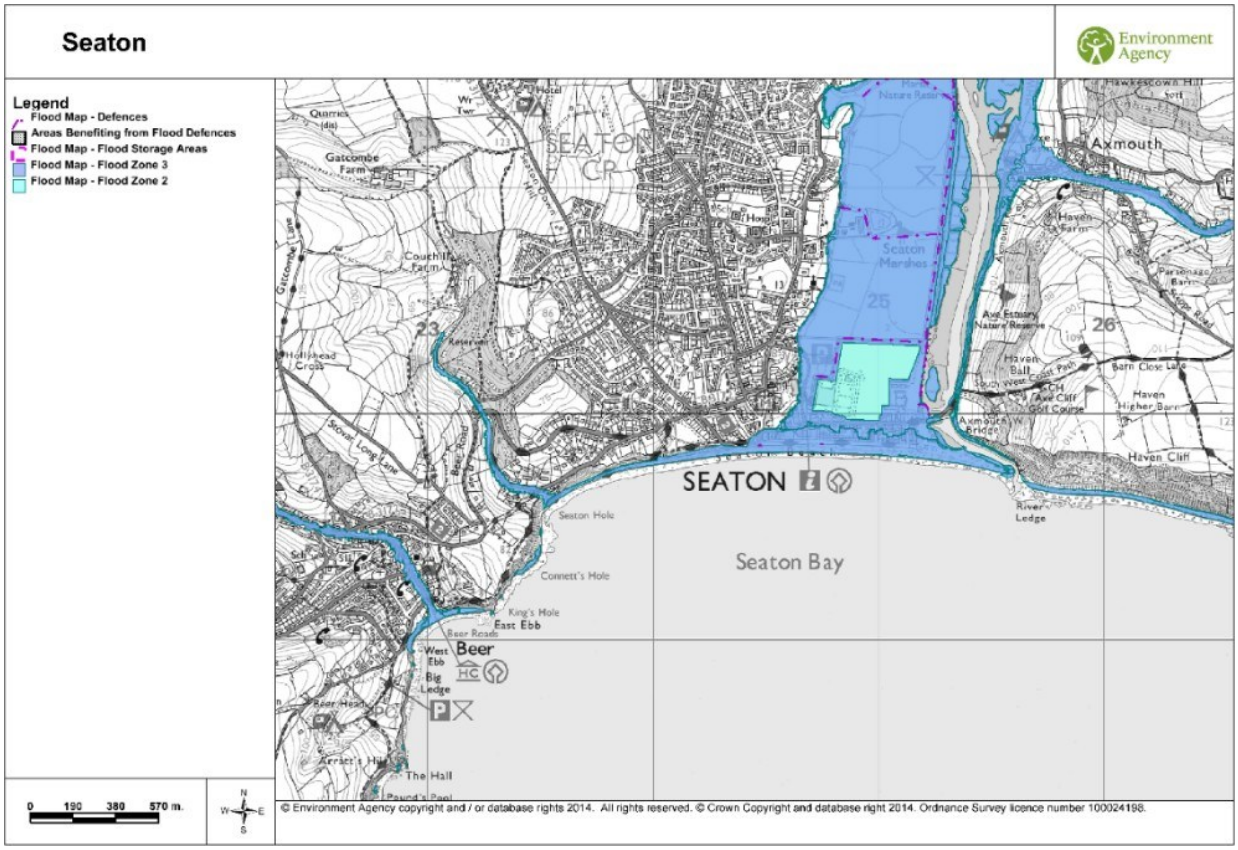

Figure 1-3 Flood Risk Map
Source: Latest mapping sourced from Environment Agency for this project

Figure 1-4 Present Day Flood Risk from Wave Overtopping of Coastal Defences Under a range of Return Periods
Source: CH2M, 2017a

The cliffs at Seaton Hole and West Seaton are subject to periodic failure events, which are well documented and are summarised below. Various rates of cliff erosion have been predicted but are based on an average rate of cliff recession caused by numerous events and do not take account of erosion that could occur during a single event. As they are therefore considered misleading, they are not reported here.

- Summer 2012 and winter 2012/2013: Landslip at Old Beer Road (David Roche Geo-Consulting, 2013; 2016). Sherrell (2012) reports that the landslip that resulted in the cracking along Old Beer Road as triggered by the saturation of the overburden soils and weathered mudstone in the upper part of the cliff.
- 13th September 2000: Landslip at Seaton Hole, with mass movement estimated to be in the region of 1,000m^3 to 5,000m^3 (David Roche Geo-Consulting, 2000).
- 1996: Landslip at Seaton Hole (observed from photos held by Seaton Museum).
- 1990s: 70m erosion Old Beer Road (Posford Duvivier, 1994).
- 1970s to 1990s: Prior to construction of the 65m long rock armour stone, local observations suggest cliff top erosion of 10m over a 20-year period (Posford Duvivier, 1994).
- 1960s – 1970s: Local erosion of the cliff toe at Seaton Hole (Posford Duvivier, 1994).
- Between 1903 and 1933: Over a period of 30 years, 5m of erosion reported to have occurred at Seaton Hole (Posford Duvivier, 1994). It is not clear from the report whether this erosion occurred during one event or a series of events over time.

Today debris, as well as man-made structures are observed to be falling out from the cliffs as they erode, which is a health and safety issue. Recommendations to address this have been included as part of the management approach for the BMP area, refer to Section 1.4.5 and Section 4.1.4.4.

1.4.2 Uncertainties Relating to Coastal Processes

A detailed review of coastal processes was undertaken as part developing this BMP. This is presented in full in Appendix A, with key information for beach management decisions summarised in Sections 2.1 to 2.5. This generally provides a reasonable understanding of the coastal dynamics along the BMP

frontage. However, there remain a number of key uncertainties and limitations to our understanding, which will ultimately determine the future behaviour and therefore management of the beach. These are discussed below:

- The sediment linkage between Beer and Seaton remains unclear as it has not been possible to identify a net cut-back at the beach downdrift and the beach profile data for the western end of the beach between Seaton Hole and West Seaton is limited and unreliable. Therefore, it is not certain as to whether the material that has accumulated in the lee of the concrete groyne at Beer has had a long-term impact on the beach at Seaton or represents only a reduction in supply. A potential option for consideration in the future could be to shorten/remove the groyne at Beer, however, there are many unknowns and uncertainties, namely, once shortened where would the material go? To better understand this, a specific study to investigate the impacts of removing the groyne at Beer could be undertaken. An action has been added to BMP Action Plan to reflect this (see item FSR_002).
- As beach profile data is only available from 2007 to 2016, through the SWRCMP, there are inherent uncertainties relating to long-term trends which extend beyond 2007. As above, in some locations, particularly at the western end of the BMP area between Seaton Hole and West Seaton, the data is limited and unreliable.
- It is evident from the review of existing data and new beach profile analysis completed for this study that the beach at Seaton is dynamic and volatile over short periods of time (i.e. from one survey to the next and in response to storms. Post-storm analysis shows a general easterly movement of material along the BMP coastline from west to east, with cross-shore changes resulting in both the build-up of material above HAT at some locations and the draw-down of material at others. This could be related to the wave direction, but, could also be a result of wave height or wave direction. Further analysis of the beach behaviour alongside wave climate could improve the certainty of this hypothesis.
- In response to severe storms in the late 1980's/early 1990's, the beach was depleted of material, however, since that time, the beach has built-up again. This behaviour may form part of a cyclical process (as observed at Sidmouth (CH2M, 2017b)), however, without a longer-term beach profile dataset, it is not possible to bring any certainty to this hypothesis.
- Review of existing data and review of aerial photographs clearly show the presence of dynamic estuary bar and delta at the mouth of the Axe Estuary, and build up material on the beach at the foot of Haven Cliffs. The part that this plays in transporting material across the mouth of the estuary and potentially storing material removed from the beach at Seaton remains uncertain and clarification could come from further study.

1.4.3 Dredging and Dredge Disposal Operations in the Axe Estuary

Dating back to the 1970's, material has been dredged from the Axe Estuary to form what is now the Axe Harbour basin, with further modifications to Seaton spit and western bank of the Axe Harbour, including the construction of various ad-hoc defences on the landward side of the spit, in order to stabilise the bank and thereby maintain the harbour. The dredged material has been disposed of within trenches dug into Seaton spit. More details are provided in Section 3.2.3.

There are now concerns that this practice is now threatening the integrity of the seawall at Seaton and the spit itself. In recognition of this, and in line with the aims and objectives of the BMP, formal consideration of dredge disposal options has been undertaken for the current BMP and an appropriate management regime for Axmouth Harbour has been defined (refer to Section 4.2).

1.4.4 Environmental Considerations

Arising from the Environmental Baseline Report (Appendix B), the following environmental considerations for beach management activities at Seaton have been identified:

- Construction works proposed below the Mean High Water Springs (MHWS) mark will require an application for a marine licence (refer to Section 1.6.1).
- Construction works above the MHWS may require planning authority permission to be sought (refer to Section 1.6.4).
- Access and noise/visual disturbance to recreational users in the vicinity of any future management beach management activities, as the beach is used extensively for amenity purposes – all works will need to be programmed to minimise the impact on amenity users by avoiding the peak holiday season, where possible. Also, there is a need to ensure safe public access during any possible recycling/re-profiling works. See also Section 4.3.2).
- Access and noise/visual disturbance to residents/local businesses.
- 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 site (refer to Section 1.6.2 and see also Section 4.3.3).
- Maintaining an existing coastal defence structure within its footprint may be considered permitted development (legal consultation required) but upgrading outside the existing footprint will likely require consent from the following organisations; Local Planning Authority, Environment Agency (environmental permitting) and the MMO.
- All BMP activities will need to comply with the requirements of the South West River Basin Management Plan, refer to Section 1.7.4.

1.4.5 Public Health and Safety

Observations made during a site visit and the visual inspection of coastal defences (refer to the Defences Baseline, Appendix C) and during the development of the BMP, raised a number of issues:

- Undermining of the gabion baskets that protect the Seaton Hole outfall is taking place, which could lead to its failure and ultimately a Health and Safety issue at the site of the outfall on the beach. It is recommended that necessary remedial works are undertaken. This action forms part of the recommended approach to management of the BMP frontage in the future, refer to Section 4.1.4.2)
- The footpath that passes directly behind the concrete-encased revetment may be unstable due to the failing defence. An assessment of the path is recommended and if necessary safety measures should be put-in place, or the pathway closed, or replaced as part of the works to upgrade the concrete encased revetment. This action forms part of the recommended approach to management of the BMP frontage in the future, refer to Section 4.1.4.3)
- As noted in Section 1.4.1, a consequence of erosion of the cliffs between Seaton Hole and West Seaton is the accumulation of debris at the cliff toe, for example an outfall pipe and a large section of trees and vegetation. Such items could represent a health and safety hazard to beach users and removal of such items should be undertaken. This action forms part of the recommended approach to management of the BMP frontage in the future, refer to Section 4.1.4.4.
- It has been observed that pollution is entering the sea from the brook running adjacent to Old Beer Road (west). An investigation should be undertaken by the Environment Agency and options to improve beach quality on the beach, which is also used by tourists, should be identified as part of

this work. This action forms part of the recommended approach to management of the BMP frontage in the future, refer to Section 4.1.4.5).

- The rubber seal on the outer section of the flood gates at Fisherman's Gap was either cracked or entirely detached from the gate, affecting the ability to achieve a complete seal. Works to improve the seals should be undertaken as soon as possible. This action forms part of the recommended approach to management of the BMP frontage in the future, refer to Section 4.1.4.6).
- As noted in the Environmental Baseline Report (and within Section 2.6.1), the top of the shingle ridge on Seaton Spit has naturally eroded over time and has become 'cliffed' and can be difficult to walk on safely in parts. The visual inspection / condition assessment undertaken for the BMP (refer to Defences Baseline Report, Appendix C; Section 3.8) also noted that exposure of the underlying dredged material has permitted cliffing of the beach to occur, and has made accessing the lower beach area more difficult. However, this cannot be remedied easily without removing the silt content from the compacted spit it its entirety; therefore, it is anticipated that the beach will be reprofiled over time by wave action.
- A suggestion was made during the development of the BMP to improve safety for people walking along the base of the cliffs between Seaton Hole and West Walk Promenade, for example signage at the location of the revetment. This is being actioned separately by EDDC through an existing project by EDDCs Beach Safety Officer, which aims to improve signage on beaches across East Devon.

1.5 Management and Funding

1.5.1 Responsibilities for Management of the Coastline

Responsibility for the management and operation of activities within the BMP 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
Seaton Hole outfall and gabions	EDDC	EDDC
Concrete encased revetment	EDDC	EDDC
'Old and new' revetment	EDDC	EDDC
'Former' gabion baskets at 'The Pillar'	EDDC	EDDC
Check House Wall	EDDC	EDDC
West Walk promenade (including concrete / stone blockwork seawall)	EDDC	EDDC
Fisherman's Gap flood gate	Environment Agency	Environment Agency
Seaton seawall	Environment Agency	Environment Agency
Seaton spit	EDDC	EDDC
Harbour management	EDDC	Axmouth Harbour Management Company Limited (AHMC)
Harbour west bank Axe Estuary	EDDC	Axmouth Harbour Management Company Limited (AHMC) Axe Yacht Club (AYC)

Coastal Defence / Management Activity	Ownership	Assigned Responsibility
Harbour walls east bank Axe Estuary	EDDC	Axmouth Harbour Management Company Limited (AHMC) East Devon Fishermen's Association (EDFA)
Harbour training wall	EDDC	EDDC
Clearance of storm debris and shingle from the seawall and esplanade/road behind	Devon County Council (Highways)	EDDC (Street Scene)
Monitoring of beach and other coastal processes	n/a	South West Regional Coastal Monitoring Programme
Initiation of post-storm surveys	n/a	EDDC
Flood warning	n/a	Environment Agency
Flood incident response actions	n/a	Environment Agency and EDDC
Emergency planning	n/a	Environment Agency, EDDC and DCC

1.5.2 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 D; Section 4.2, and Appendix E; Section 1.7.

- Environment Agency via FCERM-GiA – whereby 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, 2017b), 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 EDDC via local levy, or Devon County Council.
- Third party funding, such as utilities companies, local landowners and residents.

When managing the coastline within the BMP area, there is a need to have a realistic view of what is possible with the funding that can be achieved. An estimate of potential FCERM-GiA funding (before

third party contributions are delivered) were made as part of the development of the BMP, and was identified to be in the region of £600k, to be allocated as follows:

- £490k for Seaton Hole to Seaton (erosion damages/risk);
- £70k for Seaton (flood damages/risk); and
- £40k for east bank of the Axe Estuary (erosion damages/risk).

Signpost!

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

1.6 Licenses, Approvals and Consents

There are no current activities licensed for flood and coastal erosion risk management purposes along the BMP frontage. Dredging of the Axe Harbour, and disposal of the dredged material above Mean High Water Springs has been exempt by the Marine Management Organisation, been granted an exemption under the 'Waste Management Licensing Regulations 1994' by the Devon County Council Environment Department, and more recently, excluded from the requirement for a Flood Risk Activity Environmental permit by the Environment Agency (more details are provided in Section 3.2.3.2). However, going forwards, 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 1.6.1).
- Habitats Regulations Assessment Screening exercise (see Section 1.6.2).
- SSSI Assent from Natural England (see Section 1.6.3).
- Planning Application under the Town and Country Planning Act 1990 (see Section 1.6.4).

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).

1.6.1 Marine License

Construction works proposed below the MHWS mark will require an application for a marine licence from the Marine Management Organisation (MMO). At present no Marine Licence is held to facilitate any potential future beach management works. Therefore, for example, to implement any beach recycling along the BMP frontage (as described in Section 4.1.2.1), 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.

1.6.2 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. Statutory Nature Conservation bodies would include Natural England.

1.6.3 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.

1.6.4 Planning Application

Construction works / any capital scheme may require some form of planning consent from EDDC. It is recommended that the local planning officer be consulted at the time when the works/ 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, EDDC would likely act as the Competent Authority.

1.7 Linkages to Other Relevant Documents

1.7.1 Durlston Head to Rame Head Shoreline Management Plan (SMP2) (2010)

The Durlston Head to Rame Head (South Devon and Dorset) Shoreline Management Plan (SMP), which covers the BMP area (Halcrow, 2011) is a coastal management document formally approved by Defra, and was adopted in 2011. The BMP area is located within Policy Units 6a30, 6a29, 6a28 and 6a25. The SMP policies recommended for the BMP frontage are provided in Table 1-2.

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

Policy Unit	Short Term (to 2025)	Medium Term (to 2055)	Long-term (to 2105)
6a30 Seaton (West) to Seaton Hole	Continue to maintain existing defences under a Hold the Line policy.	Continue to maintain existing rock revetment, until it becomes ineffective; at this time consider moving the revetment back to the base of the retreating cliff toe under a Managed Realignment policy.	Continue to maintain existing rock revetment, until it becomes ineffective; at this time consider moving the revetment back to the base of the retreating cliff toe under a Managed Realignment policy.
6a29 Axe Estuary (Spit) to Seaton (West)	Continue to maintain existing defences under a Hold the Line policy to maintain protection to Seaton.	Continue to maintain existing defences under a Hold the Line policy.	Continue to maintain existing defences under a Hold the Line policy.
6a28 Axe Estuary (Spit)	Allow natural coastal evolution to continue through No Active Intervention.	Allow natural coastal evolution to continue through No Active Intervention.	Allow natural coastal evolution to continue through No Active Intervention.
6a25 Axe Estuary (Mouth Breakwater to Axmouth North)	Continue to maintain defences through Hold the Line Policy.	Continue to maintain defences through Hold the Line Policy.	Continue to maintain defences through Hold the Line Policy.

1.7.2 Local Plan 2013-2031 - East Devon (2016)

The East Devon Local Plan defined strategies and policies relevant for flood and coastal erosion risk management activities. The Plan was adopted on the 28th January 2016.

Pertinent strategies and policies to the BMP area include:

- Strategy 44: Undeveloped Coast and Coastal Preservation Area.
- Strategy 5 – Environment.
- Strategy 25.5 - Development at Seaton: Environment.
- Strategy 45 - Coastal Erosion.
- Strategy 46 - Landscape Conservation and Enhancement and AONBs.
- Strategy 47 - Nature Conservation and Geology.
- Strategy 48 - Local Distinctiveness in the Built Environment.

- Strategy 49 – The Historic Environment.
- Policy EN4 - Protection of Local Nature Reserves, County Wildlife Sites and County Geological Sites.
- Policy EN5 - Wildlife Habitats and Features.
- Policy EN6 - Nationally and Locally Important Archaeological Sites.
- Policy EN7 - Proposals Affecting Sites which may potentially be of Archaeological Importance.
- Policy EN8 - Significance of Heritage Assets and their Setting.
- Policy EN9 - Development Affecting a Designated Heritage Asset.
- Policy EN10 - Conservation Areas.
- Policy EN14 - Control of Pollution.
- Policy EN18 - Maintenance of Water Quality and Quantity.
- Policy EN21 - River and Coastal Flooding.
- Policy EN25 – Development Affected by Coastal Change.
- Policy TC4 - Footpaths, Bridleways and Cycleways.

1.7.3 South Devon Catchment Flood Management Plan

The South Devon Catchment Flood Management Plan (CFMP) acknowledges sources of flooding from rivers in the South Devon Catchment. Properties at Seaton are thought to have the greatest concentration of flooding within the South Devon catchment with some 450 properties at risk from both river and tidal flooding. The plan notes the following issues that are relevant to the BMP area:

- 'The Axe estuary, to the east of Seaton, extends from the beach on the coast upstream for three kilometres to the A3052 bridge at Colyford. The Axe estuary is influenced by both fluvial and tidal flooding, but towards Seaton the main source of flooding is from the sea'.
- 'The town is protected to a design standard of 1% annual probability by the Seaton Marshes flood defence scheme, although a recent investigation has suggested that the actual standard may be as low as 5% (1 in 20 years). Approximately 5% of the Seaton Conservation Area is at risk if the existing defences are overtopped'
- 'The main source of flooding is from the sea. A tidal flood warning service and a Major Incident Plan is in place for Seaton for this risk. There is no flood warning in Seaton for flood flows in the River Axe'.
- '…ensure that the sewage treatment works at Seaton continue to be protected from flooding, ensuring that water quality is not compromised'.

1.7.4 River Basin Management Plan (2016)

The South West River Basin Management Plan (Environment Agency, 2016) 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 one nautical mile from shore. The BMP area lies within six WFD Water Bodies (one coastal, one river, one transitional and three groundwater) and all BMP activities need to comply with the requirements of this plan.

1.7.5 Lyme Bay Coastal Flood Forecasting Phase 2 Project (2017)

A project by the Environment Agency to produce updated flood risk mapping and flood warning procedures for Lyme Bay communities at Seaton, Lyme Regis and West Bay. Findings relevant to Seaton are discussed previously in Section 1.4.1 and in 3.4.1.

1.7.6 Seaton Coastal Study (1994)

Following flooding and loss of the beach towards Seaton Hole in 1989/99, EDDC undertook a study to look at the risk of erosion and flooding from Seaton Hole to the River Axe. The study recommended the construction of a rock revetment from Seaton Hole to West Walk.

1.7.7 South West Inshore Marine Plan (in Progress)

The BMP area lies within the South Marine Inshore Plan area. This Marine Plan is currently being developed by the Marine Management Organisation (MMO) in parallel to the South Offshore Marine Plan Area, which together form the South Marine Plan. 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. Consultation on the draft South Marine Plan is now closed and the MMO are currently analysing stakeholder feedback and responses. Finalisation, adoption and publication of the plans are expected winter 2019.

1.7.8 Jurassic Coast: Dorset and East Devon Coast Word Heritage Site Management Plan 2014 – 2019

UNESCO state that the "Protection and management of World Heritage properties should ensure that the outstanding universal value, the conditions of integrity and/or authenticity at the time of inscription are maintained or enhanced in the future."

The Dorset and East Devon Coast World Heritage Site (WHS) Management Plan 2014 – 2019 outlines how this is undertaken for the Dorset and East Devon Coast WHS and defines several aims, policies and the vision for the long term sustainable management of the site.

1.7.9 Coastal Access Program (2017)

Natural England has begun to investigate how to improve coastal access along a 109 km stretch of the South West Coast Path between Kingswear and Lyme Regis. This new access is expected to be ready in 2018. In relation to the Seaton BMP area, Natural England recently published the Kingswear to Lyme Regis sensitive features report (2017) with the following information.

1.7.9.1 Sid Estuary to Axe Estuary (Sidmouth to Seaton)

The Trail: 'The route of the proposed trail follows the existing South West Coast Path, mainly following the coastline quite closely, and maintaining good views of the sea apart from near Sidmouth and Seaton where the route moves inland to avoid areas of landslip and private residences. No improvements to the route are proposed. Existing signage and waymarking will be retained. Some new plaques will be added to fingerposts at key locations to show that the route is part of the England Coast Path.'

Coastal Margin: 'All land seaward and some land landward of the trail will become coastal margin.' 'We do not expect any noticeable increase in public use of the land either side of the route as a result of the proposals because it is already accessible. There is no reason to suppose members of the public would be interested in exercising their access rights to the cliff slope at these locations, since they do not do so now. Where there are existing fences, these will remain in place, providing a physical barrier which is an effective deterrent to access. Because the extent of new access rights is in keeping with already

established use and we don't expect there to be any noticeable change in access as a result of our proposals.'

1.7.9.2 Axe Estuary to Lyme Regis

'The Trail: 'The route of the proposed trail follows the existing South West Coast Path between the Axe Estuary and Lyme Regis. The route provides views of the sea at some points, generally towards each end of this section at Axmouth and Lyme Regis. The majority of the route passes through the Axmouth to Lyme Regis Undercliffs National Nature Reserve (NNR), an active coastal landslip system, where there are limited sea views. No improvements to the route are proposed. Existing signage and waymarking will be retained. Some new plaques will be added to fingerposts at key locations to show that the route is part of the England Coast Path.'

Coastal Margin: 'All land seaward and some land landward of the trail will become coastal margin.' 'The route passes through the Undercliffs NNR for most of this section, where access is limited to the route of the trail by the density of the surrounding woodland and advisory signage. The route then leaves the Undercliffs and passes behind Monmouth Beach into Lyme Regis.' 'The nature of the seaward coastal margin along much of the coast is steep inaccessible cliffs and dense woodland, this means that walkers and other users will normally remain on the established trail particularly through the Undercliffs NNR. There is no reason to suppose members of the public would be interested in exercising their access rights to the cliff slope at these locations, since they do not do so now. Where there are existing fences, these will remain in place, providing a physical barrier which is an effective deterrent to access. Because the extent of new access rights is in keeping with already established use we don't expect there to be any noticeable change in access as a result of our proposals.'

1.7.10 National Planning Policy Framework (2012)

The National Planning Policy Framework (NPPF) was published on 27 March 2012 and sets out the government's planning policies for England and how these are expected to be applied.

Particularly relevant to the Seaton BMP is Chapter 10. Meeting the challenge of climate change, flooding and coastal change, paragraphs 93 to 108.

Other NPPF planning practice guidance categories that may be relevant (but not an exhaustive list) to the Seaton BMP include:

- Delivering Sustainable Development;
- Flood risk and coastal change;
- Climate change;
- Conserving and enhancing the historic environment;
- Natural environment; and
- Environmental Impact Assessment.

SECTION 2

Supporting Information – Physical Environment

2.1 Waves

2.1.1 Typical Waves

Measured wave data in the vicinity of the BMP area does not exist, so typical wave conditions for Seaton have been obtained from modelled data. These models utilise real-time data from wave buoys; these buoys are located at specific locations along the coast and the models generate a synthetic record of wave climate for locations in-between. The models include a wave hindcast model undertaken by the Met Office, and more recently, an inshore wave model, undertaken by HR Wallingford on behalf of the Environment Agency. More details regarding the collection of real-time wave data and the models used is provided in Appendix A; Section 2.1.1.1.

The offshore wave climate at Seaton is dominated by prevailing waves from the south west and south south-west (refer to Figure 2-1). However, the inshore wave climate at Seaton is dominated by a predominant south and south-south-westerly wave regime, with less frequent waves approaching from the south and south-south-east (refer to Figure 2-2). SCOPAC (2012) report that the coastline at Seaton is afforded a degree of shelter from incoming south and south-westerly waves by Beer Head (SCOPAC, 2012).

In a previous modelling exercise for the Futurecoast project (Halcrow, 2002), offshore wave data from the Met Office Wave Model was transformed inshore to a prediction point off Seaton at -4.37mOD; the results indicate a dominance for south-easterly conditions, as shown in Figure 2-3. This difference may reflect changes in the real-time data or differences in the modelling approaches taken.

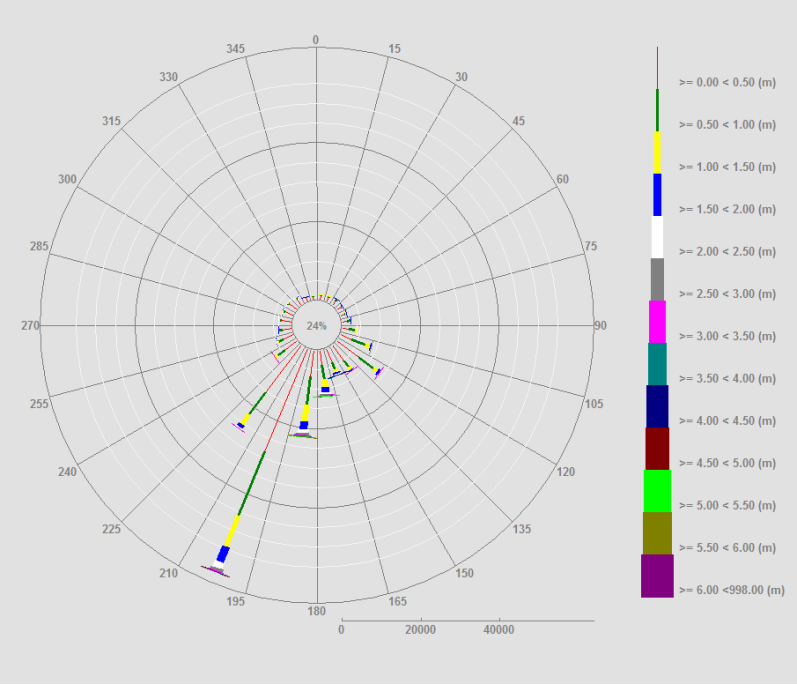

Figure 2-1 Offshore wave conditions at Seaton

Met Office WaveWatch III hindcast wave record for location '406' between 1/1/1980 and 31/12/2016

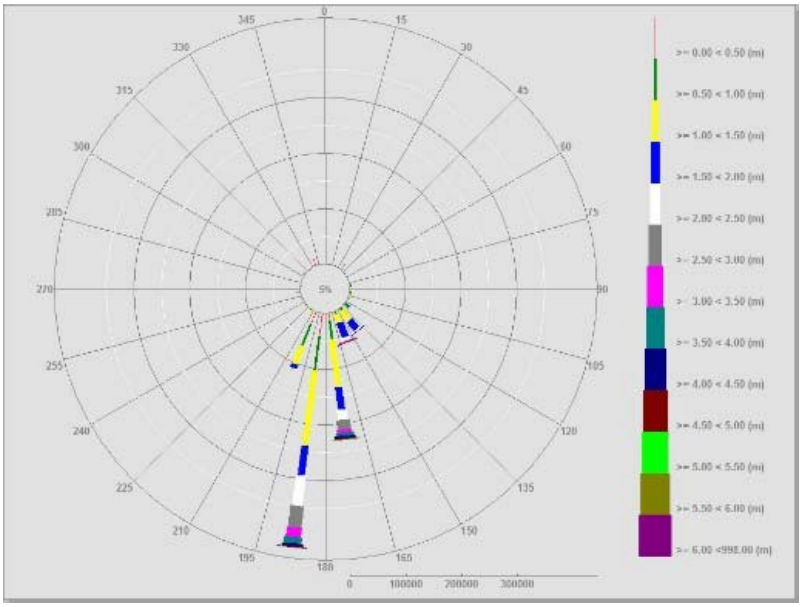

Figure 2-2 Inshore wave conditions at Seaton, generated from SoN data

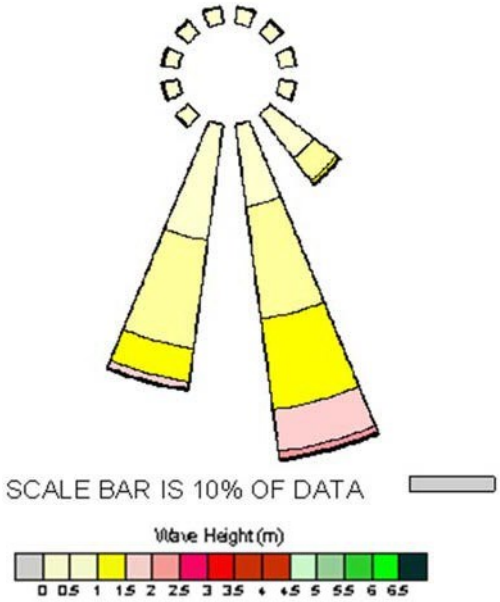

Figure 2-3 Results of wave modelling for Seaton
Source: Halcrow, 2002

2.1.2 Extreme Waves

No data on storm waves in the vicinity of Seaton was available at the time of writing this report. A history of past storms events, their direction and the impact that they had on the coastline was produced for the Coastal Processes Baseline Report (refer to Appendix A; Section 4.3.2.5).

2.2 Water Levels

2.2.1 Tidal Information

This is a meso-tidal coastline with a spring tidal range of 3.7m for Lyme Regis, the nearest tide data point to Seaton. A full list of tide levels for Lyme Regis is presented in Table 2-1.

A review of tidal currents was completed for the Seaton Coastal Study (Posford Duvivier, 1994). For a location 6km south-east of Beer Head, it is reported that tidal current speeds are low and on a spring tide, do not exceed 0.51m/s. Further inshore at Seaton, close to the spit, it is reported that there is a 2 to 3 knot (0.51 – 1.03 m/s) east to west tidal stream (*Pers. Comms*., Angus Walker, 2017).

Table 2-1 Tide levels (mOD) Lyme Regis, the nearest tide data point to Seaton (UKHO, 2013).

Tidal Condition	Tide Level (mOD) (UKHO, 2013)
Highest Astronomical Tide (HAT)	2.45
Mean High Water Spring (MHWS)	1.95
Mean High Water Neap (MHWN)	0.75
Mean Sea Level (MSL)	0.09
Mean Low Water Neap (MLWN)	-0.65
Mean Low Water Spring (MLWS)	-1.75

2.2.2 Extreme Water Levels

Still water level is defined as the water surface elevation at a point in time, including the mean sea level and storm surge (an increase in level caused by the effects of wind and atmospheric pressure changes associated with a storm), but excluding the effect of waves.

Extreme still water levels can lead to a risk of flooding and the level of risk will depend on the tide level and surge height at that time. For the purpose of coastal planning and design, a method has been adopted which enables predictions to be made about when and how frequently these extreme water levels could occur. The method involves the statistical analysis of existing water level data to determine the likelihood of a particular water level occurring and expressing this in terms of levels attributed to their respective average return period and equivalent annual exceedance probability (AEP).

In 2011, the Environment Agency undertook a national R&D project (Environment Agency, 2011a) to estimate extreme water levels for a number of locations around the coast of England, Scotland and Wales, for a range of return periods. The relevant extreme water levels for Seaton are presented in Table 2-2, showing that for a 1:200 year event, extreme water levels could be in the order of 7.45mOD, increasing up to 8.12mOD in 100 years' time.

Table 2-2 Extreme water levels for Seaton

Sourced from: Environment Agency 2011a; levels based on 'Med 95%ile' sea level rise scenario; refer to Table 2-3

Year	*Increase in Sea Level (m)*	Extreme Water Levels (mOD) by return period (1 in X years) and AEP (%)								
		1 (100%)	**5 (20%)**	**10 (10%)**	**20 (5%)**	**50 (2%)**	**100 (1%)**	**200 (0.5%)**	**500 (0.2%)**	**1000 (0.1%)**
2017	0	2.7	2.8	2.9	3.0	3.1	3.1	3.2	3.3	3.4
2025	0.051	2.7	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.5
2055	0.209	2.9	3.1	3.2	3.2	3.3	3.4	3.5	3.6	3.6
2117	0.671	3.2	3.4	3.4	3.5	3.6	3.7	3.7	3.9	3.9

2.2.3 River Flow

Little is documented on the flow of water through the estuary, however, Halcrow (2002) report that there is a mean discharge of 5 cubic metres per second (cumecs), increasing to a maximum of 108 cumecs in flood.

2.3 Climate Change and Risk

2.3.1 Sea Level Rise

The anticipated implications of climate change for the south coast of England are accelerated sea level rise, increased wave heights and increased occurrence and severity of storms (Royal Haskoning, 2011). The latest sea level rise scenarios are provided in Table 2-3 and indicate that over the next 100 years, sea level rise could be in the order of 0.28m to 0.51m, depending on the scenario considered.

Table 2-3 Cumulative sea level rise scenarios (mm/year)

Based on data presented in UKCP09 and latest guidance issued by the Environment Agency 2011b[1]

Scenario:	Low 50%ile	Med 95%ile	Upper End*	Surge for Upper End	Upper End + Surge	H++
2017 to 2025	0.03	0.05	0.03	0.23	0.20	0.05
2017 to 2055	0.11	0.24	0.26	0.61	0.35	0.48
2017 to 2116	0.28	0.51	1.09	1.79	0.70	2.30

*Although the upper end value is actually less than the medium 95%ile derived from the UKCP09 data, it is based on data within the current EA guidance note (2016).

2.4 Sediment Dynamics

SCOPAC (2012) produced a map of the principle sediment sources and sediment transport mechanisms for the area between Beer Head and Lyme Regis, refer to Figure 2-4. A summary of the sediment sources and sediment transport in and directly adjacent to the BMP area are provided in Sections 2.4.1 and 2.4.2 and respectively.

[1] This guidance has been reissued (2016), but with no changes to the parameters used here.

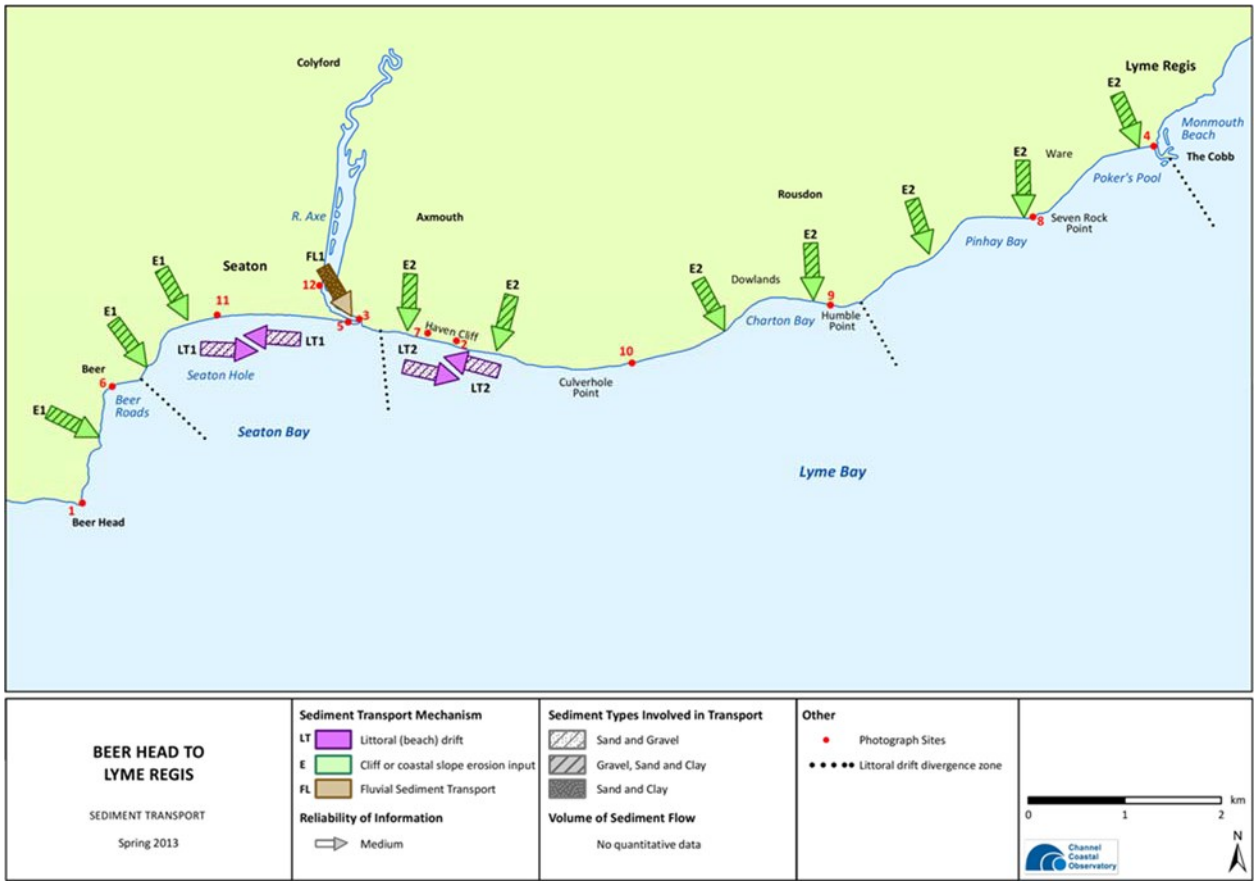

Figure 2-4 Sediment transport at Seaton and the surrounding area
Source: SCOPAC, 2012

2.4.1 Sediment Sources

Sediment is sourced from a number of locations within the study area; these are described below:

1. Erosion of the sandstone, limestone and chalk cliffs at White Cliff, however, they are largely resistant to erosion and protected at to some extent by the talus at the toe, so inputs from the cliffs are likely to be small.
2. Erosion of the mudstone cliffs between Seaton Hole and Seaton provides a source of fine sediment to the beach below (Halcrow, 2011), as observed during the coastal defence visual inspection and condition assessment undertaken for the BMP, and as shown in Figure 2-5. Past estimates of sediment supply suggest that the input is small (Posford Duvivier, 1994), but Posford Duvivier and British Geological Survey (1999) calculated a contemporary yield of approximately 6,000m³ per year (all fine sediment). A further 12,000m³ per year of fine material was calculated as being supplied from erosion of the shore-face. However, SCOPAC (2004) reported a high level of uncertainty regarding this supply.
3. There is a supply of sediment from the River Axe/River Coly into the Axe Estuary, which Rendel Geotechnics and the University of Portsmouth (1996) have estimated to be 600m³/year of fine sediment and 100m³/year of coarse sands and gravels. There is strong ebb tide flushing of material entering the Axe inlet from seaward, however, it remains uncertain as to how much of this material is stored in the estuary and how much is flushed back out from the estuary (SCOPAC, 2012).
4. Erosion of material from the cliffs east, however, quantities and transport pathways are uncertain.

5. Onshore supply of fine sediment (clay, silt and fine sand) (SCOPAC, 2012), initially eroded from the cliffs updrift and downdrift of Seaton before being transported offshore in suspension, and then back onshore, but to a different location under suitable hydrodynamic conditions.

Figure 2-5 Photographs showing release of fine material from eroding cliffs directly onto the beach
Photographs taken during defence condition assessment 14th June 2017, facing east

2.4.2 Sediment Transport Pathways

The key sediment transport pathways into, along and from the BMP area include:

- Tidal currents, both offshore and inshore of Seaton, are reported to be low and are incapable of transporting gravel, although have the capacity to move finer grained material along the coast (Posford Duvivier, 1994).
- A net eastwards longshore movement of gravel and sand, which occurs in response to the dominant wave influence from the south, south-south-west.
    - Generally, there is no discernible net transport between the discrete and closed pocket beaches at Beer, Seaton and the coastline to the east (SCOPAC, 2012). However, when wave energy is particularly intense, it is thought that there may in fact be some connectivity (SCOPAC, 2012), with the potential for transfer between Beer, Seaton and the coastline to the east. This is evident from observations made at Beer, where has been a build-up of beach material in the lee of the concrete groyne.
    - Studies indicate a net west to east movement of gravel and sand material along the coastline along the BMP area in response to this predominant wave direction (Posford Duvivier, 1994 Halcrow, 2011; SCOPAC, 2012). This is also evident by the presence of the spit that acts to deflect the Axe Estuary mouth to the east. Rates of longshore transport are considered to be low and intermittent, and estimated to be in the order of 3,000 to 3,600m³ per year (Posford Duvivier, 1994).
    - It is thought (Posford Duvivier, 1998a, 1998b; Futurecoast, 2002; SCOPAC, 2004; 2012) that there is also some sediment transport eastwards across the mouth of the estuary. SCOPAC (2004) provides a probable mechanism for this process: (i) firstly material enters the channel from the west driven by wave action (as well as small amounts of shingle from fluvial processes) and then, (ii), this is then flushed a short distance offshore by a combination of tidal and river flow, before being moved back onshore by wave action.

- A net westward movement of sediment (drift reversal) can occur under during periods when high-energy south-easterly winds and waves are prevalent, usually during the winter (SCOPAC, 2012). It is observed from aerial photography that the Axmouth harbour arm traps some of this material, however, the extent to which material accumulates in its lee is unknown. Posford Duvivier (1998a) suggest that there may be a drift divide at, or close to, Culverhole Point (located approximately 2km to the east of Seaton), with east to west movement along the gravel and boulder beach towards Axmouth:
    - Posford Duviver (1994) suggest that prolonged/extreme easterlies bring sediment to Seaton beach, where it accumulates and naturally replenishes the beach.
    - Material is not thought to move directly across the mouth of Axe Estuary (Posford Duvivier, 1994), but is firstly drawn seawards towards the bar/delta from where it makes its way westwards. In doing so, material is reported to bypass the training wall in the mouth of Axe Estuary during storms.
- Local variations in drift direction are also reported to occur as a result of:
    - The rock outcrops (rock platforms, namely at Seaton Hole and at several sites between Haven Cliffs and Pinhay Bay (Pitts, 1983)); and
    - Changes in the incident wave direction; it is reported that gross drift rates are potentially high over short periods and can operate in both east to west and west to east directions (Posford Duvivier, 1994; Axe Yacht Club, 2001).
- Approximately 1,500m^3/year of material is currently removed from the harbour within the Axe Estuary, via dredging practices, and disposed of within the Axe Spit; these operations are discussed in more detail in Section 3.2.3.2.

2.5 Shoreline Movement

2.5.1 Shoreline Evolution

2.5.1.1 Geological Evolution

Seaton is located on the fringe of the low-lying Axe Valley, which is bounded to the west and east by high cliffs and fronted by a barrier beach. The present-day coastline is a result of varying geology laid down over time, major geological earth movements and subsequent changes in sea level that has given rise to differential erosion. A summary of these key geological events is provided below, and draws from information provided by Seaton Museum (Seaton Museum, 2017) and SCOPAC (2012):

- Varying geology laid down during (some 252 to 66 million years ago (mya)):
    - firstly, mudstones (in the Triassic period, 252 to 201 mya),
    - followed by sandstone, then limestone, then chalk (in the Cretaceous period, 145 to 66 mya).
- Subsequent folding and faulting in response to major earth movements some 66 to 1.6 mya (during the Tertiary period):
    - During this time a major fault formed at a location now known as Seaton Hole, which caused the western side of the fault to drop relative to the east. This is evident today where the Cretaceous sandstone, limestone and chalk deposits that form White Cliff, lie alongside the mudstone cliffs that extend east from Seaton Hole to Seaton (as shown in Figure 2-6 and Figure 2-7).

- Sea level rise during the last interglacial (130,000 to 116,000 years ago) resulted in the formation of landsliding complexes (SCOPAC, 2012).
- Sea level fall (by up to 100m) during the last glacial (110,000 to 11,700 years ago) resulted in the weathering/mass movement of the cliffs via landslides to form debris slopes at the toes of the cliffs, specifically across the nearshore and offshore (Gallois and Davis, 2001).
- Most recently, sea level rise that began some 11, 500 years ago, resulted in different patterns of change (as described by SCOPAC, 2012):
    - Reoccupation of the debris slopes at the toe of the cliffs by the sea.
    - Mobilisation and evacuation of the debris.
    - New exposure of the cliffs to new weathering and erosion processes resulting in new cliff failures.
    - Continued coastal cliff recession and large-magnitude events, which created debris fans and boulder aprons.
    - Eastward and onshore transport of this debris is speculated to have resulted in the formation of a barrier beach, which lay seawards of the current coastline.
    - Subsequent onshore migration of the barrier beach.
    - Segmentation of the barrier as headlands emerged in the cliffs, resulting in the formation of pocket beaches.

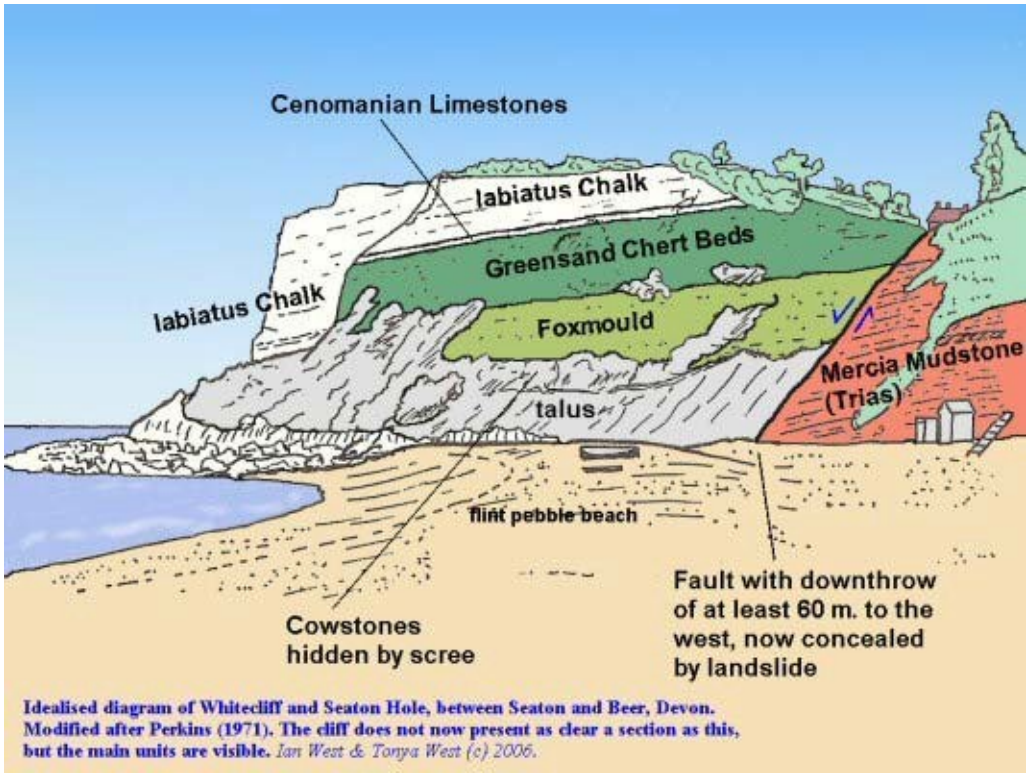

Figure 2-6 Juxtaposition of Triassic sandstone, chalk and limestones with Cretaceous mudstones at Seaton Hole
Source: Ian West and Tonya West © 2006, modified after Perkins (1971). Diagram used with permission of Dr Ian West (http://www.southampton.ac.uk/~imw/Beer.htm)

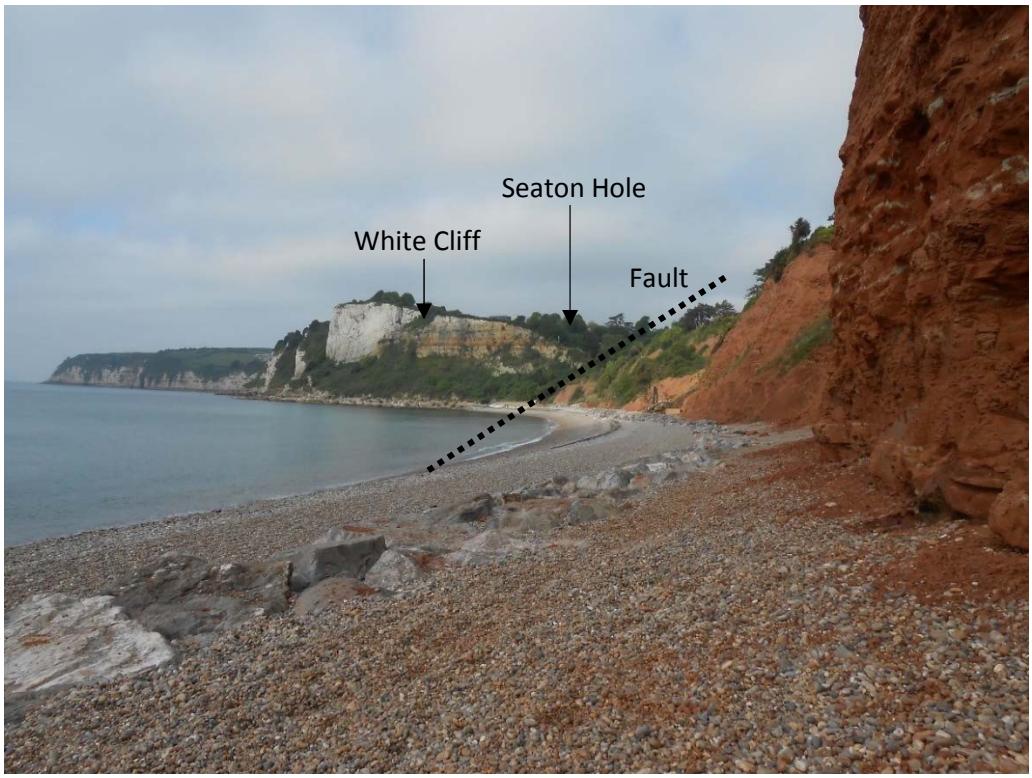

Figure 2-7 Photograph showing the geological fault at Seaton Hole
Photograph taken during site visit 24th May 2017, looking west

2.5.1.2 Geomorphological Evolution

The barrier beach is understood to have once been a long-continuous feature, located further offshore, that extended from Otterton Ledge to Chesil Beach, where it attaches to the Isle of Portland (SCOPAC, 2004). Gradual roll-back and retreat of the barrier in response to sea level rise and erosion processes, has resulted in the segmentation of the barrier between headlands (which formerly developed due to varying geological resistance to erosion (Halcrow, 2011)). Today, the barrier beach is nestled within discrete bays along the coast, such as at Beer and Seaton.

At the eastern end of the BMP study area, the barrier beach extends eastward from the foot of the cliffs at Seaton Hole and across mouth of the Axe Estuary, where it forms a spit and diverts the river mouth to the east. The spit is understood to have formed as a result of the longshore transport of material along the barrier beach from west to east (Halcrow, 2011). Both the beach and spit are reported to have remained relatively stable, in terms of overall position, over the past 100 years, with short-term changes occurring in response to storms (Halcrow, 2011).

2.5.2 Beach Profile Analysis

Existing data, observations made from aerial photography and anecdotal evidence all confirm that the shingle beach, and less frequently the spit, is subject to much fluctuation, sometimes resulting in the exposure of the underlying sandy substrate. To appraise the changes further, a detailed review of beach profile data and assessment of change has been completed for the BMP.

The review used data collected by Plymouth Coastal Observatory (PCO) and part of the Southwest Regional Coastal Monitoring Programme (SWRCMP), discussed in detail in Section 5.2.1. The review and assessment consisted of: (i) a review of existing PCO analysis; (ii) new analysis of the PCO profile data;

and (iii) post storm beach profile analysis. A summary of the findings is provided in the following sections; full results are included in Coastal Processes Baseline Report (provided in Appendix A).

2.5.2.1 Review of Annual Monitoring

A review of PCOs annual reporting on beach profile change has been undertaken for the coastline between Seaton Hole and Seaton Spit and is based on data collected between 2007 and 2017. The review compares the reported cross-sectional area change from one year to the next for the profiles between Seaton Hole and the Axe Estuary (profiles 6a01197 to 6a01157). The key findings summarised in Figure 2-8 and below.

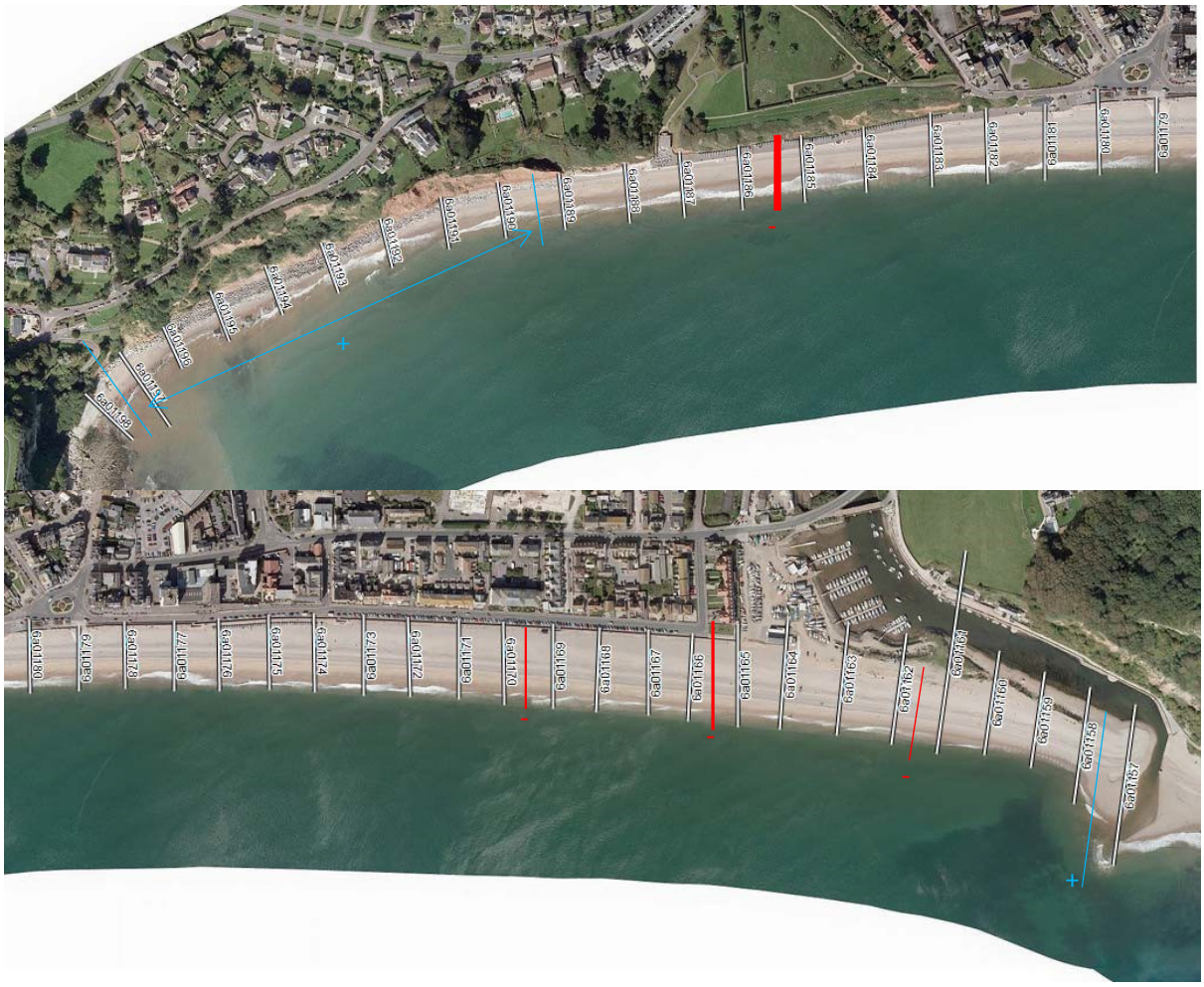

Figure 2-8 Map showing location of beach profiles with positive cross-sectional change shown in blue and negative cross-sectional change in red

- There is a clear trend of ***negative cross-sectional area change*** (i.e. erosion) during years;
  - 2007-2008.
  - 2009-2010.
  - 2011-2014.
  - 2015-2016.
- There is a clear trend of positive cross-sectional area change (i.e. accretion) during years;
  - 2008-2009.

  - 2010-2011.
  - 2014-2015 (all profiles accreted).
  - 2016-2017.
- Periods of erosion tend to be followed by periods of accretion, indicating recovery of the beach within a year of the erosion event.
- The sum of the cross-sectional change for all profiles and all years' (2007 to 2017) outputs is positive. This could indicate that the beach between Seaton Hole and the end of the Axe Estuary (profiles 6a01197 to 6a01157) is accreting. This would suggest that there is a contemporary supply of shingle to the beach, be it from downdrift (west), updrift (east), erosion of the backshore cliffs or offshore.
- At a few profile locations, the cross-sectional area change between 2007 and 2017 is positive, indicating accretion; these locations include:
  - Profiles 6a001197 to 6a01189 (Seaton Hole to Check House Wall) – these findings should be treated with caution; the latest PCO report (PCO, 2016) suggests that the large changes at profile 6a01193, reflect the profiles short length and not the material loss or gain and as observed from reviewing the beach profile data in SANDS; this can arise due to restricted access at the time of survey due to cliff hazards; and
  - Profile 6a001157 (distal end of the spit).
- At a few profile locations, the cross-sectional area change between 2007 and 2017 is negative, indicating erosion, however, it should be noted that PCO consider cross-sectional area change of less than 5m^2 to represent no change, and therefore these locations could in fact be considered to be stable. These locations include:
  - Profile 6a01185 (opposite the shelter, see Figure 2.9); and
  - Profiles 6a01169, 6a01165 and 6a0161 (eastern end of Seaton to the spit), see Figure 2.10.

Figure 2.9 Photograph of beach at the location of eroding beach at profile 6a01185 (approximate position shown by red line)
Photograph taken during defence condition assessment 28th June 2017, looking east

Figure 2.10 Map showing locations of eroding profiles at eastern the end of Seaton, including 6a01169, 6a01165 and 6a01161

Source: Photo Channel Coast Observatory, 2009

2.5.2.2 New Beach Profile Analysis

Beach profile analysis has been completed for the BMP study area to assess the change in cross-sectional area and volume of the beach for three separate sections, including;

- Seaton Hole to West Seaton – profiles 6a01198 to 6a01188 (excluding 6a01181 due to insufficient data).
- Seaton – profiles 6a01187 to 6a01165.
- Seaton Spit – profiles 6a01164 to 6a01157.

The analysis was completed using CH2M's SANDS programme and beach profile data collected by PCO for the SWRCMP. Since PCO survey only selected profiles on a regular basis, the analysis is limited to years 2007, 2012 and 2017. **As noted above, caution should be given to the figures generated for Seaton Hole to West Seaton as the profile data appears to have been affected by the presence of the cliff, rock revetment and accumulation of material on the rock revetment/at the cliff toe and restricted access during the survey due to cliff hazards; together this could bring about errors in the data.*

A summary of the key changes is presented below and in Table 2.5 and Table 2.5.

- The cross-sectional area and volume of the beach between Seaton Hole and West Seaton has increased between 2007 and 2017. **It should be noted that the profiles show that beach within this section is very volatile and varies considerably in height and width depending on the survey, and further, as mentioned above the results could potentially be driven by errors in the data.*
- The cross-sectional area and volume of the beach at Seaton decreased between 2007 and 2012, but increased between 2012 and 2017; the net result being an overall decrease. However, the difference was small and therefore it is concluded that the overall net change is one of stability. It is

observed from the beach profile data plotted in SANDS for 2007 to 2016, that the beach levels at the seawall do vary;

- At West Seaton, between profiles 6a01187 and 6a01181, beach levels are observed to fluctuate considerably, by as much as 2m at profile 6a01185; however, they do not reach the height of the esplanade.
- At the bottom of Castle Hill (between profiles 6a01180 and 6a01177), beach levels do not reach the height of the esplanade, but at the seawall, they fluctuate in the region of 0.6m.
- Along the western and central esplanade, between profiles 6a01176 and 6a01173, beach levels at the seawall are relatively stable, fluctuating by only approximately 0.1m.
- Along the central and eastern esplanade, as far as the Axe Yacht Club, between profiles 6a01172 and 6a01165, beach levels at the seawall fluctuate by approximately 0.6m and reach the height of the esplanade.

- The cross-sectional area and volume of the beach at Seaton Spit has increased between 2007 and 2017.

Table 2.4 Beach profile cross-sectional area change* above MLWS
**Change is calculated by taking the sum of the difference in CSA of the profiles within in section over time*

	Change in CSA (m^2) March 2007 to March 2012	**Change in CSA (m^2) March 2012 to April 2017**	**Change in CSA (m^2) Total Change March 2007 to April 2017**
Seaton Hole to West Seaton	73	125	199
Seaton	-155	137	-18
Seaton Spit	-77	260	183
	Subtotal (Seaton and Seaton Spit)		***165***
	Total Change (Seaton Hole to West Seaton)		***364***

Table 2.5 Beach profile volume change*
**Change is calculated by taking the sum of the difference in volume of the profiles within in section over time*

	Volume Change (m^3) March 2007 to March 2012	**Volume Change (m^3) March 2012 to April 2017**	**Volume Change (m^3) Total Change March 2007 to April 2017**
Seaton Hole to West Seaton	4,584	6,060	10,644
Seaton	-7,741	7,459	-281
Seaton Spit	-5,674	13,117	7,443
	Subtotal (Seaton and Seaton Spit)		***7,162***
	Total Change (Seaton Hole to West Seaton)		***17,806***

2.5.2.3 Beach Response to the 2014 Storms

Specific analysis has been undertaken by PCO to investigate the impact of the series of severe storms in January and February 2014 (PCO, 2014a; 2014b). PCO used LiDAR data to prepare a map of beach elevation change between 25th November 2011 and 15th May 2014, as shown in Figure 2.11.

Several key observations are made, as described below.

- A decrease in beach levels between Seaton Hole and West Seaton. **It should be noted that these findings are not reflective of the positive changes in cross-sectional area and volume observed from the beach profile data.*
- A decrease in upper beach levels and increase lower beach levels between West Seaton and the Esplanade, just west of Burrow Road, (half way along the Seaton frontage); this is indicative of beach draw-down.
- A decrease in beach levels along the upper beach and increase of the middle and lower beach at the eastern end of Seaton and along Seaton Spit and around the estuary bar/delta.
- A decrease in beach level along the top of Seaton Spit. It has also been reported that 40% of the eastern end of the spit was lost following the January/February 2014 storms (Author unknown 2, 2015); it is assumed that this is referring to material lost from the top of the spit as observed from the LiDAR difference plot, and from the post-storm beach profile data, discussed in the next Section.

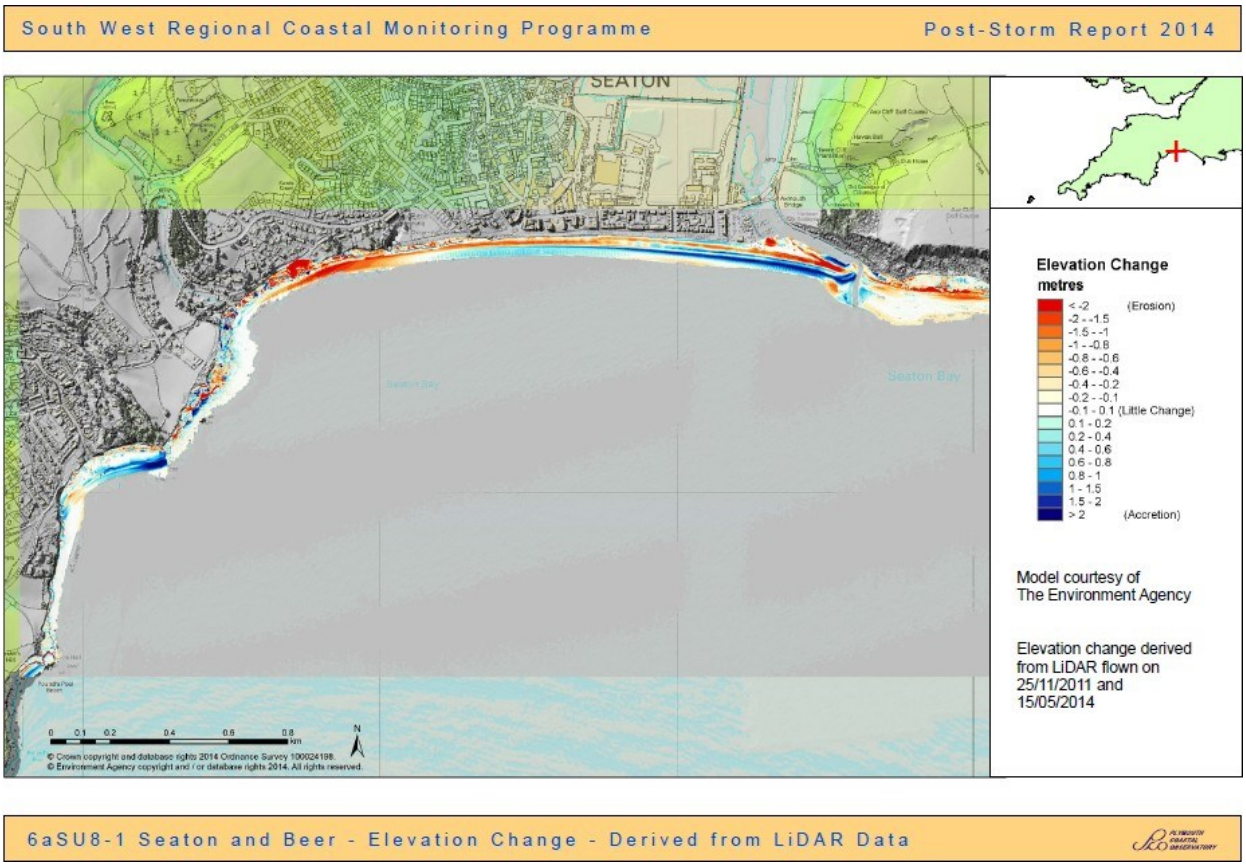

Figure 2.11 LiDAR topographic difference model plot for Seaton, showing the change in elevation between November 2011 (pre-storm) and May 2014 (post storm) (PCO, 2014b)

2.5.2.4 Beach Response to 2016 and 2017 Storms

As part of the SWRCMP, the response of the beach to storms has been assessed and post-storm profile data is available for 2016 and 2017. It is assumed that the 2016 post-storm profile was surveyed in response to the storm that occurred on the 6th February 2016, which was from the south-west, and from another storm that occurred sometime before the 7th February 2017; the direction of the storm is unknown. The data indicates that during storms there is significant redistribution across the frontage, with some profiles exhibiting build-up whilst others exhibit significant sediment loss. The varying

response of the beach to storms from one location to another and from one storm to another, suggests that the response of the beach is very sensitive to the direction of the prevailing storm waves.

- At the western extent of the Seaton seawall, opposite the bottom of Castle Hill (profile 6a01181), during both storms the beach lowered in front of the seawall, forming a berm or ridge further down the profile. During the 2016 storm, the berm formed around 3.6mOD, whilst during the 2017 storm, the berm formed at a much lower level, around HAT (2.6mOD). Unlike other profiles, the beach at this location tends to develop a single berm during storms whereas elsewhere a series of ridges form across the beach; this may be related to the volume of material on the beach. It is also noted that over time, the beach height at the seawall is observed to vary by over 1m.
- At the centre of Seaton beach (profile 6a01173), the beach immediately in front of the seawall appears to have remained relatively stable during the two storms, with the build-up of material above HAT during the 2016 storm but draw-down of the beach to below HAT during the 2017 storm.
- At the eastern end of Seaton beach (profile 6a01165), the beach was generally unaffected by the 2016 storm (which could be due to the beach level at the time). The 2017 post-storm profile was actually surveyed at the same time that the trench had been opened for the disposal of the dredged material (removed during winter 2016) and is therefore the profile above HAT is not reflective of post-storm beach behaviour. However, it is observed from the profile that during this time there was also some draw-down of material below MHWS (1.95mOD). Similarly, to the two profiles to the west, formation of a berm below HAT during the 2017 storm.
    - There is a clear trend for beach build-up of Seaton beach immediately in front of the seawall and an onshore movement of material when storm waves approach from the south-west. The opposite has occurred during 2017, so it is assumed that the storm waves may have approached the coastline from a different direction, perhaps the south or south-east.
- At the western end of the spit (profile 6a01161), material was eroded from the erosion of the base of the cliffed-beach / above HAT and deposited on the foreshore below HAT (2.45mOD) (i.e. drawn down). Although the profile appears to show significant cut-back of the upper beach to form a cliffed- faced, this erosion occurred previously sometime between the 16th November 2013 and 19th February 2014 (possibly the severe storms that occurred in January and February 2014, described above). Since then, the beach at the base of the beach (below a height of 5.5m) has fluctuated but the upper cliffed-beach remains largely unchanged.
- At the centre and distal end of the spit (profile 6a01159 and 6a01157), the 2017 storm resulted in lowering of the spit, but with deposition of material on both the landward and seaward face; which may have been caused by a combination of overtopping/overwashing and draw-down. The 2016 storm resulted in narrowing of the distal end of the spit, but a survey the following month shows widening of the spit, suggesting a rapid recovery.

2.5.3 Predictions of Future Shoreline Change

A requirement of developing this BMP is to provide predictions of future shoreline change for the 'With Present Management' and 'No Active Intervention' scenarios. A number of broad-scale assessments have already been completed including Futurecoast (Halcrow, 2002), the South Devon and Dorset SMP2 (Halcrow, 2011), and in 2012, the Environment Agency's National Coastal Erosion Risk Mapping Project.

The SMP2 (Halcrow, 2011) predicts how the shoreline at Seaton would respond to a 'No Active Intervention' and 'With Present Management' policy, and the predictions are summarised here. However, as raised by the Axmouth Spit Report (CH2M, 2015a), the dredging activities currently undertaken within Axmouth Harbour and subsequent disposal within the spit were not known about at the time of the development of the SMP2. Considering the information that is now known, the

predictions of future change for Seaton spit and Axmouth Harbour have been updated for the present study.

2.5.3.1 With Present Management

White Cliff

The cliffs and shoreline are presently undefended, so behaviour will be similar to the No Active Intervention scenario (see Section 6.2.1 below).

Seaton Hole to West Seaton

Erosion of the cliff toe behind the rock revetment at Seaton Hole will be prevented, thereby helping to reduce the rate of erosion of the cliffs. The defended sections of cliff, between Seaton Hole and West Seaton, will continue to help to keep the soft mud cliffs stable; however, the cliffs from above, would continue to experience simple landslide failures. Over time, narrowing of the beach could occur in response to future sea level rise as it becomes squeezed against the cliffs behind. Where defences occur, sea level rise could make the toe protection less effective and beach narrowing could cause the increased risk of failure of defences by undermining.

Seaton

The backshore will be held in position by the seawall. The beach and foreshore is anticipated to continue to undergo cyclic change in response to incident wave conditions and storms. Future sea level rise may result in narrowing and steepening of the beach as it attempts to roll back in response to higher sea levels.

Seaton Spit

The position and volume of the beach and spit would be maintained by the continuation of sediment feed from the west. It is anticipated that some roll back may occur as a result of overwashing during storm events. Continued deposition of dredge material within trenches dug into the spit will affect the ability of the spit to respond to incident wave conditions, potentially resulting in exacerbated cut-back, cliffing and narrowing of the beach as storm conditions vary in response to future sea level rise and any increase in the frequency of storm events.

Changes in sea-level and wave climate could also increase the risk of further overtopping of the spit. The continued defence at the western end of the spit may lead to a discontinuity in the plan form of the spit which could cause a breach in the spit.

Axe Harbour

On the western side of the estuary, ad-hoc defences will continue to fix the perimeter of the Axe Harbour basin in position. Continued dredging will reduce the rate of sediment build-up in the estuary, but reduce the overall resource of sediment in the system.

On the eastern side of the estuary, the training walls and quay walls will retain a stable inlet position except during periods of river flood. However, the impacts of changes to the shoreline updrift of here have not been considered by this report.

Haven Cliffs

Although there are currently no defences protecting this length of shoreline, the future behaviour of the cliffs will be determined by the presence of the river training wall and quay walls within the Axe harbour. The training wall is acting to hold the beach in front of the western end of the cliffs and the quay walls are acting to contain the river flow, thereby preventing erosion of the hinterland. With these structures in place, the beach width would be maintained and the harbour mouth fixed in position. The cliffs will continue to erode via active landsliding complexes at a frequency that is similar to present. This erosion would continue to provide a supply of material to the beach in ‘pulses’.

2.5.3.2 No Active Intervention

The SMP2 (Halcrow, 2011) has been used to provide predictions of how the shoreline at Seaton would respond to a 'No Active Intervention' policy, and the information is summarised, and amended in places, here.

White Cliff

The presently undefended cliffs would continue to experience only isolated failures at a similar frequency to that presently observed.

Seaton Hole to West Seaton

To the west, there would be little change to the existing situation until the concrete covered revetment reached the end of its working life. Following failure of the defence, the toe would become exposed to marine erosion and potentially increasing the rate of the cliffs there and adjacent, and there would be a new release of sediment to the foreshore, which may contribute to the beach stocks. The cliffs between Seaton Hole and Seaton would continue to experience toe erosion and simple landslide failures, releasing fine sediment to the shoreline.

Seaton

Without intervention, the integrity of the seawall would be compromised and there would be an increased risk of overtopping and flooding, particularly as sea levels rise. Following complete failure of the seawall, the backshore and shingle beach is likely to retreat and rollback. This section has a long history of flooding, which without the protection of the seawall would result in increasing overwash, overtopping and flood events. A barrier may form, but would depend on the rate at which the beach rolls back and the evolution of the beach and intertidal hinterland behind. The beach will receive an increased supply of sediment from the west and the undefended cliffs release material to the foreshore.

Seaton Spit

As for the 'With Present Management' scenario, the position and volume of the spit would be maintained by the continuation of sediment feed from the west. It is anticipated that some roll back may occur as a result of overtopping and overwashing during storm events. A barrier may form, but would depend on the rate at which the beach rolls back and the evolution of the beach and intertidal hinterland behind. Future sea level rise and any increase in the frequency of storm events could increase the risk of overtopping and overwash, which the risk of breach may reduce if a more natural barrier system were to form.

The problems associated with the disposal of dredge material in the spit would no longer apply, however, there would still be a legacy of historic fill which will affect how the spit is able to respond to prevailing conditions. In the short term, there could be a risk that the spit erodes through cutting-back, rather than rolling landwards, which may result in net narrowing. Once the fill has been washed out a more naturally functioning beach-spit system may resume.

Axe Harbour

On the western side of the estuary, without intervention, the integrity of the defences would be compromised, resulting in increased risk of overtopping and flooding, particularly as sea levels rise. Eventually, failure of the defences and cessation of the current dredging and disposal practices, would result in the landward face of the shingle spit becoming more mobile and dynamic, potentially improving the spit's ability to respond to storms and the longer-term process of rollback in response to rising sea levels.

On the eastern side of the estuary, without intervention, the integrity of the harbour walls would also be compromised and there would be an increased risk of overtopping and flooding, particularly as sea levels rise. In time, their failure could lead to increased exposure of the toe of the high, inactive, cliffs to

erosion. Such erosion of the cliff toe could lead to the re-activation of ancient major landslides. Failure of the landslides would result in the deposition of a sediment on the shoreline, which could ultimately lead to the blocking of the present Axe channel and the back-up of freshwater upstream, flooding the lower Axe valley. The pressure build-up behind the blockage would eventually cause a breach and a new tidal inlet would form towards the western side of the Axe valley which in turn would eventually be deflected back towards the east by coastal longshore processes.

Haven Cliffs

Without intervention, the integrity of the harbour walls, harbour arm and training wall within the Axe harbour would be comprised, and their failure, in time, would affect the future behaviour of the Haven Cliffs. The beach in front of the cliffs would no longer be held in place, and likely to be subject to narrowing and more fluctuation. Without the harbour walls and training wall, the mouth of the estuary and channel would be able to migrate. The cliff toe would be exposed to increased marine erosion, and the frequency of landsliding is likely to increase. This erosion would continue to provide an increased supply of material to the beach.

2.5.4 Conceptual Model

A conceptual understanding of shoreline behaviour and response has been developed based on a synopsis of the various data sources reviewed in this report and the new analysis undertaken. The conceptual understanding is summarised below.

- At a large scale, this coastline is controlled by the geology and geomorphology features. Varying geology laid down over time, major geological earth movements and subsequent changes in sea level have given rise to differential erosion and the emergence of a series of headlands and bays. To the west, this is by the more resistant sandstone, limestone and chalk deposits that make up Beer Head and White Cliff, east of there, the less resistant mudstone cliffs between Seaton Hole and West Seaton, to the centre, the low-lying Axe Valley and to the east, the Axe Estuary and Haven Cliffs.
- The beach is defined by a gravel/shingle barrier and sandy substrate that extends virtually along the entire length of the BMP area. The barrier is thought to be derived predominately from Holocene deposits transported onshore as sea levels rose, added to over the years with material derived from erosion of the cliffs to the west and east.
- Wave data for Seaton indicates that the predominant wave direction is from the south and south-south-west, with less frequent waves approaching from the south and south-south-east. The wave climate directly influences sediment transport along the coast, so that sediment transport is predominantly from west to east. During storms, the beach is particularly dynamic and the gravel/shingle ridge can be pushed up the beach or drawn-down to the nearshore/offshore. It is thought that the behaviour of the beach can depend on its geographical location within Seaton Bay.
- Defences constructed along the coastline at Seaton have helped to stabilise the cliffs to the west and fix the backshore position at Seaton. The construction of defences around the perimeter of the Axe Harbour basin also act to fix the backshore of Seaton spit where it joins to the mainland. Ongoing dredging over the years prevents siltation of the harbour, but disposal of the dredge material within trenches dug into the spit and beach have changed the composition of the beach and is likely to have affected its permeability, potentially increasing the rate of erosion and potentially threatening the ability of the spit to respond naturally to storms. The distal end of the spit has experienced significant cut-back in the past, particularly between November 2016 and February 2017, and although it has made some recovery, the upper beach is defined by steep cliff face and compacted interstitial sand and silts are exposed on the foreshore.

- Significant beach depletion occurred during the 1989/1990, 1992 and 1993 storms. The beach between Seaton Hole and Seaton has since built back-up again and over the period 2007 to 2017 (period covered by beach monitoring data) is generally stable at the western end of Seaton, however, in places, it is very dynamic and the beach volume fluctuates above MLWS over time. This change could be considered to represent a period of recovery, and form part of a larger cyclic process of erosion and accretion occurring over a 20-30-year period. This is not dissimilar from the 40-year cycle of recovery identified at Sidmouth (CH2M, 2017b).
- An absence of beach control structures on the beach means that it can respond naturally to storms, and as such is considered to generally be stable. However, changes to the beach profile that occur in a cross-shore direction whereby material is pushed up the beach in response to south-westerly storms, could result in increased run-up and overtopping of the seawall and spit during storms.

2.6 Environmental Characteristics

This section builds on the information on Environmental Setting in Section 1.3.2 and provides an overview of the key environmental characteristics and features within the BMP 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 B), which follow the recommended structure contained in the Beach Management Manual (CIRIA, 2010). As included within Section 1.4.4, 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).

2.6.1 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).

Axmouth harbour undertakes regular maintenance dredging every autumn/winter season, however sediment quality testing has not been undertaken since 1993 (since there has been no requirement under either the Marine Management Organisation (MMO) or the Environment Agency (EA) licensing exemption rules). Licensing exemption of the maintenance dredging was declared due to the small volume of dredged material involved and previous sediment quality testing being reported within the pass threshold. The existing method of burying dredge material within the spit (described in Section 3.2.3.2) has meant that over time the permeable and mobile shingle ridge has become unnaturally fixed and impermeable, so much so that a stable shingle ridge vegetation community has become well established (noted during the May 2017 site visit). This habitat is a UK Priority Inventory habitat, and a qualifying feature of the Sidmouth to West Bay SAC (although the spit is not part of the SAC designation, it does sit adjacent, on the eastern side of the Axe Estuary mouth within the study area). The fixed shingle ridge has naturally eroded over time and has become ‘cliffed’ and difficult to walk on safely in parts.

2.6.2 Water Quality

There are important water quality designations within the BMP area (see Figure 2-12).

2.6.2.1 Water Framework Directive Designated Waterbodies

There are five WFD designated waterbodies (WFD Estuarine and Coastal Water Bodies Cycle 2) within the South West River Basin District and the BMP area. They are listed below, with more details provided in Appendix B; Section 2.11.1.

- The Axe WFD water body, which comprises the River Axe section of the study area.

- The Lyme Bay WFD water body, which runs one nautical mile along the coastline of the BMP area.
- Three WFD water bodies, which protect groundwater areas that are located within the BMP area:
  - River Yarty and Lower Axe - Mercia Mudstone.
  - Lyme Regis.
  - Devon East – Greensand.

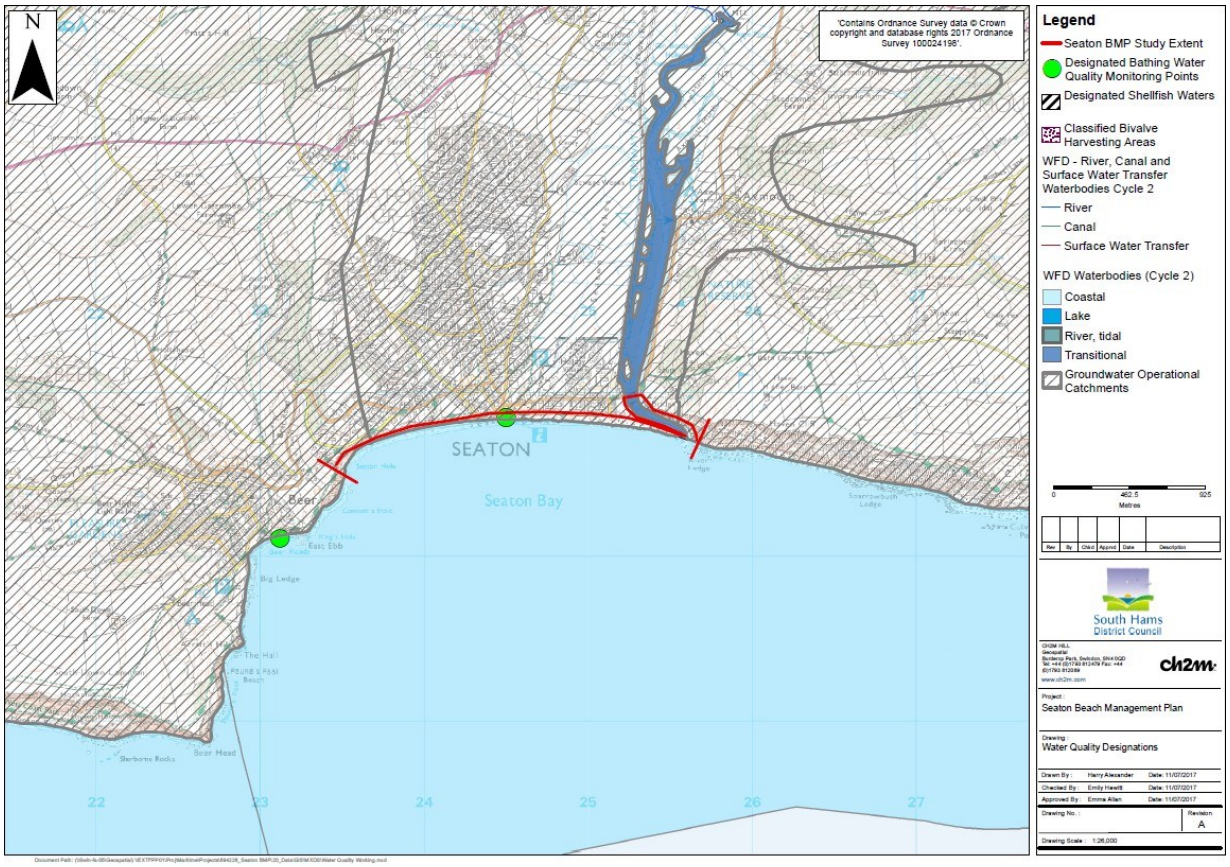

Figure 2-12 Water designations in the BMP area

2.6.2.2 Water Framework Directive: Sensitive Habitats

Within the BMP area, these waterbodies contain Water Framework Directive (WFD) Habitats considered of High and Low Sensitivity, as described below and shown in Figure 2-13 and Figure 2-14 respectively.

- High Sensitivity: Chalk Reefs, Subtidal Kelp Beds and Saltmarsh, including:
  - **Chalk reefs** (rMCZ designated Habitat Feature of Conservation Importance (FOCI). Present within the BMP area along the length of the BMP frontage and along the length of the Axe Estuary (ABPmer dataset, 2012).
  - **Subtidal Kelp Beds** (linked to SAC designated reef habitat in the Torbay and Lyme Bay SAC). Present at the eastern and western sections of the BMP area (Natural England dataset, 2014). Subtidal kelp beds, are associated with the presence of Subtidal Rocky Reef (see low sensitivity below).
  - **Saltmarsh** (SPA: Supporting Habitat and Priority Habitat (Environment Agency dataset, date unknown). Saltmarsh is present within the Axe Estuary. There is Saltmarsh near to the BMP area, north of the Axmouth Harbour and the Axmouth Bridge.

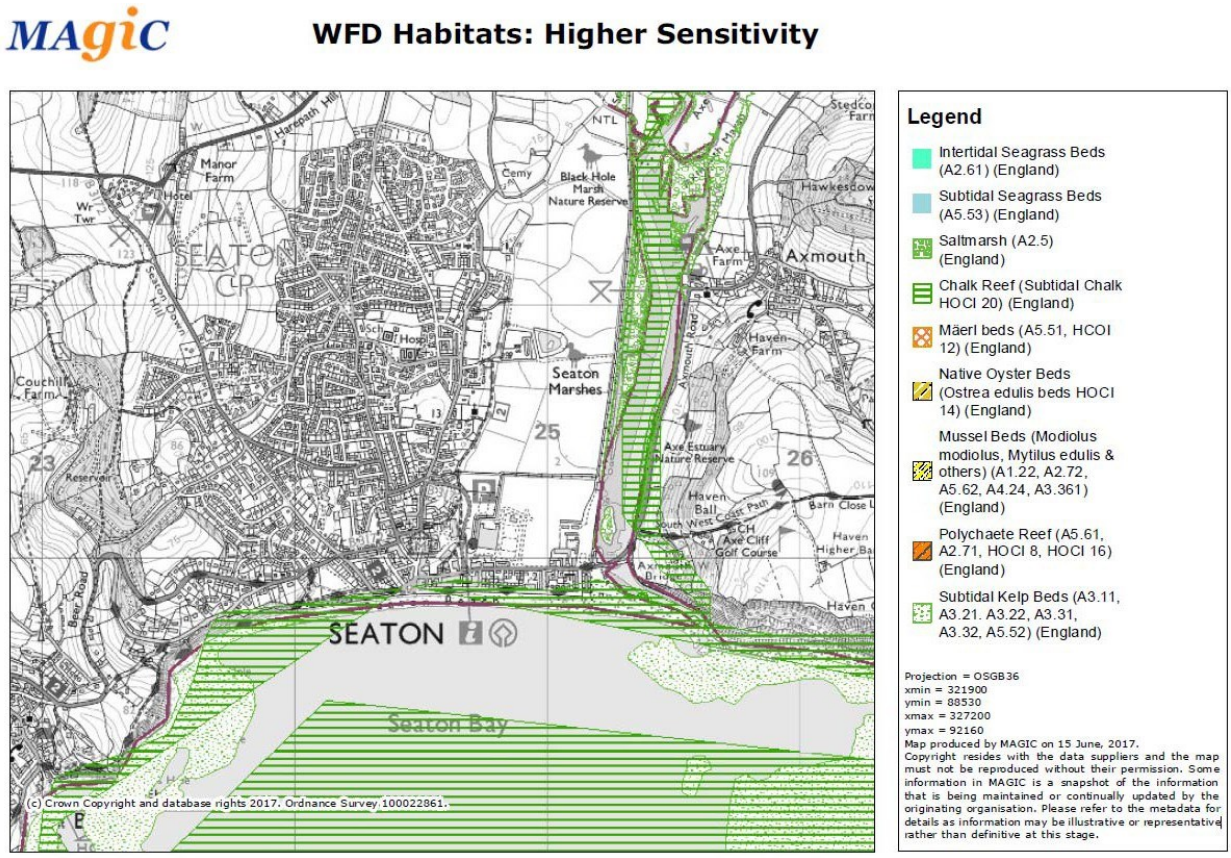

Figure 2-13 WFD habitats: high sensitivity

- Low Sensitivity: Gravel & Cobbles, including:

  - **Gravel & Cobbles** (also MCZ Broad habitat feature, (intertidal & subtidal coarse sediment). Present along the full length of the BMP frontage. (Natural England dataset, 2015).
  - **Intertidal Soft Sediment** (also MCZ Broad habitat feature, Sand, Mud & Mixed). Present within the Axe estuary and forms part of the shingle ridge (Natural England dataset, 2015).
  - **Subtidal Rocky Reef** (also designated SAC feature, and MCZ Broad habitat feature Infralittoral and Circalittoral rock). Present within the far east and far west sections of the BMP area (Natural England dataset, 2015).
  - **Rockyshore** (MCZ Broad habitat feature (intertidal rock). Present within the Axe Estuary, and fringes the Axmouth Harbour within the BMP area (Natural England dataset, 2013 - 2014).

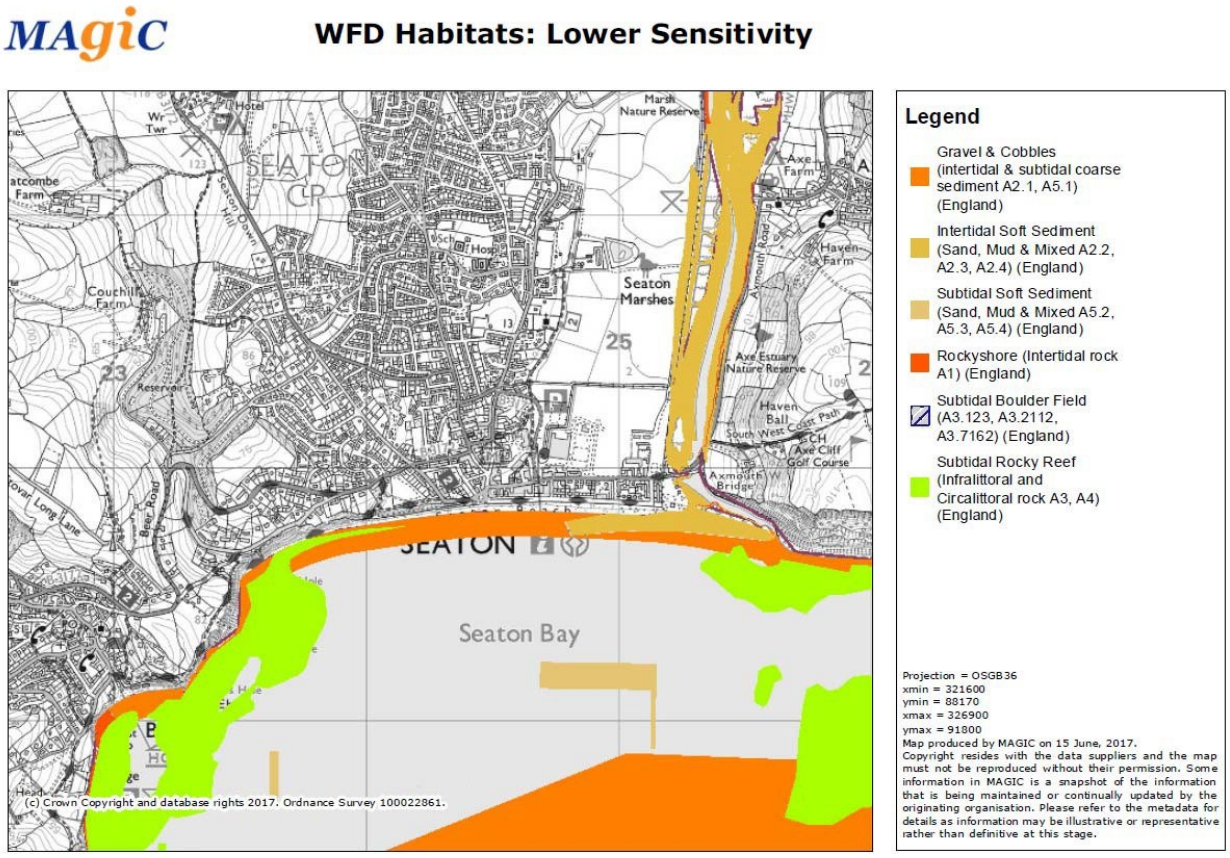

Figure 2-14 WFD habitats low sensitivity

2.6.3 Designated Bathing Waters

The Seaton BMP area is situated within the designated Seaton Bathing Waters, and adjacent to the Beer Bathing Waters (see Figure 2-12). The Bathing Water quality profile is tested by the Environment Agency at these two locations. The results for 2013 to 2016 are summarised in Table 2-6 and presented in full in Appendix B, Section 2.11.2, Table 2.1.

Table 2-6 Environment Agency Bathing Water Classification for Seaton and Beer

Environment Agency Water sampling point Environment Agency Bathing Beach Profile (2017)	**Water Quality Classification**			
	2013	**2014**	**2015**	**2016**
Seaton	Good	Excellent	Excellent	Excellent
Beer	Good	Excellent	Excellent	Excellent

2.6.4 Designated Sites

Designated and non-designated nature conservation sites within the BMP area include biological and geological protected features, as shown in Figure 2-16 and described in the following sections.

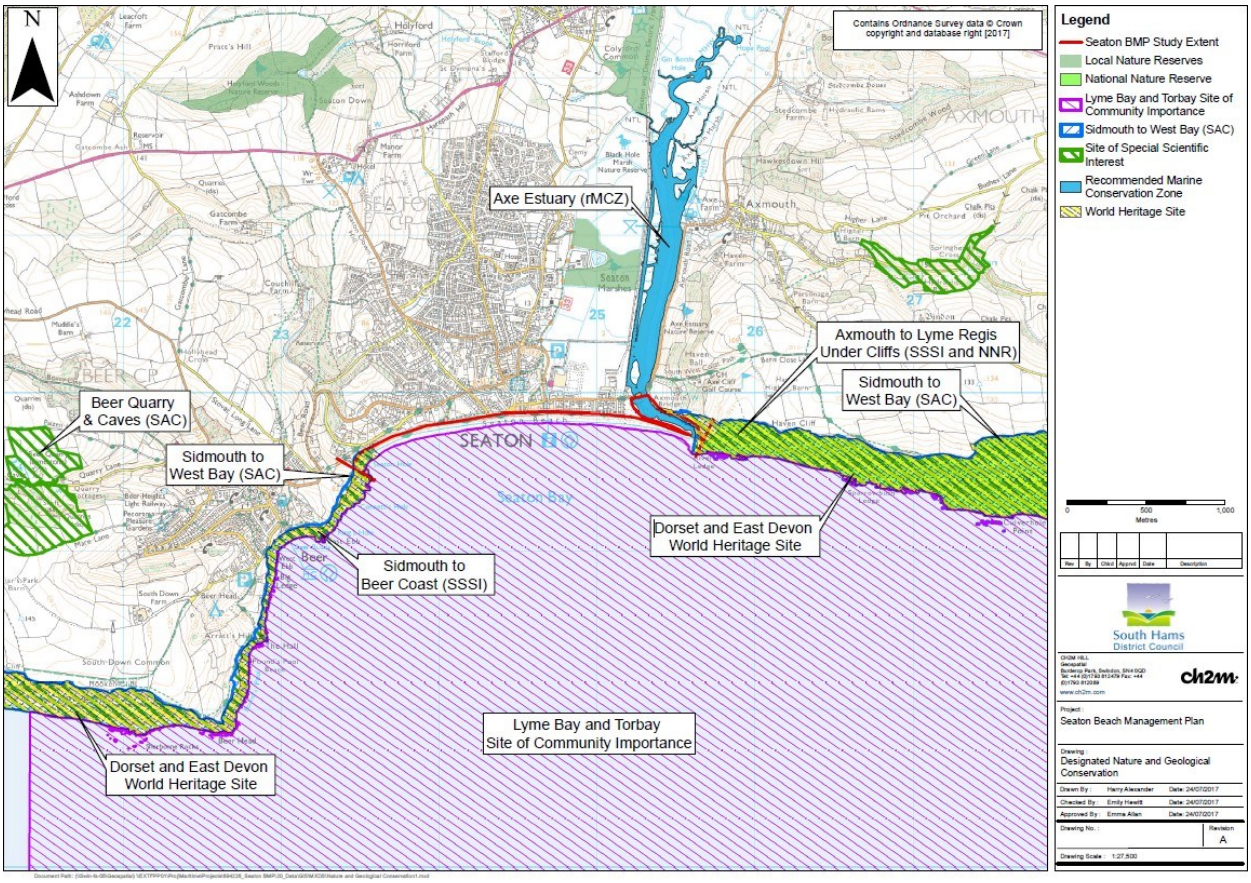

Figure 2-15 Nature and geological conservation designations in the BMP area

2.6.4.1 Internationally Designated Sites

Internationally Designated Sites Within the BMP Area

- **Dorset and East Devon World Heritage Site (WHS)**. The cliffs on both side of the town are located within the UNESCO Dorset and East Devon World Heritage Site ('Jurassic Coast') designated for their geological importance. These cliffs, which extend from Exmouth in East Devon to Studland Bay in Dorset, contain a nearly complete sequence through the entire Mesozoic period of geological time, displaying evidence of 185 million years of evolution from the Triassic, Jurassic and Cretaceous periods. The Jurassic Coast's Management Plan (Jurassic Coast Partnership, 2014) policies seek to avoid or mitigate any negative impacts of coastal defence works on the natural processes of erosion and exposed geology. As such the undeveloped nature of the site is important. The setting of the site is also protected by the East Devon Area of Outstanding National Beauty (See Section 2.6.8.1).
- **Lyme Bay and Torbay Site of Community Importance (SCI)**. The SCI designation is a marine site and present within the BMP area below the Mean Low Water Mark (MLWM). The site is designated under Annex 1 of the EC Habitats Directive for supporting Annex I habitats, including 1170 Reefs and 8330 Submerged or partially submerged sea caves (one sea cave present along the coast south-west at Beer Head). The range and diversity of the reef and sea cave habitats distinguish the area as one of conservation significance. The associated ecological communities of the Lyme Bay reefs are noted

to have particularly high species richness supporting a diverse number of invertebrates, immobile filter feeders and anemones anchored to the substrate. An assortment of hydroids, bryozoans, sea squirts, erect sponges and corals populate the area. Lyme Bay has been marked a marine biodiversity 'hotspot'. Lyme Bay is also one of only five areas in the British Isles where the sunset cup coral *Leptopsammia pruvoti* is known to occur. Other important species include the nationally scarce sponge *Adreus fascicularis* and the pink sea fan *Eunicella verrucosa*.

- **Sidmouth to West Bay Site Special Area Conservation (SAC).** The SAC runs along the coast in both directions of Seaton. The SAC designation sits within the far western section of the BMP area, briefly stopping at Seaton Hole and Seaton Town and Beach where the frontage has been modified before resuming protection of the coast to the east of the mouth of the Axe estuary and beyond. The SAC is designated for Annex I habitats including 1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts, 9180 Tilio-Acerion forests of slopes, screes and ravines and 1210 Annual vegetation of drift lines. The Sidmouth to West Bay Site Improvement Plan identifies inappropriate coastal management as a priority issue.

Internationally Designated Sites Within Approximately 2km of the BMP Area

- **Beer Quarry & Caves Special Area Conservation (SAC)/ Site Special Scientific Importance (SSSI)** is situated approximately 1.8km from the BMP area at its nearest point. The SAC is designated under Annex 1 of the EC Habitats Directive for supporting Annex II species including 1323 Bechstein`s bat *Myotis bechsteinii*, 1303 Lesser horseshoe bat *Rhinolophus hipposideros* and 1304 Greater horseshoe bat *Rhinolophus ferrumequinum*. The BMP area lies at a sufficient distance from the SAC so as not to impact on the cave bat roost habitat of the SAC, but the Axe Estuary may provide foraging opportunities for the qualifying bat species.
- **The River Axe Special Area Conservation (SAC)** is situated approximately 2.7km from the BMP area at its nearest point, and upstream of the tidal range of the Axe Estuary (within the BMP area). The SAC is designated under Annex 1 of the EC Habitats Directive for supporting Annex II species including 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, 1095 Sea lamprey *Petromyzon marinus*, 1096 Brook lamprey *Lampetra planeri* and 1163 Bullhead *Cottus gobio*. Due to the waterflow direction, and relative distance from BMP area to the River Axe SAC site area, any future BMP options are thought unlikely to affect the designated habitat feature. However, designated fish species that may use the lower reaches of the estuary such as Sea lamprey, Brook lamprey and Bullhead will require consideration as part of future BMP options.
- **Exe Estuary Special Protection Area (SPA)** is situated approximately 17.7km from the BMP area at its nearest point. This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European species listed on Annex I of the Directive, including over winter;
    - Avocet *Recurvirostra avosetta*, 359 individuals representing at least 28.3% of the wintering population in Great Britain (5-year peak mean 1991/2 - 1995/6)
    - Slavonian Grebe *Podiceps auritus*, 20 individuals representing at least 5.0% of the wintering population in Great Britain (5-year peak mean 1984/85-1988/9)
    - The area also qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 23,513 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Black-tailed Godwit *Limosa limosa islandica*, Dunlin *Calidris alpina alpina*, Lapwing *Vanellus vanellus*, Grey Plover *Pluvialis squatarola*, Oystercatcher *Haematopus ostralegus*, Red-breasted Merganser *Mergus serrator*, Wigeon *Anas penelope*, Dark-bellied Brent Goose *Branta bernicla bernicla*, Cormorant *Phalacrocorax carbo*, Avocet *Recurvirostra avosetta*, Slavonian Grebe *Podiceps auritus*, Whimbrel *Numenius phaeopus* (Natural England, 2014).

Saltmarsh present upstream of the Axe Estuary, north of the Axe Harbour, and near to the study area, has been classed as supporting habitat for SPAs (Natural England, 2015. Data viewed via magic.co.uk). Connectivity between the Axe Estuary and the Exe Estuary SPA, may be likely. The BMP will require consideration of adjacent saltmarsh habitat and bird features which may be present.

- **East Devon Heaths Special Protection Area (SPA)** is situated approximately 16 km from the BMP area. It is designated under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:
  - During the breeding season:
    - Dartford Warbler *Sylvia undata*, 128 pairs representing at least 8.0% of the breeding population in Great Britain (count, as at 1994).
    - Nightjar *Caprimulgus europaeus*, 83 pairs representing at least 2.4% of the breeding population in Great Britain (count, as at 1992).

  Due to the distance of the site from the BMP area, and no similar habitat that may provide habitat connectivity with the BMP area, this site will not require further consideration by the BMP options.

2.6.4.2 Nationally Designated Sites

Nationally Designated Sites Within the BMP Area

- **Sidmouth to Beer Coast SSSI** designation protects the cliffs within the far western section of the BMP area and underpins the Sidmouth to West Bay SAC (see section 2.3.1) The site contains important geological, stratigraphic features and is famous for its fossil deposits and important biological features. The notified geological features of this site are:
  - Geological features
    - EC - Aptian – Albian.
    - EC - Cenomanian-Maastrichtian.
    - EC - Mesozoic - Tertiary Fish/Amphibia.
    - EC - Permian - Triassic Reptilia.
    - EC - Non Marine Permian Triassic (Red Beds).
    - ER - Non Marine Permian Triassic (Red Beds).

    As described by the SSSI citation, '…These cliff sections provide the finest exposures of the Foxmould Sands and Chert Beds (Upper Greensand) in South- West England…The quality of exposure allows particularly good opportunities to study the sedimentology of Upper Greensand Chert and hardground formation. The site is also of importance as it contains some of the most westerly major Upper Cretaceous exposures in England, which are of great stratigraphic importance.' (Natural England, 1989). It should be noted that not all of the features of interest described in the SSSI citation lie within the BMP area.
  - Biological features:
    - Tilio-Acerion forests of slopes, screes and ravines (mixed woodland on base-rich soils associated with rocky slopes).
    - Lowland calcareous grassland (CG2, CG6 and CG7).
    - H1230 Vegetated sea cliffs of the Atlantic and Baltic coasts.
    - Soft maritime cliff and slope.

        - Vascular plant assemblage.
        - Invertebrates:
            - Invert. assemblage F111 bare sand & chalk.
            - Invert. assemblage F112 open short sward.
            - Population of Schedule 5 crustacean - *Chirocephalus diaphanus*, a freshwater fairy shrimp (within a seasonally flooded freshwater pool) (Natural England, 2017b).

- **Axmouth to Lyme Regis Undercliffs SSSI/NNR** Is the largest and most important landslip area on British coast and underpins the Sidmouth to West Bay SAC in the far eastern section of the BMP area, east of the Axe Estuary. The site contains geological and biological features including exposures to lias and cretaceous rocks with a species-rich naturally developed ashwood, rich grassland and cliff flora.
    - Geological features:
        - EC - Hettangian Sinemurian and Pliensbachian.
        - EC - Jurassic - Cretaceous Reptilia.
        - EC - Mesozoic - Tertiary Fish/Amphibia.
        - EC – Rhaetian.
        - IA - Mass Movement.
    - Biological features:
        - CG1 - Festuca ovina - Carlina vulgaris lowland calcareous grassland.
        - CG2 - Festuca ovina - Avenula pratensis lowland calcareous grassland.
        - CG6 - Dry grassland/ scrub transitions (MG1-related, CG2d-related).
        - CG7a,b,d,e - Festuca ovina - Hieracium pilosella - Thymus preaecox grassland.
        - Vascular plant assemblage:
            - W21 - Crataegus monogyna - Hedra helix scrub.
            - W8 - Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland.

    The Axmouth to Lyme Regis Undercliffs NNR describes the site as supporting woodland, lowland grassland, rocky shore and cliffs (Natural England, 2008)

- **Axe Estuary rMCZ.** The Axe Estuary is situated in the far eastern section of the BMP area and is being recommended as a MCZ to protect the following important habitats, coastal saltmarshes, saline reedbeds, intertidal coarse sediment, intertidal mixed sediments, intertidal mud, subtidal mixed sediments and Species of Conservation Importance, the European eel (*Anguilla anguilla*). The estuary is also known to be a nursery area for fish, including bass. The rMCZ area overlaps with the Lyme Bay SAC no-tow area.

Nationally Designated sites within approximately 2km of the BMP Area

- **Beer Quarry and Caves SSSI**, is situated approximately 1.8km from the BMP area and underpinsthe Beer Quarry SAC in the same location and notified for its geological and biological features. The quarry provides one of the best exposures of a suite of clay filled chalk pipes in southern England, and also provides important roost habitat for bats. Notified features of the SSSI are:
    - Geological features:

        - IS - Quaternary of South-West England.
    - Biological features:
        - Hibernating populations of bats - mixed species.

    The geological features of the Beer Quarry and Caves SSSI are situated inland, 1.8km from the BMP area. Due to the distance of the site from the BMP area and no likely connectivity with future BMP options, this site will not require further consideration in the BMP in terms of impact on geology. However, bats are mobile species, and there is potential connectivity with the Axe estuary (potential feeding and roost habitat), which should be considered by the BMP options.

- **River Axe SSSI** is situated approximately 2.7km from the BMP area and underpins the River Axe SAC designation. Migratory salmon, bullhead and sea trout and otter are designated features of the site, and have potential to move downstream within the BMP area. These species should be considered by BMP options.
    - Biological, hydrological and geomorphological features:
        - Bullhead, Cottus gobio.
        - Flowing waters - Type II: slow-flowing, naturally eutrophic lowland rivers, dominated by clays.
        - Flowing waters - Type IV: a degraded lowland river type that does not qualify for designation.
        - Flowing waters - Type V: principally a lowland type, widespread over resistant rocks in England and Wales.
        - IA - Fluvial Geomorphology.
        - Invertebrate assemblage.
        - Otter, Lutra.
        - Population of Schedule 5 leech - Hirudo medicinalis, Medicinal Leech.
- **Spring Head - Axmouth SSSI** is located approximately 1.7km north east of the BMP area, west of Axmouth. The area is designated for woodland and grassland. As there is no likely connectivity with future BMP study options, it will not require further consideration.
    - Biological features:
        - CG6 - Dry grassland/ scrub transitions (MG1-related, CG2d-related).
        - M13 - Schoenus nigricans - Juncus subnodulosus mire.
        - W1 - Salix cinerea - Galium palustre woodland.

2.6.4.3 Locally Designated Sites

Locally Designated Sites Within the BMP Area

- Axmouth to Lyme Regis Geological Conservation Review (GCR2) Block site (800: Mass movement). Notable for cliff landslips. The GCR description of the site underpins features of the Sidmouth to Beer Coast SSSI and Axmouth to Lyme Regis SSSI, which in turn underpins the Sidmouth to West Bay SAC.

Locally Designated Sites Within Approximately 2km of the BMP Area

- Beer Quarry GCR site (1682). Notable for describing climate change. The GCR underpins features of the Beer Quarry and Caves SSSI, which underpins the Beer Quarry and Caves SAC.
- Beer Head County Wildlife Site (CWS). Locally designated for semi-improved calcareous grassland.
- Seaton Marshes Local Nature Reserve (LNR). Attracts an abundance of birds and wildlife. Habitats include saltmarsh, freshwater grazing marsh, saline lagoon with a self-regulating tidal exchange gate and freshwater pond.
- Nature Conservation Review (NCW) Sites. The following sites aim to locally conserve wildlife not afforded statutory protection under the SSSI designation of the same name:
    - Axmouth to Lyme Regis Under Cliffs Nature Conservation Review (NCR).
    - Beer Quarry and Caves Nature Conservation Review (NCR) site.

2.6.5 Ecology

2.6.5.1 Priority Habitats

The following Priority Habitats are present within, or in close proximity to, the BMP area, and include:

- Mudflats (within the Axe Estuary).
- Coastal vegetated shingle, present along the shingle spit and at the eastern end of the BMP area (noted during June 2017 site visit). *A likely positive outcome from the presence of dredge material providing a medium and stable environment for growth.*
- Maritime cliff and slope (present along the western section of the BMP area from Castle Hill, and west of the mouth of the Axe Estuary.
- Coastal saltmarsh (within the Axe Estuary, upstream of the Axmouth bridge, classed as supporting habitat of the Exe Estuary SPA).

Devon Biodiversity Action Plan habitats within the BMP area include:

- Sea cliff and slope (within the far western section, and eastern section).
- Rocky foreshore (intertidal, within the far western section, and eastern section).
- Rocky seabed (subtidal, exact location within Seaton bay is not known).
- Rivers, streams, floodplains and fluvial processes (of the Axe River and Estuary).
- Grazing marsh (within the Axe Estuary, upstream of the Axmouth bridge).

2.6.5.2 Other Protected and Notable Species

The Seaton BMP area and surrounding area are likely to support a number of rare and protected species in addition to those found within the designated sites.

*Implementation of the management approach for the BMP area will require a detailed desk study to identify ecological risks and locate Biodiversity Action Plan species and habitats, which is acknowledged in the BMP Action Plan (see Section 6; Action FSR_003).

2.6.5.3 Fish Ecology

In addition to those fish species found within the designated sites of the River Axe and Axe Estuary (Salmon (*Salmo salar*), Sea trout (*Salmo trutta*), Bass (*Dicentrarchus labrax*), Eel (*Anguilla anguilla*)) there are commercially important fish nursey and spawning areas within Seaton Bay.

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 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 nursery area
Anglerfish *Lophius piscatorius*	Low intensity nursery area
Sandeels *Ammodytidae*	Low intensity spawning area
Mackerel *Scomber scombrus*	High intensity nursery area
Sole *Solea solea*	Low intensity spawning area and low intensity nursery ground

The Axe estuary is also an important nursery area for fish, including bass (see Section 2.6.4.2 Axe Estuary rMCZ).

2.6.6 Fisheries

There are important commercial and recreational fisheries present within, and adjacent to the BMP area.

2.6.6.1 Commercial Fishing

Lyme Bay (which includes all of Seaton Bay and the BMP area) is a commercially and culturally important fishery to the local area. It is diverse in species and includes pelagic and demersal finfish, elasmobranchs (sharks, skates and rays), and shellfish including crustaceans, molluscs and cephalopods (cuttlefish and squid).

Pelagic fish (within the water column) include bass, herring, mackerel, horse mackerel, shad and sprat. Pelagic fish include bass, herring, mackerel, horse mackerel, shad and sprat. Dermersal (bottom dwelling) fish include flatfish (brill, dab, flounder, lemon sole, plaice, sole and turbot) and roundfish (cod, haddock, whiting, ling, pollack, bib, John Dory, mullets, breams, wrasses, gurnard and monkfish). Demersal elasmobranch species (sharks, skates and rays) include Lesser Spotted dogfish, Smoothhound, Tope, spurdog, Blonde ray, Spotted ray, Small-eyed ray and Thornback ray.

The shellfish fishery includes bottom dwelling crustaeans such as brown crab, spider crab, velvet crab and lobster, brown and pink shrimp and common prawn, and molluscan shellfish King scallop (bivales) and whelks (gastropods) living on or beneath the surface. Cephalopods 'swimming' molluscs include cuttlefish and squid.

It is thought that three key ports of Beer, Lyme Regis and West Bay target fish and shellfish of the local area (Lyme Bay Consultants, 2014). The small fishing fleet operating from Axmouth Harbour, are likely to also target the area.

Axmouth Harbour is situated at the eastern end of the beach at the foot of the Haven Cliffs and within the mouth of the River Axe Estuary. At low tide the harbour bottom is exposed with just a narrow channel of river water making its way down to the sea. Two bridges cross the river (one old, one new) adjacent upstream of the harbour entrance, and prevents navigation up the river by larger vessels therefore keeping the fishing fleet based at Axmouth Harbour (moored up along Axmouth Quay wall) to relatively small vessels and largely potters.

Lyme Bay is a closed area to Demersal Mobile Gear (for example scallop dredging and bottom-trawling) to protect the fragile reef ecosystems of the Torbay to Lyme Bay SAC (see Figure 2-16). Other fishing practises are permitted within the SAC, and the Lyme Bay Working Group (a collaborative body of local fishermen, scientists, regulators and the Blue Marine Foundation) have signed a memorandum of understanding (MoU) designed to ensure that Lyme Bay's local fishing communities benefit from a sustainable approach to marine conservation, whilst recognising the need to balance commercial necessity with the need to protect the protected fragile habitats.

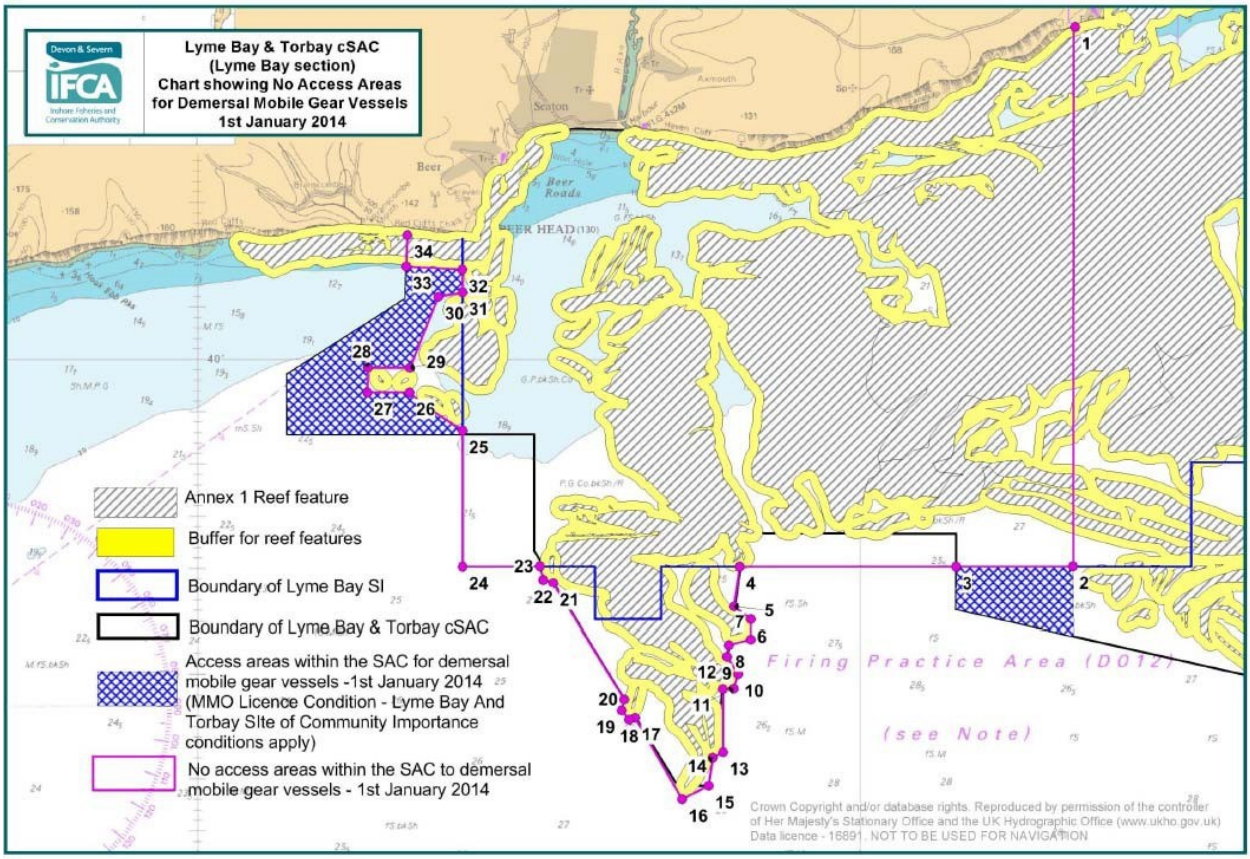

Figure 2-16 Lyme Bay and Torbay cSAC – No Demersal Mobile Gear Area: Lyme Bay Section

2.6.6.2 Recreational Fishing

Seaton Beach is a particularly popular local angling spot. Angling also occurs in Axmouth Harbour for species such as mullet and, occasionally, flounder, as well as further up the river (Finding Sanctuary, 2012)

Beach fishing is popular across the entire frontage of the BMP area. For fish species, see commercial fishing above (Section 2.6.6.1).

2.6.7 Navigation

2.6.7.1 Road Transportation

Local roads in the BMP area include Harbour Road that runs parallel to the shoreline behind the promenade, and connects to the B3172 passing over the new Axe bridge (adjacent to the old Axe bridge) with access to Axmouth Harbour (east side to the Axe Yacht Club and west side for the Fishermen's Association). Other local routes perpendicular to the shoreline include Sea Hill and Castle Hill, which connect to Old Beer Road in the centre of Seaton.

The Old Beer Road runs along the top of the eroding cliff within the western section of the Seaton BMP area. The scenic road provides access to a number of properties along its route and was once thought to be of great tourist value to Seaton Town before the road was cut off by erosion. It is now used far less as a tourist/walking route.

Esplanade Road runs adjacent to the beach and East Walk promenade, and connects Seaton Town centre and the B3172 via a small number of side roads.

There are no motorways or major A-roads within the BMP area.

2.6.7.2 Seaton Tramway

The Seaton Tramway attraction runs heritage trams from the town centre through the countryside at the rear of the beach and town.

2.6.7.3 Marine Navigation

Within the lower section of the estuary is Axe Harbour. This is a relatively small harbour, with the Axe Yacht Club located on the western side and the Fishermen's Association located on the eastern side. Entrance and exit is limited to a relatively narrow window either side of high tide. Annual dredging is required to maintain safe navigation around the harbour and occasional dredging of the sand bar at the mouth of the estuary (see Section 2.4, Sediment Quality) (Finding Sanctuary, 2012).

Boat traffic within the BMP area, includes yachts, fishing vessels (based at Axmouth Harbour and Beer) and recreational water craft largely accessed from Seaton Yacht club. There are slipways and lifting areas utilised by pleasure craft within the harbour. There is also a small craft launch area to access the water from the harbour directly across the beach. Aside from fishing vessels (based at Axmouth Harbour and Beer) utilising the area, there is no other commercial navigation within the estuary, or Seaton Bay. Axmouth Harbour is, however, a designated refuge port and an area is maintained along the seawall for any fishing vessel (subject to size) to use in case of emergencies; for example, if crew are ill, or have a mechanical problem etc.

2.6.8 Landscape Setting

2.6.8.1 National Landscape Designations

The importance of landscape to the BMP area is recognised by a number of important designations, as described below.

East Devon Area of Outstanding Natural Beauty

East Devon Area of Outstanding Natural Beauty (AONB) is one of several protected landscapes in the UK. East Devon characteristics include 'wooded combes, vast areas of heathland, fertile river valleys and breath-taking cliffs and hilltops' (Halcrow, 2011). The AONB designation, surrounds Seaton town and beach is shown in Figure 2-17.

In the east, the AONB designation covers the BMP area. The designation includes the lower estuary and shingle spit at the mouth of the estuary, and adjacent coastal cliffs and following the River Axe north. The coastal border then runs along the coast to Dorset. In the west (not covering the BMP area, but seen from Seaton), the AONB designation runs along the coast (and inland) from Beer to Exmouth.

East Devon Heritage Coast

Heritage coasts are 'defined' rather than designated, and were 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). The designation covers the far western and eastern sections of the BMP area which runs along the coast and out into Seaton Bay. The designation also includes the Axe Estuary, which is within the BMP area (see Figure 2-17).

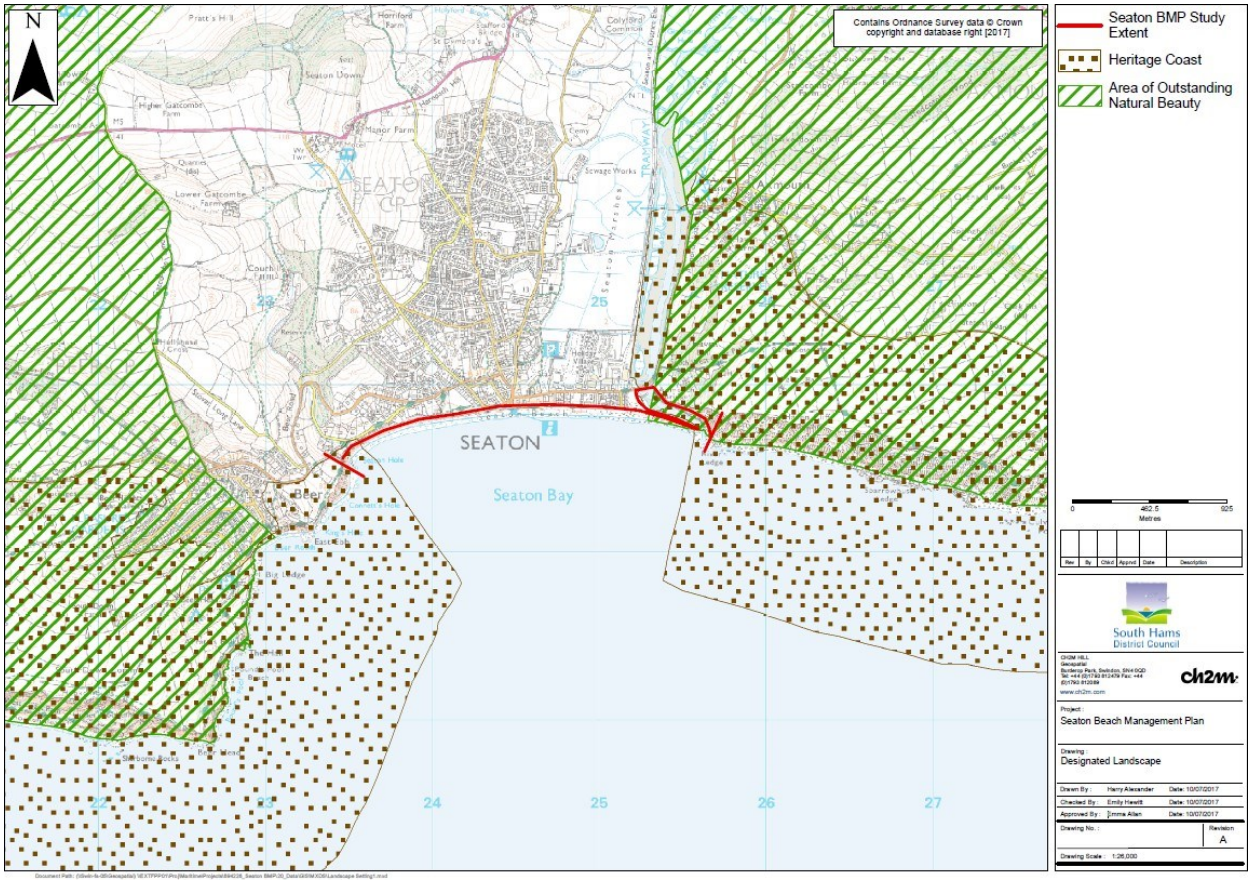

Figure 2-17 Landscape designations within and around the BMP area

2.6.8.2 Landscape Character

The key characteristic features of BMP area and surrounding coastal area is described by the following Landscape Character Zones, from the Devon County Council 2002 Landscape Appraisal Study:

- Axe & Otter Valleys – covers the Axe Estuary
  - Lowland rivers with noticeable flood plains and tightly meandering courses, unusual in most of Devon's major rivers.
  - Shingle or pebble bars across estuaries, backed by ecologically important salt marsh.
  - Historic settlements sited at old crossing points, just above the flood plain.
  - Drainage channels.
- Coastal Chalk Plateaux - covers the coastal area west of Beer and between Axmouth and the Dorset boundary:
  - Long greensand ridges including heath and forestry, beech hedges and avenues.
  - Plateau landscape on ridge tops which includes common land, parliamentary enclosures, airfields and communications structures.
  - Steep valleys between ridges enclosing a varied farming landscape, with woodland, hedgerow trees and springline flushes.
  - Historic farm buildings utilising local materials.
  - Springline settlements.

2.6.9 Archaeology and Cultural Heritage

2.6.9.1 Designated Archaeology and Cultural Heritage

The importance of historic and cultural heritage to Seaton and the surrounding area is recognised by a number of archaeology and cultural heritage designations, as described below and shown in Figure 2-18.

Scheduled Monument

There are two Scheduled Monuments in the BMP area; Axmouth Bridge and The Axe Boat, 22m north of the Axmouth Road Bridge. Both Scheduled Monuments are situated directly adjacent along the estuary, north of Axmouth Harbour.

There are three further Scheduled Monuments in close proximity to the BMP area. The Roman and earlier settlement at Honeyditches Scheduled Monument is located at a minimum distance of approximately 1km north of the BMP area and Promontory Fort on Seaton Down is located a further 0.7km northwest. The Scheduled Monument Hawkesdown Camp and associated outwork is approximately 1.7km north-east of the BMP area.

Listed Buildings

The closest listed buildings to the BMP area are Cliff Castle and St Elmo (Grade II) and Bridge Cottage (Grade II), which both lie within 50m of the beach. Further listed buildings lie within Seaton Town, east of Axmouth Harbour, and in Axmouth Village. There are in the region of 64 listed buildings within 2km of the BMP area.

Conservation Area

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. The seafront boundary of the Seaton CA borders the BMP area in the centre of the study area and includes Castle Hill and Esplanade to Beach Road.

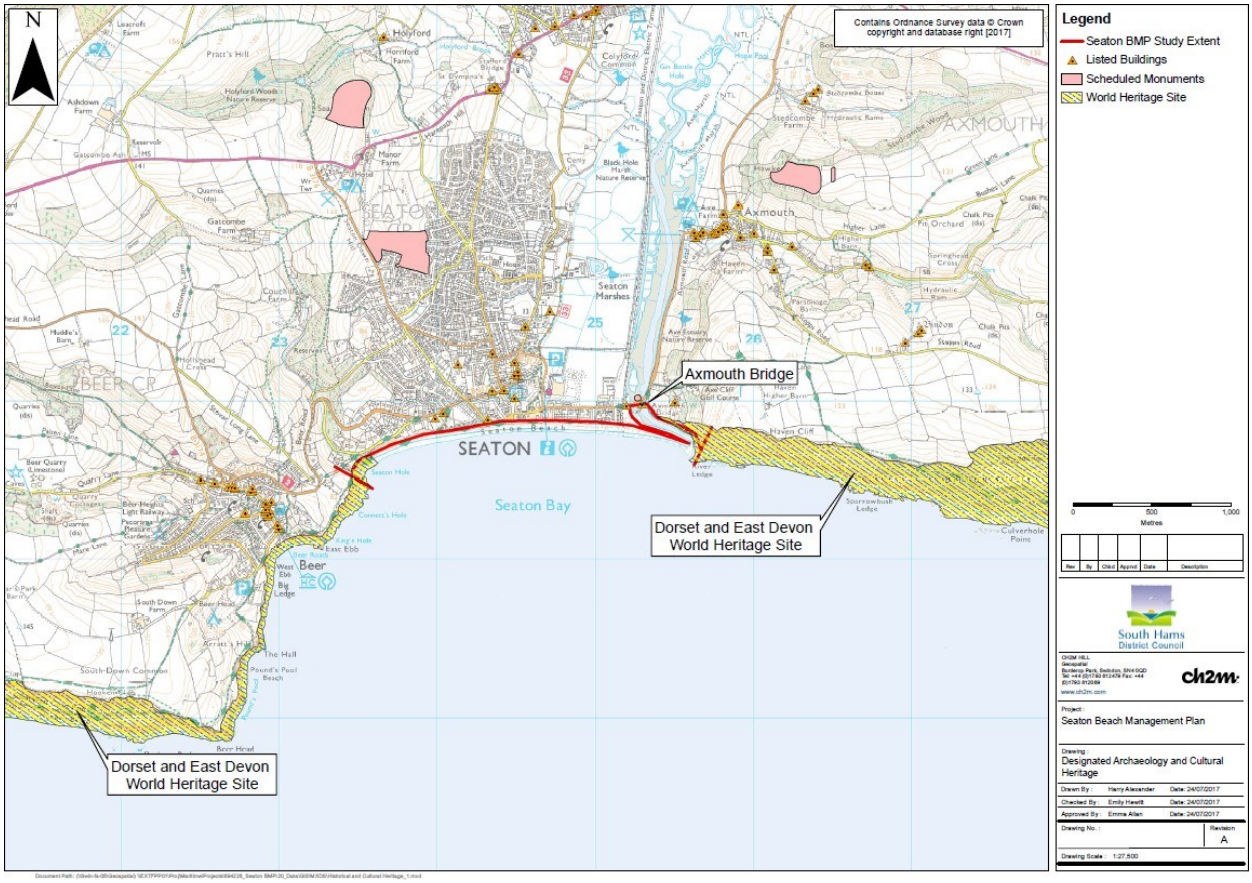

Figure 2-18 Designated historical and cultural heritage in the BMP area

2.6.9.2 Non-Designated Archaeology and Cultural Heritage

Within the Axe Estuary, there is a Roman/Medieval harbour, wrecks and potential palaeo-environmental deposits. The marine environment between Durlston Head and Rame Head has preserved countless underwater artefacts and potentially contains many buried landscapes (Halcrow, 2011). There is potential for underwater artefacts to be present within Seaton Bay.

A WWII Coastal Defence searchlight emplacement structure, with memorial plaque and public information board is located on the seafront promenade (West Walk). The searchlight emplacement was used to illuminate the sea and beaches to detect enemy ships and surfaced submarines.

2.6.10 Air Quality

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

2.6.11 Noise

No baseline data on existing ambient noise levels has been sourced for this baseline report. This may be required prior to any beach construction/management works depending on their scale, scope and proposed working methodologies.

SECTION 3

Scheme Design (Existing Coastal Defences)

As described in Section 1.3.3, the coastal defences between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge have been constructed over many years, starting sometime prior to the 1960's and most recently in 2003. This Section provides a summary of the existing coastal defences within the BMP area; including the concrete encased revetment, rock revetment and seawall. Full details of all previous and existing defences, including a chronological summary, photos and technical drawings, defence ownership and visual inspection / condition assessment, are provided in the Defences Baseline Report (Appendix C).

3.1 West Seaton

The coastal defences along the western extent of the BMP area have been constructed to protect the cliff toe from erosion by marine action, and today they include gabion baskets, a concrete encased revetment; rock revetment, former gabion baskets at 'The Pillar', gravity wall (Check House Wall), and promenade protected by concrete / stone blockwork and includes integrated access steps and ramps.

3.1.1 Seaton Hole Outfall and Gabions (2002 to 2005)

The Seaton Hole outfall receives emergency/storm overflow from the pumping station at Beer Brook and Seaton Hole (see Section 1.3.6.2). Protecting the Seaton Hole outfall is a series of stone-filled gabion baskets. A major landslip in the autumn of 2000 resulted the outfall outlet being obstructed by landslip debris (EDDC, 2000). In 2002/2003, wing walls and a head wall were constructed around the culvert outlet/outfall to protect the area from obstruction. The wing walls and head wall was constructed from gabion baskets filled with concrete sand bags.

The gabion baskets protected the culvert outlet/outfall during the winter storms in 2004, however a significant volume of landslip debris was washed away along with the loss of many loosely placed concrete-filled sand bags. This allowed some erosion at the western edge of the structure (David Roche GeoConsulting Limited, 2003).

In 2005, further storms resulted in the loss of additional concrete-filled sand bags, and works were undertaken to strengthen the wing walls (David Roche GeoConsulting Ltd, 2005). The work included the introduction of additional gabion baskets filled with concrete-filled sand bags in front of the western wing wall as well as extending the wing wall further west (Figure 3-1).

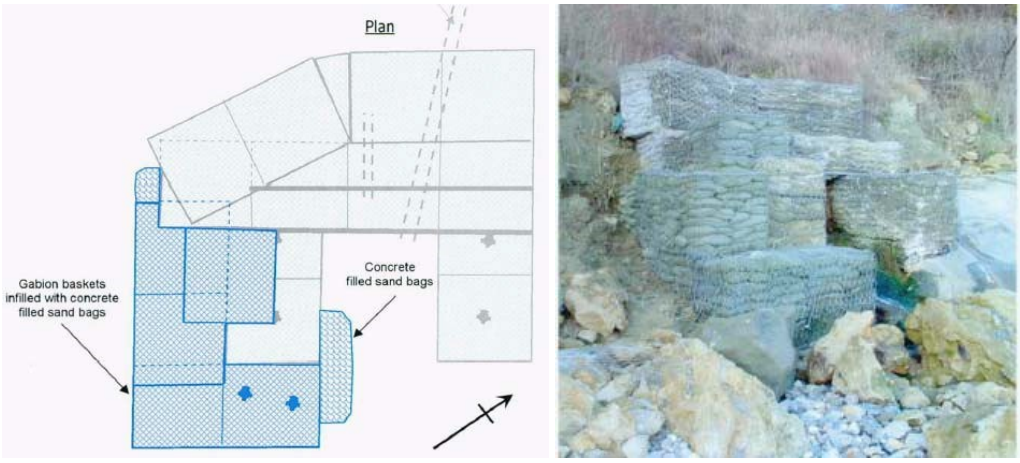

Figure 3-1 Outfall protection works constructed in 2005 shown in blue and completed in the adjacent photo
Source: David Roche GeoConsulting Ltd, 2005

3.1.2 Concrete Encased Revetment (1970s)

The Seaton Hole concrete encased revetment was first constructed in the 1970s using scree material from the base of the White Cliffs. The scree was later encased in concrete to prevent their displacement during wave attack.

Figure 3-2 Seaton Hole concrete encased revetment

Source: Photograph taken during visual inspection and condition assessment on the 14th June 2017, facing northwest

3.1.3 Rock Revetment (Prior 1994 to 1989)

Sometime prior to 1994, a rock revetment, approximately 65m in length, was constructed to stop further erosion at the cliffs east of the encased concrete defence. The rock revetment consisted of 3-5 tonne Mendip limestone blocks which were placed along the toe of the cliff with an average crest height of 6.2m OD and front slope of 1:1.5 (Posford Duvivier, 1994).

In 1998 a £550,000 scheme to construct a rock revetment at the base of the cliffs was designed by Posford Duvivier Consulting Engineers. This was then constructed in 1998/1989 by Costain Civil Engineering Ltd. The revetment was intended to absorb wave energy and reduce the rate of erosion along this stretch of coast. The revetment extended approximately 410m east from Seaton Hole to the older concrete wall to the west of the main Seaton flood defences (Figure 3-3), and was formed of 5 to 8 tonne limestone rock for the primary armour.

The structure adopted two cross-sectional profiles (outlined in Figure 3-4) that were applied to different parts of the frontage depending on the perceived erosion risk. The single-sided revetment was adopted in sections where cliff recession was stable, while the double-sided revetment was used in more unstable sections.

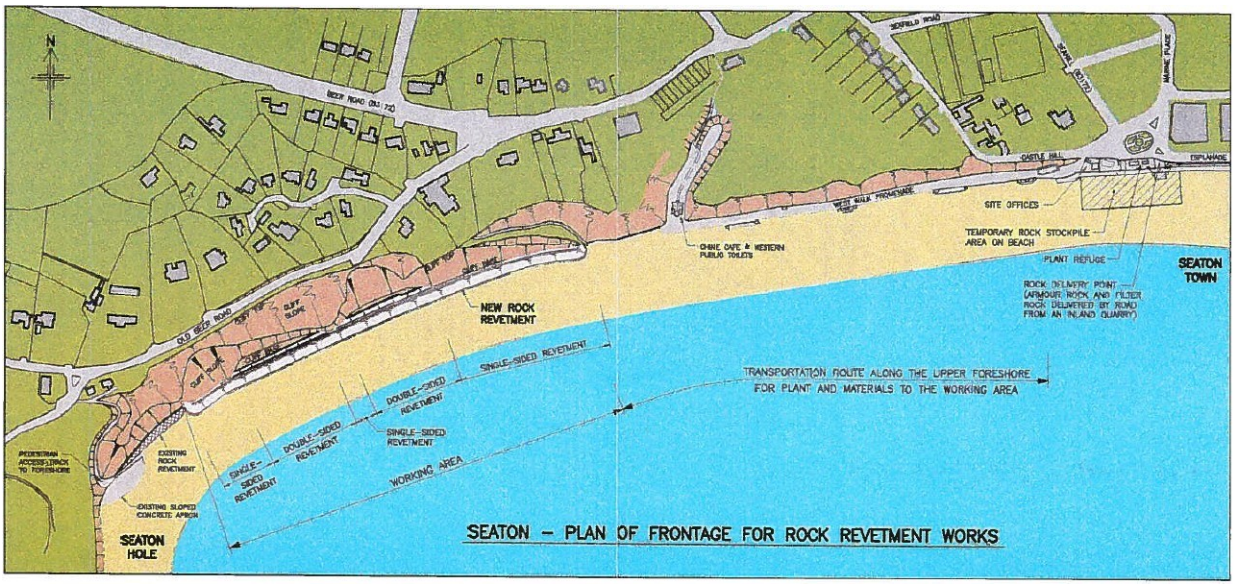

Figure 3-3 Rock revetment works between Seaton Hole and Seaton
Source: EDDC, no date

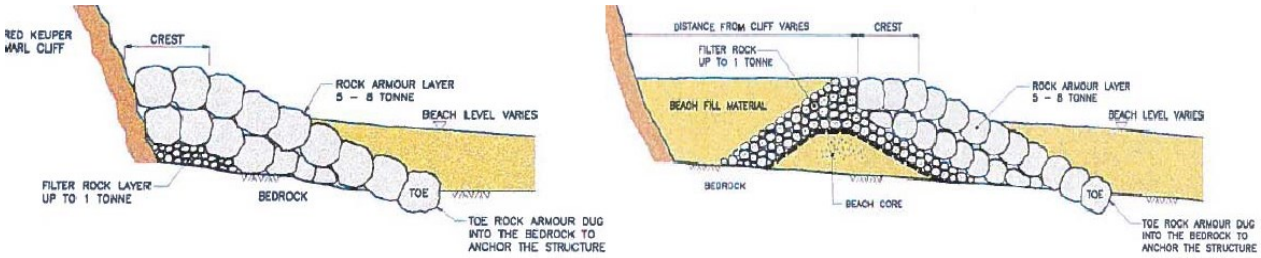

Figure 3-4 Typical section of single-sided revetment (left) and Typical section of double-sided revetment (right)
Source: EDDC, no date

3.1.4 The Pillar Gabion Baskets (2003 to 2005)

Following an inspection of the area, beach/cliff protection works were recommended and constructed at the location of 'The Pillar'. Works included the construction of gabion baskets infilled with concrete-filled sand bags. Construction was completed by Celtic Rock Services during October 2003 (David Roche GeoConsulting Limited, 2003), as shown in Figure 3-5 and Figure 3-6. As part of wider renovation work in the area by Bridge Civil Engineering Ltd, additional stone-filled gabions were added in 2005 (EDDC, 2005).

In March 2015, an inspection of the Check House Wall and the western cliff area was completed. The inspection revealed that the stone filled gabions had suffered significant damage with more than half destroyed and the remaining gabions severely distorted and in danger of collapse (David Roche GeoConsulting Limited, 2015). Figure 3-7 shows the damage identified in 2015 compared with post-construction in 2005.

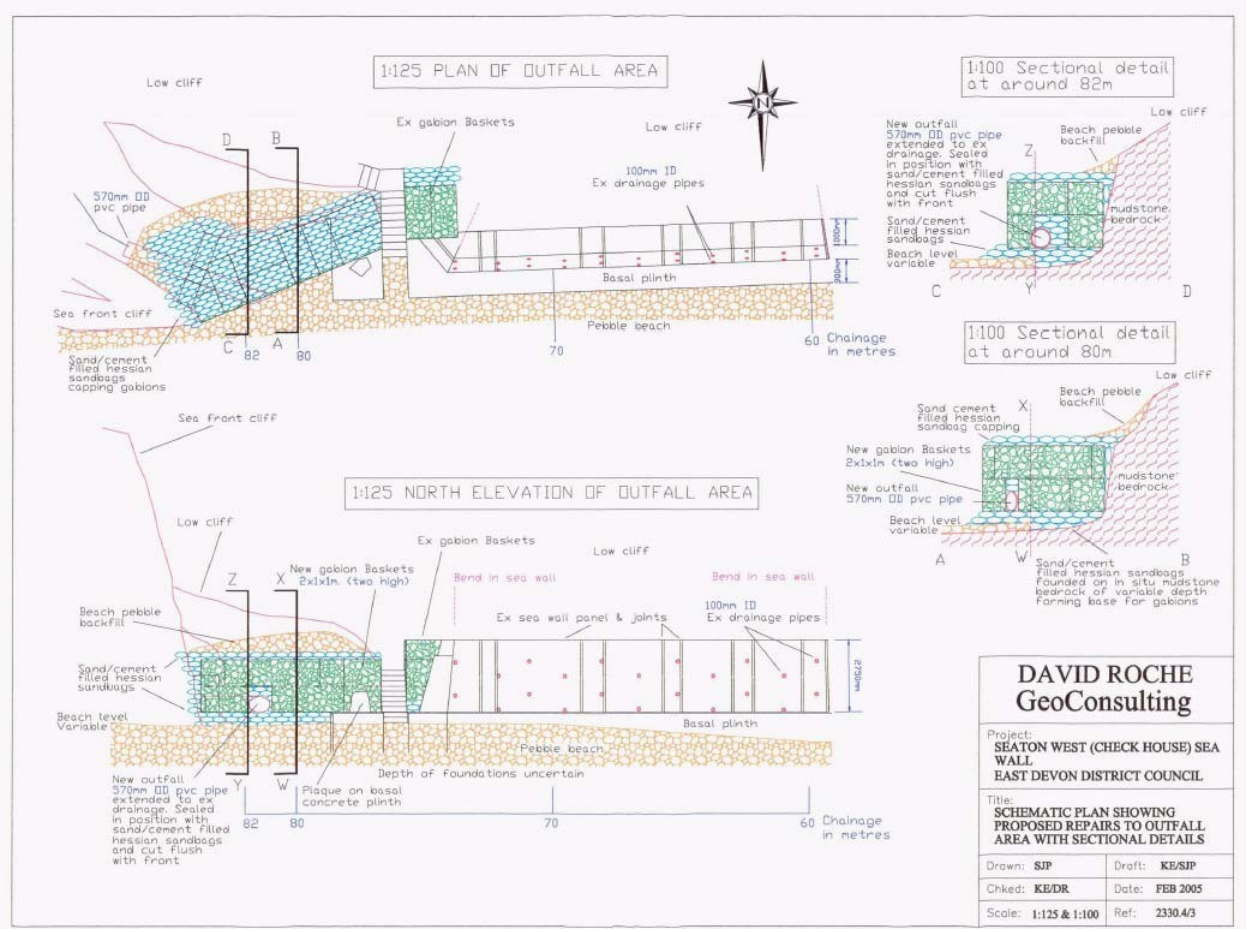

Figure 3-5 Schematic plan showing proposed repairs to the outfall area with sectional details
Source: David Roche GeoConsulting Limited, 2005

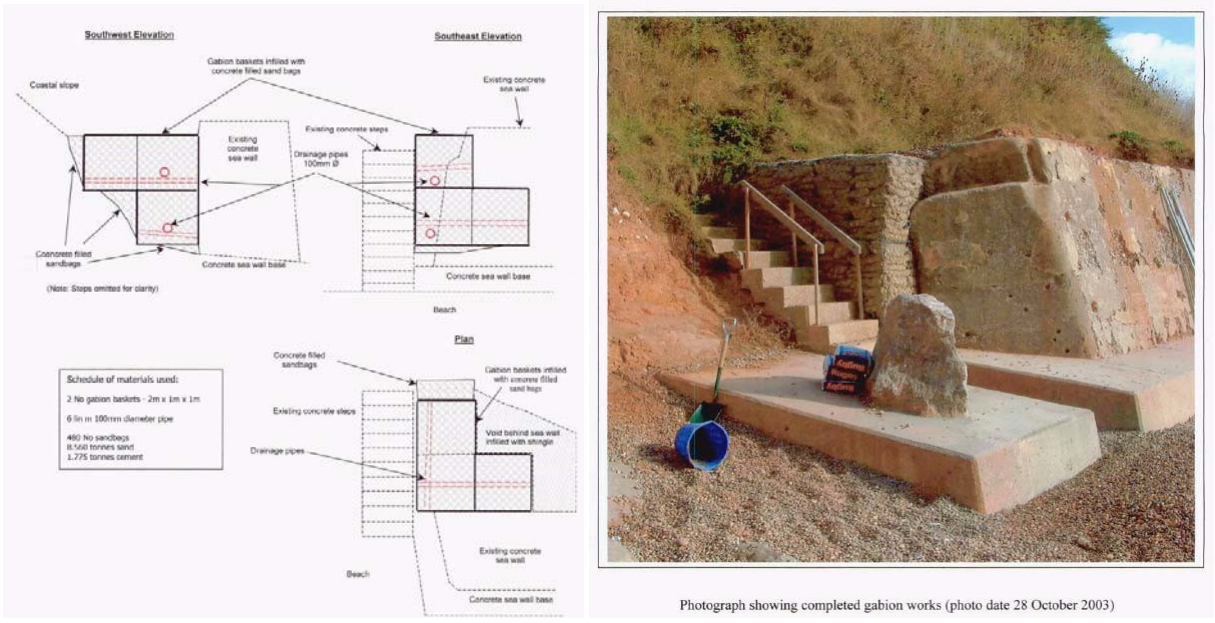

Figure 3-6 Side elevation plan of the emergency gabion works west of Check House Wall
Source: David Roche GeoConsulting, 2003

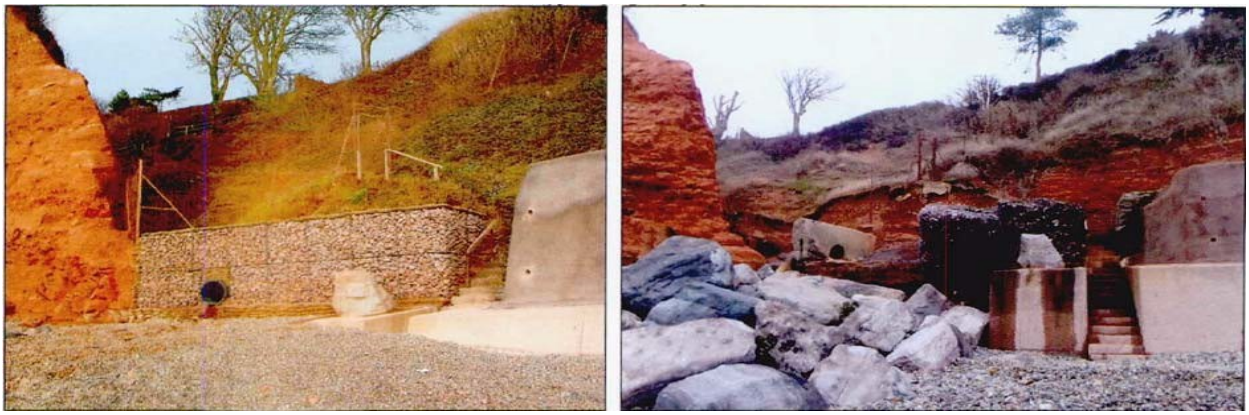

Figure 3-7 Construction photograph (2005) alongside the inspection photograph (2015)
Source: David Roche GeoConsulting, 2015

3.1.5 Check House Wall (early 1990's to 2005)

The Check House Wall is located between the previously discussed rock revetment and the flood defences protecting the promenade to the west of Seaton. The wall consists of reinforced concrete with drainage holes and a recent sprayed concrete cover.

A 60m long concrete gravity wall was constructed to provide erosion protection for the cliff between the rock revetment and the flood defences protecting the promenade to the west of Seaton. It is unknown when the wall was originally constructed, however in a survey in the early 1990s recorded the wall to be in very poor condition with its foundations exposed (Posford Duvivier, 1994).

In 1995 serious structural problems were identified at the concrete wall, and was highlighted as likely to fail at any time. In 1995/1996, EDDC carried out underpinning protection works to address the concerns, with work estimated to cost £35,000 (Posford Duvivier, 1995a).

In July 2003 David Roche GeoConsulting inspected the wall and reported its condition as poor, recommending the wall should be upgraded with a skin of fine concrete placed in-situ; and

Renovation of the Check House Wall was completed by Bridge Civil Engineering Ltd in 2005. The renovation included the introduction of steel mesh reinforcement, the application of 150mm thick layer of sprayed concrete (gunite) to the existing wall (EDDC, 2005). Existing drainage channels through the structure were also extended (Figure 3-8).

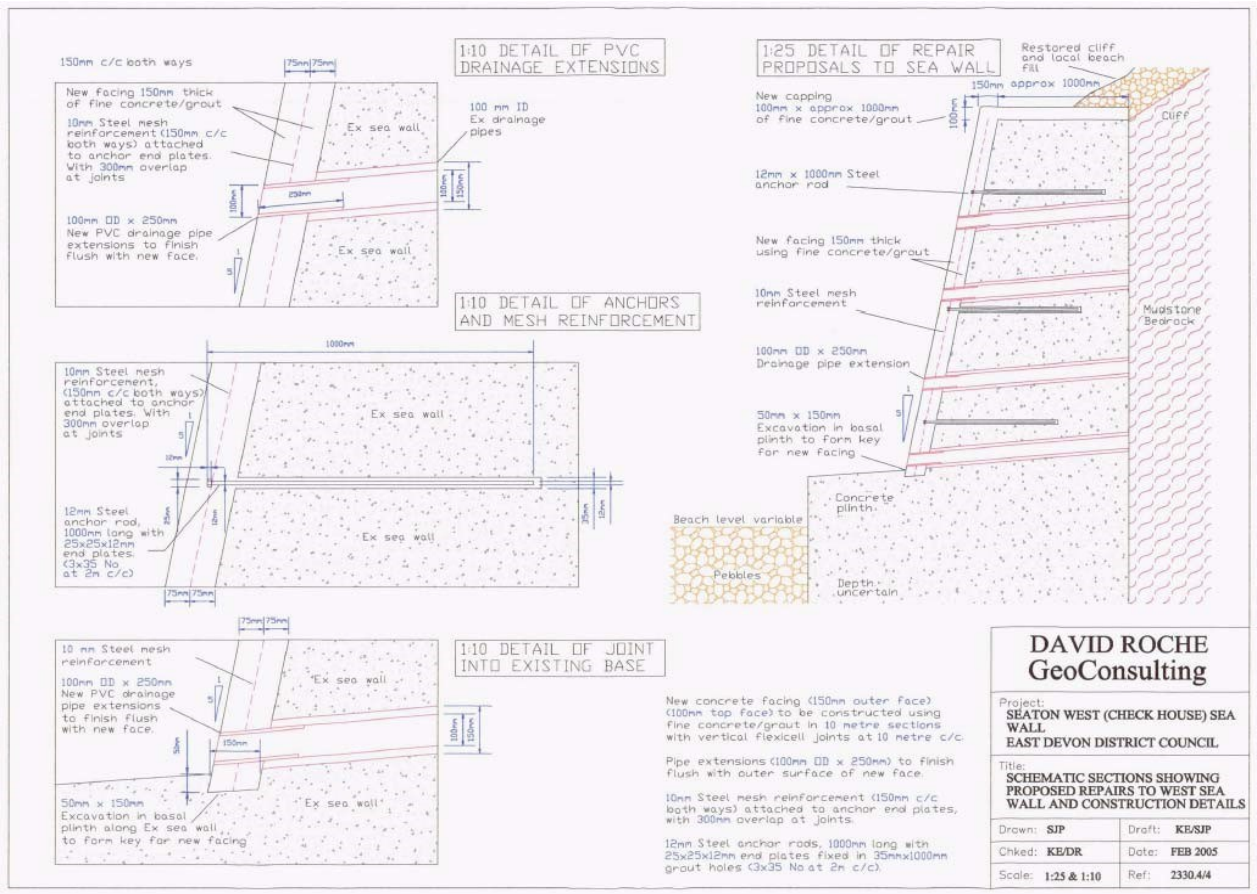

Figure 3-8 Schematic section showing proposed repairs to the west sea wall and construction details
Source: David Roche GeoConsulting, 2005

3.1.6 West Walk Promenade

Prior to the 1960s, the West Walk Promenade, founded with a vertical concrete seawall, was constructed along the base of the cliffs, creating a link between Seaton and the café close to the Check House Wall (today the Hideaway Café) (Posford Duvivier, 1994).

Remedial measures were undertaken in 1993 to protect the toe of the promenade and seawall due to concerns regarding undermining and collapse (Posford Duvivier, 1994). However, the seawall remained in danger of collapse due to overturning or subsidence. Therefore, in 1996/1997, improvements were made consisting of the construction of a 370m long concrete seawall dressed with stone blockwork, which encased the older vertical concrete structure (see Figure 3-9).

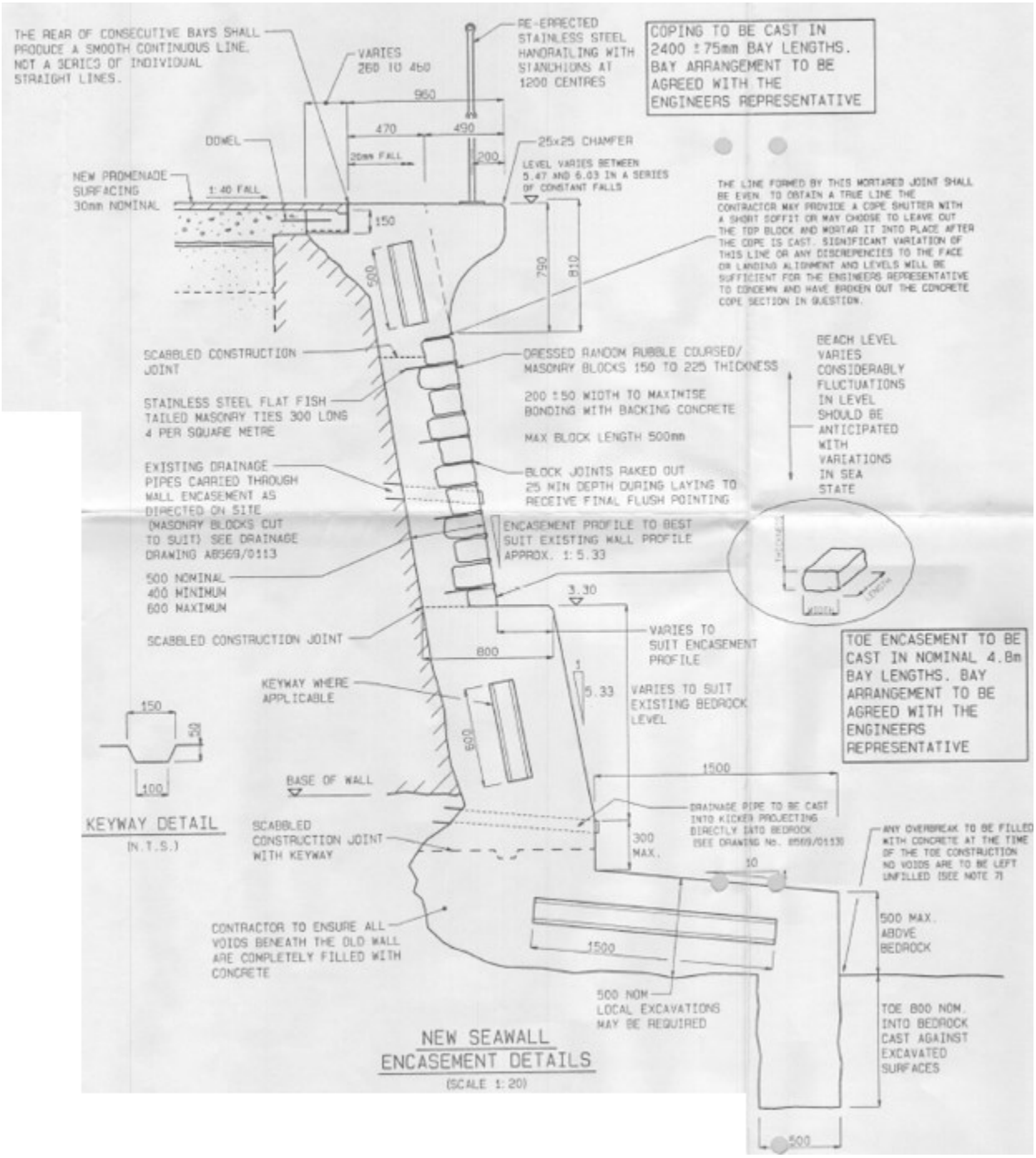

Figure 3-9 Revised seawall design for flood defence protecting the promenade to the west of Seaton
Source: Posford Duvivier, 1995b

3.2 Seaton

The primary defence along the length of the Seaton frontage is a seawall. Seaton spit provides an element of protection to Axmouth Harbour. Following regeneration of Axmouth Harbour, the inner spit has been protected with some ad-hoc coastal defences, and continues to be managed via ongoing dredging and dredge disposal activities.

3.2.1 Seaton Seawall

The main defence protecting Seaton Town is a concrete seawall that runs adjacent to the Esplanade. The 780m long concrete seawall and wave return wall was constructed in 1980 by the South West Water Authority (now property of the Environment Agency) in response to severe flooding and damage following storms in 1979 (Posford Duvivier, 1994). The wall includes integrated access steps and ramps, flood gates and the main slipway. The wall protects the Esplanade in Seaton between the main slipway and the eastern end of the esplanade, adjacent to the Axe Yacht Club clubhouse. It is understood that a report exists that outlines the design beach level to accompany the seawall (Angus Walker, *Pers. Comms.*, 2017), however, it has not been possible to locate the report. A review of modelled data suggests that lowering the beach profile in front of the seawall only acerbates the risk of overtopping (see Section 3.4.1).

The Environment Agency is currently considering modification to the main slipway gates should road levels along the Esplanade change in the future and to improve safety during operation. This would also improve the baseline condition of the assets.

3.2.2 Seaton Spit

Seaton spit is largely undefended, with no defences constructed on its seaward face. However, development of the estuary inside of the spit to form the Axe Harbour basin, starting in the 1970's, has resulted in modification to its landward face, including the construction of the defences, as described in Section 3.2.3 below.

3.2.3 Axmouth Harbour (River Axe West Bank and Axe Harbour Basin)

The present harbour was a small trading port until construction of the railway branch line in 1886, which assisted in the development of Seaton as a holiday destination. Following storm damage in the 1870s, the entrance reportedly narrowed and the harbour became derelict (Author unknown 1, 2000). Today, Axmouth Harbour is protected from the substantial wave action by Seaton spit.

Regeneration of the harbour began in the 1950s, with further development since the 1970s by EDDC also, who have become custodians and the statutory authority for the harbour. In 1988, the Axe Harbour Management Company was formed, and the harbour is now leased to them, who sub-lease the western side to the Axe Yacht Club (AYC) and the eastern side to the East Devon Fisherman's Association.

A summary of the actions taken to develop the harbour are included in the following sections; further detail can be found in the Coastal Processes Baseline Report (Appendix A; Section 4.4) and the Defences Baseline Report (Appendix C).

3.2.3.1 Axmouth Harbour Development – Defence Construction

Extraction of material from the landward side of the spit for bank repair first took place in the late nineteenth century (Parkinson, 1985).

Development of the harbour basin began in the 1970s (Author unknown 1, 2000), with further works in 1977 to create a mooring basin; this included the excavation of the estuary by the AYC (with support from the EDDC and approval from NRA) and construction of a rock gabion bastion at the seaward end of the spit. A fence was also built along the basin to protect the bank at high water (Author unknown 1, 2000).

In 1995/6, secondary fencing was installed with rock armouring downstream of the harbour and bastion on the west bank of the River Axe (Author unknown 1, 2000).

In 2000, severe gales and excessive flood water caused erosion to the end of the spit, over-widening the mouth and leading to significant erosion along the inner side of the spit. This event also caused damage to the protective bastion for the mooring basin, undermining of the protective fencing within the basin, and erosion of the inner side of Seaton Spit (Axe Harbour Management Company Ltd, 2001).

Between 2001 and 2003, the defences within the harbour basin were revised to address erosion issues, with the final structure involving reno mattresses and gabions (Axmouth Harbour Management Company Ltd, 2003). The defences are shown in Figure 3-10 and Figure 3-11.

The conversion from trot moorings to a marina style pontoon finger berth was initiated in 2007 with three pontoons ordered from the Solent Marina of Southampton (AYC, no date).

Between 2007 and 2009 pontoons and finger berths were installed, increasing the capacity of the harbour (AYC, no date). Today, there are 105 moorings in Axmouth Harbour.

Figure 3-10 Photos of the protective fencing undermined and the construction of the gabion groyne
Source: Axmouth Harbour Management Company Ltd, 2003

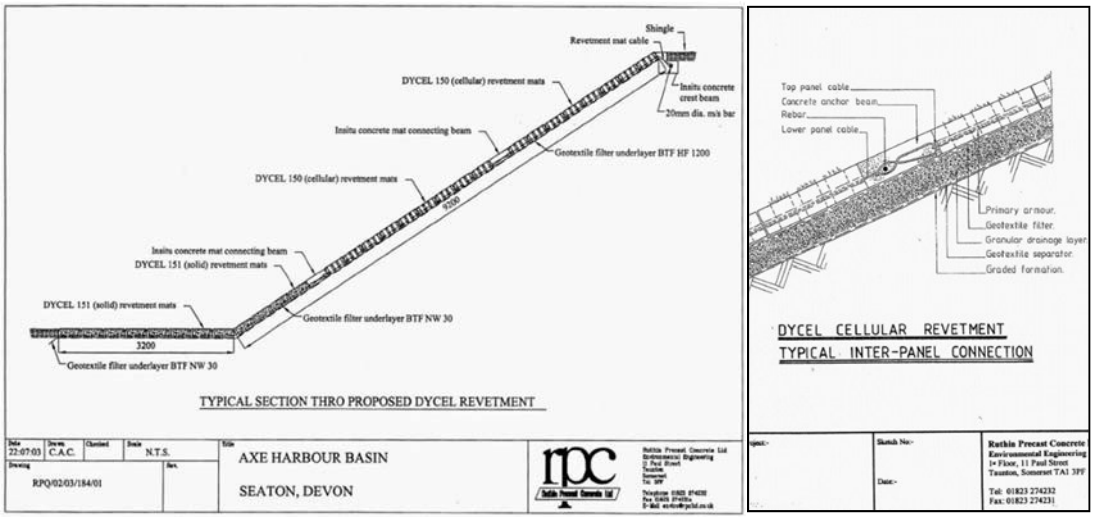

Figure 3-11 Typical Section through Proposed Dycel Revetment and Typical Inter-Panel Connection
Source: Axmouth Harbour Management Company Ltd, 2003

3.2.3.2 Axmouth Harbour Development – Dredging

Maintenance dredging of the channel was periodically undertaken to improve access to the harbour. In 1970, deposition of dredge spoil material was used to strengthen the shingle spit, increasing its width and height.

In 1996 the Axe Harbour Management Company were granted an exemption under the Waste Management Licensing Regulations 1994 by Devon County Council for the disposal of dredge spoil. Since 1996, dredging has continued annually, and Flood Defence Consent has been granted by the National Rivers Authority and the Environment Agency with no requirement for further consideration of a Waste Management License or exemption.

Since 2008, suction dredging has been used to remove the silt from the estuary. Subsequently, dredged material has been pumped into and disposed of within a series of trenches dug into the shingle spit; this includes an eastern trench located 130m west of the distal end of the spit, used between 1978/1979 and 2008, and more recently a trench in front of the Axe Yacht Club that has been used since 2008. The locations of the trenches are shown in Figure 3-12, with the open trench in the spit shown in Figure 3-13. Between the 1970s and 2015, the spit has reportedly been widened and raised two meters above the former shingle bank crest level (CH2M, 2015a).

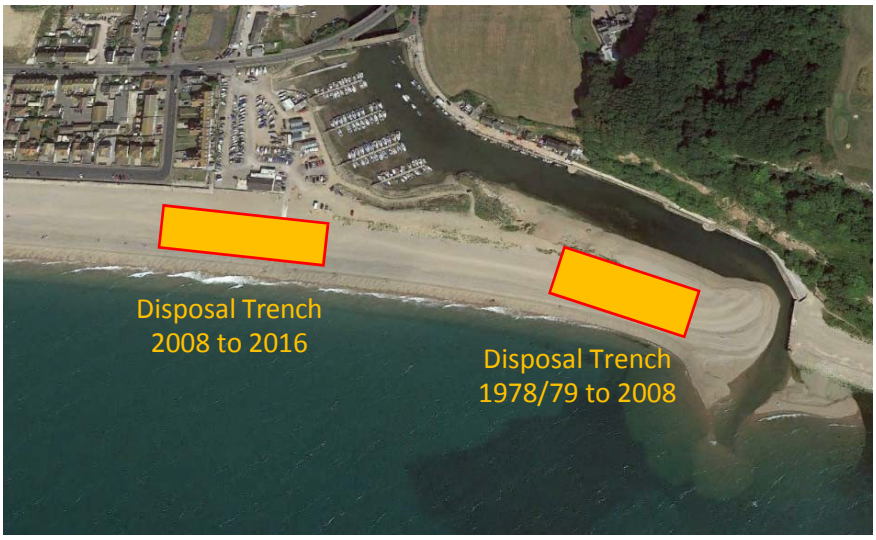

Figure 3-12 Map showing approximate locations of dredge disposal sites
Aerial image © 2015 Google Earth

Figure 3-13 Trench for disposal of dredge material 2009/2010
Source: Author unknown 2, no date specified

Today, the inlet of the Axe is dredged to maintain the Axe Yacht Club access channel to -1.0mOD. Typically, 1000 – 1500 tonnes of silt is dredged from the harbour (Site Visit Notes, 2017), which is suggested to equate to 1,500m³ per year (David Turner, East Devon Council, *Pers. Comms.*, 2016). In 2017, 800m^3 of dredge material was buried in front of the seawall (Site Visit Notes, 2017). The harbour is dredged over the winter period and during the day not weekends as to minimise disruption.

Historically disposal of dredge material by the methods described was granted consent by the National Rivers Authority (NRA, now subsumed into the Environment Agency) in 1993 (Axe Yacht Club, 2015), with no objections by the Ministry of Agriculture, Fisheries and Food (MAFF) (now the Department for Environment, Food and Rural Affairs (Defra)) or English Nature (now Natural England) (Author unknown 1, 2000). It is also reported (Axe Yacht Club, 2015) that MAFF required that dredge material was disposed of within the spit to help reinforce and raise it, following overtopping in 1993. On the 2nd January 1996, exemption under the 'Waste management Licensing Regulations 1994' was granted by the Devon County Council Environment Department (Axe Yacht Club, 2015).

The latest guidance from the Environment Agency is that dredging operations (including both dredging and disposal) are excluded from the requirement for a Flood Risk Activity Environmental permit for the reason that the Harbour Authority is considered a protected statutory body, whereby the specific operation of dredging is considered as a protected statutory undertaking to maintain the operation of the harbour (Environment Agency, *Pers. Comms.*, 2017). However, ahead of the outcomes of the Seaton BMP*, the Environment Agency note that this exclusion is on the assumption that dredge material will be placed within the reception trench shown by the blue hatched area on the map in Figure 3-14 and above mean high water.

*An appropriate management regime for Seaton spit and the Axmouth Harbour basin, specifically dredge disposal options, is being developed as part of the Seaton BMP. An options appraisal process has been commenced, but to be developed further, will require information relating to sediment quality and licensing approvals from the Marine Management Organisation. A placeholder has been allowed within the BMP for this, refer to Section 4.2.

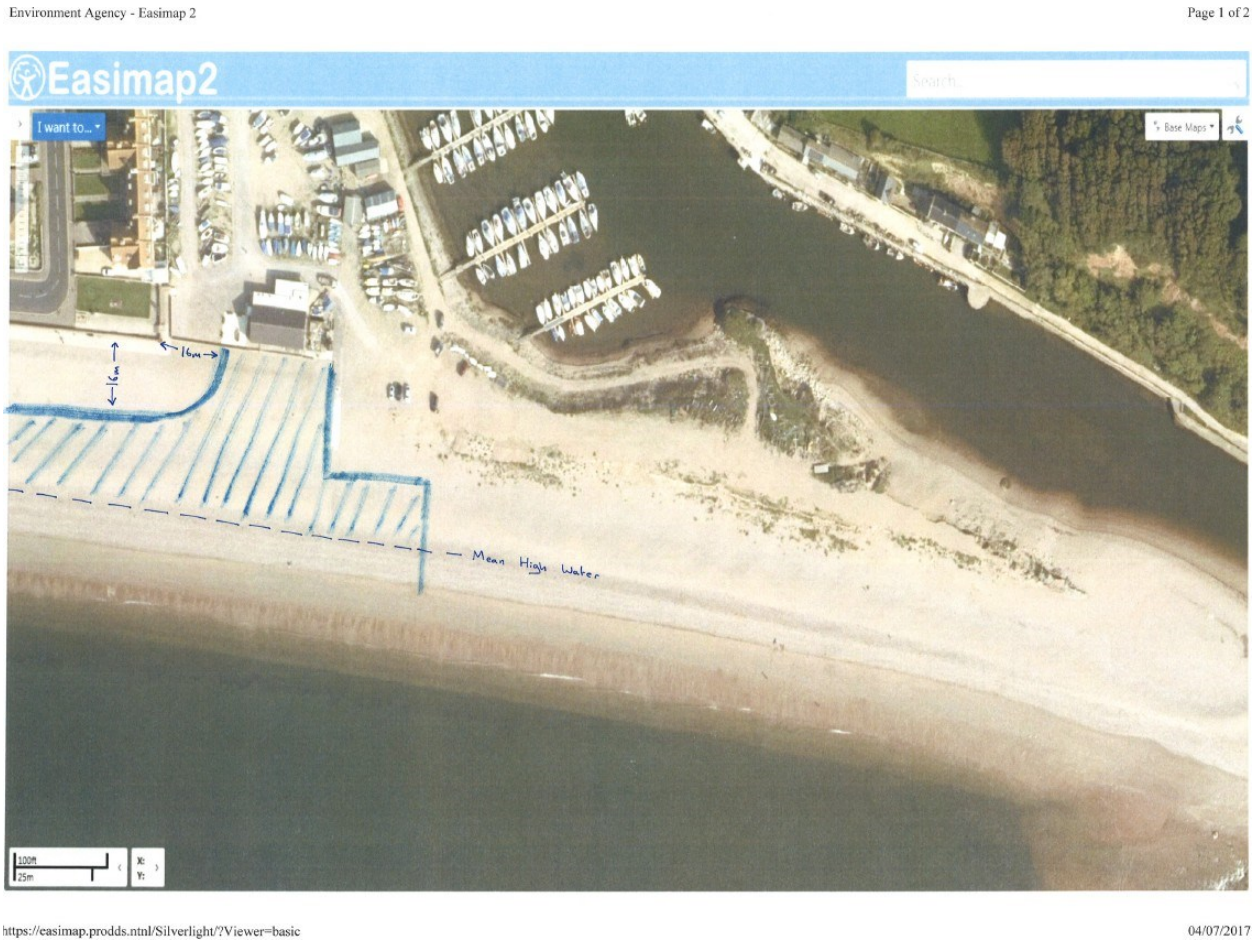

Figure 3-14 Permitted dredge disposal zone for 2016/2017 arisings
Source: Environment Agency, Pers. Comms., 2017

3.3 River Axe East Bank (1800's to 2003)

Construction of a quay walls along the eastern side of the estuary began in the 1800's (Author unknown 1, 2000), later extended with rock walls and concrete walls and renovated in 1996 (Prichard, 2006).

In 1978, the original harbour arm was constructed as a mass concrete gravity structure surrounded by sheet piling and in 1985, the harbour wall was refurbished (Royal Haskoning, 2015).

Further refurbishment of the Axmouth Harbour walls was undertaken between 1998 and 2001, with a new 20m Harbour Arm extension constructed in May 2001 (Pritchard, 2006). The extension at the river mouth consisted of a lower level cellular structure, backfilled with concrete and supported by timber fendering and breastwork. The design was undertaken by Posford Duvivier and the general arrangement is shown in Figure 3-15 and Figure 3-16.

In 2003, repairs to the steel sheet piling that formed the harbour arm were undertaken, along with treatment to small areas of Accelerated Low Water Corrosion (ALWC) (Royal Haskoning 2015).

In 2005, there was an inspection of the harbour arm, which identified ALWC across a broader area than previously recorded. No work was identified for scour repair (Royal Haskoning, 2015).

In 2006, an ALWC inspection was commissioned by EDDC, and undertaken by Royal Haskoning. The investigation concluded there was little risk to the harbour walls stability, and recommended a programme of repeat surveys to monitor the condition (Royal Haskoning, 2015).

In 2015 scour inspection by Royal Haskoning recommend the adoption of an annual monitoring regime, and appropriate remedial works on ad hoc basis (Royal Haskoning,2015).

Implementation of the management approach for the harbour walls/harbour arm will require adoption of the annual monitoring (see Section 4.1.1.5(a) and Section 5.1.5).

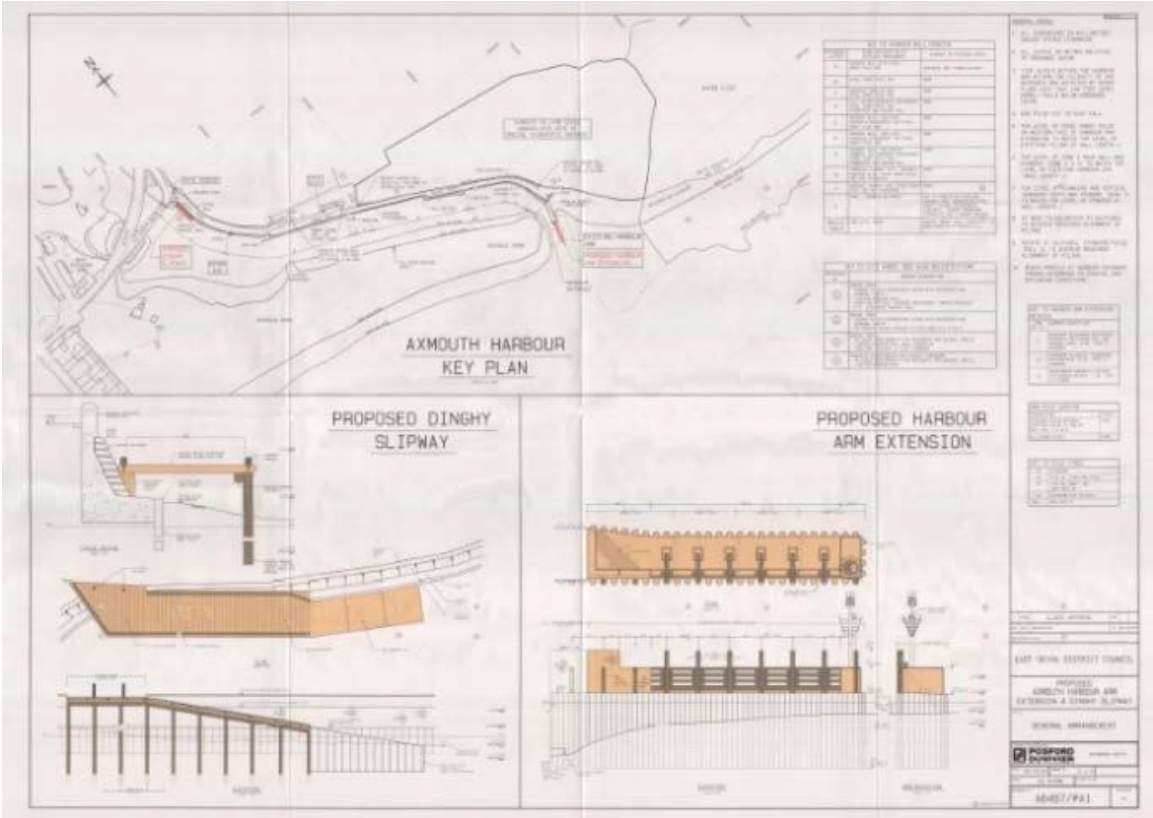

Figure 3-15 Axmouth Harbour Arm extension plans
Source: Posford Duvivier, 1997

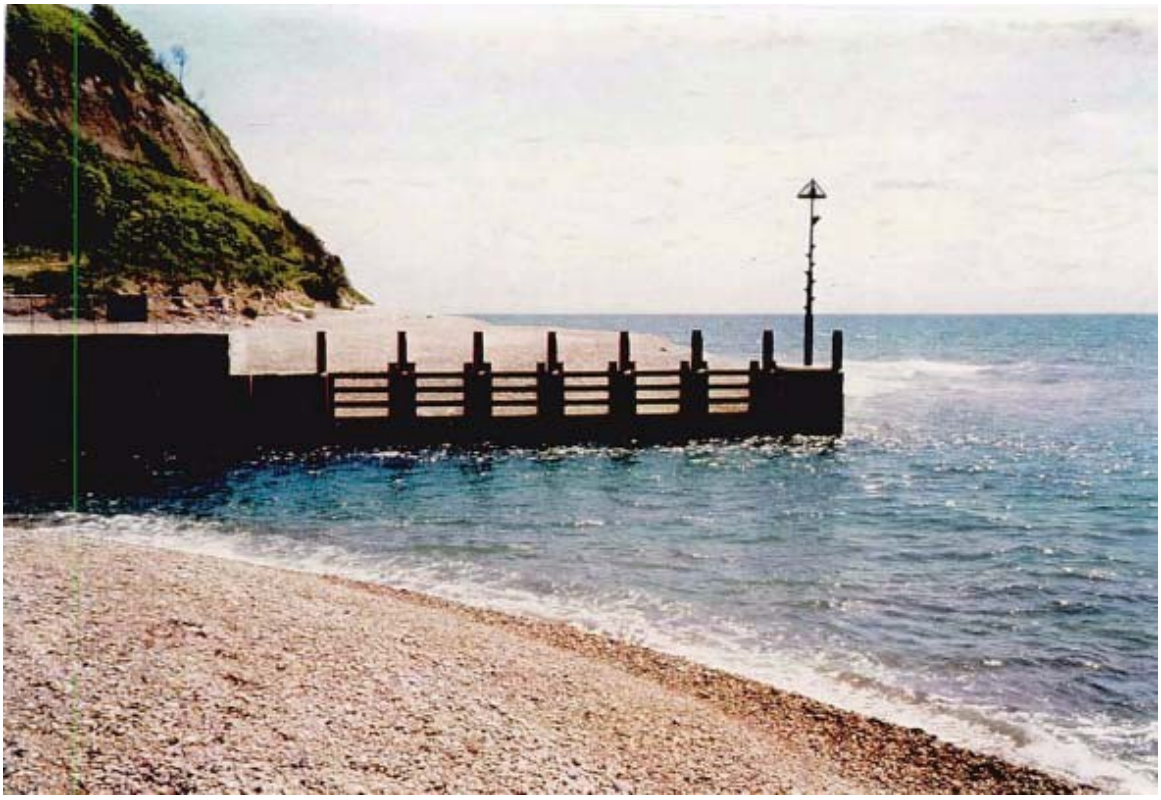

Figure 3-16 Axmouth Harbour Arm extension
Source: Axe Harbour Management Company, 1997

3.4 Existing Standard of Protection

3.4.1 Overtopping Analysis

One of the key performance criteria of coastal defence assets 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 along the BMP frontage.

New wave overtopping analysis was completed for the Lyme Bay Coastal Flood Forecasting Phase 2 project and used for the present BMP to determine the level of protection that the current defences the afford against wave overtopping in 2017 and how it may change in the future. The current defences included the slipway at Fisherman's Gap (with and without the flood gates closed) and the Seaton seawall (western end; beach profile 6a01177 and eastern end; beach profile 6a01169, see Section 2.5.1.2 and Section 5.2.1.1 for locations). Overtopping thresholds used were based on existing guidance, which sets out the overtopping limits for the safety of people and vehicles, and overtopping limits for the structural design of flood defences. As it was determined that the Seaton flood defences are exposed to wave heights between 2m and 3m, the overtopping thresholds were defined as follows:

- The overtopping threshold for people and vehicle safety is defined as 0.3 l/s/m;
- The threshold for flooding of properties behind the seawall of 1 l/s/m; and
- An approximation can be made for the structural design overtopping threshold by assuming the structure is equivalent to a breakwater with rear side designed for wave overtopping, with a threshold of 5 l/s/m.

Full details of the overtopping analysis undertaken, including the data used, methodology and results, is presented in Appendix C; Section 4.

The key findings of the analysis under present day conditions are:

- Analysis at the slipway underlines the importance of effective gate closure. With the gates closed and open, overtopping that exceeds public and vehicle safety threshold occurs under all the extreme events considered. With the gates closed and effectively sealed, overtopping that could cause damage to properties via flooding, would be expected to occur under a 1 in 200-year event. With the gates open, overtopping that could cause damage to properties via flooding, would be expected to occur under a 1 in 2-year event. Structural damage would not be expected to occur to the closed gates under present-day conditions, or future conditions until a 1 in 1000-year event in 2115. Structural damage of the open gates would not be expected to occur under present-day conditions, however, as the impacts of climate change are realised, structural damage is expected to occur under a 1 in 200-year event by 2070.
- Analysis of the western end of the seawall, where the beach is narrow (described by Profile 6a01177), indicated more significant flood risk than to the east. Overtopping that exceeds the public and vehicle safety threshold under all the extreme events considered, however, overtopping that could cause damage to properties via flooding, would be expected to occur under a 1 in 20-year event. Structural damage would not be expected to occur under present-day conditions, but as the impacts of climate change are realised, damage is expected to occur under a 1 in 1000-year event by 2070.
- Analysis of the eastern end of the seawall, where the beach is wider (described by Profile 6a01169), indicated less significant flood risk than to the west. Overtopping that exceeds the public and vehicle safety threshold under all the extreme events considered, however, overtopping that could cause damage to properties via flooding, would be expected to occur under a 1 in 1000-year event. A diminishing standard of protection is expected as the impacts of climate change are realised. Structural damage was not exceeded under any tested condition for the wider beach area during present-day or with sea level rise included.

In addition, examination of the cross-shore profile response using Shingle-B was completed to assess how beaches of varying cross-sectional area could behave under extreme conditions. The analysis suggests that:

- At the western end of the beach, where it is narrower, material may build up against the seawall for the existing profile.
- Material may be prevented from reaching the seawall by extending the width of the beach, however, more tests are required to establish a reliable design profile. The rate of increase in volume of material required to move the crest progressively further offshore gradually increases as the beach slope extends into deeper water.
- Reshaping the beach is not predicted to affect the build-up of material against the seawall for the condition tested. A possible exception to this would occur if the storm duration at a given water level was sufficiently short to prevent the dynamic equilibrium profile from establishing. In these circumstances reprofiling by moving material away from the seawall could offer some benefit.
- At the eastern end of the beach, where it is wider, material is not predicted to build up against the seawall for the existing profile. Material has been observed to accumulate at the seawall in the past, however the initial beach state prior to the events which led to accumulation at the seawall are not known. Storms occurring when beach levels were depleted may have allowed the beach crest to roll back further. Alternatively, long-shore transport may have affected beach

behaviour, and such impacts may be significant at Seaton. Shingle-B does not take into account longshore affects.

3.4.1.1 Lyme Bay Flood Forecasting Phase 2 Project – Overtopping Analysis

This Lyme Bay Flood Forecasting Phase 2 project (see Section 1.7.5), included a sensitivity assessment to investigate how different beach profile conditions (including emergency profile, i.e. low beach levels, baseline, and increased profile, i.e. higher beach levels), could affect the amount of overtopping occurring under a 1:200 return period event. This assessment included the coastline at Seaton, specifically the slipway at Fishermans Gap, profile 6a01177 (western end of the seawall), profile 6a01169 (central-eastern section of the seawall) and profile 6a01163 (opposite the Axe Yacht Club).

- The key findings suggest that beach levels lower than the baseline result in an increase in overtopping rates and increasing beach levels (shingle filled to the edge of the promenade with a wider berm than present) returns overtopping rates that are the same as (or a little less) than with the baseline profile.
- This would suggest that drawing beach material way from the seawall could increase rates of overtopping, whilst increasing the height and width of the beach could reduce rates ofovertopping.

3.4.2 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 C; Section 3).

In summary, this assessment concluded that the rock revetment at West Seaton and the seawall at Seaton ate not experiencing damage resulting from scour and undermining.

However, outflanking of the gabion baskets surrounding the Seaton Hole outfall (described in Section 3.1.1) is resulting in undermining at the toe of the structure, has allowed loss of the underlying material and settlement of the structure. Although works to the outfall do not form part of the management approach to reduce flood and coastal erosion risk for the next 20-30 years, a recommendation has been made within the BMP to undertake redial works to the structure (refer to Section 4.1.4.2).

Large cracks and one particular large failure within the concrete encased revetment (described in Section 3.1.2), has allowed the rock core to be scoured and washed out. The condition of the structure is poor and the revetment is being considered for remedial works, or even replacement, as part of the management approach to reduce flood and coastal erosion risk for the next 20-30 years (refer to Section 4.1.1.1(a)).

The former beach/cliff protection works at ‘The Pillar’ (described in Section 3.1.4), are subject to undermining (and outflanking). Having failed, and now in poor condition with little to no performance function, the management approach for this stretch of coastline is to extend the rock revetment eastwards to Check House Wall (see Section 4.1.1.1(c)).

SECTION 4

Maintenance 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 Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 years. An outline programme of the key activities that form the management approach for the next 5 years is presented in Table 5-1, with full details of the activities presented in the following sections.

Table 4 1 5-year programme of management activities to reduce the flood and coastal erosion risk between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge the next 20-30 years.

Key Activity Number	Key Activity Description	Programme of Activities				
		Year 1 2018-2019	Year 2 2019-2020	Year 3 2020-2021	Year 4 2021-2022	Year 5 2022-2023
1	Upgrade concrete encased revetment at Seaton Hole.					
2	Maintain 'old and new' revetment at Seaton Hole / Old Beer Road.					
3	Extend 'new' revetment at 'The Pillar'.					
4	Upgrade Check House Wall.					
5	Maintain West Walk Promenade including concrete / stone blockwork.					
6	Improve drainage behind the Seawall and implement road closures in response to flood warning.					
7	Do Nothing Seaton spit and consult with SMP group to guide future management of the landward side of the spit.					
8	New defences west bank Axe Estuary.					
9	Maintain the existing seawall at Seaton.					
10	Maintain existing walls and harbour arm on the east bank Axe Estuary.					
11	Consider whether to undertake beach recycling, guided by ongoing monitoring, consultation with SMP group and new study.					

Key Activity Number	Key Activity Description	Programme of Activities				
		Year 1 2018-2019	Year 2 2019-2020	Year 3 2020-2021	Year 4 2021-2022	Year 5 2022-2023
12	Undertake beach management works instigated by alarm and crisis trigger levels. This includes storm debris and shingle clearance, more frequent and focused beach monitoring, defence works, and beach recycling if suitable.					
13	Cliff drainage measures. EDDC to investigate suitable options for cliff-top drainage (that are agreeable environmentally and affordable), and for EDDC to identify a funding stream for this erosion risk management activity. A study into surface water flows on the cliff-top would also be required in support.					
14	Works to address undermining of Seaton Hole outfall.					
15	Assessment of pathway along concrete encased revetment at Seaton Hole.					
16	Removal of fallen debris from cliffs between Seaton Hole and West Seaton.					
17	Address issue of pollution of beach at Old Beer Road. To be informed by an investigation and if relevant, development of suitable options.					
18	Fisherman's Gap flood gate procedures.					
19	Formally recognise and define the BMP area as a Coastal Change Management Area (CCMA) and update the Local Plan and Neighbourhood Plan. Produce a CCMA Adaptation Plan.					

The strategy to managing the coastline between Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge has been developed via a robust options appraisal process and ongoing stakeholder engagement throughout development of the BMP (as described in Appendix E and Appendix F).

The options have been selected as they provide the best balance between technical viability, environmental acceptability and economic case. The overall management approach going forward has

been developed 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.

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.

Signpost!

Full details of the options appraisal are presented in the **Options Appraisal Report**, which is provided Appendix E; and specifically, for **Axmouth Harbour, the Options Appraisal Report** is provided in Appendix F.

4.1 Management Activities

4.1.1 Structure Maintenance and Modification

4.1.1.1 West Seaton – Seaton Hole to West Walk Promenade

Works to improve the existing defences between Seaton Hole and Seaton should be undertaken to provide a more robust and continuous line of defence and protect the cliffs from marine erosion at the toe and in turn protect the cliff-top properties and infrastructure. These works are to include:

(a) Upgrade Concrete Encased Revetment at Seaton Hole

Upgrade the failing concrete encased revetment, tying it into adjacent rock revetment if possible, or replace it with new a structure. This will improve/significantly extend the working life of the asset beyond its original design. If replacement occurs within the same footprint as current concrete revetment then no additional direct impacts to the West Bay SAC/ Beer Coast SSSI are anticipated (Natural England, *Pers.Comms.*, 2017).

(b) Maintain 'Old and New' Revetment at Seaton Hole / Old Beer Road

Maintain the 'old and new' revetment between Seaton Hole and Old Beer Road (as far as 'The Pillar'), and re-profile by re-packing the existing rock. These works will ensure that the condition and performance of the revetment is continuous along its length and will improve/significantly extend the working life of the asset beyond its original design. This would not lead to additional impacts upon the Sidmouth to West Bay SAC and Sidmouth to Beer Coast SSSI (Natural England, *Pers.Comms.*, 2017).

(c) Extend 'New' Revetment at 'The Pillar'

At the location of 'The Pillar', replace the former gabion baskets with a new revetment by extending the existing 'new' revetment eastwards to Check House Wall.

(d) Upgrade Check House Wall

Upgrade the Check House Wall, which is showing signs of deterioration, by for example, adding a thicker concrete layer the structure, or replace with a new structure. These works will improve/significantly extend the working life of the asset beyond its original design.

It is anticipated that funding for these activities could be sought from both the Environment Agency via Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM-GiA), EDDC and any available third-party funding.

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

4.1.1.2 West Seaton – West Walk Promenade

(a) Maintain West Walk Promenade

Maintain West Walk Promenade including concrete / stone blockwork to ensure that it continues to provide a robust defence for the cliff-top properties and infrastructure against cliff toe erosion by marine action. It is not anticipated that the seawall is upgraded and made higher due to its good condition and existing level of performance.

The West Walk Promenade (and concrete / stone blockwork seawall) is currently owned and maintained by EDDC. Future maintenance of the existing seawall will be undertaken by EDDC 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).

4.1.1.3 Seaton and West Bank Axe Estuary – Excluding Seaton Seawall

Works to maintain the existing defences along the length of Seaton and potentially introduce new defences on the west bank of the Axe Estuary should be undertaken to provide a continuous line of defence and protect the town, infrastructure and environmental habitats, from flooding via wave overtopping. These works are to include:

(a) Improve Drainage Behind the Seawall

Overtopping events are likely to occur along the Seaton in the future, but as long as the seawall remains as present, there is a need to manage the flood waters. Improving the existing drainage behind the seawall will encourage water that has overtopped the defences to flow back to sea. Any drainage improvements to the seawall must be done in consultation with the plans for 'Seaton Sea Front Enhancement'.

Reactive management could also include road closures at times of anticipated storms to reduce the risk to the general public from overtopping. This could be informed by flood warning procedures, co-ordinated by the Environment Agency's Flood Incident Management Duty Officer based in Exeter (refer to Section 5.5.1), or in the future by those being developed for the Lyme Bay Coastal Flood Forecasting Phase 2 project.

(b) Do Nothing Seaton Spit

Maintain a management approach of Do Nothing for Seaton spit, as defined by the SMP Policy (Policy Unit 6a28) for the frontage (see Section 1.7.1).

Consideration needs to be given to the management of existing defences on the landward site of the spit. The current SMP policy for the coastline for this area (Policy Unit 6a25), is Hold The Line. However, this may contravene the policy of No Active Intervention of the spit.

Future maintenance of the existing ad-hoc defences or construction of any new defences along the landward side of the spit needs to consider the SMP policy going forward. In the meantime, it is anticipated that the responsibility of the defences falls with the Axmouth Harbour Management Company Limited (AHMC)/Axe Yacht Club / EDCC (see Section 1.5.1). It may also be that the future management of the landward side of the spit is considered alongside the works being developed by the Environment Agency manage flood risk on the west bank of the Axe Estuary (see Section below).

The next steps would be to prepare a paper on the No Active Intervention policy for Seaton spit, considering the management of the landward side of the spit for presentation to and consultation with the SMP Group in order to agree a way forward if necessary.

(c) New Defences West Bank Axe Estuary

Works to manage the risk of flooding to the east of Seaton via overtopping from the west bank of the Axe Estuary will be determined by a study being completed by Mott Macdonald on behalf of the Environment Agency.

It is anticipated that funding for these activities could be sought from both the Environment Agency via Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM-GiA), EDDC and any available third-party funding.

The next steps to implement these activities would be to prepare and submit a project proposal to the Environment Agency for consideration. *Close liaison with the Environment Agency is crucial when developing the business case for this option to allow for the inclusion of the preferred management activity once confirmed.*

4.1.1.4 Seaton and West Bank Axe Estuary – Seaton Seawall Only

(a) Maintain the Existing Seawall at Seaton

Maintain the existing seawall at Seaton to provide a robust defence for the properties, infrastructure and environmental habitat against flooding via wave overtopping. It is not anticipated that the seawall is upgraded and made higher due to its current condition, level of performance and landscape issues.

The Seaton 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).

4.1.1.5 East Bank Axe Estuary

(a) Maintain Existing Harbour Walls East Bank Axe Estuary

Works to maintain existing harbour walls, harbour arm and training wall will need to be informed by the results of ongoing monitoring and surveys (see 5.1.5). Providing the footprint of the wall is not extended then this option should not lead to additional impacts to the designated sites (Natural England, *Pers.Comms.*, 2017).

In the event that works are required to the walls, it is anticipated that funding for these activities could be sought from both the Environment Agency via Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM-GiA), EDDC and any available third-party funding.

4.1.2 Beach Management

4.1.2.1 Undertake 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. Beach recycling would not, however, provide protection to the full length of the BMP 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 redistributed along the frontage or to the nearshore area in one storm. Any disruption to the existing sediment regime, could have impacts on designated sites, including SAC, SSSI and WHS (see Section 2.6.4). As the options appraisal process has identified (see Appendix E), there are pros and cons to implementing such structures. Given that control structures are in the main not favoured by stakeholders and local residents, conflict with plans for 'Seaton Sea Front Enhancement', are expensive and could potentially cause adverse effects along the coast, it is recommended that beach recycling is only considered in isolation.

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.

Consideration also needs to be given to the Shoreline Management Policy for the Seaton spit, which is No-Active Intervention. Recommendations for beach recycling along the BMP frontage would involve recycling of material from the spit to the west. The question is raised 'would movement of material from the spit go-against the SMP policy'. It is therefore recommended that the SMP Group is consulted with to discuss this option and agree a way forward if necessary.

The next steps to implement this activity would therefore be to (i) prepare a paper on the No Active Intervention policy for Seaton spit and its implications for future management (as identified by the BMP) for presentation to and consultation with the SMP Group; and following that, (ii) undertake a study to determine the suitability of beach recycling and an assessment of the quantities that could be removed and where from and to. Once a better understanding has been achieved, then funding could be sought.

4.1.3 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 along the length of the BMP frontage, resulting from low beach levels will be triggered by defined alarm and crisis levels described in Sections 4.1.3.1 and 4.1.3.2 below. Along the length of the West Walk Promenade and the Seaton seawall, following overtopping events, beach material can be deposited on the promenade and the esplanade road, and depending on the volume, lead to road closure. Further to this, the rock revetment has been displaced 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.

4.1.3.1 Alarm Trigger Levels

To prompt works along the BMP frontage as described above, the alarm trigger levels, and associated actions to be taken when met, are defined in Table 4-1 below.

Table 4-1 Alarm Trigger Levels and associated actions

Alarm Trigger Reference	Alarm Trigger Description	Alarm Trigger Action
Alarm Trigger 1	Deposition of storm debris and shingle on the West Walk Promenade and esplanade as a result of wave overtopping.	Clear the promenade of storm debris and shingle and road and place shingle back on the beach.

Alarm Trigger Reference	Alarm Trigger Description	Alarm Trigger Action
Alarm Trigger 2	High beach levels leading to increased risk of deposition of shingle on the road as a result of wave overtopping.	More frequent beach monitoring to determine if high beach levels are a temporary or persistent trend occurring over several weeks. Details of the monitoring requirements are described in detail in Section 5.2.2.
Alarm Trigger 3	Low beach levels leading to exposure/damage of the West Walk Promenade (and concrete / stone blockwork) and Seaton seawall, undermining and increased risk of overtopping and overtopping/overwashing/breach of Seaton spit 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 5.2.2.

4.1.3.2 Crisis Trigger Levels

To prompt immediate works along the BMP frontage as described above, the crisis trigger levels and associated actions to be taken when met, are defined in Table 4-2 below.

Table 4-2 Crisis Trigger Levels and associated actions

Crisis Trigger Reference	Crisis Trigger Description	Crisis Trigger Action
Crisis Trigger 1	Persistent (over several weeks) high beach levels poses an increased risk of beach overtopping, overtopping / overwashing / breach of Seaton spit particularly in 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 4.1.2.1).*
Crisis Trigger 2	Persistent (over several weeks) low beach levels poses an increased risk of beach overtopping, overtopping / overwashing / breach of Seaton spit particularly in storm events. This will be informed by the increased beach monitoring instigated in response to Alarm Trigger 2.	If appropriate implement works to address the rock revetment, West Walk Promenade (including concrete / stone blockwork), Seaton seawall, and any new defences constructed, 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 4.1.2.1).*
Crisis Trigger 3	Structural damage or failure of existing / new defences that occurs at a time when beach levels are neither high or low, such as that brought about by storm-damage or otherwise, and has not been picked-up by structure monitoring (see Section 5.1).	Implement necessary emergency works to address the rock revetment, West Walk Promenade (including concrete / stone blockwork), Seaton seawall, and any new defences constructed, defects.

4.1.4 Other Related Management Activities

The following section sets out a number of other related management activities to be undertaken alongside the activities (outlined in Section 4) to manage flood and coastal erosion risk along the BMP frontage over the next 20-30 years.

4.1.4.1 Cliff Drainage Measures

Works to address the eroding cliffs above the West Walk Promenade planned for April 2018 to April 2019, including works to improve drainage and stability using catch nets. These cliffs will continue to be monitored as part of the annual monitoring programme by EDDC (see Section 5.3).

However, elsewhere, there remains a need to address the risk of cliff erosion from the top-down. A key finding of the BMP is that groundwater saturation of the cliffs is a key driver to cliff erosion at Seaton and for the cliffs to be fully protected this issue needs to be addressed; protecting from marine erosion at the toe alone will not solve the problem. The action is to therefore for EDDC to investigate suitable options for cliff-top drainage (that are agreeable environmentally and affordable), and for EDDC to identify a funding stream for this erosion risk management activity. A study into surface water flows on the cliff-top would also be required in support. Further, due to the unavailability of funds via FDGiA for cliff-top measures, EDDC will need to fund / seek third-party funds (e.g. DCC Highways) to implement this investigation / works.

4.1.4.2 Works to Address Undermining of Seaton Hole Outfall

Undermining of the gabion baskets that protect the Seaton Hole outfall is taking place, which could lead to its failure and ultimately a Health and Safety issue at the site of the outfall on the beach. It is recommended that necessary remedial works are undertaken.

4.1.4.3 Assessment of Pathway Along Concrete Encased Revetment at Seaton Hole

The footpath that passes directly behind the concrete-encased revetment may be unstable due to the failing defence. An assessment of the path is recommended and if necessary safety measures should be put-in place, or the pathway closed, or replaced as part of the works to upgrade the concrete encased revetment (see Section 4.1.1.1).

4.1.4.4 Removal of Fallen Debris from Cliffs Between Seaton Hole and West Seaton

As noted in Section 1.4.1 and Section 1.4.5, a consequence of erosion of the cliffs between Seaton Hole and West Seaton is the accumulation of fallen debris at the cliff toe, for example an outfall pipe and a large section of trees and vegetation. Such items could represent a health and safety hazard to beach users and removal of such items should be undertaken by EDDC.

4.1.4.5 Pollution of Beach at Old Beer Road

It has been observed that pollution is entering the sea from the brook running adjacent to Old Beer Road (west). An investigation should be undertaken by EDDC and options to improve beach quality on the beach, which is also used by tourists, should be identified as part of this work.

4.1.4.6 Fisherman's Gap Flood Gate Procedures

The visual inspection / condition assessment undertaken for the BMP (refer to Defences Baseline Report, Appendix C; Section 3.7) found the rubber seal on the outer section of the flood gates at Fisherman's Gap to be either cracked or entirely detached from the gate, affecting the ability to achieve a complete seal. Works to improve the seals should be undertaken as soon as possible.

Keys to the flood gates are understood to be held by the Environment Agency. It is recommended that a set of keys is also held locally, at a location within Seaton, and in agreement with the Environment Agency, to ensure access to the flood gates is possible during any emergency conditions.

4.1.4.7 Coastal Change Management and Adaption

It is evident from undertaking the Seaton BMP that funding for the management of flood and coastal erosion risk is limited and that combatting the effects of ongoing coastal change will be a challenge going forward. With time, ongoing cliff erosion should be expected putting properties and infrastructure at risk.

The concept of coastal change management and adaptation is currently considered by the East Devon Local Plan 2013 – 2031 (see Section 1.7.2) within Development Management Policy (EN25), and at locations including Budleigh Salterton (Section 9.2(h)) and Sidmouth (Section 14.3(i)), management of the impact of coastal change is being sought through designations of those locations as a 'Coastal Change Management Area' (CCMA).

There is now a need to formally recognise this in the immediate future at Seaton and define the coastline as a CMMA in order to drive future coastal change adaptation efforts in the area.

- In the first instance, update the existing East Devon Local Plan 2013 – 2031, to include a statement within Section 13.6 (Seaton), in line with Budleigh and Sidmouth, stating 'We will seek to manage the impact of coastal change through designation of a 'Coastal Change Management Area'. This should be completed in accordance with the Coastal Change Planning Guidance (CH2M, 2015b) and will need to be mapped as a 'zone', for which specific planning policies will need to be defined. As and when the new local plan is developed, this information should be transferred across.
- Secondly update the Neighbourhood Plan, and formally adopt the Seaton CCMA within in it.
- Prepare a Coastal Change Adaptation Plan (CCAP) for the BMP area, including the newly defined CCMA.
    - The CCAP should seek to identify plans for existing assets and proposed construction of assets, and any appropriate policies (for example defining relocations sites, plot/land prices). This will require technical advice / inclusion of a planning consultant.
    - Plans could also include alternative approaches to local land use and management, such as the way gardens are watered and trees are managed.
    - 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 cliffs in the future and the realities of this.

4.1.4.8 Non-FCERM Related Activities

Engagement with stakeholders and the local community as part of the BMP development process, identified a number of activities that could enhance the amenity value of the beach and may be incorporated into the preferred option. However, for reasons of funding and suitability, these activities do not fall into the recommended BMP management approach for the next 20-30 years. These activities are listed within the log of 'issues, current management practices and actions', prepared during the development of the BMP and in support of the options appraisal process; refer to the Options Appraisal Report (Appendix E) for more details.

For completeness, the activities are included here, and it is recommended that they are followed up by EDDC either with an action, or with notice on why they may not be achieved. An item has been included in the BMP Action Plan (FSR_007) to acknowledge this.

- Landscape and connectivity with the beach: the stakeholder group have raised concerns over the height of the existing Environment Agency wall which can cut off views from Esplanade, and the lack of connectivity between the Esplanade and beach as a result of the limited access points through the seawall itself.

- Opportunities for Concessions: EDDC Streetscene, who manage the beach, and the stakeholder group have expressed a desire to encourage more activity on the beach to attract visitors, generate income to maintain the area and add to the economic activity within the Town.
- Waterborne Transport: Seaton currently lacks landing facilities for tourist boats (for example Stuart Line Cruises in Exmouth) and as such, it is difficult for operators to regularly run services as landing onto the beach is heavily weather dependant. The stakeholder group would like to see improved landing facilities considered as part of options for management of the frontages.
- Overnight anchorage: overnight anchorage and development of an enclosed bay. Moorings are also being looked at as part of aspirations to improve of waterborne access (see above).
- Car parking on Harbour Road: there is a local feeling that Devon County Council charging for Parking on harbour road all year round has resulted in a decrease in visitors to the beach and town centre in the winter period.
- Beach access: access over shingle for walking, wheelchairs and pram, is difficult.
- Boat access across the beach: extend slipway at Fisherman's Gap for day-trippers to launch boats from.

4.2 Management of the Axmouth Harbour

An appropriate management regime for Seaton spit and the Axmouth Harbour basin, specifically dredge disposal options within, is being developed as part of the Seaton BMP. An options appraisal process has been commenced, but to be developed further, will require information relating to sediment quality and licensing approvals from the Marine Management Organisation. Details of the options appraisal and the outcomes will be provided in an Options Appraisal Report – Axmouth Harbour, to be included in Appendix F. It is recommended that the BMP document, specifically, the Action Plan, are updated in the future in recognition of this.

4.3 Implementation of Management Activities

In the event that the management activities described in Section 4.1 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 existing / new coastal defences and beach recycling, a review of the impacts on the environment should be undertaken. This should 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 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).
- Devon Historic Environment Service (in relation to historic environment 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 Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 years, it is recommended that an ongoing comprehensive monitoring programme is undertaken. The monitoring activities would 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 Seaton 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 area is 'Portland Bill to Exmouth' and the survey unit that covers the BMP area is 6aSU8-1 (Seaton).
- The report and data is available through the PCO website (www.coastalmonitoring.org) from 2007 onwards (when PCO was established).

Table 5-1 Programme of monitoring activities for Seaton BMP area (Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge)

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018-2019	Year 2 2019-2020	Year 3 2020-2021	Year 4 2021-2022	Year 5 2022-2023
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	Undertake inspection of the harbour walls and harbour arm on the east bank of the Axe Estuary.					
6	SWRCMP to continue with current monitoring including routine/bi-annual surveys, post-storm surveys, bathymetric					

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018-2019	Year 2 2019-2020	Year 3 2020-2021	Year 4 2021-2022	Year 5 2022-2023
	surveys, aerial LiDAR and aerial photographs and annual reporting.					
7	SWRCMP to extend annual/bi annual monitoring to include Beer.					
8	Undertake more frequent monitoring in response to Alarm Trigger Levels					
9	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.					
10	Continue annual monitoring of cliffs along West Walk Promenade, and ensure this is undertaken for BBMP frontage, between Seaton Hole and Fisherman's Gap.					
11	SWRCMP to continue to monitor and analyse wave data sourced from the Dawlish and West Bay 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 works to coastal assets/ beach recycling activities 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.					

Monitoring Activity Number	Monitoring Activity Description	Programme of Activities				
		Year 1 2018-2019	Year 2 2019-2020	Year 3 2020-2021	Year 4 2021-2022	Year 5 2022-2023
18	Data capture and storage that is collected outside of the SWRCMP 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 Defences Baseline Report (refer to Appendix C).

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 Defences Baseline Report (refer to Appendix C; 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 defences between Seaton Hole and Seaton (east) to ensure that the trigger levels defined in Section 4.1.3 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. voids in the rock revetment, cracks in the seawall, 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 Defences Baseline Report (refer to Appendix C).

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 Defences Baseline Report (refer to Appendix C).

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.

5.1.5 East Bank Axe Estuary Harbour Walls / Harbour Arm Inspection

The harbour walls, harbour arm and training wall on the east bank of the Axe Estuary are to be monitored on an annual basis, to assess their condition and status; specific inspections relating to scour and Accelerated Low Water Corrosion (ALWC) should be undertaken every five years. This work will follow on from inspections completed in 2006 and 2015 by Royal Haskoning (as described in Section 3.3).

The outcomes of the inspections will inform the timing and type of any remedial works, such as ALWC treatments and the replacement of sheet piles (as outlined in Section 4.1.1.5(a)). Appropriate funding should be allocated by EDDC for these inspections to be undertaken.

5.2 Beach Monitoring

Beach monitoring is primarily undertaken as part of the South-West Regional Coastal Monitoring Programme. The data was analysed as part of the current BMP (refer to Appendix A).

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 (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).

As flagged in the Coastal Processes Baseline Report (Appendix A; Section 7.3), beach profile data is not collected at Beer as part of the SWRCMP. It is recommended that the annual monitoring is extended to include the beach there. This will inform any assessments of future changes, and could also be used should a strategic study for Beer; as identified by the SMP2 Action Plan.

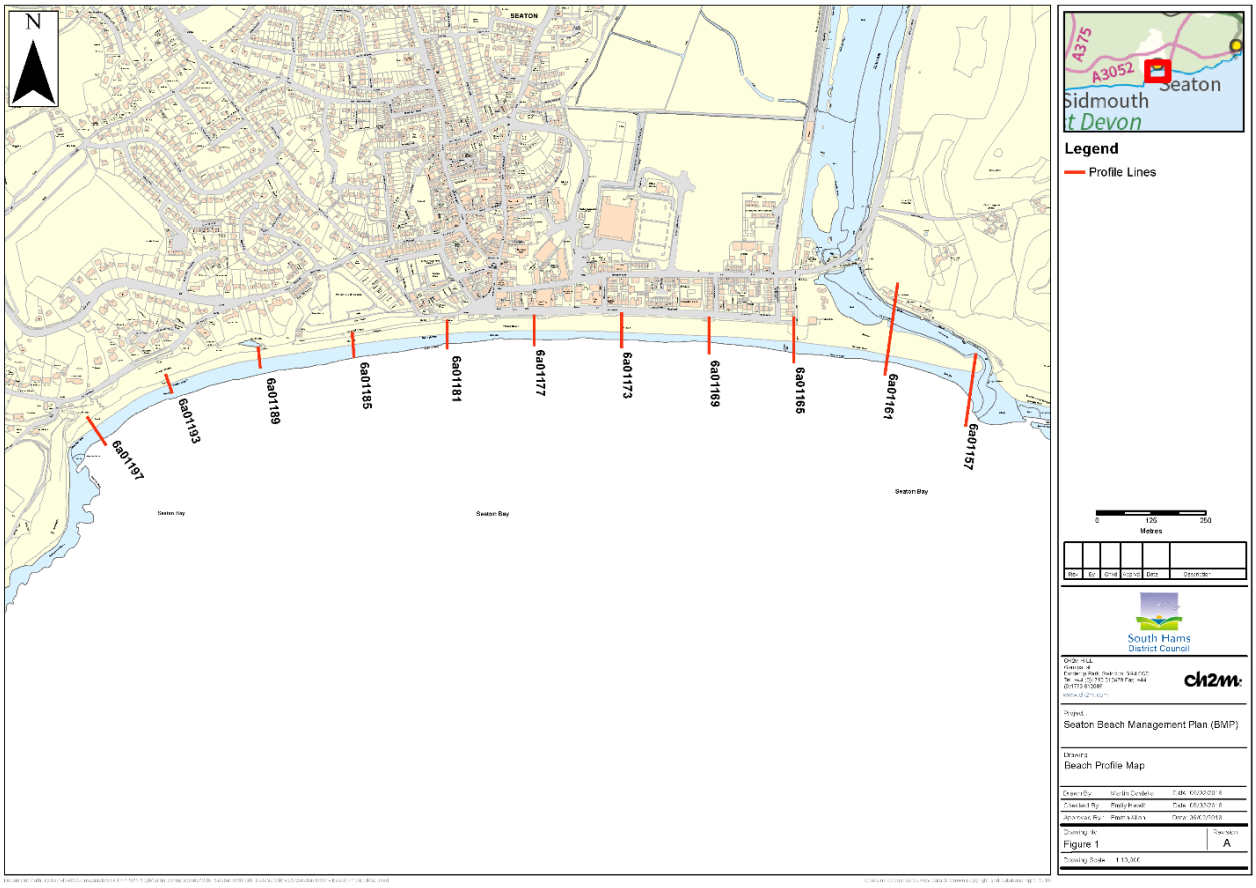

Figure 5-1 PCO beach profile survey locations

Table 5-2 PCO beach profile survey locations within the BMP 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)
6a01197	**323528.082566**	**89660.05642**	**21.03.2007**	**24.10.2017**
6a01193	**323715.019525**	**89766.006612**	**21.03.2007**	**24.10.2017**
6a01189	**323933.979012**	**89848.997844**	**21.03.2007**	**24.10.2017**
6a01185	**324153.048705**	**89874.00391**	**21.03.2007**	**24.10.2017**
6a01181	**324375.013**	**89851.000**	**21.03.2007**	**24.10.2017**
6a01177	**324575.009**	**89863.000**	**21.03.2007**	**24.10.2017**
6a01173	**324775.059**	**89868.001**	**21.03.2007**	**24.10.2017**
6a01169	**324975.011**	**89858.000**	**21.03.2007**	**24.10.2017**
6a01165	**325169.954**	**89845.001**	**21.03.2007**	**24.10.2017**
6a01161	**325408.974408**	**89937.003761**	**21.03.2007**	**24.10.2017**
6a01157	**325597.01443**	**89836.997699**	**21.03.2007**	**24.10.2017**

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 EDDC 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 EDDC 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 and the next scheduled survey would take place sometime in the next funding phase. However, a new bathymetric survey has been commissioned by the Environment Agency in support of the BMPs being completed along the Devon coastline (extending east of the mouth of the Axe Estuary, and is due to take place in 2018. This also addresses the recommendation made in the Coastal Processes Baseline Report (Appendix A), and the survey information collected will help to improve the understanding of the sediment movement between the beach, nearshore and offshore.

- Aerial LiDAR surveys are typically flown every five years, however, Seaton is a 'repeat site', so is flown every two years. The latest survey was completed in 2016 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 Alarm Trigger Level Monitoring

As described in Section 4.1.3.1, 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.*

5.2.3 Beach Recycling Logs

Whenever beach recycling works occur in the future (as described in Sections 4.1.2.1 and 0), then beach recycling logs are to be maintained by those undertaking the works, with the records then being passed to EDDC 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 Cliff Monitoring

Annual inspections of the cliffs above the West Walk Promenade between the Hideaway Café and Castle Hill, are undertaken to ensure public safety. As described in Section 4.1.4.1, works to stabilise the cliffs is planned to take place between April 2018 and April 2019. It is recommended that ongoing monitoring of the cliffs here and along the length of the BMP frontage, between Seaton Hole and Fisherman's Gap is continued and the findings used to update existing estimates of cliff erosion, inform of any works that may need to be undertaken to stabilise the cliffs, and ultimately ensure the safety of the public.

5.4 Physical Condition Monitoring

5.4.1 Wave and Water Levels

Measured wave data in the vicinity of the BMP area does not exist, so typical wave conditions for Seaton have been obtained from modelled data. These models utilise real-time data from wave buoys; located at specific locations along the coast and positioned offshore in a water depth of approximately 10m water depth. The first wave buoy is located to the west at Dawlish and the second located to the east at West Bay (refer to Section 2.1.1). The wave buoys are 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 Lyme Regis in Devon, which is the nearest tide data point to Seaton (refer to Section 2.2.1).

5.4.2 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 Dawlish Warren and West Bay wave buoys and the tide data point at Lyme Regis 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.

5.5 Warning and Emergency Procedures

5.5.1 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.

5.5.2 Pollution Incidents

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

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

5.6 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 1.3.2 and Section 2.6).

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 area (refer to Section 2.6.3). 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.

5.7 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 assets (see Section 5.1.1) or beach recycling logs (see Section 5.2.3), should also be stored in the same location.

SECTION 6

Action Plan

The Seaton 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 Seaton Hole, in the west, to the Harbour Wall, on the east side of the River Axe, and the Axe River up to the Axe Bridge for the next 20-30 (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.

SECTION 6

Table 6-1 Seaton 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.	EDDC	January 2018	January 2023	General	Not started
BMP_002	In the event that beach recycling becomes a suitable management activity in the future (see Action MAI_011), it is strongly recommended that a Scoping Opinion be sought from the MMO to clarify 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). If needed, 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.	EDDC	January 2018	July 2018	General	Not started
BMP_003	If beach recycling works are to occur within the BMP 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.	EDDC	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 prepare the outline design, more detailed environmental assessments and breakdown of partnership funding / refine the economic case and confirmation of funding contributions. This could include a funding workshop (see Action BMP_005 below).	EDDC	January 2018	With immediate effect	General	Not started
BMP_005	Undertake a funding workshop with stakeholders, utilities companies (e.g. South West Water), highways (e.g.Devon County Council Highways) and other third-parties to identify funding opportunities. S	EDDC	January 2018	With immediate effect	General	Not started
BMP_006	Finalise scope for East Devon capital funding bid.	EDDC	January 2018	With immediate effect	General	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
Maintenance						
MAI_001	Upgrade concrete encased revetment at Seaton Hole.	EDDC	January 2018	January 2020	Section 4.1.1.1(a)	Not started
MAI_002	Maintain 'old and new' revetment at Seaton Hole / Old Beer Road.	EDDC	January 2018	January 2020	Section 4.1.1.1(b)	Not started
MAI_003	Extend 'new' revetment at 'The Pillar'.	EDDC	January 2018	January 2020	Section 4.1.1.1(c)	Not started
MAI_004	Upgrade Check House wall.	EDDC	January 2018	January 2020	Section 4.1.1.1(d)	Not started
MAI_005	Maintain West Walk Promenade including concrete / stone blockwork.	EDDC	January 2018	Ongoing	Section 4.1.1.2(a)	Started
MAI_006	Improve drainage behind the Seawall and implement road closures in response to flood warning.	Environment Agency / EDDC	January 2018	January 2025	Section 4.1.1.3(a)	Not started
MAI_007	Do Nothing Seaton spit and consult with SMP group to guide future management of the landward side of the spit (refer to Action FSR_004).	EDDC	January 2018	Ongoing	Section 4.1.1.3(b)	Started
MAI_008	New defences west bank Axe Estuary.	Environment Agency / EDDC	January 2018	January 2020	Section 4.1.1.3(c)	Started
MAI_009	Maintain the existing seawall at Seaton.	Environment Agency	January 2018	Ongoing	Section 4.1.1.4(a)	Started
MAI_010	Maintain existing walls and harbour arm on the east bank Axe Estuary. Works will be informed by specific inspections of the harbour walls, refer to Action MON_005.	EDDC	January 2018	As and when required	Section 4.1.1.5(a)	Not started
MAI_011	Consider whether to undertake beach recycling, guided by ongoing monitoring, consultation with SMP group (refer to Action FSR_004) and new study (refer to Action FSR_005).	EDDC	January 2018	If suitable and as required	Section 4.1.2.1	Not started
MAI_012	Undertake beach management works instigated by alarm and crisis trigger levels. This includes storm debris and shingle clearance, more frequent and focused beach monitoring, defence works, and beach recycling if suitable.	EDDC	January 2018	As and when required	Section 4.1.3	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
MAI_013	Cliff drainage measures. EDDC to investigate suitable options for cliff-top drainage (that are agreeable environmentally and affordable), and for EDDC to identify a funding stream for this erosion risk management activity. A study into surface water flows on the cliff-top would also be required in support.	EDDC	January 2018	With immediate effect	Section 4.1.4.1	Not started
MAI_014	Works to address undermining of Seaton Hole outfall.	EDDC	January 2018	With immediate effect	Section 4.1.4.2	Not started
MAI_015	Assessment of pathway along concrete encased revetment at Seaton Hole.	EDDC	January 2018	With immediate effect	Section 4.1.4.1	Not started
MAI_016	Removal of fallen debris from cliffs between Seaton Hole and West Seaton.	EDDC	January 2018	With immediate effect	Section 4.1.4.4	Not started
MAI_017	Address issue of pollution of beach at Old Beer Road. To be informed by an investigation and if relevant, development of suitable options.	Environment Agency	January 2018	With immediate effect	Section 4.1.4.5	Not started
MAI_018	Fisherman's Gap flood gate procedures.	Environment Agency / EDDC	January 2018	With immediate effect	Section 4.1.4.6	Not started
MAI_019	Formally recognise and define the BMP area as a Coastal Change Management Area (CCMA) and update the Local Plan and Neighbourhood Plan. Produce a CCMA Adaptation Plan.	EDDC	January 2018	December 2018	Section 4.1.4.7	Not started
Monitoring						
MON_001	Undertake an annual visual inspection of the coastal defence assets along the BMP frontage.	Environment Agency / EDDC	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 / EDDC	January 2018	As and when required	Section 5.1.2	Not started
MON_003	Undertake defence monitoring as and when required.	Environment Agency / EDDC	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 / EDDC	January 2018	January 2023	Section 5.1.4	Not started
MON_005	Undertake inspection of the harbour walls and harbour arm on the east bank of the Axe Estuary. The inspection will inform any necessary works, refer to Action MAI_010.	EDDC	January 2018	Ongoing	Section 5.1.5	Started
MON_006	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_007	SWRCMP to extend annual/bi annual monitoring to include Beer.	SWRCMP at EDDC request	January 2018	With immediate affect	Section 5.2.1.1	Not started
MON_008	Undertake more frequent monitoring in response to Alarm Trigger Levels.	EDDC	January 2018	As and when required	Section 5.2.2	Not started
MON_009	Continue annual monitoring of cliffs along West Walk Promenade, and ensure this is undertaken for BBMP frontage, between Seaton Hole and Fisherman's Gap.	EDDC	January 2018	With immediate effect	Section 5.3	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.	EDDC / Environment Agency	January 2018	As and when required	Section 5.2.3	Not started
MON_011	SWRCMP to continue to monitor and analyse wave data sourced from the Dawlish and West Bay wave rider buoy.	SWRMP	January 2018	Ongoing	Section 5.4.1	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.	EDDC	January 2018	With immediate effect	Section 5.4.2	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.	EDDC	January 2018	With immediate effect	Section 5.4.2	Not started
MON_014	Flood warning and response to be continued by Environment Agency practice.	Environment Agency	January 2018	Ongoing	Section 5.5.1	Started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
MON_015	Continue with current pollution incident practices.	EDDC, Devon County Council and the Environment Agency	January 2018	Ongoing	Section 5.5.2	Started
MON_016	Environmental monitoring will be required at the scoping stage of any works to coastal assets/ beach recycling activities and subsequently to monitor the status of the environment post -works.	EDDC/Natural England	January 2018	As and when required	Section 5.6	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 / EDDC	January 2018	As and when required	Section 5.6	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.	EDDC	January 2018	With immediate effect	Section 5.7	Not started
Future Studies / Research						
FSR_001	In the event that a 'scheme' for Seaton is progressed, undertake a more detailed assessment of flood risk/damages that assesses climate change impact for a full range of return periods. This will enable a more accurate assessment of benefits and damages now and in the future to be undertaken, which can then be used to better determine the viability of options for the frontage.	EDDC	January 2018	As and when required	Section 1.4.1	Not started
FSR_002	Undertake a Beer groyne study to better understand sediment dynamics of the groyne being shortened or removed.	EDDC	January 2018	January 2019	Section 1.4.2	Not started
FSR_003	Undertake a detailed desk study to identify ecological risks and locate Biodiversity Action Plan species and habitats.	EDDC	January 2018	July 2018	Section 2.6.5.2	Not started
FSR_004	Prepare a SMP group paper on No-Active Intervention policy for Seaton spit. The SMP policy for the spit is No Active Intervention. Consideration needs to be given to the management of the landward side of the spit and any potential beach recycling along the BMP frontage, since both activities may conflict with the SMP policy.	EDDC	January 2018	With immediate effect	Section 4.1.1.3(b) Section 4.1.2.1	Not started

Action No.	Action Description	By Who?	Date Action First Defined	When By?	Related BMP Section	Current Status*
FSR_005	Specific study to determine suitability of beach recycling along the BMP frontage and if so, potential volumes and frequencies of movement.	EDDC	January 2018	As and when required	Section 4.1.2.1	Not started
FSR_006	As explained in Section 4.1.2.1 and following on from FSR_005, recycling options may also require the inclusion of control structures, which come with cost implications. Should recycling prove to be a preferred option, then a sensitivity test should be competed to determine the likely cost of including such structures (ultimately the type, size, number and spacing will determine the cost).	EDDC	January 2018	As and when required	Section 4.1.2.1	Not started
FSR_007	Non-FCERM related activities for action by EDDC or notice on why the activity cannot be achieved.	EDDC	January 2018	With immediate effect	Section 4.1.4.8	Not started

SECTION 7

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Appendix A – Coastal Processes Baseline Report

Appendix B – Environmental Baseline Report

Appendix C – Defences Baseline Report

Appendix D – Economics Baseline Report

Appendix E – Options Appraisal Report

Appendix F – Options Appraisal Report (Axmouth Harbour)

Appendix G – Environment Agency Guide to Engagement

Appendix H – Defence Inspection Proforma

Appendix I – Defence Repair Works Proforma

Appendix J – Beach Recycling Log Template