

Appendix C

Baseline Report

Stage 1 Report: Par Sands

Cornwall Beach & Dune Management Plans

Prepared for
Cornwall Council

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Contents

Section	Page
1	Introduction 1
1.1	Background 1
1.2	Project aim, objectives and approach 1
1.3	About this document 4
2	Site Visit Report..... 5
2.1	Attendees..... 5
2.2	Site Visit Record 5
2.3	Thoughts on Potential Management Solutions for Consideration 6
2.4	Data Sources 7
2.5	Photos 7
3	Environmental Characteristics 10
3.1	Introduction 10
3.2	Methodology..... 10
3.2.1	Designated Nature Conservation sites and Protected Habitats Considered 10
3.3	Environmental Setting 11
3.3.1	Ecology 12
3.3.2	Designated Geological Conservation Sites 15
3.3.3	Landscape Setting 15
3.3.4	Archaeology and Cultural Heritage..... 15
3.4	Main human impact pressures affecting the natural dynamics of the site 15
4	Coastal Processes Understanding..... 17
4.1	Introduction 17
4.2	Shoreline Processes Overview 17
4.2.1	Key Characteristics of the Coastline Today..... 17
4.2.2	Forcing Factors..... 22
4.2.3	Sediment Dynamics 25
4.2.4	Historical Shoreline Change 26
4.3	New Shoreline and Beach Profile Analysis..... 28
4.4	Summary and Recommendations..... 32
4.4.1	Summary 32
4.4.2	Recommendations to Consider for Future Beach and Dune Management 32
5	Site Summary 33
5.1	Dune Inventory Summary 33
6	References..... 35

1 Introduction

1.1 Background

Many of the sand dunes and beaches around Cornwall's coast are currently experiencing erosion and sediment loss. This is a pressing concern as these sand dunes and their associated sandy beaches are one of the most important resources in Cornwall due to:

1. Their role in providing protection against the risk of coastal flooding due to the dynamic nature of beach-dune interactions and their sheer size preventing the sea from impacting upon the hinterland behind the dune systems.
2. Their role in providing important biologically diverse habitats that cannot be easily recreated elsewhere if it were to be lost to coastal erosion or inappropriate development.
3. Their role in providing access to the sea for residents and visitors alike, which is vital to the holiday industry upon which a significant proportion of Cornwall's economy depends.

It is vital therefore that the sand dunes and beaches around Cornwall's coast, that represent some 15% of the total sand dune habitat in Britain, are managed in a holistic, sustainable way over the long-term that balances the needs of each of the three distinct functions of sand dunes and beaches that combined make up the beach-dune system, as illustrated in Figure 1.1.

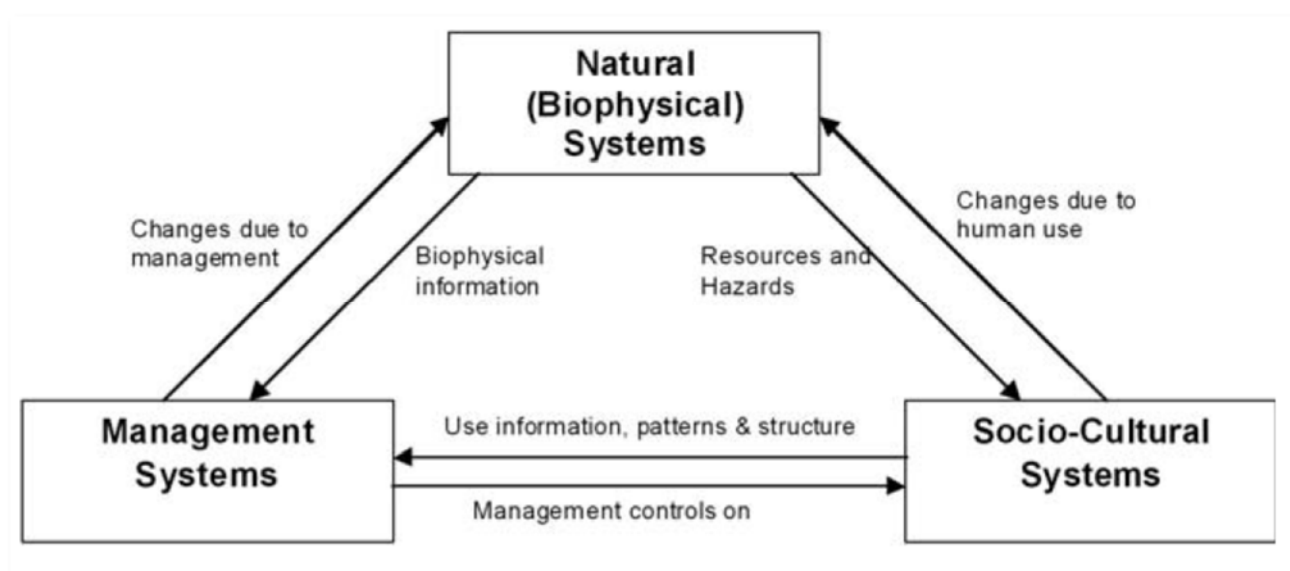


Figure 1.1 The interaction of beach systems that compose the 'beach environment' and which must be considered together to provide a holistic approach to beach management (after James, 2000 in Frampton, A.P.R. (2010). "A review of amenity beach management". *Journal of Coastal research*, 26(6), 1112-1122, November 2010).

The approach to managing the beaches and sand dunes was investigated in between 2006 and 2009 by Halcrow on behalf of the Cornwall and Isles of Scilly Coastal Group, and led to the production of the *Cornwall Sand Dune and Beach Management Strategy* (Halcrow, 2009a). The main focus of the strategy is the management of flood and coastal erosion, although the habitat and tourism value of the dunes will also be considered. This 2009 project delivered an Inventory of Beaches and Dunes; a Best Practice Management Guide and two pilot Beach and Dune Management Plans (BDMPs) for Harvey's Towans and Fistral Beach. It is this 2009 work that this current project is building upon to develop six new BDMPs and review the two pilot BDMPs (see Section 1.2).

1.2 Project aim, objectives and approach

The purpose of the project is to develop six new long-term strategic BDMPs for Constantine Bay, Porthtown, Summerleaze, Par Sands, Widemouth Bay and Praa Sands; and review the need (or

otherwise) to update the two pilot BDMPs produced in 2009 for Fistral Beach and Harvey's Towans. This will be achieved by:

1. Identifying the best management approach; in terms of monitoring and intervention (when trigger levels are reached) requirements for beach and dune systems at each individual site, based upon the best practice framework developed as part of the *Cornwall Sand Dune and Beach Management Strategy* produced by Halcrow in 2009.
2. Providing a long-term (50 year) approach to each site that is based upon an up-to-date understanding of the beach-dune system and coastal processes at each site, as well as predictions of future coastal evolution.

The locations of these eight sites is shown in Figure 1.2.

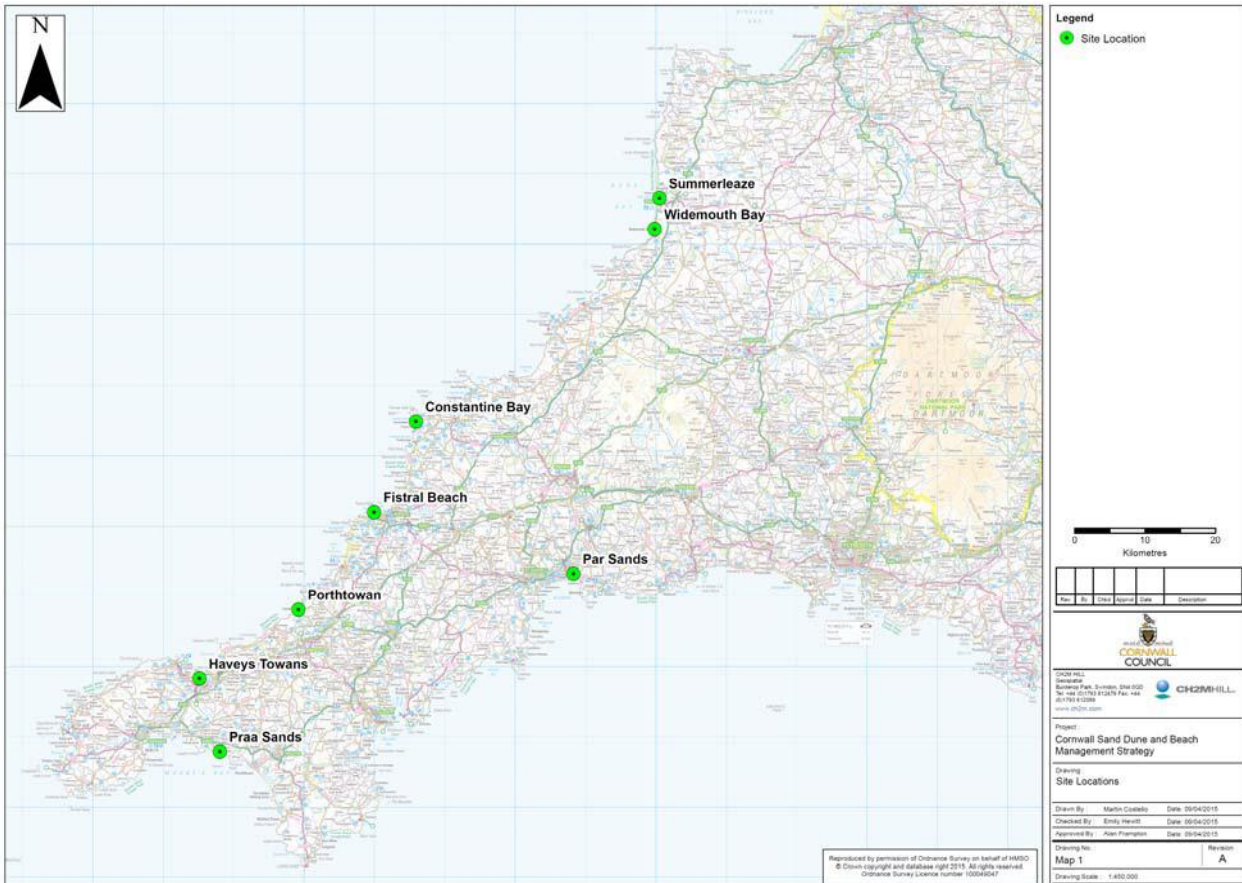


Figure 1.2 Map showing location of the eight BDMP locations.

Development of the BDMPs will involve four stages. Local community stakeholders and statutory stakeholders will be engaged to seek local knowledge and guide selection of preferred management options. These stages, and the times when engagement with local community representatives and other statutory consultees is planned, are shown in the flow diagram below (Figure 1.3). This report represents outputs from “Stage 1 – Baseline Understanding.”

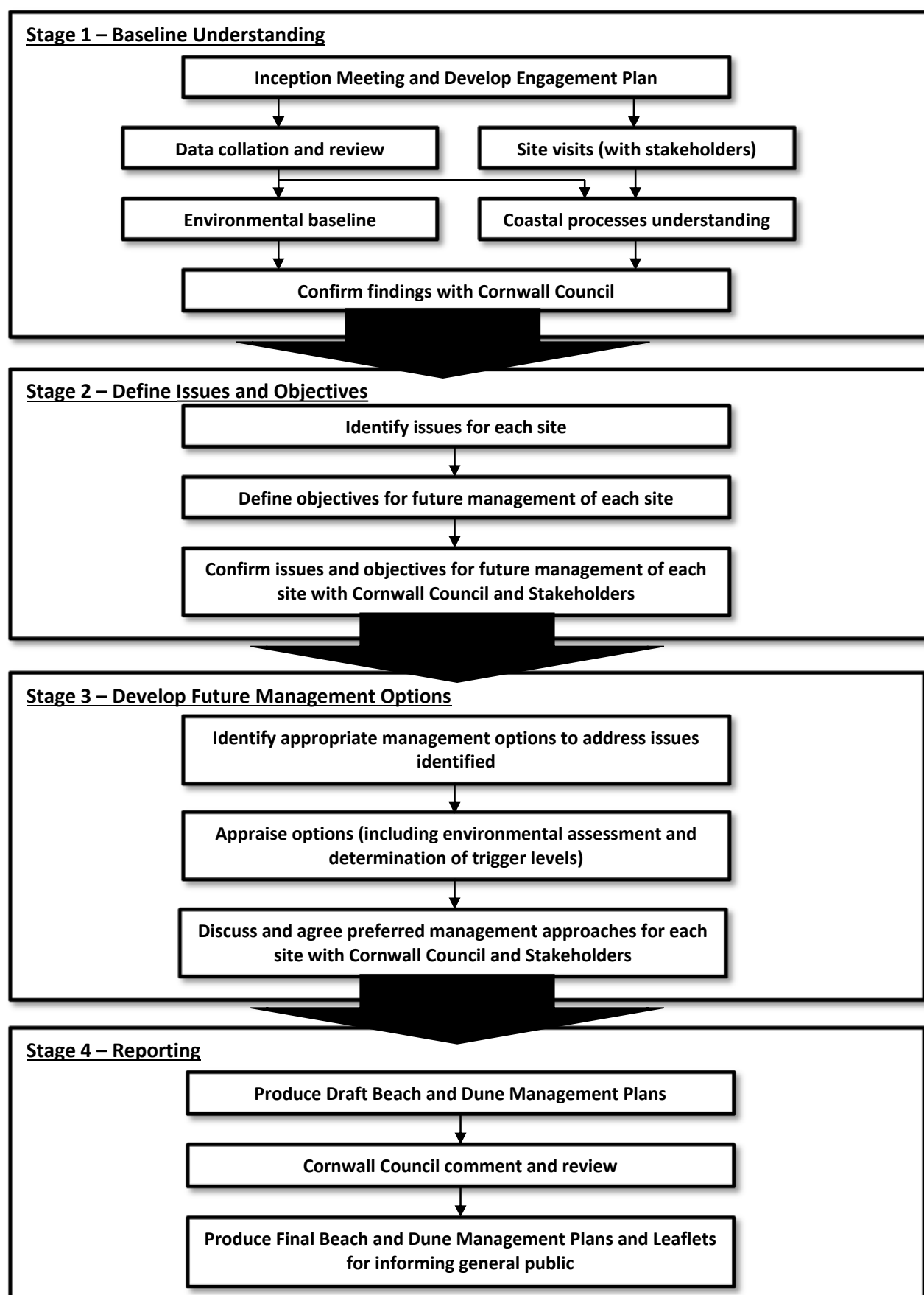


Figure 1.3 Overview of the staged approach to developing BDMPs for the eight locations around Cornwall.

1.3 About this document

This report provides the results of the Stage 1 work to develop the baseline understanding of the Par Sands BDMP location (see Figure 1.4). Specifically, it:

- Reports the findings of a site visit made on 12th March 2015 by members of CH2M's project team and invited stakeholders (Section 2);
- Provides details of the environmental characteristics of the BDMP area (Section 3);
- Describes the coastal processes and recent shoreline evolution of the beach and dune system in the area (Section 4);
- Summarises the information from Sections 2, 3 and 4 into a revised dune inventory record for the site, updating the dune inventory record produced as part of the 2009 *Cornwall Dune and Beach Management Strategy* (Halcrow, 2009b) (Section 5).



Figure 1.4 Map showing the Par Sands BDMP location and extent (red outline).

2 Site Visit Report

Over a period of four days, three members of CH2M’s project team visited the eight BDMP sites to capture information about each site and take ground-level photos. At each site, client representatives, stakeholders and local community groups were given the opportunity to attend, meet with the project team, discuss their aims and objectives for the site, and raise any issues and concerns. Information collected during the site visits will be considered when developing later stages of the project, including:

- Stage 1 – Baseline Understanding (refer to Sections 3 and 4 of this report)
- Stage 2 – Define Issues and Objectives; and
- Stage 3 – Develop Future Management Options.

The site visit report for the Par Sands BDMP area, which was undertaken on 12th March 2015, is presented within this section and provides:

- a list of attendees at each site (Section 2.1);
- a record of the site visit including both factual information, comment and opinion provided stakeholders (Section 2.2);
- a summary of potential management solutions identified on the day of the site visit for consideration in later stage of the project (Section 2.3);
- a section on ‘Data Sources’ where CH2M’s project team were informed of, or provided with, relevant information at the site or following the site visit (Section 2.4); and
- a selection of photographs taken during the site visit to highlight salient points (Section 2.5).

The information presented is a record of both information recorded during the site visit, and additional information provided by stakeholders as comments on the draft site visit report between 8th and 15th April 2015.

2.1 Attendees

Name	Role	Organisation
Emma Allan	Senior Coastal Scientist	CH2M Hill
Emily Hewitt	Environmental Scientist	CH2M Hill
James Clapp		Cormac
Nick Ely	Area Coastal Engineer	Environment Agency
Richard Parks	Resident Chair	Friends of Par Beach
Mike Freemantle	Resident Treasurer	Friends of Par Beach

Comments on the draft site visit report for this location were received from: Martin Clemo and Jolyon Sharpe (Cornwall Council).

2.2 Site Visit Record

The key issue at Par Sands is that there is low-lying land behind the dunes and should they breach this will result in significant flooding of the land behind which is in a variety of ownership.

The Par River, used to exist to the sea along the breakwater, but changed its course about 8 years ago and now flows out to sea further to the west in a straight line and against the footings/defences of the China Clay factory.

Upriver, the dunes on the east bank are eroding, particularly during the last floods. Stabilisation is required.

At the western end of the beach there is a small section of landfill, which is comprised of seaweed and litter picked up from the strandline (see Photograph 2.1). Some of this fill was washed away during the 2014 storms. The process of beach clearing is no longer undertaken, and seaweed is left to build-up along the strandline in the summer for environmental reasons.

Surrounding the banks and strip of sand alongside the stream leading up to the slipway in this location, is heavily deposited clay. The clay can be easily seen underneath the top layer of sand and presents a distinct clay feeling underfoot. It is thought that the nature of clay is not insoluble and therefore poses no problem. The deposited clay is the legacy from the industrial clay mining further upstream. The slipway at this location leads to a field next to the carpark containing rare orchids and wetland that the LNR management together with Friends of Par Beach are making management attempts to protect. It was noted that vandalism of management measures (pulling up of newly planted trees) was currently an issue.

Along the dunes, there is clear evidence of dune growth with the formation of embryo dunes and young dune grass (see Photograph 2.2). Marram Grass is growing well and effectively stabilising the dunes. This is likely to be a response to a dune planting programme in the 1980's when the dunes were fenced off and Marram Grass was planted. There are gaps within the embryo dune, and it was questioned if they will join to form one long ridge over time as sand continues to accumulate.

Within the dunes, Gorse, Sea Buckthorn and Rosa Regosa are all invasive species and fighting for space. There is growth of Rosa Regosa within the new dunes and stakeholders would like to know if this can and should be managed now, by removing it by spraying or whether it is acting to stabilise the dunes and encourage dune growth.

There is a historic landfill site within the eastern part of the dunes which would be exposed, and so pose an environmental hazard, should the dunes erode in the future.

High tides do reach the toe of the dunes.

At the eastern end of the beach, at Polmear stream, sand tends to be deposited in the mouth of the stream by high tides. If there is a simultaneous big head of water the sand will be washed out from the river, but if the weather is dry and there is no rainfall, the sand is not washed out and the stream becomes blocked with sand. This occurs in the narrow entrance and Cornwall Council has to arrange for the stream to be cleared to preventing backing-up of water upstream and flooding of the caravan park/Polmear village.

During the summer, the stream flows out and over the east bank of the river (only over a small isolated area at the bottom of the cliffs where Trill Farm is). Boulders were placed in the stream in the late 1970's to help stabilise the bank of the river at a pinch point (see Photograph 2.3 and Photograph 2.4). They were placed at the same time as a scheme at Polmear, when before it used to flood during high tides.

To the west, the beach at Carlyon Bay was recharged with material comprised of gritty sand, some of which was later found on the beach at Par indicating a sediment pathway exists between the two beaches.

Flooding occurred last year in February 2014 and the dune breached (Nick Ely is to provide details). Presently, there is a flood warning system on the ground, which the Environment Agency respond to.

There is a clockwise movement of tidal currents within the bay.

2.3 Thoughts on Potential Management Solutions for Consideration

- The dunes appear to be stable and in places accreting, so the need for intervention was questioned on the day of the site visit. If there is one aim, it would be a preference to make the dunes mores robust.

- Should any dune stabilisation methods such as fencing be selected as an option, there would be a preference for continued access.
- Communication with, and involvement of, the local interest group, landowners, and general public is key for future integrated and sustainable management of the site.

2.4 Data Sources

- Cornwall Council undertook beach lowering analysis.
- St Blazey Catchment Flood Management Plan (addresses requirements of EU Water Framework).
- Nick Ely has difference elevation model plots that he can provide us, along with details of the location etc. of the breach that occurred in February 2014.

2.5 Photos



Photograph 2.1 Western end of beach.



Photograph 2.2 Evidence of dune growth.



Photograph 2.3 River bank stabilisation placed in 1970s (view seawards)



Photograph 2.4 River bank stabilisation placed in 1970s (view landwards)

3 Environmental Characteristics

3.1 Introduction

The purpose of this section is to identify key environmental features within and near the Study Area. This is to ensure that appropriate consideration of these features is made when developing a future Beach and Dune Management Plan for Par Sands (including ongoing monitoring and maintenance works and any new works that may be required) in the later stages of the Beach and Dune Management Plan (BDMP) development.

It should be noted that the level of detail presented in this document allows for an initial appraisal of environmental features to provide for an environmentally sustainable future management regime. This does not negate the requirement for future detailed environmental assessment which may be required to support consent applications or prejudge the scope of the assessment. Background information on possible consenting requirements and legislative drivers are described in the methodology section below.

3.2 Methodology

Conservation designations and their qualifying interest features (with exception of Special Protected Areas (SPAs) see below), and UK priority Biodiversity Action Plan (BAP) habitats that lie within the study area or within 2km have been described and will require consideration during the development of the BDMPs. Only those features that are currently considered relevant to the Study Area, i.e. those that are likely to be impacted upon or are likely to have an influence on the proposed scheme, have been described.

In the case of SPA sites, they have been considered within around 150km of the BDMP Study area and on the basis of bird-habitat connectivity in line with standard practice for habitat regulations assessments (i.e. how the birds use the habitat in a region and so depend on different resources in a regional context, for example estuarine mudflats and fully marine areas at different stages of the tidal cycle).

The designation information has been sourced using the online interactive mapping tool Magic <http://www.magic.gov.uk/>.

3.2.1 Designated Nature Conservation sites and Protected Habitats Considered

The following nature conservation designations and their qualifying interests have been considered:

- **International Nature Conservation Sites:**
 - The Natura 2000 European network of protected sites represents areas of the highest value for natural habitats and species of plants and animals that are rare, endangered or vulnerable in the European Community.
 - **Special Areas of Conservation (SACs)** are strictly protected sites designated under the EC Habitats Directive, and contribute to conserving habitat and species identified in Annexes I and II of the Directive.
 - **Special Protection Areas (SPAs)** are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species.
- **National and Local Conservation sites:**
 - **Site of Special Scientific Interest (SSSI)** sites are nationally designated sites, selected for being the best examples of our natural heritage in terms of wildlife habitats, geological features or landforms. A SSSI area is notified as being of special interest under the

Wildlife and Countryside Act 1981. Geological SSSI sites may also afford further designation as **Geological Conservation Review sites (GCR)** that make a special contribution to our understanding and appreciation of Earth science and the geological history of Britain, which stretches back hundreds of millions of years

- **Marine Conservation Zones (MCZs)**. The Marine and Coastal Access Act 2009 allows for the creation of MCZs. MCZs protect a range of nationally important marine wildlife, habitats, geology and geomorphology, and can be designated anywhere in English and Welsh territorial and UK offshore waters. 27 MCZs were designated in 2013 with a further round of six recommended MCZs (rMCZ) are being considered for 2015.
- **Local Nature Reserves (LNRs)** are declared and managed for nature conservation by local authorities under the National Parks and Access to the Countryside Act 1949, and provide opportunities for research and education, or simply enjoying and having contact with nature.

- **Habitats and Species**

The government has a commitment “to conserve and enhance the biological diversity within the UK and to contribute to the conservation of global biodiversity through all appropriate mechanisms”.

Former Biodiversity Action Plans (BAPs) were developed at a national and local level to protect and enhance the diversity of flora and fauna. The UK BAP (Biodiversity: The UK Action Plan, 2004) set out action plans for priority species and habitats. As a result of devolution, and new country-level and international drivers and requirements, much of the work previously carried out by the UK BAP is now focussed at a country-level rather than a UK-level, and the UK BAP was succeeded by the '[UK Post-2010 Biodiversity Framework](#)' in July 2012. The UK list of priority habitats, however, remains an important reference source and has been used to help draw up statutory lists of priority habitats in [England](#), as required under [Section 41](#) (England) of the Natural Environment and Rural Communities (NERC) Act 2006. Habitats and species of principal importance, which could potentially be affected by the management options, are considered.

- **Heritage Designations:**

- **World Heritage Sites** are designated to meet the UK's commitments under the World Heritage Convention. Sites are designated for their globally important cultural or natural interest and require appropriate management and protection measures.
- **Historic and archaeological sites** of significance are designated as historical assets by English Heritage and include listed historic buildings, scheduled monuments, registered parks and gardens, battlefields and protected wreck sites. They designation are afforded to protect against any future loss of their significance.
- **Heritage Coast** is a section of coast exceeding one mile in length that is of exceptionally fine scenic quality, substantially undeveloped and containing features of special significance and interest.

- **Landscape Designations:**

- **Area of Outstanding Natural Beauty (AONB)** are designated under the National Parks and Access to the Countryside Act 1949, amended in the Environment Act 1995, with responsibility of care assumed by local authorities and the rural community.

3.3 Environmental Setting

The Study Area contains the following nature conservation designations. These are central in the consideration of options for the beach and dune management plan:

- Par Beach and St Andrews Road Local Nature reserve (LNR)
- Cornwall Area of Outstanding Natural Beauty.

These features are shown on Figure 3.1 and discussed in further detail below.

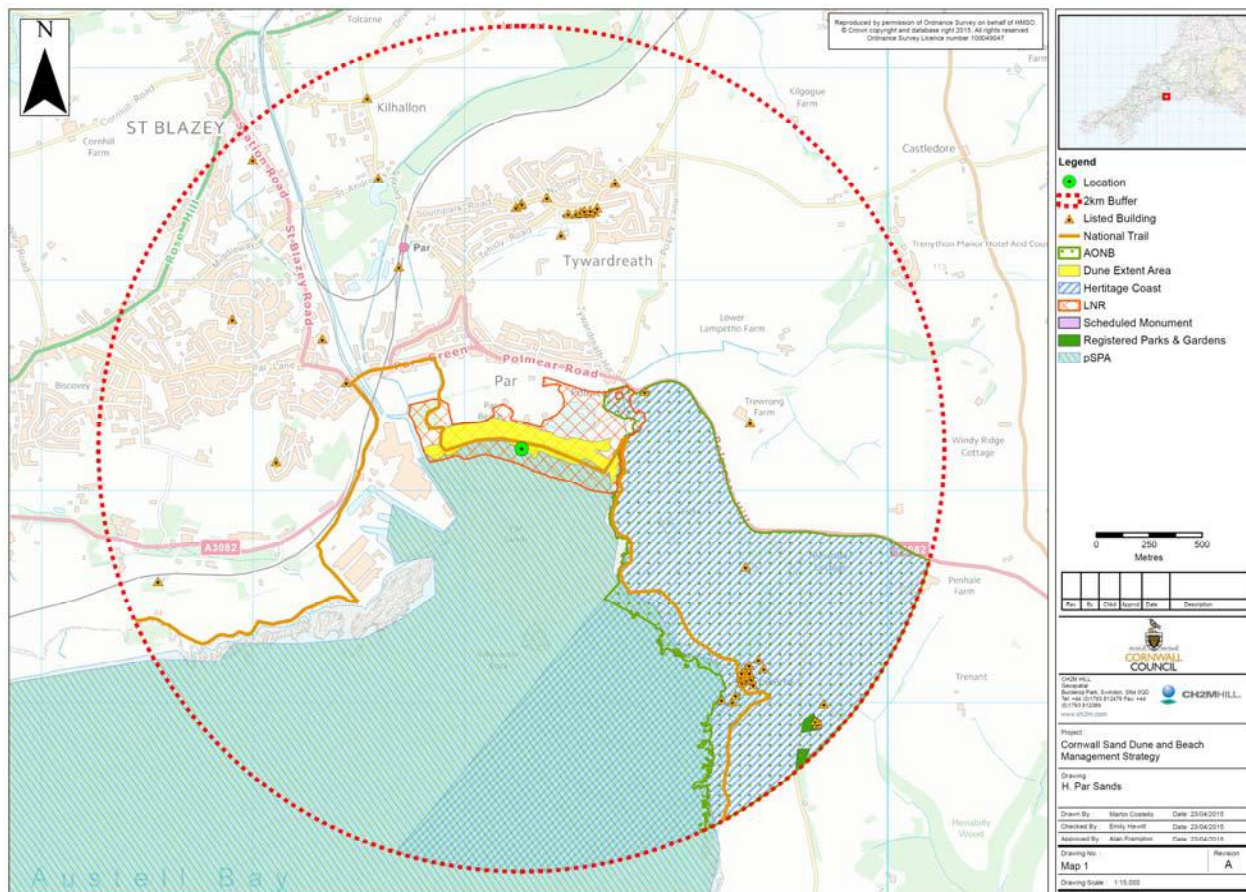


Figure 3.1 Environmental designation features in the vicinity of the Par Sands BDMP area.

3.3.1 Ecology

3.3.1.1 Designated Nature Conservation Sites

The following nature conservation designations and their qualifying interest features are all within or lie in close proximity to the Study Area and will require consideration during the development of the BMP:

- Par Beach encompasses The Par Beach and St Andrews Road Local Nature reserve (LNR). The LNR supports a dune system, open water lagoon and reedbeds behind the dunes which is frequented by overwintering birds and birds in passage. At the western end of the site (a reclaimed refuse area), marshy grassland supports a variety of plant species and wildflowers. The site contains a number of non-native plant species, with the dunes dominated by introduced shrub species Sea Buckthorn *Hippophae rhamnoides* and Japanese Rose *Rosa rugosa*. The active volunteer group 'Friends of Par Beach' work to help to assist manage the LNR along with Cornwall County Council.

Designated sites identified and considered or discounted for bird-habitat connectivity between the protected area and the site, are described below. Sites identified as having possible connectivity will require consideration during the development of the BDMP (see also Figure 3.2):

- Par Sands falls within the northeast section of a possible Special Protected Area (pSPA), Falmouth Bay to St Austell Bay pSPA. The pSPA supports rare wintering birds and diving birds that are proposed for designation under the Birds Directive (2009/147/EC). The pSPA is a large area, and encompasses the Fal and Helford SAC within the pSPAs north western section. This site is designated under article 4 (4) of the Habitats Directive (92/43/EEC) for the following Annex 1 habitats: Sandbanks which are slightly covered by sea water all the time; Mudflats and sandflats not covered by seawater at low tide; Large shallow inlets and bays that include low tidal sandbanks and Atlantic salt meadows (*Glauco-Puccinellietalia*

maritimae). Other Annex I habitats that are present as a qualifying feature of the SAC but not the primary reason for selection include Estuaries and Reefs and includes the Annex II plant species Shore dock *Rumex rupestris*. **Consideration is required.**

- Loe Pool geological and biological SSSI is approximately 6km southeast of Par Sands, and is the largest freshwater lagoon in Cornwall protected from seaward influx by a shingle sand bar. The site has geologically interesting features and supports a scarce habitat found nowhere else in Cornwall with important wintering birds, wild-fowl and rare plant species. **Connectivity with Par sands is unlikely** due to the stark differences in saline and freshwater habitats.
- Tamar Estuaries Complex SPA is approximately 26km from Par Sands. The estuary system is a large marine inlet on the English Channel coast comprising the estuaries of the rivers Tamar, Lynher and Tavy. Habitats include extensive tidal mud-flats bordered by saltmarsh communities. The mud-flats contain extensive and varied infaunal communities rich in bivalves and other invertebrates, and feeding grounds for waterbirds in numbers of European importance. Saltmarshes provide important feeding and roosting areas for large numbers of wintering and passage waterbirds. This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Little Egret *Egretta garzetta* (on passage, and a population over winter) and Avocet *Recurvirostra avosetta* (over winter). **Unlikely to be any connectivity** with Par Sands due to the lack of estuarine influence.
- Marazion Marsh SPA/SSSI is approximately 60km southwest from Par Sands from its nearest point. The marsh is at the mouth of a wide coastal valley, separated from the sea by a shingle bar with fringing sand dunes. The marsh is important for passage and wintering birds associated in particular with the extensive reedbed. The site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Annex I species Aquatic Warbler *Acrocephalus paludicola* (in passage) and Bittern *Botaurus stellaris* (over winter). **Connectivity with Par Sands is possible** due to the site providing a small amount of similar habitat.
- The Exe Estuary SPA is approximately 95km northeast from Par Sands, is a complex of coastal habitats waters, foreshore, low-lying land, three saltmarshes and an unusual double spit across the mouth of the estuary, and the sand dunes of Dawlish Warren. The mud and sandflats support Eelgrass *Zostera* spp. and Enteromorpha beds, and contain an abundance of invertebrates including extensive Mussel *Mytilus edulis* beds, which together provide rich feeding habitats for wintering waders and wildfowl. site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Annex I species Avocet *Recurvirostra avosetta* and Slavonian Grebe *Podiceps auritus* (over winter) and qualifies under Article 4.2 of the Directive (79/409/EEC) as a wetland of international importance for regularly supporting at least 20,000 waterfowl. **Unlikely to be any connectivity** with Par Sands due to the lack of estuarine influence.
- Isles of Scilly SPA is approximately 120km from Par Sands from its closest point. The SPA qualifies for its seabird assemblage of international importance and breeding seabird assemblage of European importance. The isolated nature of the islands and rocks, together with their low levels of disturbance and predation, makes them particularly suitable for nesting seabirds. This site qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of European importance of the following Annex I species Storm Petrel *Hydrobates pelagicus* and Lesser Black-backed Gull *Larus fuscus*. The site also qualifies under Article 4.2 of the Directive (79/409/EEC) for regularly supporting a seabird assemblage of international importance of at least 20,000 seabirds. The SPA boundary only encompasses those areas used for nesting. The vast majority of the feeding areas used by the seabirds are marine waters outside the SPA. **Connectivity with feeding areas seaward around Par Sands is a possibility.**

- The Severn Estuary SPA/SSSI (approximately 147km from Par at its nearest point) is located northwest between Wales and England. It is a large estuary with extensive intertidal mud-flats and sand-flats, rocky platforms and islands. Saltmarsh fringes the coast backed by grazing marsh with freshwater ditches and occasional brackish ditches. The seabed is rock and gravel with sub-tidal sandbanks. High densities of ragworms, lugworms and other invertebrates form an important food source for passage and wintering waders and large numbers of wintering waterbirds, especially swans and ducks. The site qualifies 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: Bewick's Swan (over winter). This site also qualifies under Article 4.2 of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species: Ringed Plover (on passage), Curlew, Dunlin, Pintail, Redshank and Shelduck. The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. **May be some connectivity** with the small amount of similar grazing marsh habitat within the LNR, although numbers are not likely to be significant.

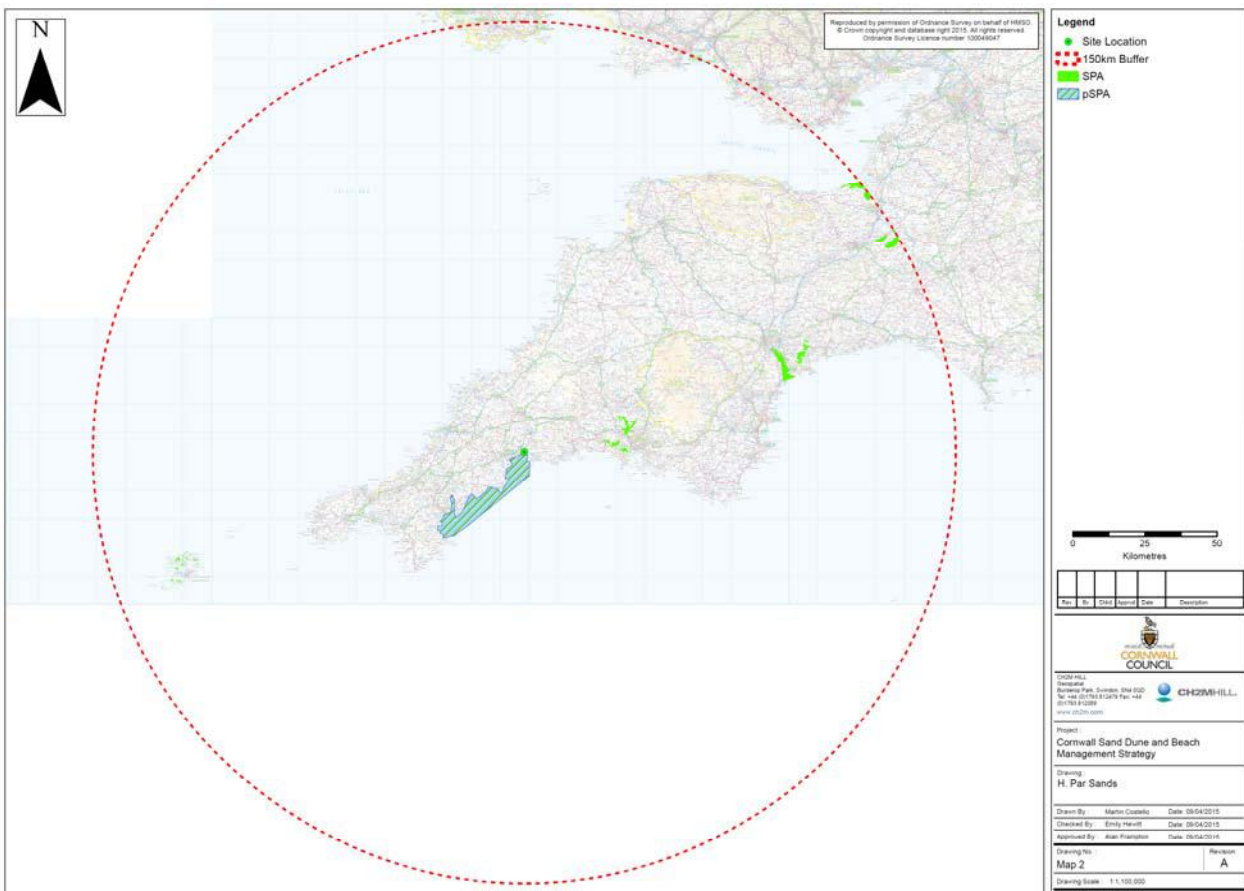


Figure 3.2 Potential bird-habitat connectivity between the protected area and the BDMP site.

3.3.1.2 Biodiversity Action Plan (BAP) Habitats

The following are listed as UK priority BAP habitats and are either represented in the Study Area or are within 1km as identified in the Cornwall County Council report: Ecological Assessment of Coastal Zone Management Issues at Par sands (Spalding Associates Ltd, 2005). Only habitats that are considered relevant to the Study Area, i.e. they are likely to be impacted upon or are likely to have an influence on the proposed scheme, have been described. The associated targets are quoted under them:

- Coastal Sand Dunes
 - Strandline and mobile dunes (open dune) (Quality assessment: Unfavourable due to presence of non-natives)
 - Retain extent of existing open dune

- Re-instate strandline habitat where possible
- Monitor trampling erosion of foredune and yellow dune
- Eliminate invasive non-natives, reduce other non-natives
- Control ruderal species.
- Dune grassland (Quality assessment: Unfavourable due to restricted zonation, lack of short turf, presence of non-natives and frequent scrub)
 - Retain existing dune extent
 - Re-instate grey dune and dune grassland wherever possible by removal of scrub particularly non-natives
 - Maintain areas of bare sand on grey dune habitat
 - Eliminate invasive non-natives, reduce other non-natives.
- Reed beds (swamp) (Quality assessment: Unfavourable due to indicators of negative change – scrub invasion of reed bed)
 - Maintain reed bed cover
 - Reduce scrub on reed bed
 - Target management to retain reed beds for reed fauna
 - Littoral and infralittoral sediment.
- Mudflats and sandflats not covered by seawater at low tide (Quality assessment: Probably unfavourable although no baseline data exists)
 - Re-instate strandline habitat (it was noted on the site visit, March 2015 that strand line sea weed is no longer being managed and removed).

3.3.2 Designated Geological Conservation Sites

There are no designated geological sites in the BDMP area.

3.3.3 Landscape Setting

The following landscape designations run from the eastern edge of Par Beach (see Figure 3.1 above):

- Cornwall Area of Outstanding Natural Beauty (South Coast eastern) runs from Par Sands to Looe. The Fowey ria characterised by a drowned Fowey river valley forming a network of creeks that lead toward a coastline of low cliffs and small beaches, with rounded land masses dominated by oak woodland, much of which is ancient and panoramic views from Gribben Head along the coast and across the Fowey estuary.
- The AONB also encompasses the Gribben Head - Polperro Heritage Coast which stretches seaward and along the coast and around the River Fowey to West Looe.

3.3.4 Archaeology and Cultural Heritage

A number of historic sites are located within the area and include a registered Historic Park and Garden (Menabilly), a Scheduled Monument (Wayside Cross) and listed buildings (see Figure 3.1 above).

3.4 Main human impact pressures affecting the natural dynamics of the site

The following observations were made by Spalding Associates Ltd (2005) and are still relevant following the site visit in March 2015 (refer to Section 2):

- recreational pressure
- localised trampling erosion and loss of sand cover on the dune

-
- restriction of the dune system
 - presence of invasive non-native plant species
 - localised pollution
 - removal of strandline habitat
 - trampling of the rocky shore.

4 Coastal Processes Understanding

4.1 Introduction

This section of the report provides the coastal processes understanding for the Par Sands BDMP area, which will be used in Stage 2 of the development of the BDMP for this area to help define the issues for each of the BDMP site and the objectives for their future management.

Specifically, this section of the report presents a review of existing literature and the findings of new data analysis to assess the coastal processes and shoreline change at the BDMP location. The work draws primarily from key data sources, including the 2009 sediment budget report (Halcrow, 2009c), the SMP2 (Royal Haskoning, 2011a), latest beach profile monitoring data (Plymouth Coastal Observatory (PCO), 2014a, b and c) and new data received from stakeholders. It provides:

- A review of past shoreline evolution, characteristics of the coastline today, hydrodynamics and sediment transport patterns, to provide a conceptual understanding of the coastline;
- Review of the latest beach profile data by Plymouth Coastal Observatory (PCO);
- Recommendations for consideration when developing the future management options.

4.2 Shoreline Processes Overview

4.2.1 Key Characteristics of the Coastline Today

Par Sands is located on the south coast of Cornwall (refer to Figure 4.1), approximately 4km to the east of St Austell. The beach is set-back within St Austell Bay, enclosed by the docks and china clay works in the west and the steep cliffs of Kilmarth in the east. Par Sands was originally formed at the mouth of an in-filled river valley (Halcrow, 2009b). The wide sandy beach is formed from the erosion of valley infill material and small inputs of material from erosion of the flanking cliffs (Halcrow 2009b), although much of the modern beach sand consists of quartzose sand waste washed down from China Clay workings to the north of St Austell (Pye *et. al.*, 2007). The beach is backed by dunes (estimated in 2009 to be around 10ha, Halcrow 2009a), which have become well established and form a successive dune habitat. Here, the land is low-lying and is designated as a Local Nature Reserve. Embryo dunes have formed at the interface of the dune toe and beach. The Par River discharges to the sea to the west of Par Sands. The river used to exit to the sea along the breakwater but changed its course in 2007/2008 and now flows out to sea further to the west in a straight line, and against the footings/defences of the china clay factory (refer to Section 2). The Polmear stream also discharges across the beach at the eastern end of Par Sands.

The evolution of this section of coastline has fundamentally been changed through man's interventions. Par Harbour began as a port to export copper and tin, and was converted from an open bay into a safe port in the early 1800s. From the 1830s onwards it became increasingly important for the shipping of china clay. Historically china clay was dumped on the beach at Par, but this practice has since ceased (Royal Haskoning, 2011b) as a result of an environmental clean-up of the industry (Halcrow, 1999b). There is evidence of the china clay waste on the east bank of the River Par, opposite the china clay works, where recent erosion of the overlying sand has exposed the clay layer beneath. The Port of Par was closed to shipping at the end of 2007.

Old photographs (Francis Firth, online) show the beach huts were originally on the beach, with no presence of dunes. Today, the same huts are fronted by sand dunes that have developed and accreted since then; this suggests that the dunes are a fairly recent feature and possibly formed a result of the china clay waste being dumped on the beach. At the western end of the beach there is a small section of fill, which is comprised of seaweed and litter picked up from the strandline (refer to Figure 4.2). Some of this fill was washed away during the 2014 storms. The process of beach clearing is no longer undertaken, and seaweed is left to build-up along the strandline in the summer for environmental reasons. Aerial photos analysed for the Par Beach Management Plan show that the dune area advanced 100-150m

seaward between 1946 and 1997. This represents an advance of over 2m per year (Environmental Consultants (CTNC) Ltd, 1997).

The dunes today are generally healthy and show signs of accretion along the dune toe, where during the site visit, there was clear evidence of dune growth with the formation of embryo dunes and young dune grass (refer to Figure 4.3). Marram Grass is growing well and effectively stabilising the dunes. This is likely to be a response to a dune planting programme in the 1980's when the dunes were fenced off and Marram Grass was planted. Within the dunes, Gorse, Sea Buckthorn and Rosa Regosa are growing, but are all invasive species and fighting for space. They can be removed by spraying them with chemicals, however, if they are having a stabilising effect on the dunes then this may prove detrimental to the dune state and therefore the flood defence function they perform (see description of flood risk below). There are some isolated areas of dune erosion, generally limited to the east bank of the River Par. Aerial photographs from 2007, 2009 and 2012 are shown in Figure 4.4, showing how the dunes have remained stable.

There is a risk of flooding at Par Sands as there is low-lying land behind the dunes and should they breach this will result in significant flooding of the land behind (refer to Section 2). Following the 2013/2014 storms Royal HaskoningDHV, (2015) report that the dunes were breached and there was flooding between the first and second dune ridge and there was evidence of overtopping into the dune slack between the fore dune and the back dune. However, they do suggest that it is unlikely that the storm damage resulted in any increased risk of overtopping of the main dune ridge, but it is possible that there is an increased flood risk to the car park at the western end of the beach, which is situated on the lower part of the dune. Waves in this location are expected to be reduced due to its sheltered location. Presently, there is a flood warning system on the ground, which the Environment Agency respond to. A tidal gate on the River Par helps to reduce tidal flooding up river (Royal Haskoning, 2011b) but high tides do reach the toe of the dunes (refer to Section 2).

Current management intervention at Par Sands is limited to the western and eastern extents of Par Sands. At the western end, hard defences constructed on the west bank of the Par River protect the clay mining works and harbour. The Par River channel is also dredged on an annual basis, with 45,000 tonnes removed to improve navigation through the channel (Royal Haskoning, 2011b). To the eastern end of Par Sand, boulders were placed in the stream in the late 1970's to help stabilise the bank of the river at a pinch point (refer to Figure 4.5); prior to this work this area used to flood during high tides. It is reported (Halcrow, 2009b) that beach nourishment has been implemented at the eastern end of Par Sands for the caravan park behind.

Par Sands is located within SMP2 PDZ2 / Management Area 6 and the future management policy for the frontage is No Active Intervention in the first epoch (to 2025) and Managed Realignment in the second and third epochs (to 2105) (Royal Haskoning, 2011a). The policy is to identify landfill risks and a possible strategy for Managed Realignment and dune roll back into hinterland. The SMP2 suggests that this area may need to be identified as a 'Coastal Change Management Area' within the land use planning system if necessary.



Figure 4.1 Map showing location of Par Sands.



Figure 4.2 Landfill, comprised of seaweed and litter collected from the strandline at Par Sands (taken during site visit 12th March 2015, looking west).



Figure 4.3 Dune accretion and embryo dune growth at Par Sands (taken during site visit 12th March 2015, looking south-east).



2007



2009



2012

Figure 4.4 Historical photographs of Par Sands (source: Plymouth Coastal Observatory).



Figure 4.5 Rock boulders in Polmear stream, used to stabilise the channel (taken during site visit 12th March 2015, above – looking south and below – looking north).

4.2.2 Forcing Factors

4.2.2.1 Typical Waves

The coastline at Par Sands is orientated east-west, with the beach and dunes facing approximately 180 to 195 degrees (south). The predominant wave direction along the south coast of Cornwall is reported to be from the south and south-west (approaching from 180° – 270°) and the coastline is exposed to open Atlantic swell waves (Royal Haskoning, 2011b).

The Looe Bay Directional Waverider Buoy, operated as part of the South West Regional Coastal Monitoring Programme (SWRCMP), is the nearest wave buoy to Par Sands, and has been reviewed for this study (refer to Figure 4.6 for the wave data point). The wave buoy is located approximately 15 miles east from Par Sands, and provides a record of wave height for a seven year period between 18th

December 2006 and 30th June 2014. A plot of wave height in Figure 4.7 4.7 shows that the predominant wave direction in this area is from the west. The data set also indicates significant wave heights frequently exceed 5m during the winter months and that wave periods of 15 seconds and higher (i.e. powerful well waves generated by storms offshore) are not uncommon (Royal Haskoning, 2011b).



Figure 4.6 Map showing the locations of the wave data collection points.

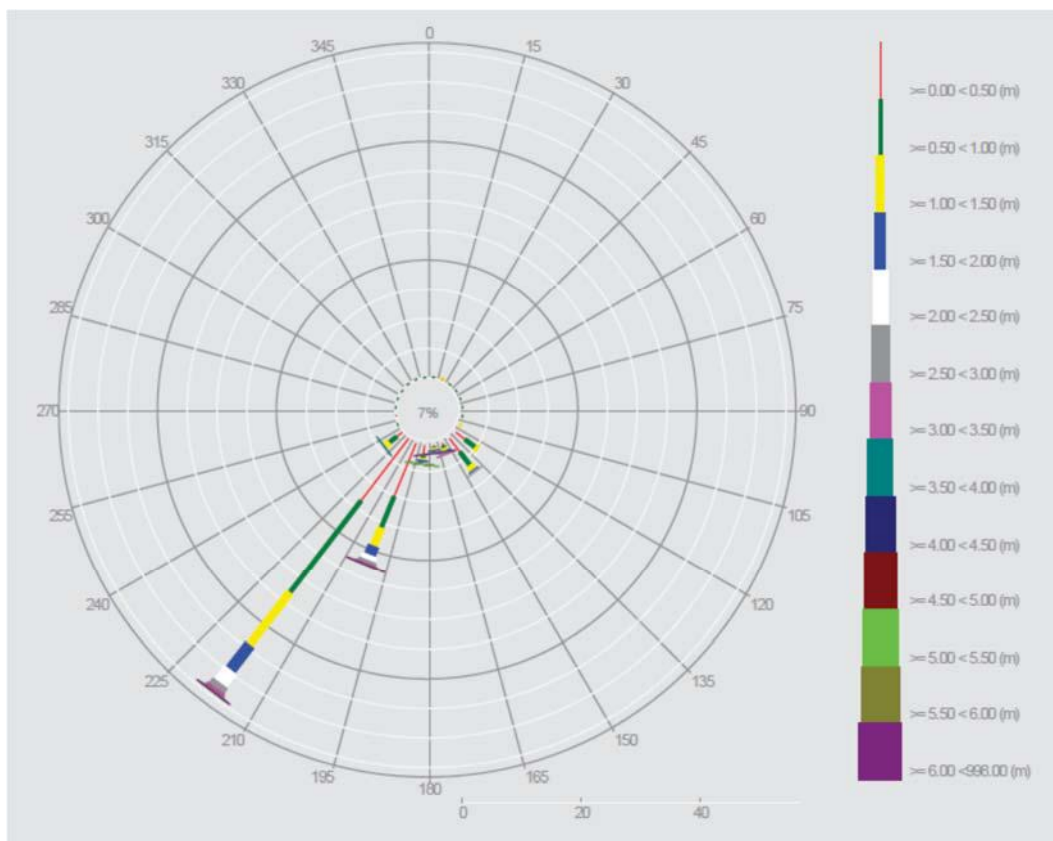


Figure 4.7 Offshore wave height recorded by the Looe Bay Directional Waverider Buoy between 22nd June 2009 and 30th June 2014 (PCO, 2014a).

4.2.2.2 Storm Waves

Storm analysis undertaken by PCO (2014d) provides an overview of the storm conditions recorded by the Looe Directional Waverider Buoy since 2007.

For each wave buoy in the SWRCMP, an individual storm threshold is set. A storm event is defined when significant wave heights equivalent to the 0.25 year return period (i.e. the threshold wave height (H_s) for 2 to 4 storms in an average year) occurs for set period of time (i.e. 16 hours). The significant wave height is calculated when a 5 year time series of data becomes available for the wave buoy and is then reset each year. Prior to that, the height is based on an educated conservative guess from looking at the wave data available. The reason that the 0.25 year return period is used is because the SWRCMP have found that in general there are 3 to 4 storms in any one year that result in the movement significant amounts of sediment.

For their reporting, PCO produce a storm calendar. The calendar includes a graph, where each dot represents a storm (i.e. where the H_s exceeds the storm threshold) and shows the H_s for that particular storm. PCO plot the significant wave height for the 1 year return period for that particular buoy on the graph (calculated in the same way as significant wave height for the 0.25 year return period) as a red line. Where storms plot above the red line they are considered to be more severe/extreme and are listed in a separate table. The storm calendar and table for the Perranporth Directional Waverider Buoy are presented in Figure 4.8 and Table 4.1 respectively.

The storm calendar shows that nine severe/extreme storms have exceeded the 1 year Return Period since 2009; six of those storms (67 %) occurred between October 2013 and February 2014. The impact of these storms on beach change is described in Section 4.3.

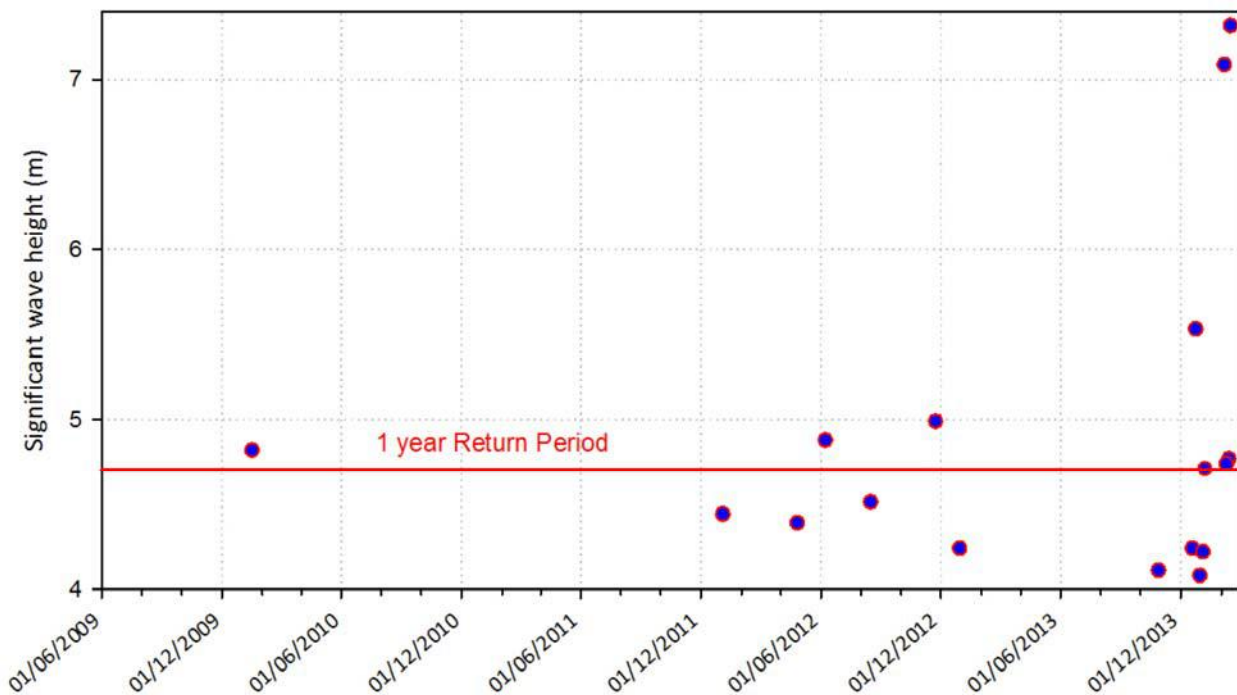


Figure 4.8 Storm calendar for Looe (source: PCO, 2014b).

Table 4.1 Storms exceeding 1 year Return Period at Looe since deployment in 2009. Those occurring during the storm season October 2013 to February 2014 are shaded pink (source: PCO, 2014b).

Date	Wave Height (m)	Return Period
14/02/2014	7.32	> 1 in 30 years
05/02/2014	7.09	> 1 in 30 years
23/12/2013	5.53	> 1 in 5 years
22/11/2012	4.99	1 in 2 years
07/06/2012	4.88	> 1 in 1 year
16/01/2010	4.82	> 1 in 1 year
12/02/2014	4.77	> 1 in 1 year
08/02/2014	4.74	> 1 in 1 year
06/01/2014	4.71	> 1 in 1 year

4.2.2.3 Tides

Tidal levels have been extracted from the current Admiralty Tide Tables (UKHO, 2013) for the closest location with the best available data, in this case Par, and converted to Ordnance Datum (mOD), see Table 4.2.

Table 4.2 Tide levels (in mOD) for Par, adjusted from standard port Plymouth (Devonport).

Tidal Condition	Tide Level (mOD)
Highest Astronomical Tide (HAT)	Data not available
Mean High Water Spring (MHWS)	1.55
Mean High Water Neap (MHWN)	0.45
Mean Sea Level (MSL)	0.08
Mean Low Water Neap (MLWN)	-1.25
Mean Low Water Spring (MLWS)	-2.35
Lowest Astronomical Tide (HAT)	Data not available

4.2.3 Sediment Dynamics

At Par Sands, sediment movement is dominated by alongshore and cross-shore transport process. It has been previously reported (Halcrow, 2009b) that there is no alongshore movement outside of the Par Sands bay as a result of the bounding rock headlands, however, the beach at Carlyon Bay was recharged with material comprised of gritty sand and geotextile material and local residents report that some of this sediment was later found on the beach at Par Sands (refer to Section 2), which suggests that there is potential for sediment to be moved alongshore between the headlands.

Following cessation of the dumping of mining waste, the main sources of sediment to the beach at Par now include erosion of cliffs, discharge from the Par River and Polmear Stream and beach nourishment, as described below:

- Material supplied from erosion of the cliffed headlands is a possible sediment source to the beach, but the composition of beach material indicates that this has not been a significant supply of material over the last few hundred years (Halcrow, 1999a).

-
- The Par River and Polmear Stream are reported to potentially supply the beach with an input of sediment, although the quantity and type of sediment are not specified (Royal Haskoning, 2011b).
 - It is reported (Halcrow, 2009b) that beach nourishment has been implemented for the caravan park behind.

There are no significant offshore sand deposits in the area and input from further along the coastline is limited.

4.2.4 Historical Shoreline Change

For the Cornwall Sand Dune and Beach Management Strategy, Halcrow (2009b) undertook a series of analysis of historical behaviour. The results of the analysis are described below. It should be noted that no further analysis has been undertaken as part of this study.

4.2.4.1 Comparison of Ordnance Survey Mapping

A comparison of 1888/1889 and 2000 editions of Ordnance Survey Mapping shows:

- Mean High Water is observed to have advanced more at the eastern end (200m) than the western end (150m).
- The eastern side near to the river has built out to the west of the rock. The western side has remained constant. The beach plan orientation has not changed at the low water mark.

4.2.4.2 Analysis of Aerial Photographs

Using aerial photographs, the dune toe was digitised and compared (refer to Figure 4.9). The analysis shows that the between 2001 and 2007:

- Significant accretion along the majority of the frontage of the dunes at Par Sands. In general, the seaward face of the fully mature dune system has accreted seaward between 5 and 13m over the 5 year period. This represents an average rate of accretion of between 1 and 2.5m per year.
- The exception to this is at the western extremity of the beach (nearest the river), where a stretch of dunes roughly 60m wide eroded landwards approximately 5m, and where a section of foredune roughly 100m wide by 10m deep was completely lost.
- Over this period, there was notable build-up of the foredunes in the middle of the beach over the past 5 years, with the original embryo dunes increasing in width and growing slightly seaward. The density of vegetation cover appeared to have increased over time as well.

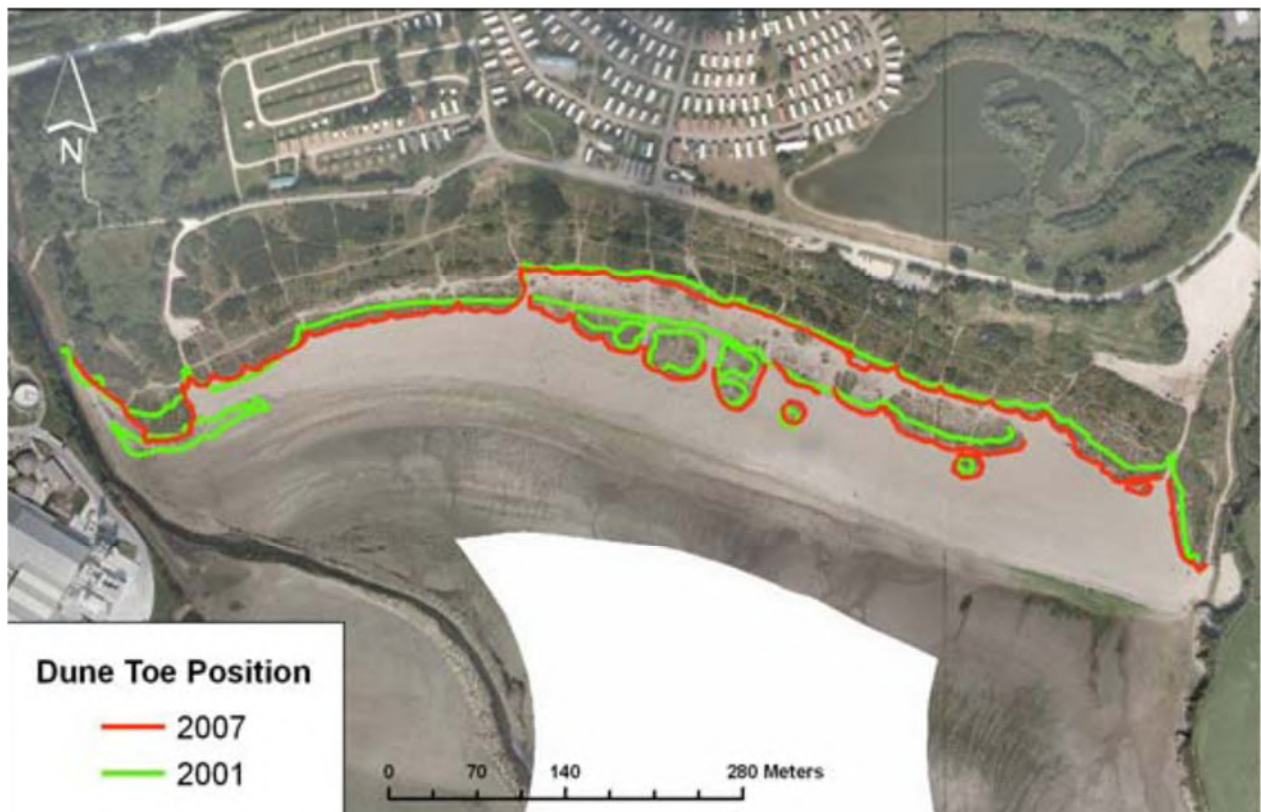


Figure 4.9 Dune toe position at Par Sands in 2001 and 2007 (source: Halcrow, 2009c).

4.2.4.3 Beach Profile Analysis

Analysis of the beach profile data collected by the SWRCMP was undertaken to identify changes in the dunes and beach, including cross-sectional area (CSA), between December 2006 and March 2008 for four locations: 6d00965, 6d00960, 6d00956 and 6d00952 (refer to Figure 4.10). The study concluded the following:

- **Dunes:** The four profiles at Par Sands generally show no discernible trends for the dune area. All changes over this period equate to less than 1% of the material present above the master profile. The maximum variability on any profile was 10m^2 , but this equates to a small volume over the 100m of dunes surveyed. The exception to this along the two profiles (6d00956 and 6d00960) in the centre of the site, which show a slight increase in the sand levels on top of a foredune in front of the main dune system. The increase in crest height of the foredune feature was in the order of 15 to 50 cm between 2008 and 2006, indicating that this may be a growing feature.
- **Beach:** Only one of the four profiles showed a loss of beach material over the analysis period. The western-most profile lost 1% of its CSA over that time. A possible explanation for this is the loss of the foredune in this area. The other three profiles remained stable or accreted slightly.



Figure 4.10 Diagram showing position of SWRCMP beach profiles at Par Sands.

4.3 New Shoreline and Beach Profile Analysis

Beach profile monitoring undertaken by PCO for the SWRCMP, provides recent data and analysis for the beach at Par Sands. A summary of the findings from the latest annual survey report (PCO, 2014c) are presented in this section and provide an overview of beach profile change in the past year, between Spring 2013 and Spring 2014, and over the longer-term from the baseline survey in 2007 to the most recent survey in Spring 2014. The calculations of CSA include the beach and part of the dunes.

- In the past year, between Spring 2013 and Spring 2014 (refer to Figure 4.11), profile 6d00965 remained stable, whilst profiles 6d00952, 6d00956 and 6d00960 all lost material.
- Over the longer term, between 2007 and Spring 2014 (refer to Figure 4.12), the two profiles to the west, 6d00960 and 6d00965, gained material (possibly linked to change in course of the river), but at the east of the beach, profiles 6d00956 and 6d00952 lost material.
- Mapping of the Mean High Water (MHW) contour (refer to Figure 4.13) shows variation on the position of the MHW contour, with no clear trend.

As part of the SWRCMP, PCO have also prepared two reports (PCO, 2014d and 2014e), which examine the change to a selection of the beaches along the south-west coast, with a view to identify how beach change occurring as a result of the 2013/2014 winter storms compares to the longer-term behaviour of the beach. For the first report (PCO, 2014d) have undertaken analysis of beach profile data to assess beach volume change over the longer term (typically between 2003 and 2013), the 2013/2014 winter storm period (typically between October/September 2013 and February 2014), and over a post-storm period between winter 2013/2014 and summer 2014. The second report (PCO, 2014e) provides the results of topographic difference modelling undertaken by the Environment Agency. The modelling compares the last available LiDAR flown sometime before the 2013/2014 winter storms and LiDAR flown after the 2013/2014 storms. Where this analysis has been completed for the BMP sites, a summary of the changes are described below.

- The long-term volume change between the baseline survey in 2007 and Summer 2013 was $16,400\text{m}^3$. The net change over the 2013/2014 winter period (from March 2013 to January 2014) was $-27,400\text{m}^3$, but the net change from Winter 2013/14 to Summer 2014 was $20,522\text{m}^3$. The percentage of beach volume recovered by Summer 2014 was therefore +75% (refer to Figure 4.14).
- The topographic difference model plot for Par Sands (refer to Figure 4.15) shows the beach elevation change between the 21st March 2012 and 1st April 2014. The plots shows that the dunes have accreted vertically over this time and a reduction in beach level along the MHW line (particularly at the western end around the site of fill, corresponding to loss following the 2013/2014 storms, and the eastern end of the beach).

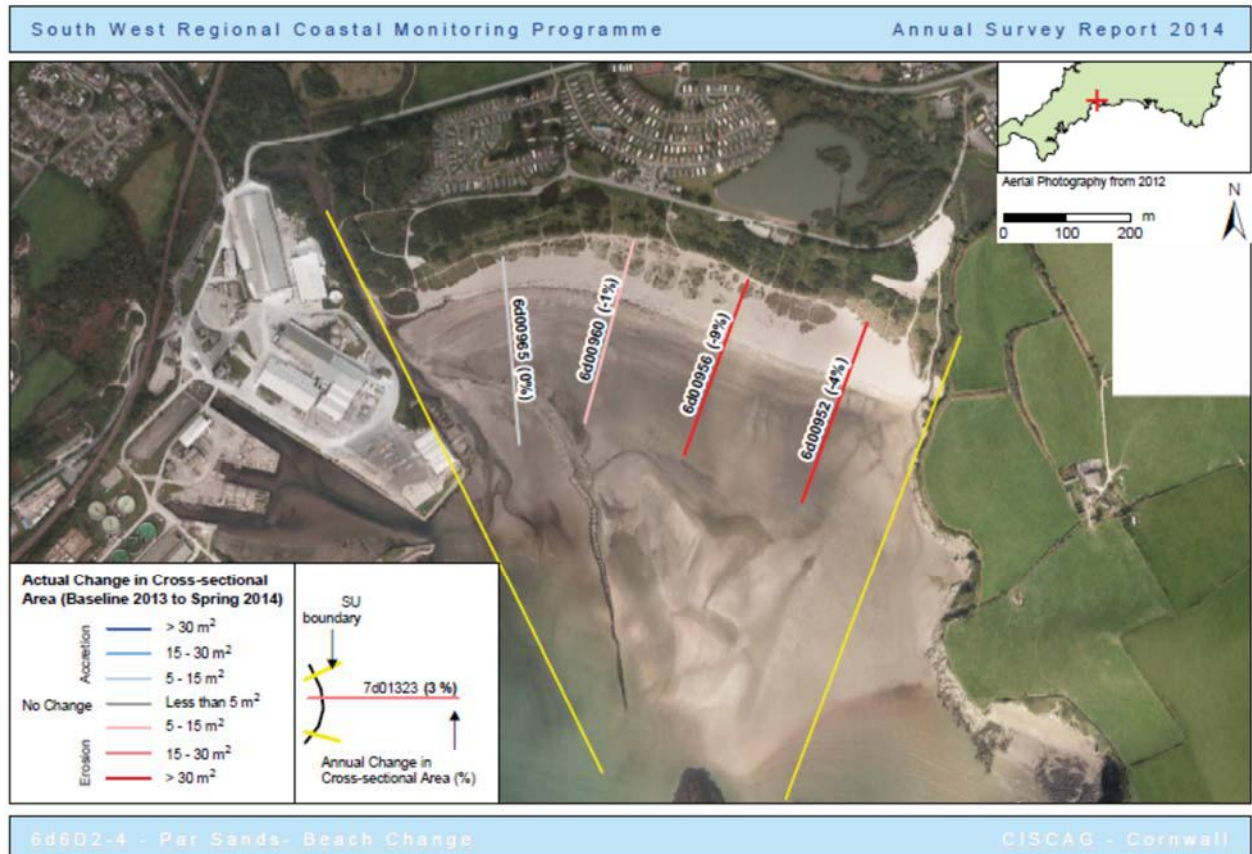


Figure 4.11 Beach profile change at Par Sands Spring 2013 to Spring 2014 (source: PCO, 2014a).

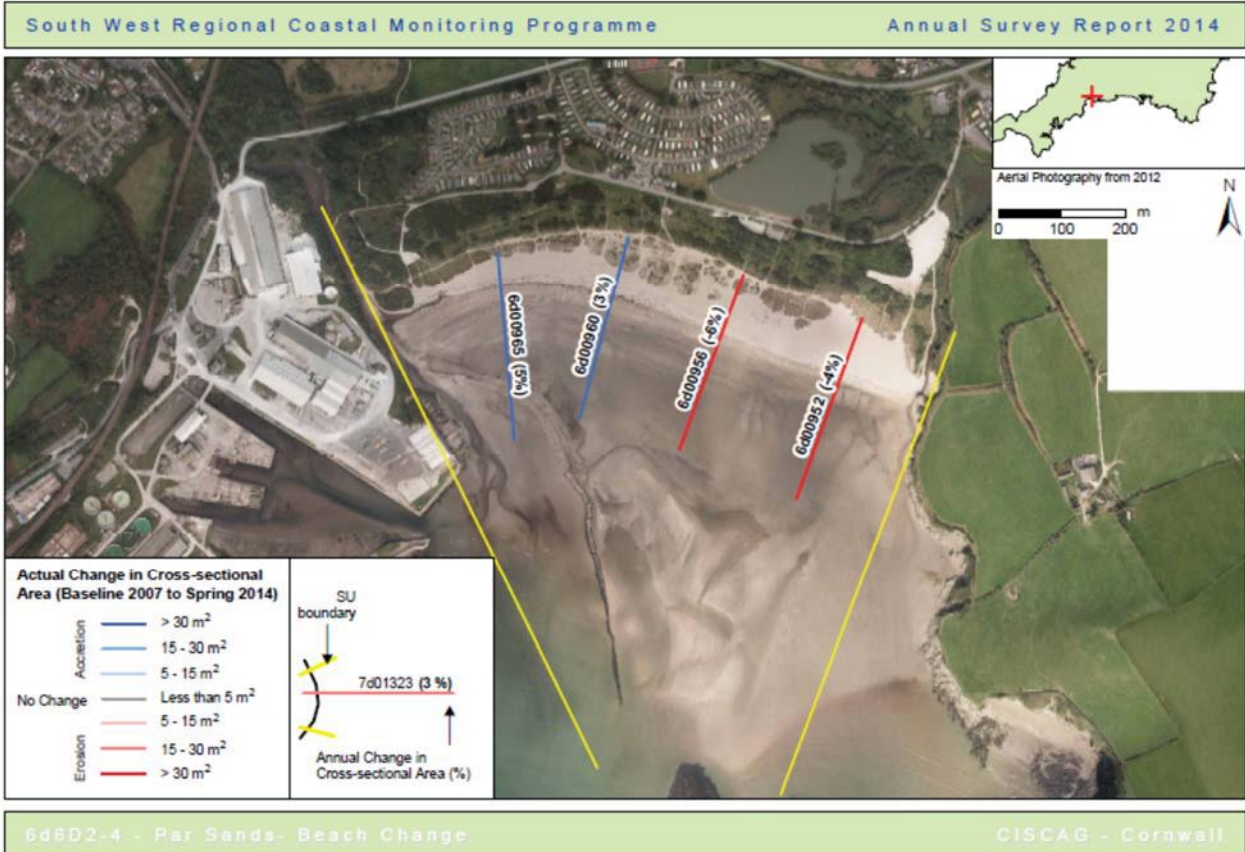


Figure 4.12 Beach profile change at Par Sands baseline 2007 to Spring 2014 (source: PCO, 2014a).

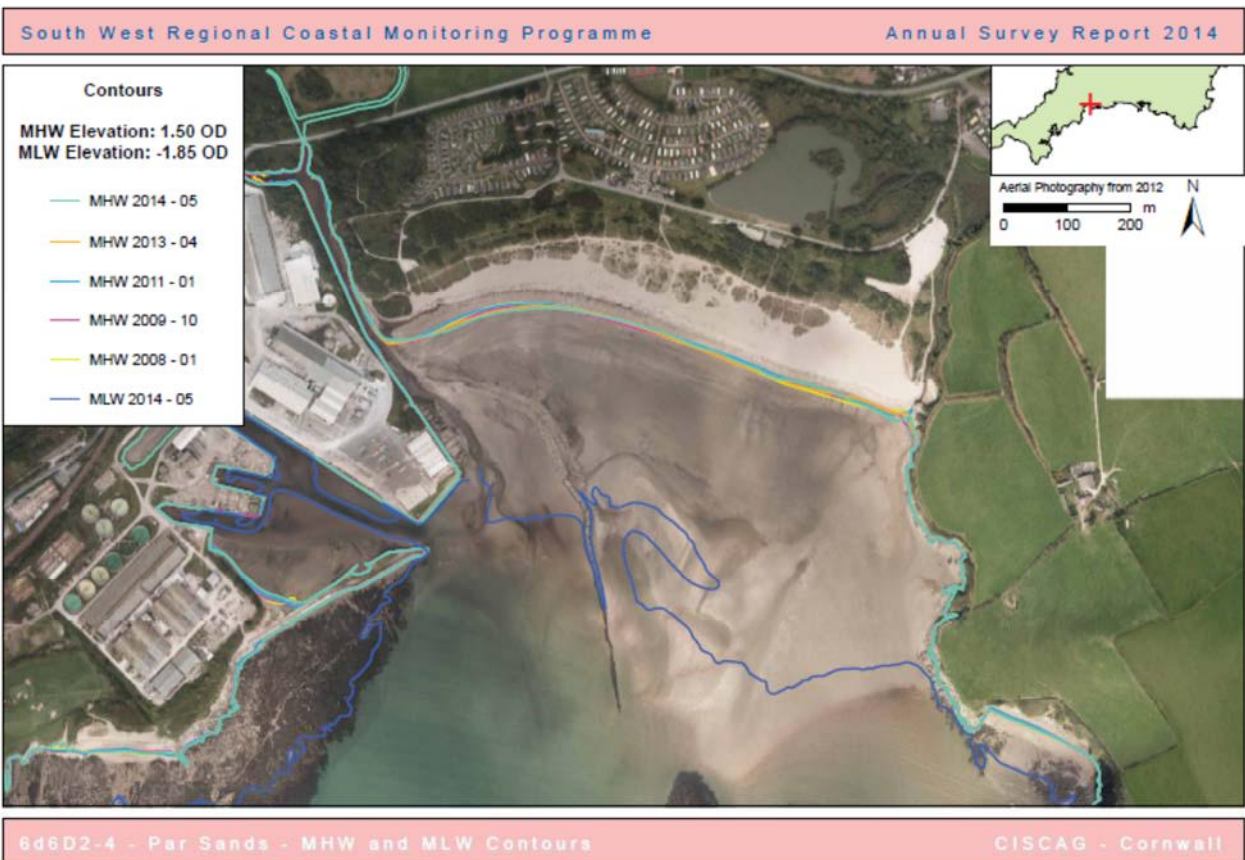


Figure 4.13 MHW contour change at Par Sands (source: PCO, 2014a).



Figure 4.14 Volume change at Par Sands (PCO, 2014b).

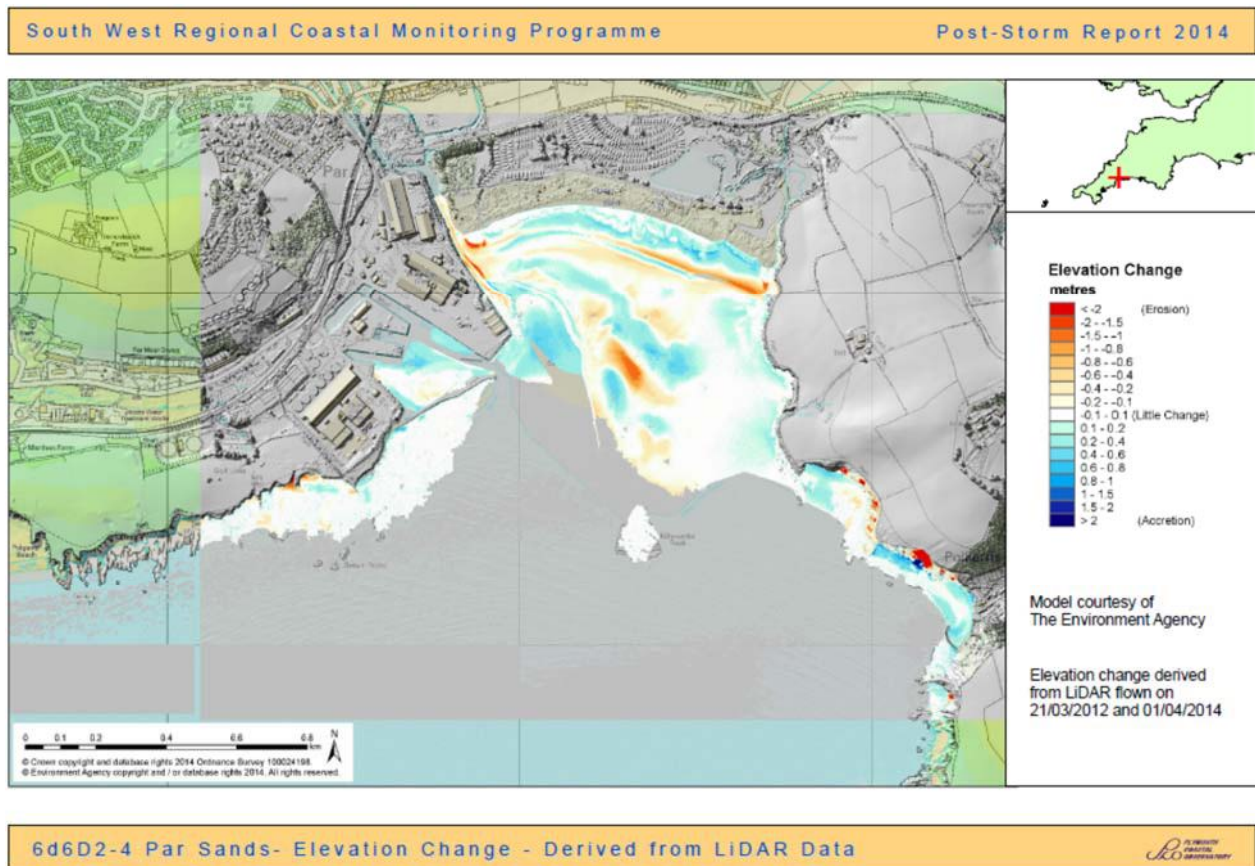


Figure 4.15 Post storm elevation change at Par Sands (source: PCO, 2014c).

4.4 Summary and Recommendations

4.4.1 Summary

Par Sands is south-facing and open to the south-westerly Atlantic swell waves. It is set back within St Austell Bay and therefore sediment transport to the beach by alongshore processes is limited, although there is evidence of nourishment material from Carlyon Bay ending up on Par beach which suggests a west to east import of material alongshore. The beach has been highly influenced by mining in the past, when waste material was dumped on the beach. Although this practice has now ceased, the dunes, and in places the beach, continue to accrete vertically.

The dunes have a flood defence function to the low-lying behind and it therefore very important that they are maintained in their current if not a more robust state. The dunes to appear to be accreting at the dune toe along the length of the frontage, however, beach profile analysis shows that the beach at the western end of Par Sands is accreting whilst the east is eroding. This may be linked to the change in course of the river, or another explanation could be that the beach nourishment material placed at the eastern end of the beach for the caravan park (as reported on by Halcrow, 2009b) could have moved from east to west, which is contrary to the net drift direction for this section of coastline. The overall net volume change between 2007 and Summer 2014 was accretion (PCO, 2014e), despite the storms of 2013/14, and given that the profiles include sections of the dunes is likely to be representing their vertical accretion.

4.4.2 Recommendations to Consider for Future Beach and Dune Management

The key issue at Par Sands is that the dunes provide a flood defence function to the low-lying land behind. The dunes appear to be stable and in places accreting, so intervention required at present is probably limited. However, as the dunes fulfil an important flood defence role, there are a few actions that should be explored through the BMP process and they include:

- Options to make the dunes more robust to prevent further breaching during flood events. Should any dune stabilisation methods such as fencing be selected as an option, the Friends of Par Beach have expressed a preference for continued access (refer to Section 2). Communication with the local interest group and general public is key.
- At the time of the site visit (refer to Section 2), Cornwall Council expressed an interest at looking at the effect of removing invasive species from within the dunes, so this needs to be investigated. If no adverse effect is identified, options to remove the plants from the dunes should be explored.

5 Site Summary

5.1 Dune Inventory Summary

DUNE SYSTEM	PAR SANDS
CHARACTERISTICS	
LOCATION MAP	<ul style="list-style-type: none"> See Figure 1.2.
AERIAL PHOTOGRAPH	<ul style="list-style-type: none"> See Figure 4.4.
DUNE EXTENT	<ul style="list-style-type: none"> See Figure 1.4.
AREA OF SITE	<ul style="list-style-type: none"> Active 10 ha Total 10 ha
DUNE TYPE	<ul style="list-style-type: none"> Linear Hummocky Embryo
MORPHOLOGICAL FEATURES OF DUNES	<ul style="list-style-type: none"> Some trampling on foredune.
PAST (150 YRS) EVOLUTION OF DUNES	<ul style="list-style-type: none"> Analysis of historical maps indicates accretion of dunes. Caravan park development in the 1960's. 1997 became LNR.
VEGETATION TYPE	<ul style="list-style-type: none"> Foredune, yellow dune, grey dune, scrub, dune grassland. Invasive species.
BACKSHORE CHARACTERISTICS	<ul style="list-style-type: none"> Low lying land behind dunes. Backed by nature reserve, Caravan Park, area of standing water, reed beds, marshy ground, scrub, woodland, plantation and car parking. Extent of dunes restricted by road.
COASTAL SETTING	<ul style="list-style-type: none"> Extensive beach formed at mouth of infilled river valley. Wide flat foreshore with coarse sand to small slate pebbles. Medium sand on lower foreshore and rippled sand flat. Par River discharges across beach. Forms part of larger St Austell Bay system but bounded by rock headlands. South facing dunes.

DRIVERS	
LINKS TO ADJACENT COAST	<ul style="list-style-type: none"> No longshore sediment movement outside of bay.
WIND ENERGY	<ul style="list-style-type: none"> No contemporary data identified. Refer to SMP1 (Halcrow, 1999) for historical data.
WAVE ENERGY	<ul style="list-style-type: none"> See Sections 4.2.2.1 and 4.2.2.2.
WATER LEVELS	<ul style="list-style-type: none"> See Section 4.2.2.3.

SEDIMENT BUDGET	<ul style="list-style-type: none"> • Main sediment source in recent history is china clay waste (quartz sand <4mm) carried by Par River. • China clay waste supply now ceased.
PRESSURES	
ENVIRONMENTAL DESIGNATIONS	<ul style="list-style-type: none"> • Par Beach and St Andrews Road Local Nature Reserve (LNR). • UK BAP Priority Habitats with management objectives (Coastal Sand Dunes; Reed beds; Mudflats and sand flats not covered by seawater at low tide). • See Section 3.3 also.
ARCHAEOLOGY/ HERITAGE	<ul style="list-style-type: none"> • Cornwall Area of Outstanding Natural Beauty. • A number of historic sites are located within the area and include a registered Historic Park and Garden (Menabilly), a Scheduled Monument (Wayside Cross) and listed buildings (see also Section 3.3.4).
LAND USE	<ul style="list-style-type: none"> • Holiday park and car park behind dunes.
RECREATIONAL PRESSURES	<ul style="list-style-type: none"> • Aerial photographs show evidence of recreational pressures such as - Holiday park, car park and paths through dunes. • Beach huts within dunes. • Quad Bikes and Horse Riders on Beach. • Popular for water sports such as windsurfing and kite surfing. • Popular with dog walkers all year round.
SAND EXTRACTION/ DREDGING	<ul style="list-style-type: none"> • Dredging of sand off Par Harbour to west.
COASTAL DEFENCES	<ul style="list-style-type: none"> • Natural sand beach protects road and properties from flooding. • Training works to both rivers.
CURRENT MANAGEMENT PRACTICES	<ul style="list-style-type: none"> • 1997 Par Beach Management Plan for Nature Reserve, supported in implementation by Friends of Par Beach. • Beach Cleaning - Litter removed by hand. • Fencing of older dunes. • Disabled ramp. • RNLI/Council beach information boards.
SHORELINE MANAGEMENT PLAN POLICY <i>(from Royal Haskoning, 2011a)</i>	<ul style="list-style-type: none"> • Policy Unit 6.3 (Par Sands): <ul style="list-style-type: none"> ○ Short term = No Active Intervention; medium term = Managed Realignment; long term = Managed Realignment. ○ Policy intent = <i>“Investigate landfill risks and identify possible strategy for MR & dune roll back into hinterland. Identification of this area as a ‘Coastal Change Management Area’ within the land use planning system may be necessary.”</i>
MANAGED BY	<ul style="list-style-type: none"> • Cornwall Council.

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Appendix D

Options Appraisal

*Stage 3 Report: Future Management
Options for Par Sands*

Cornwall Beach & Dune Management Plans

Prepared for
Cornwall Council

22 January 2016

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Contents

Section	Page
1	Introduction 1
1.1	Background 1
1.2	Project aim, objectives and approach 2
1.3	About this document 4
2	Par Sands..... 5
2.1	Options Appraisal..... 5
2.2	Options Summary 11
3	References..... 13

1 Introduction

1.1 Background

Many of the sand dunes and beaches around Cornwall's coast are currently experiencing erosion and sediment loss. This is a pressing concern as these sand dunes and their associated sandy beaches are one of the most important resources in Cornwall due to:

1. Their role in providing protection against the risk of coastal flooding due to the dynamic nature of beach-dune interactions and their sheer size preventing the sea from impacting upon the hinterland behind the dune systems.
2. Their role in providing important biologically diverse habitats that cannot be easily recreated elsewhere if it were to be lost to coastal erosion or inappropriate development.
3. Their role in providing access to the sea for residents and visitors alike, which is vital to the holiday industry upon which a significant proportion of Cornwall's economy depends.

It is vital therefore that the sand dunes and beaches around Cornwall's coast, that represent some 15% of the total sand dune habitat in Britain, are managed in a holistic, sustainable way over the long-term that balances the needs of each of the three distinct functions of sand dunes and beaches that combined make up the beach-dune system.

The approach to managing the beaches and sand dunes in Cornwall (refer to Figure 1.1) was investigated in between 2006 and 2009 by Halcrow (now CH2M) on behalf of the Cornwall and Isles of Scilly Coastal Group, and led to the production of the *Cornwall Sand Dune and Beach Management Strategy* (Halcrow, 2009). The main focus of the strategy is the management of flood and coastal erosion, although the habitat and tourism value of the dunes are also considered. This 2009 project delivered an Inventory of Beaches and Dunes; a Best Practice Management Guide and two pilot Beach and Dune Management Plans (BDMPs) for Harvey's Towans and Fistral Beach. It is this 2009 work that this current project is building upon to develop six new BDMPs and review the two pilot BDMPs (see Section 1.2).

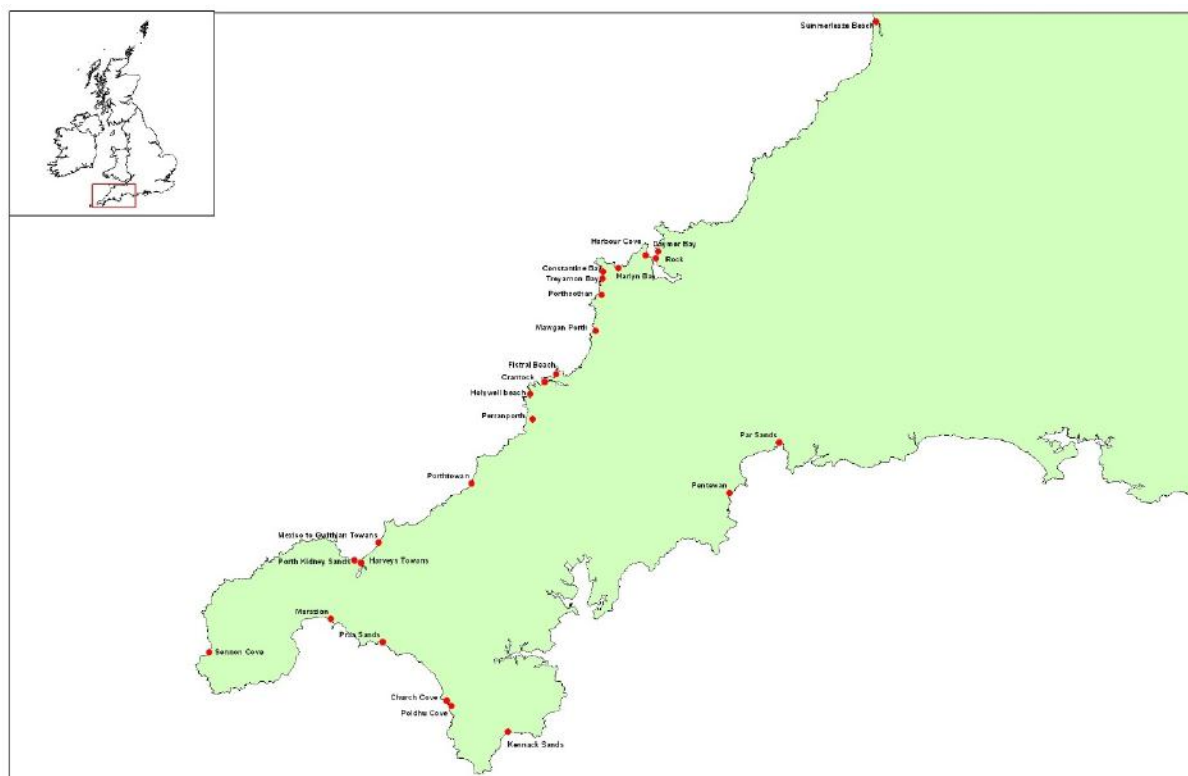


Figure 1.1 Map showing location of all dune locations in Cornwall assessed as part of the *Cornwall Sand Dune and Beach Management Strategy* (Halcrow, 2009).

1.2 Project aim, objectives and approach

The purpose of the project is to **develop six new long-term strategic BDMPs for Constantine Bay, Porthtowan, Summerleaze, Par Sands, Widemouth Bay and Praa Sands; and review the need (or otherwise) to update the two pilot BDMPs produced in 2009 for Fistral Beach and Harvey's Towans** [NB: following Stage 1 of this project – see below – it was confirmed that the two 2009 pilot BDMPs will be updated through this project]. This will be achieved by:

1. Identifying the best management approach; in terms of monitoring and intervention (when trigger levels are reached) requirements for beach and dune systems at each individual site, based upon the best practice framework developed as part of the *Cornwall Sand Dune and Beach Management Strategy* produced by Halcrow in 2009.
2. Providing a long-term (50 year) approach to each site that is based upon an up-to-date understanding of the beach-dune system and coastal processes at each site, as well as predictions of future coastal evolution.

The locations of these eight sites is shown in Figure 1.2.

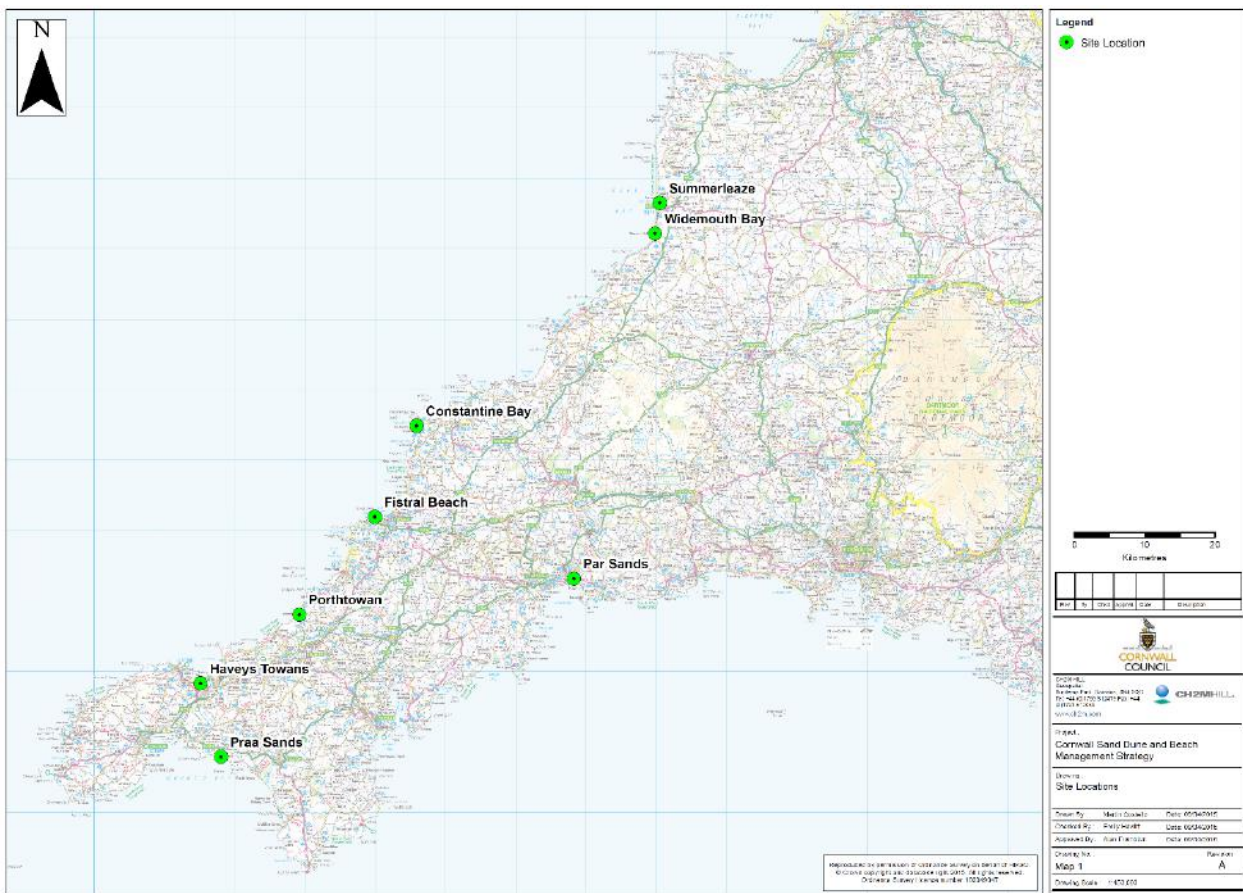


Figure 1.2 Map showing location of the eight BDMP locations.

Development of the BDMPs will involve four stages. Local community stakeholders and statutory stakeholders will be engaged to seek local knowledge and guide selection of preferred management options. These stages, and the times when engagement with local community representatives and other statutory consultees is planned, are shown in the flow diagram below (Figure 1.3). This report represents outputs from “Stage 3 – Develop Future Management Options.”

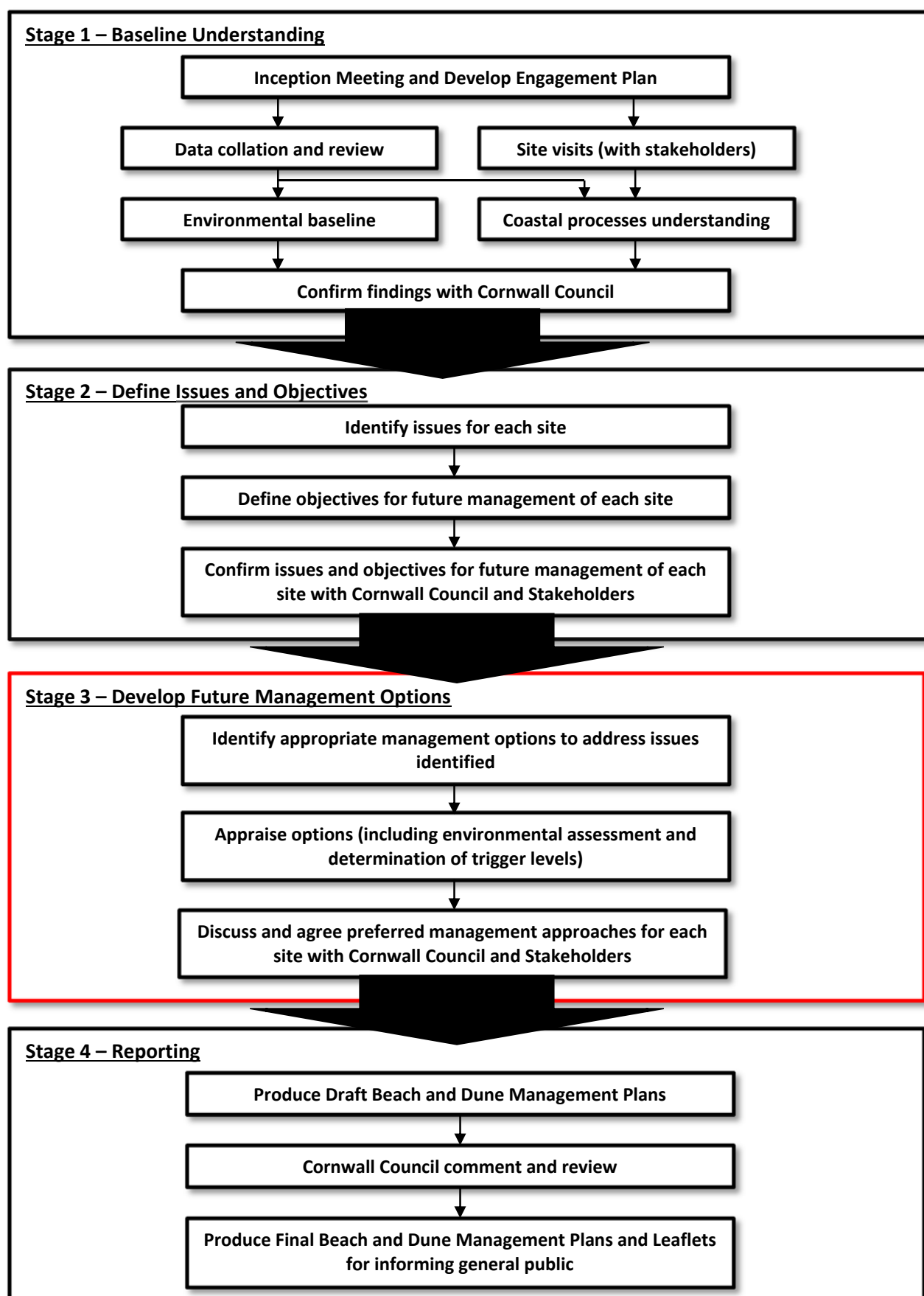


Figure 1.3 Overview of the staged approach to developing BDMPs for the eight locations around Cornwall; current stage highlighted by red box.

1.3 About this document

This report identifies and appraises potential management options to address the issues and objectives identified in Stage 2 (CH2M, 2015b) as being 'in scope' for the Par Sands BDMP area. These issues were identified from the baseline understanding developed for this location as part of Stage 1 (CH2M, 2015a).

The potential management options to appraise have been identified using the Sand Dune Management Techniques Decision Support Tool (Halcrow, 2009), updated with additional techniques identified as part of Stage 3 of this current project. The updated tool and associated user guide will form part of the final project deliverables at the end of Stage 4 (refer to Table 1.3 above).

Each potential option is appraised technically, environmentally and economically in the following way:

- Technical Appraisal considers the likely performance of different options giving consideration to the understanding of coastal processes determined in Stage 1 of the project for the BDMP location. This aspect also considers likely trigger points when either management intervention should occur or when a change in management approach will likely to be implemented.
- Environmental Appraisal considers potential impacts of options upon features of environmental designation and amenity, drawing upon baseline information defined Stage 1 of the project for the BDMP location.
- Economic Appraisal is based (where appropriate) upon a broad assessment of costs of each option (low: £0-£5k per 100m run; medium: £5k-£50k per 100m run; high: £50k + per 100m run) as informed by 'costs' contained in the updated Sand Dune Management Techniques Tool referred to above. The level of maintenance required for each option (None: No maintenance required; low: Maintenance required within a 10 year period; medium: maintenance required every 1 to 10 years; high: maintenance required at least yearly) is also provided, as informed by 'maintenance' contained in the updated Sand Dune Management Techniques Tool. Where information is available, the Present Value¹ (PV) 'SMP2 stated costs' for implementation of the stated policy and 'SMP2 stated benefits' (value of properties protected) for the policy (Royal Haskoning, 2011), and associated benefit cost ratio's² (BCR) are also given.

The appraisal of options for Par Sands is presented in the remainder of the document. The appraisal of all options is presented in tabular form, followed by a short summary discussion of what is considered the preferred approach to future management for the location, referring back to the project aims (refer to Section 1.2) and site specific objectives identified for Par Sands in Stage 2 of this project (CH2M, 2015b).

¹ Present value is the estimated current value of a future amount of money to be received or paid out, discounted at an appropriate rate.

² Benefit cost ratio is a technique to value a project, directly comparing benefits and costs. The higher the BCR, the greater the benefits relative to the costs.

2 Par Sands

Par Sands is located on the south coast of Cornwall, approximately 4km to the east of St Austell. The beach is set-back within St Austell Bay, enclosed by the docks and china clay works in the west and the steep cliffs of Kilmarth in the east (refer to Figure 2.1).



Figure 2.1 Map showing the Par Sands BDMP location and extent (red outline).

2.1 Options Appraisal

The following Table 2.1 contains appraisal of a range of possible options for future beach and dune management for Par Sands to address the issues and objectives identified for this location as part of Stage 2 of this project (refer to Section 1.3).

Table 2.1 Options Appraisal Table for Par Sands

ID	Issue Description	BDMP Objective for Issue	Current Management Practice related to issue	Sand Dune Management Category and Technique (identified from the Sand Dune Management Preliminary Decision Assistance Tool (Halcrow, 2009); UPDATED 2015)	Short (0-20 years), Medium (20-50 year) or Long Term (50-100 years) Action	Comments / Additional Categories / Techniques To Be Investigated	Technical Appraisal of Options	Environmental Appraisal of Options	Economic Appraisal of Options
1	<p>Although the dune system is accreting both vertically and seawards at present, low-lying land behind Par Sands beach and dunes would be vulnerable to flooding should the dunes be breached in the future.</p> <p>This includes the holiday park located on the low-lying land behind the dunes which hinders the ability for natural dune rollback to occur. This is likely to become an ever more constraining factor as sea levels rise in the future.</p>	Reduce the risk of future coastal erosion and flooding to the low-lying land behind the dunes through coastal adaptation and resilience measures (e.g. rollback of existing development) and directing future development away from areas at risk of coastal change.		<p>ADAPT BACKSHORE MANAGEMENT/USES</p> <ul style="list-style-type: none"> Adapt Backshore Management/ Uses 	Short/Medium term		<p>MR in the medium to long term (SMP2) may require adaptation of backshore uses, namely relocation of car parks, access road and parts of the leisure park to allow dune rollback (implementation will be dependent on local planning policy and landownership).</p> <p>Adaptation of the backshore will mean natural process would be allowed to continue combined with stabilisation measures if required, to maintain the dunes as the primary flood defence to remaining holiday park assets.</p>	<p>ADAPT BACKSHORE MANAGEMENT/USES</p> <p>Impact to car parks, access road and parts of leisure park from rollback/removal</p> <p>Long term positive benefits to designated features/BAP habitat through encouraging natural processes.</p> <p>Possible impact to coastal path</p> <p>Relocation of car parks, access road and parts of leisure park would require careful consideration of impact to designated ecological features (in particular for birds) in new location and impact on landscape, archaeological and cultural heritage features.</p>	<p>SMP2</p> <p>Relocation of car park access road and leisure park</p> <p>Costs not specifically included in the SMP2, but likely to be Medium to High.</p>
2	The dunes along the bank of the Par River are eroding and require stabilisation.	Undertake ongoing monitoring of this part of the dunes and that if an erosion trend is identified, to consider dune stabilisation / restoration measures that encourage sediment entrapment and dune growth.		<p>MONITORING</p> <ul style="list-style-type: none"> Monitoring Schemes <p>STABILISATION</p> <ul style="list-style-type: none"> Planting (and to prevent access to planted/ thatched areas) Thatching (and to prevent access to planted/ thatched areas) Mulching/ Matting/ Sand Binders Control Fencing (see also ACCESS MANAGEMENT) <p>ACCESS MANAGEMENT</p> <ul style="list-style-type: none"> Zoning Boardwalks Control Fencing <p>MORPHOLOGICAL MODIFICATION</p> <ul style="list-style-type: none"> Dune Fencing Planting (see STABILISATION). Bulldozing / Contouring (see STABILISATION). 	<p>Short term</p> <p>Medium term</p> <p>Medium term</p> <p>Medium term</p>		<p>Requires ongoing commitment from coastal monitoring programme (funded nationally) and council.</p> <p>Monitor the dunes in this location to inform future management methods and inform future management decisions. Different survey techniques could be employed, including LiDAR, photography and laser scanning.</p> <p>In the medium term, under MR, dune stabilisation / restoration methods could help address any dune erosion issues identified along the eastern bank of the Par River, however how effective this would be in the long term will depend on the movement of the river channel.</p> <p>Sediment entrapment measures along with restricting access to this area could help embryo dune formation, and allow natural processes to continue unhindered. This may require a degree of bulldozing/contouring to help initial development, but is not considered likely as an ongoing measure.</p> <p>Stabilisation methods need ongoing management, monitoring and maintenance.</p>	<p>MONITORING</p> <p>Will inform management decision that can assist in the promotion of these features to ensure a positive long term impact on designated sites and BAP habitat.</p> <p>STABILISATION</p> <p>Long term positive benefits to improvement of designated site features and BAP habitat. Assuming native plants are used and represent species on site.</p> <p>Possible impacts from stabilisation works on designated/protected species, although can be mitigated by best practice methods being applied.</p> <p>ACCESS MANAGEMENT</p> <p>Positive impact to designated site features and BAP habitat from access management.</p> <p>Advantages: natural processes can continue; eroded areas are able to recover; zoning limits trampling and erosion to zoned pathways and boardwalks encourage use of designated paths.</p> <p>Disadvantages: Existing access routes may need to be redirected or closed; relocation of access routes and SW coastal path needs to be considered carefully as not to impact on other designated</p>	<p>Planting</p> <p>Cost: low/medium, (medium maintenance)</p> <p>Thatching / Mulching etc</p> <p>Cost: low, (high maintenance)</p> <p>Control fencing</p> <p>Cost: low, (medium/high maintenance)</p> <p>Zoning</p> <p>Cost: medium, (high maintenance)</p> <p>Boardwalks</p> <p>Cost: medium, (medium maintenance)</p> <p>Bulldozing / contouring</p> <p>Cost: Low, (medium maintenance)</p>

ID	Issue Description	BDMP Objective for Issue	Current Management Practice related to issue	Sand Dune Management Category and Technique (identified from the Sand Dune Management Preliminary Decision Assistance Tool (Halcrow, 2009); UPDATED 2015)	Short (0-20 years), Medium (20-50 year) or Long Term (50-100 years) Action	Comments / Additional Categories / Techniques To Be Investigated	Technical Appraisal of Options	Environmental Appraisal of Options	Economic Appraisal of Options
								<p>features present; may impact upon natural dune processes;</p> <p>MORPHOLOGICAL MODIFICATION</p> <p>Long term positive benefits to improvement of designated features and BAP habitat.</p> <p>Possible impacts from fencing/planting works on designated features/protected species, although can be mitigated by best practice methods being applied.</p> <p>Fencing can be destroyed by storm-wave action. Fencing, when damaged, can be visually unattractive with possible impacts to setting of designated landscape, archaeological/cultural heritage features. Best practise maintenance management can mitigate this.</p>	
4	The mouth of the Polmear Stream requires occasional clearance of sand to reduce flood risk to development upstream.	Ensure sediment removed from the Polmear Stream is retained with in the Par Sands beach-dune system.		<p>SEDIMENT MODIFICATION</p> <ul style="list-style-type: none"> Beach Recycling and Reprofilling (see STABILISATION). 	Short term		The stream is occasionally blocked from sand moved by tides, not from windblown sand. Return sand cleared from the mouth of the Polmear Stream back to the beach, to ensure the sediment remains in the system and to reduce flood risk upstream. Supports other stabilisation measures at this site.	<p>SEDIMENT MODIFICATION</p> <p>Beach recycling/profilling has the potential to impact BAP habitat. Sediment should be carefully recycled to areas away from BAP habitat to prevent smothering.</p> <p>The presence of plant on the beach may cause disturbance to birds and other potential protected species present.</p>	<p>Beach recycling / reprofilling</p> <p>Cost: medium, (medium maintenance)</p>
5	Beach levels vary regularly over short periods of time. Monitoring as part of the South West Regional Coastal Monitoring Programme does not occur frequently enough to detect these rapid variations. Monitoring has also only been occurring consistently since 2007 so longer-term trends are not necessarily apparent in the available data. Continuation of monitoring is needed. The extent/coverage of monitoring and the frequency with which it occurs could both be increased to ensure it provides sufficient information covering both the beach and sand dunes to inform future management decisions.	Ensure existing coastal monitoring is continued, modified as necessary to provide greater coverage and frequency of survey to provide greater levels of data to inform future management decisions.	Monitoring by the South West Coastal Monitoring Programme since 2007.	<p>MONITORING</p> <p>Monitoring Schemes</p>	Short term	Specify locations, landward extents pf profiles and frequency of beach profiles required. Landward limited particularly important to define dune extent being monitored.	<p>Requires ongoing commitment from coastal monitoring programme (funded nationally) and council.</p> <p>Increased extent (beach and dunes) and frequency of surveys (including post storm) will help understand dune and beach behaviour, monitor the performance of management methods and inform future management decisions.</p> <p>Different survey techniques could be employed, including LiDAR, photography and laser scanning.</p>	<p>MONITORING</p> <p>Will inform management decision that can assist in the promotion of these features to ensure a positive long term impact on designated sites and BAP habitat.</p>	<p>The regional coastal monitoring programme is funded nationally by Government. Funding for the next 5 years (to 2021/22) has recently been committed.</p> <p>Monitoring</p> <p>Cost: medium, (high maintenance)</p>
6	Access by visitors through the dunes using non-defined access routes causes trampling of dune vegetation and erosion of the dunes. Pressure for more formalised access which could create a liability in a shifting dune system.	Minimise dune erosion caused by human access.		<p>ACCESS MANAGEMENT</p> <ul style="list-style-type: none"> Zoning Boardwalks Control Fencing <p>PUBLIC AWARENESS</p>	<p>Short term</p> <p>Short term</p>		<p>Restricted routes, designated pathways (boardwalks), formalised routes, fenced off areas and clear information signage in the dunes are all technically feasible.</p> <p>Would restrict access to areas currently experiencing trampling and</p>	<p>ACCESS MANAGEMENT</p> <p>Positive impact to BAP habitat from access management.</p> <p>Possible impact to coastal path, access route and beach hut use.</p>	<p>Zoning</p> <p>Cost: medium, (high maintenance)</p> <p>Boardwalks</p>

ID	Issue Description	BDMP Objective for Issue	Current Management Practice related to issue	Sand Dune Management Category and Technique (identified from the Sand Dune Management Preliminary Decision Assistance Tool (Halcrow, 2009); UPDATED 2015)	Short (0-20 years), Medium (20-50 year) or Long Term (50-100 years) Action	Comments / Additional Categories / Techniques To Be Investigated	Technical Appraisal of Options	Environmental Appraisal of Options	Economic Appraisal of Options
				<ul style="list-style-type: none"> Signs and Display Boards, Guided Walks, Public Talks, Interpretative Leaflets, Wardens and Visitor Centres 			<p>help re-stabilisation and allow natural process to continue, maintaining the dunes as a flood defence.</p> <p>Careful placement of beach huts and associated access routes to avoid damage to the dune system.</p> <p>Would require ongoing commitment to maintain safe access routes, signage etc.</p>	<p>Advantages: natural processes can continue; eroded areas are able to recover; zoning limits trampling and erosion to zoned pathways and boardwalks encourage use of designated paths.</p> <p>Disadvantages: Existing access routes may need to be redirected or closed; relocation of access routes and SW coastal path needs to be considered carefully as not to impact on other designated features/BAP habitat; may impact upon natural dune processes</p> <p>PUBLIC AWARENESS</p> <p>Environmental education provided by the public awareness campaign may help to promote conservation of the dunes which would promote recovery resulting in a positive impact to designated site features and BAP habitat allowing natural processes and recovery. Positive impact on setting of landscape, archaeological and cultural. If ignored however, dune erosion will continue.</p>	<p>Cost: medium, (medium maintenance)</p> <p>Control fencing</p> <p>Cost: low, (medium/high maintenance)</p> <p>Signage/boards</p> <p>Cost: low, (high maintenance)</p>
7	The seasonal increase in the amount of litter on the beach, related to increased visitor numbers, and dog fouling within the dunes is an issue. Manual beach cleaning and a number of bins are provided at the site to address this issue though bin locations/numbers could be reviewed.	Reduce impact of human activity causing pollution of the natural environment.	Manual beach cleaning occurs. Litter bins are provided.	<p>ACCESS MANAGEMENT</p> <ul style="list-style-type: none"> Zoning Boardwalks Control Fencing <p>PUBLIC AWARENESS</p> <ul style="list-style-type: none"> Signs and Display Boards, Guided Walks, Public Talks, Interpretative Leaflets, Wardens and Visitor Centres <p>MANUAL MAINTENANCE</p> <ul style="list-style-type: none"> Beach cleaning Ranger/warden Friends of the dunes group. 	<p>Short term</p> <p>Short term</p> <p>Short term</p>		<p>Designated pathways (boardwalks) through the dunes would be technically feasible, and should be designed to have minimal impact on natural processes. Would also help to stabilise dunes.</p> <p>Signage to educate and increased waste provision (refuse and dog bins) / carefully located to start addressing the issue in the short term. Beach / dune rangers would reinforce the message during the summer months.</p> <p>Potential to make use of local interest groups.</p> <p>Would however require ongoing commitment to maintain fences, signage, management of activities etc.</p>	<p>ACCESS MANAGEMENT</p> <p>Positive impact to designated site features and BAP habitat from access management.</p> <p>Advantages: natural processes can continue; eroded areas are able to recover; zoning limits trampling and erosion to zoned pathways and boardwalks encourage use of designated paths.</p> <p>Disadvantages: Existing access routes may need to be redirected or closed; relocation of access routes and coastal path needs to be considered carefully as not to impact on other designated features present; may impact upon natural dune processes;</p> <p>Possible impact to coastal path</p> <p>PUBLIC AWARENESS</p> <p>Environmental education provided by the public awareness campaign may help to promote conservation of the dunes which would promote recovery resulting in a positive impact to designated site features and BAP habitat allowing natural</p>	<p>Zoning</p> <p>Cost: medium, (high maintenance)</p> <p>Boardwalks</p> <p>Cost: medium, (medium maintenance)</p> <p>Control fencing</p> <p>Cost: low, (medium/high maintenance)</p> <p>Signage/boards</p> <p>Cost: low, (high maintenance)</p> <p>Beach cleaning</p> <p>Cost: low, (high maintenance)</p> <p>Rangers</p> <p>Cost: Medium (high maintenance)</p>

ID	Issue Description	BDMP Objective for Issue	Current Management Practice related to issue	Sand Dune Management Category and Technique (identified from the Sand Dune Management Preliminary Decision Assistance Tool (Halcrow, 2009); UPDATED 2015)	Short (0-20 years), Medium (20-50 year) or Long Term (50-100 years) Action	Comments / Additional Categories / Techniques To Be Investigated	Technical Appraisal of Options	Environmental Appraisal of Options	Economic Appraisal of Options
								<p>processes and recovery. Positive impact on setting of landscape, archaeological and cultural. If ignored however, dune erosion and littering will continue.</p> <p>MANUAL MAINTENANCE</p> <p>Positive long term impacts to designated site features, BAP habitat and landscape/cultural heritage features. Best practise methods are required to prevent possible trampling impacts during beach cleaning operations within zoned areas.</p>	
8	Within the western part of the dunes is a historic landfill site. Should the dunes erode in the future then this will cause an environmental issue.	Ensure historic landfill within the dunes is not exposed to erosion risk.		<p>STABILISATION</p> <ul style="list-style-type: none"> Planting (and to prevent access to planted/ thatched areas) Thatching (and to prevent access to planted/ thatched areas) Mulching/ Matting/ Sand Binders Control Fencing (see also ACCESS MANAGEMENT) 	Short/Medium term	Consider when appraising options.	<p>Maintain and enhance the robustness of the dunes by using stabilisation / sand entrapment measures if required. Dune stabilisation methods in the medium term under MR would help address erosion issues and maintain the dunes as flood defence to the backshore.</p> <p>Stabilisation methods would need to allow the continued interaction between the dunes and beach, allowing natural processes to continue. Natural forms of stabilisation, such as planting, thatching, mulching, matting and sand binders would allow this. Fencing has also worked well in the past.</p>	<p>STABILISATION</p> <p>Long term positive benefits to improvement of designated site features and BAP habitat. Assuming native plants are used and represent species on site.</p> <p>Possible impacts from stabilisation works on designated/protected species, although can be mitigated by best practice methods being applied.</p> <p>Positive impact to designated site features and BAP habitat from access management fencing.</p>	<p>Planting</p> <p>Cost: low/medium, (medium maintenance)</p> <p>Thatching / Mulching etc</p> <p>Cost: low, (high maintenance)</p> <p>Control fencing</p> <p>Cost: low, (medium/high maintenance)</p>
9	The Shoreline Management Plan policy is for No Active Intervention to occur in the short term (as the dunes are considered to be in a stable condition requiring no management for the purpose of flood risk management. However, the policy is to transition to one of Managed Realignment in the medium to long term, reflecting the likely impacts of sea level rise to result in pressure on the dunes to rollback landwards onto the backing low-lying land. This policy means that there will be potential for some funding to be forthcoming for coastal flood and erosion risk management (e.g. dune management) from central Government. However, it is likely that partnership funding will be needed to fulfil all of the required funding for such activities.	Ensure future management of the area is in line with SMP policy and identify potential funding streams to enable economically sustainable beach and dune management to occur.	Friends of Par Beach group exists and may be a suitable forum to take forward future integrated, sustainable management of the beach and dunes.	<p>FUNDING</p> <ul style="list-style-type: none"> Seek funding from Environment Agency Seek funding from Local Authority Seek funding from sole private source Seek match funding (government+ private) <p>ADAPT BACKSHORE MANAGEMENT/USES</p> <ul style="list-style-type: none"> Adapt Backshore Management/ Uses 	Short term Medium term	Make sure management options assessed comply with SMP policy	<p>MR in the medium to long term may require adaptation of backshore uses, namely relocation of car parks, access road and parts of the leisure park to allow dune rollback (implementation will be dependent on local planning policy and landownership).</p> <p>Natural process would be allowed to continue combined with stabilisation measures if required, to maintain the dunes as the primary flood defence. SMP Policy is MR medium to long term, so some funding for beach or dune management activities related to managing coastal flood/erosion risk is likely to be available.</p> <p>Funding for activities beyond FCERM will need to be derived from other non-FDGIA sources (i.e. private/non-FDGIA sources). A funding</p>	<p>FUNDING</p> <p>An increase in funding could be beneficial if allocated towards the positive long term impact on protection of designated sites, BAP habitat, and setting of landscape and cultural heritage features</p> <p>ADAPT BACKSHORE MANAGEMENT/USES</p> <p>Impact to car parks, access road and parts of leisure park from rollback/removal</p> <p>Long term positive benefits to designated features/BAP habitat through encouraging natural processes.</p> <p>Possible impact to coastal path</p> <p>Relocation of car parks, access road and parts of leisure park would require careful consideration of</p>	<p>SMP2</p> <p>Relocation of car park access road and leisure park</p> <p>Costs not specifically included in the SMP2, but likely to be Medium to High.</p>

ID	Issue Description	BDMP Objective for Issue	Current Management Practice related to issue	Sand Dune Management Category and Technique (identified from the Sand Dune Management Preliminary Decision Assistance Tool (Halcrow, 2009); UPDATED 2015)	Short (0-20 years), Medium (20-50 year) or Long Term (50-100 years) Action	Comments / Additional Categories / Techniques To Be Investigated	Technical Appraisal of Options	Environmental Appraisal of Options	Economic Appraisal of Options
							partnership could be established for this purpose.	impact to designated ecological features (in particular for birds) in new location and impact on landscape, archaeological and cultural heritage features.	
10	UK Biodiversity Action Plan Priority Habitats (coastal sand dunes, reed beds, mudflats and sandflats) generally in unfavourable condition. This includes need to remove non-native invasive species within the dune vegetation.	Improve condition of UK BAP priority habitats. Remove non-native invasive species		<p>ECOLOGICAL MODIFICATION</p> <p>Maintain existing condition through for example:</p> <ul style="list-style-type: none"> Regular cutback of vegetation. Maintaining defences that control water levels. Allowing coastal processes to continue on maritime cliff/slope. <p>Improve existing condition through for example:</p> <ul style="list-style-type: none"> Removal of non-native invasive species within the dune vegetation. Planting with additional vegetation, such as marram grass 	Short term		<p>Improves existing ecological health of the dunes which is important in working with natural processes to provide coastal flood and erosion risk management with the aid of sand dunes.</p> <p>Removal of some vegetation may make 'uncontrolled' access more problematic (i.e. non-native vegetation hinders access in places) and so needs to be undertaken in combination with access management measures.</p>	<p>ECOLOGICAL MODIFICATION</p> <p>Positive long term impact to improvement of designated features and BAP habitat</p> <p>Possible impact from removal of non-native species and cut back of vegetation to possible protected/rare ecological species that may be present. Although can be mitigated by best practice methods being applied.</p>	<p>Vegetation cut-back / removal</p> <p>Cost: Low, (high maintenance)</p> <p>Planting</p> <p>Cost: low/medium, (medium maintenance)</p>
11	Future beach and dune management needs to consider the environmental impacts on a small number of designated features, including: <ul style="list-style-type: none"> Par Beach and St Andrews Road LNR. Cornwall AONB. 	Ensure the identified environmental features are considered in management decisions for future coastal flood and erosion risk management.		No techniques contained in dune management preliminary decision assistance tool for this aspect. Appraisal of environmental impacts on difference features have different requirements depending upon the nature of the designation, and environmental appraisal should always be undertaken when considering management options.		Consider the impact of potential future management measures on designated features in this options assessment.	N/A	<p>Environmental appraisal of options is provided above.</p> <p>Consideration is required for:</p> <ul style="list-style-type: none"> Par Beach and St Andrews Road LNR (dune system, open water lagoon, reed beds, rare plant species, overwintering birds and birds in passage. Falmouth Bay to St Austell BAP pSPA (wintering birds and diving birds). Future plans or projects will require an HRA to confirm no likely significant effect. BAP Habitat (coastal sand dunes, dune grassland, reed beds, mudflats and sandflats not covered by seawater at low tide) Cornwall AONB Archaeology and cultural Heritage (Menabilly Registered Historic Park and Garden, Wayside Cross scheduled Monument and listed buildings) SW Coastal Path. 	N/A

2.2 Options Summary

Par Sands is a wide sandy beach backed by healthy sand dunes, which provide an important flood defence function for the low lying land to the north. The beach and dunes, which have been accreting over the past 50 years, form part of a designated Local Nature Reserve (LNR) and Cornwall Nature Conservation Site, and are bordered to the west by the Par River and to the east by Polmear Stream. Both these watercourses have basic rock training works to control their migration across the beach. The caravan park, located behind the dunes, is a popular recreation attraction for both tourists and locals. An area of historic landfill is situated in the dunes to the west, and there are a number of beach huts located within the dunes, however, the number is steadily decreasing. The hinterland is in multiple ownership. Par Sands is managed by Cornwall Council, however, the wetland in the vicinity of the stream is managed by the Local Nature Reserve together with the group, Friends of Par Beach.

In the past, dune restoration has been undertaken using wooden fences to trap sand and build up the dunes in areas of breach, however the buried fencing later became a hazard to walkers. Other current management practices include the manual removal of litter, raking of seaweed to the western end of the beach, fencing of older dunes to prevent access and the construction of ramps to provide disabled access. Habitat management is also undertaken.

The SMP policy for Par Sands is No Active Intervention (NAI) in the short term, transitioning to Managed Realignment (MR) in the medium to long term. In the short term, under a NAI policy there would likely be no public funding for flood or erosion risk management unless a case can be made to transition to the MR policy – this will need to be informed by ongoing monitoring. Under a MR policy in the medium to long term, some funding for beach or dune management activities related to managing coastal flood/erosion risk is likely to be available. However, funding for activities beyond FCERM will need to be derived from other non-FDGIA sources (i.e. private/non-FDGIA sources).

Even in the short term under NAI policy, some form of dune stabilisation for ‘access or safety management’ may be acceptable to, for example, ensure historic landfill within the dunes is not exposed and to address erosion of the River Par dune bank. Natural forms of stabilisation, such as planting, thatching, mulching, matting or sand binders, combined with fencing and signage, would allow natural processes to continue, help retain sand on the dune system, and assuming native plants are used, could have long term positive effects on BAP habitats. Although these are relatively low cost measures, they would require ongoing commitment to management and maintenance. Clearance of sand at the mouth of the Polmer Stream may also be acceptable to reduce flood risk upstream. Removed sand should be placed back to the beach, to areas away from BAP habitat, but ensuring that the sediment remains in the system.

The frequency of ongoing monitoring by the regional coastal monitoring programme could be increased or supplemented by local inspection to include post-storm events/post-winter surveys and provide greater coverage (beach and dunes). This will provide information for later management decisions to inform of any patterns in beach and dune erosion.

Trampling of the dunes has previously been a problem which has been overcome through access management and at present manual cleaning is undertaken to remove litter. Ongoing maintenance of these access routes will help minimise dune erosion through human activity, reduce litter problems, encourage dune stabilisation and have positive impacts to BAP habitat. Increased refuse and dog bin provision combined with education signage will help address the issue of littering and dog fouling. Currently, BAP habitat is in unfavourable condition. Removal of non-native invasive species will improve the condition of designated features, however, best practice methods should be used to minimise impacts of protected species.

The holiday park located on the low-lying land behind the dunes will hinder the ability for natural dune rollback to occur in the future. To maintain the flood defence function of the beach and dune system, and reduce risk of flooding to low-lying land, the dune and beach system needs to be able to roll-back naturally. Under a MR policy in the medium and long term, coastal adaptation measures involving the relocation of existing development and car parks will be required to allow natural processes to occur and lead to positive benefits to designated features and BAP habitat, while avoiding any impact on features

elsewhere. The trigger for rollback will be when assets are assessed as being at imminent risk of loss to erosion (Halcrow, 2015), guided by ongoing monitoring. However, at Par Sands, rollback will need to be planned for at the earliest opportunity and the work on implementation will be over a longer period of time to reduce flood risks. Coastal adaptation will require longer term land use planning with relevant land owners and authorities. Implementation will likely require development of Coastal Change Management Areas by the planning authority in line with National Planning Policy Framework.

To feed into Stage 4, the management options discussed here have been divided into short, medium and long term interventions in Table 2.2 below. The short, medium and long terms indicated below, reflect the three SMP epochs (0-20 years; 20-50 years and 50-100 years) to help focus management actions in line with the SMP.

Table 2.2 Short, medium and long term management options for Par Sands

Short term
Adapt backshore (relocation of assets)
Dune stabilisation (planting, thatching, mulching, control fencing)
Access management (zoning, boardwalks, control fencing)
Public awareness (signage, wardens)
Manual maintenance (beach cleaning, rangers/wardens)
Sediment Modification (sand recycling, reprofiling)
Monitoring
Funding
Ecological modification (vegetation cut-back)
Medium term
Dune stabilisation (planting, thatching, mulching, control fencing)
Adapt backshore (relocation of assets)
Access management (zoning, boardwalks, control fencing)
Morphological modification (dune fencing, planting)
Long term
Dune stabilisation (planting, thatching, mulching, control fencing)
Adapt backshore (relocation of assets)
Access management (zoning, boardwalks, control fencing)
Morphological modification (dune fencing, planting)

3 References

- CH2M (2015a). *Stage 1 Report: Par Sands*. Report produced as part of the Cornwall Beach & Dune Management Plans project for Cornwall Council, June 2015.
- CH2M (2015b). *Stage 2 Report: Issues and Objectives*. Report produced as part of the Cornwall Beach & Dune Management Plans project for Cornwall Council, September 2015.
- Halcrow (2015). *Coastal Change Adaptation Planning Guidance*. East Riding of Yorkshire Council, August 2015.
- Halcrow (2009). *Cornwall Sand Dune and Beach Management Strategy*. Report produced by Halcrow Group Limited for the Cornwall and Isles of Scilly Coastal Advisory Group, September 2009.
- Royal Haskoning (2011). *Cornwall and Isles of Scilly Shoreline Management Plan Review (SMP2): Final Report*. Report produced by Royal Haskoning for the Cornwall and Isles of Scilly Coastal Advisory Group, February 2011.

Appendix E
Site Actions Summary Map



Visual condition inspection should assess:

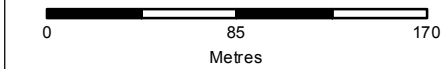
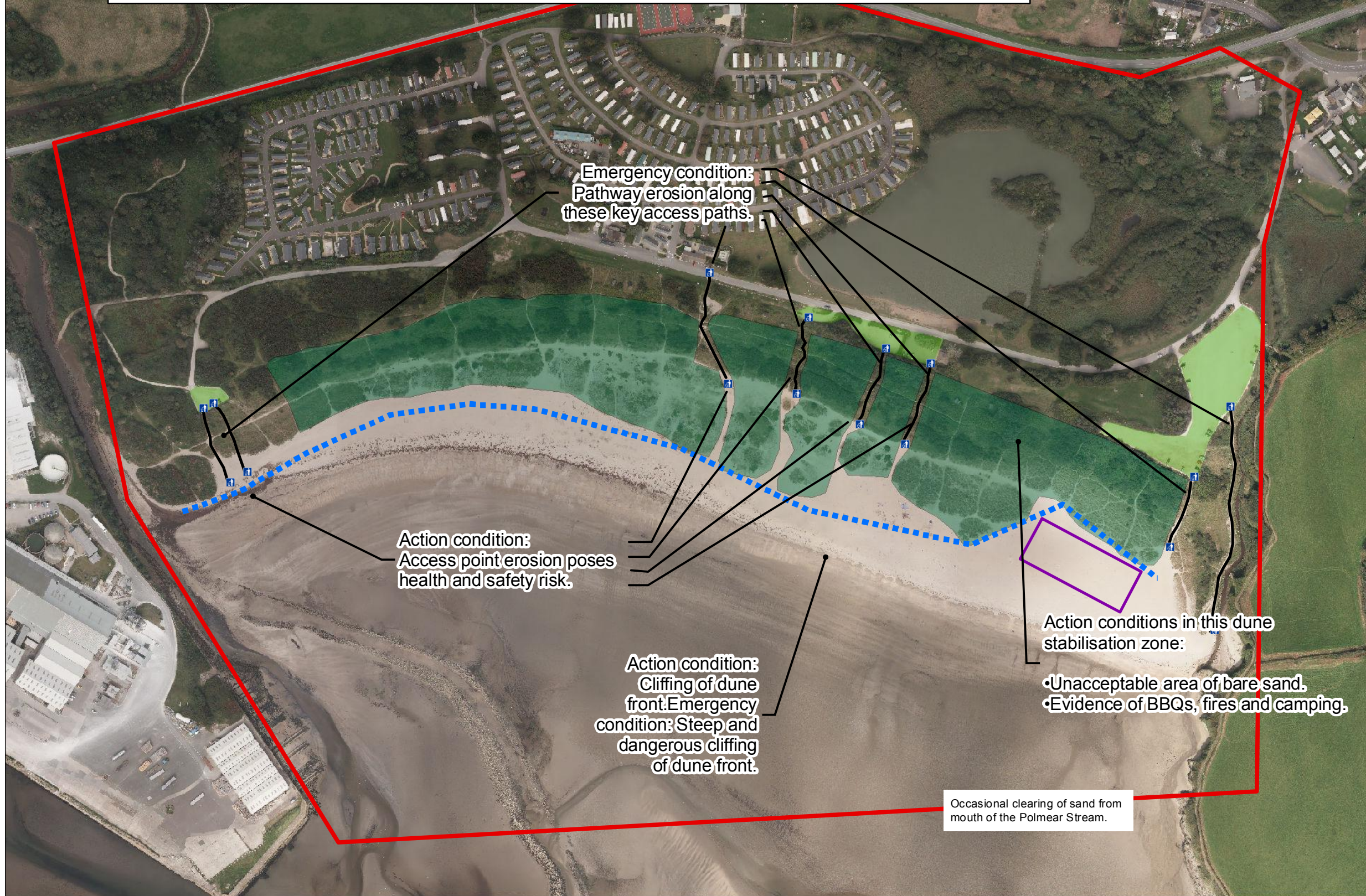
- General condition of beach, dune and other assets.
- Barbeque debris and litter.
- Damage to information signs.
- Damage to fencing and information signs.
- Number of and size of bare sand areas within dune stabilization zone.
- Erosion along access routes.
- Any structures which need repair such as boardwalks or fencing.
- Growth and spread of vegetation in planted areas if implemented.
- Vegetation coverage and condition within dune stabilization zone.
- Distribution and abundance (i.e. increase/decrease) of invasive species.
- Embryo dune formation at the dune toe.
- Consideration of whether or not trigger levels have been reached (see also overleaf and/or Section 4.4.2 of BDMP).

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Legend

- Key locations to ensure adequate signage and litter bins are in place
- Dune Front
- Key access paths through dunes to encourage use of and thus focus access management on
- Area to place sand cleared from mouth of Polmear stream
- Car park areas for beach users
- Zone in which dune stabilisation and ecological modification measures most likely to be required in



Rev	By	Chkd	Apprvd	Date	Description



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Project :
 Cornwall Sand Dune and Beach Management Strategy

Drawing :
 Par Sands

Drawn By : Ruby Simmons Date: 26/09/2016
 Checked By : Emily Hewitt Date: 26/09/2016
 Approved By : Alan Frampton Date: 26/09/2016

Drawing No. : Revision
 A

Drawing Scale : 1:3,383

ACTION CONDITIONS AND RESPONSES FOR PAR SANDS

Criteria	Response
Unacceptable area of bare sand	
<ul style="list-style-type: none"> Area is of significant size and/ or depth to cause concern and is unlikely to recover without management. Area of bare sand has been present for more than one year without recovering. Area of bare sand is increasing in size. 	<ul style="list-style-type: none"> Fence off bare sand areas to prevent access and enable recovery. If vegetation does not establish following fencing, and area of bare sand is of concern, implement dune stabilisation planting following discussion with Natural England. Implement rotation of access routes to aid recovery.
Access Points eroded to a level at which they cause a health and safety risk.	
<ul style="list-style-type: none"> Access points eroded to form a high step which is not safe for pedestrians and is at high risk of causing injury. Access point has been eroded to form a steep cliffed step for more than one season. Erosion is continuing and access is becoming more difficult and/or a greater health and safety risk. 	<ul style="list-style-type: none"> Construct boardwalks or steps along eroded access paths. Consider re-routing pathways away from the eroded area where possible. Fence off and stabilise the eroded access route to enable it to recover.
Missing Management Infrastructure	
<ul style="list-style-type: none"> Infrastructure removed or damaged by beach users such as; signage removed or vandalised, planks taken from board walks, fencing removed. Due to missing infrastructure beach management measures are impaired. Trend is continuing with more infrastructure being removed or damaged by visitors. 	<ul style="list-style-type: none"> Assess why management has been damaged/ removed and whether an alternative form of management would be more successful. Replace missing infrastructure with the same or an improved form to enable management measures to be effective. Implement/ increase educational signage and leaflets and ensure liaison with beach users and local instructors to encourage visitors to consider the need for dune management and the implications of damaging/ removing management techniques. Implement/increase presence of dune warden.
Evidence of barbecues, campfires and camping within exclusion zones	
<ul style="list-style-type: none"> Debris indicates numerous barbecues and/or camp fires are being held on the dunes (e.g. more than 3). Camping within the dunes is observed. Evidence of barbecues, camping and campfires over a period of three months or more. Number of barbecues, people camping and campfires being held is consistent or increasing. 	<ul style="list-style-type: none"> Implement/increase presence of dune warden. Provide barbecue zone for permitted barbecues. Ensure clear educational signage is visible stating that these activities are not allowed.
Cliffing of dune front	
<ul style="list-style-type: none"> Cliffing of the dune front as a result of wave action is at a height that can cause a health and safety risk and is present along a significant length of frontage which cannot be easily avoided by visitors. Cliffing of the dune front has been present for more than one season and hence is not likely to be a post storm response followed by recovery during calmer conditions. Cliffing is becoming steeper and higher as erosion continues with no sign of recovery. Cliffing erodes dune back to a point where there is an imminent risk of loss of assets. 	<ul style="list-style-type: none"> Ensure monitoring of dune front is carried out to provide information on trends in the dune front position and to monitor whether cliffing worsens to emergency state. If erosion of beach and dunes is a consistent issue, commission study to assess whether beach nourishment or another soft engineering solution is justified. Fence off area that forms a health and safety issue and apply dune stabilisation measures such as planting to reduce instability and make the dunes more resilient against erosion. Most suitable if significant storm conditions are not predicted in the immediate future and dune front is not exposed to constant wave action. If assets are deemed to be at imminent risk of loss, implement coastal adaptation measures (to be defined in CCMA that Cornwall Council is to produce).

EMERGENCY CONDITIONS AND RESPONSES FOR PAR SANDS

Criteria	Response
Steep and dangerous cliffing of dune front	
<ul style="list-style-type: none"> Cliffing of the dune front leads to unstable dune front, possible with an overhang, which causes a health and safety issue. Steep dangerous cliffing present during tourist season when high visitor numbers predicted. 	<ul style="list-style-type: none"> Re-profiling of the beach and/or dunes. Bulldozers can be used to move sand from lower down the beach to eroded areas, to remove dangerous overhangs from the cliffed dune face or to make the dune face less steep. The requirement for this should be carefully assessed to ensure economic justification and minimum damage to the dune system. Fence off dangerous areas until a solution is implemented or the dune face readjusts.
Pathways eroded leading to erosion of dune system and unsafe pathways	
<ul style="list-style-type: none"> Pathways eroded to form a very steep path or significantly cliffed path which causes significant health and safety risk to beach users such as the elderly or children. Access point/ pathway has eroded to the magnitude stated when beach visitor numbers are significant. 	<ul style="list-style-type: none"> Re-route access pathways to avoid eroded areas using fencing and signage. Fence off eroded areas to enable recovery with planting and dune stabilisation methods applied as necessary. If erosion is close to beach, and sand is available, carry out re-profiling of pathway by adding sand to eroded areas to remove unsafe cliffing and large steps.
Missing or Damaged Management Infrastructure	
<ul style="list-style-type: none"> Infrastructure removed or damaged by beach users resulting in management techniques being ineffective such as: <ul style="list-style-type: none"> signage removed or vandalised, planks taken from board walks fencing removed. Infrastructure lost or damaged during peak season when high visitor numbers are forecast. 	<ul style="list-style-type: none"> Replace or repair management infrastructure as soon as possible to ensure effective management can continue. Increase presence of dune warden.