Geo Factsheet

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COASTAL DEPOSITION

Introduction
Almost 20% of the world's coastlines are depositional in nature. Deposition generally occurs in low energy environments where the effects of waves, storms and tides are much reduced. Sediment input from rivers and the presence of coastal currents tends to trigger deposition locally. A range of coastal features result from these processes – these include landforms such as beaches and spits together with sand dune and saltmarsh ecosystems. Scientists' views on how some depositional landforms have evolved are changing and with 70% of coasts worldwide currently suffering net erosion, managing these depositional environments sensitively is seen as a pressing problem, especially against a background of global rise in sea level.

Low energy environments and deposition
Deposition occurs when there is insufficient energy to move sediments further. In low energy environments, factors such as wave and wind direction, the supply of sediment and the depth of water are often significant. Large depositional landforms are only found where the tidal range is less than 3 metres.

Four physical features occupy these environments, often occurring together *(see Fig. 1)*:

- Many beaches are 'swash-aligned' forming when waves break parallel to the coast. **Bay beaches**, such as those along Dorset coast, **bay bars** (Looe, Bare near Porthleven, in Cornwall) and **barrier beaches**, like Start Bay (Devon) may have similar origins.

- 'Drift-aligned' beaches form when **longshore drift** moves material down the coast producing a range of partly detached features. **Spits** like that at Orford Ness (Suffolk) are created in this way.

- **Sand dunes** form when dry material from flat, open beaches is blown inland. Dunes migrate and a succession of plants colonise and adapt to this environment forming a dune or **psammosere** ecosystem *(see Geo Factsheet, Sand Dunes No 119)*.

- **Mudflats** and **salt marshes** (halosere ecosystem) are formed of finer material which **flocculates** (sticks together) in the shallow water of estuaries. Here plants adapt to salt water and tidal conditions *(see Geo Factsheet, Salt Marshes 124)*.

The coastal system
The coastal (or beach) system is an **open system** into which rivers input large amounts of sediment (perhaps 70% of beaches are from this source). Other inputs come from terrestrial and marine coastal erosion. Currents may move sediments along the beach whilst the swash and backwash of the waves can move them in- or off-shore. Beaches are the **stores** of material with spits and dunes acting as **sinks** *(see an example of a littoral cell in 'The Holderness Coast', Geo Factsheet No 141)*. Where there are few losses and outputs, the system is said to be in **dynamic equilibrium**.

Fig. 2 The coastal system.

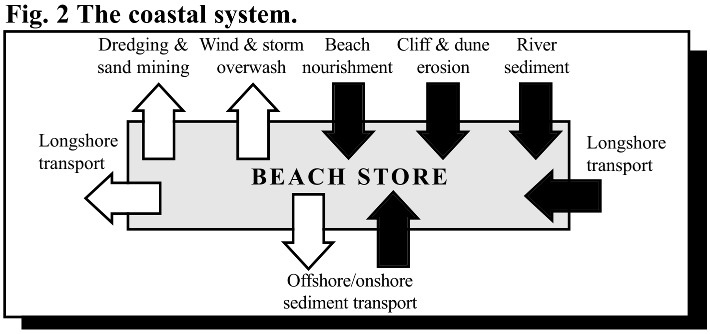


Fig. 1 Typical combination of depositional features in the Mawddach estuary, Wales.

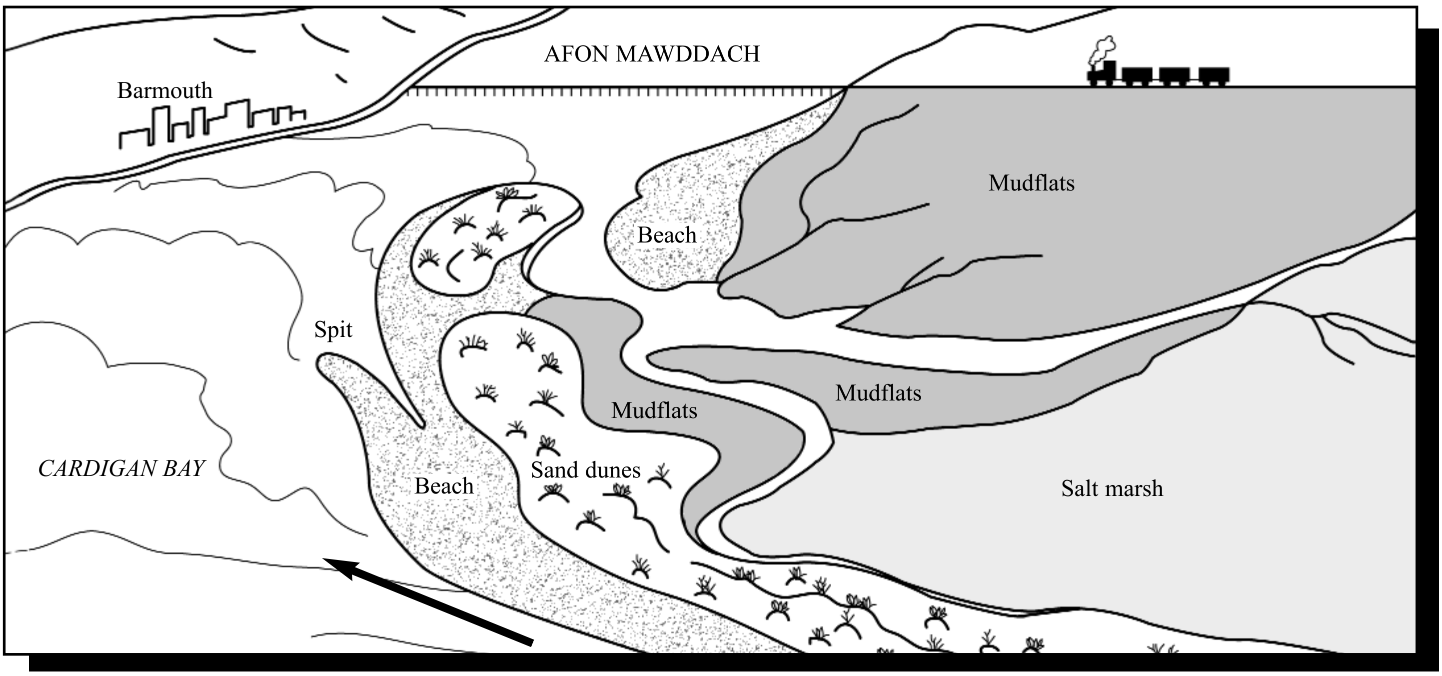
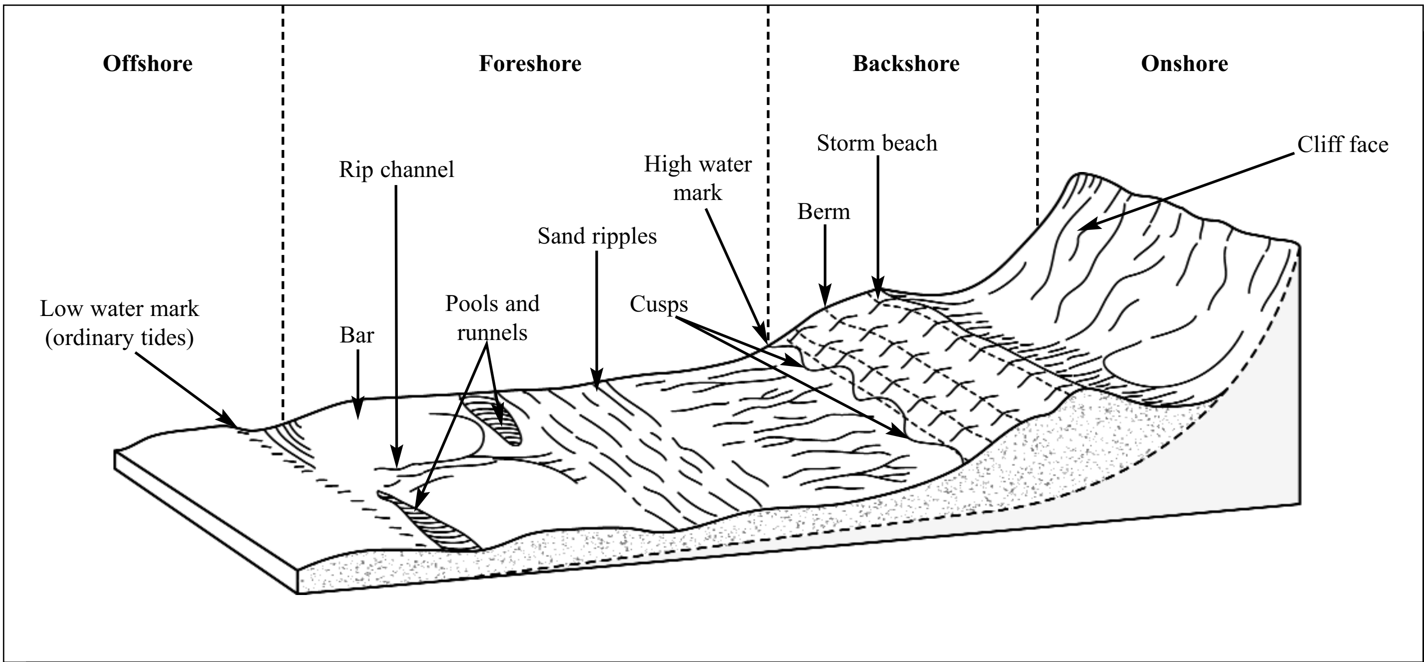


Fig. 3 The zones and characteristic features of a beach.



How are beaches shaped by deposition?

Beaches occur in the littoral zone between low and high tide. **Constructive waves** with their strong swash and weak backwash allow a net increase of material. These waves are flatter and smaller than destructive waves and material 'spills' forwards building up the beach, whilst the water often percolates into the beach. In addition to these **swash** processes, **beach drift**, caused by longshore currents, may move material laterally along the shoreline.

Many beaches form in bays, where there are more sheltered conditions and shallower water. Others are found in a range of situations where their shape and gradient (profile) vary considerably, as does the calibre of material in them. Despite variations in energy, waves, currents and sizes of material, many beaches do seem to have similar features.

A clear pattern of micro-features is seen as you progress up the beach often leading to cliffs or sand dunes onshore *(see Fig. 3 above)*. These features and the processes involved in forming them provide a variety of opportunities for fieldwork investigation *(see the results in Table 1, page4)*.

At the lower edge of beaches, sand accumulates to form **longshore bars**, parallel to the waves. This material has probably been combed from the beach by plunging (destructive) waves. Breaks in these ridges result from rip currents which form in the strong backwash. Inland of these, **runnels** form, separating pools of standing water at low tide. As the slope of the beach increases, small **ripple** marks appear, made as the tide moves over the beach. A network of temporary drainage channels may also appear here in finer, sandy beaches.

Material at the top of the beach is of a larger calibre and this supports steeper concave slopes. **Beach cusps** occur where this coarser material is absorbing wave swash. Large waves reaching the high tide limit build up ridges or **berms**. Beyond the foreshore, the most landward feature is the **storm beach** which will consist of larger pebbles and even boulders. This forms only in the high-energy conditions of a surge or a spring tide.

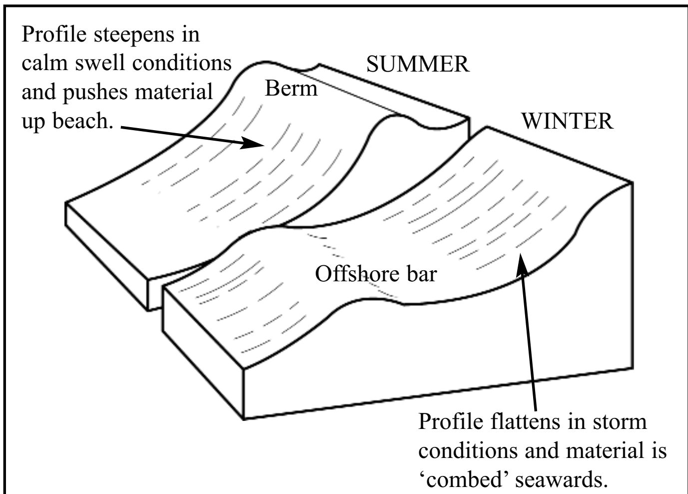
Beach profiles show marked short-term and seasonal change. This **sweep zone** variation is often related to the type of waves involved.

Beach fieldwork

Beach fieldwork can produce valuable data and lead to interesting and rewarding coursework reports. Details of how to carry out beach fieldwork can be found in *'Fieldwork Investigations' (Curriculum Press)*. It is very important to carry out a risk assessment before beginning any fieldwork and to be very careful throughout.

Some useful research ideas include:
- Is there a link between beach profiles and the size of beach material?
- How do beach materials vary in size and shape?
- How and why do infiltration rates vary on a beach?
- Are materials in the east of X beach are smaller, more rounded and better sorted than those in the west?
- How far does Y beach match the characteristic features of the beach model? *(see Fig. 3)*

Fig. 4 Beach profiles adjust to different waves



How do swash-aligned beaches develop?

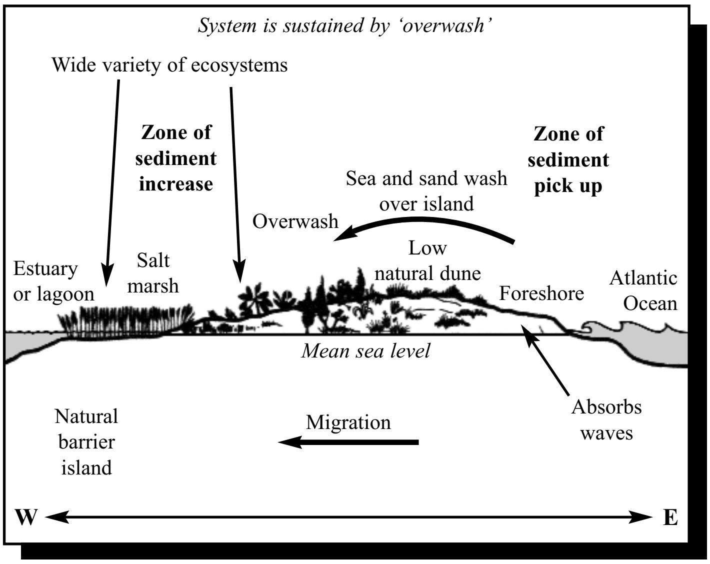
When waves break parallel with the coast, the movement of water and material is largely up and down the beach, producing features similar to those already seen in *Fig. 3*.

- ***Bay head beaches*** build up in the sheltered, low energy environments of coves. In fact, wave refraction focuses erosion on the surrounding headlands and so encourages deposition in the bay. These beaches can however be larger especially if they face directly into prevailing winds or the path of swell (good surfing) waves. Morfa Harlech (Wales) is such an example in the UK.

- ***Bay bars*** form across estuaries, blocking off rivers. Studies suggest that these features have been formed from materials offshore, driven in by waves, rather than any drift along the shore.

- ***Barrier beaches*** such as those along the eastern seaboard of the USA rely upon waves recycling offshore material. However, increasingly winds and storm waves are removing material from the foreshore and moving it inland and into the lagoons. This migration creates problems for coastal residents and businesses which have set up along the coast *(Fig. 5)*.

Fig. 5 The formation of barrier beaches (islands).



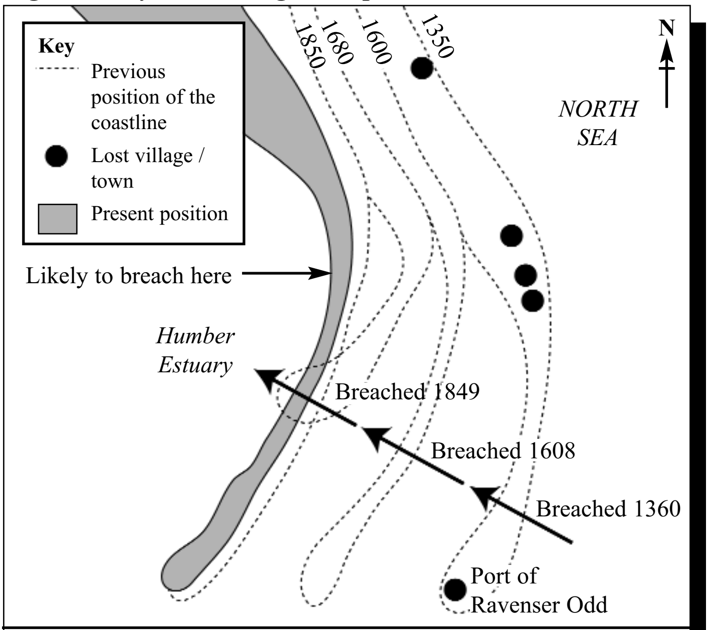
How do drift-aligned beaches develop?

Where waves approach the coastline at an angle, the swash moves material up the beach in that direction. The backwash returns at right angles. The constant repetition of this causes pebbles and sand to drift along the beach. Maximum effects occur at around a 30 degree angle. This process of longshore drift is thought to be responsible for the formation of a variety of types of **detached** features as well as beaches. These include **spits**, **bay bars**, **tombolos** and **cuspate forelands**:

- A **spit** is a long narrow extension of sand or shingle which has one end attached to the coastline and the other projecting out to sea, or into an estuary. A change in the shape of the coastline or a sudden interruption by a river estuary causes this deposition to continue offshore. Orford Ness (Suffolk) is one of the largest examples in the UK.

- **Recurved spits** are shaped by the effects of tides or local changes in wind direction. As spits migrate they may form ridges of shingle and these enable scientists to plot their growth. In the shelter of a recurved spit, mudflats and saltmarshes can develop, increasing the size of the feature. Dawlish Warren (Devon), Hurst Castle Spit (Hampshire) and Spurn Head (Yorkshire), in *Fig. 6*, have grown in this way.

Fig. 6 The cycle of changes at Spurn Head.

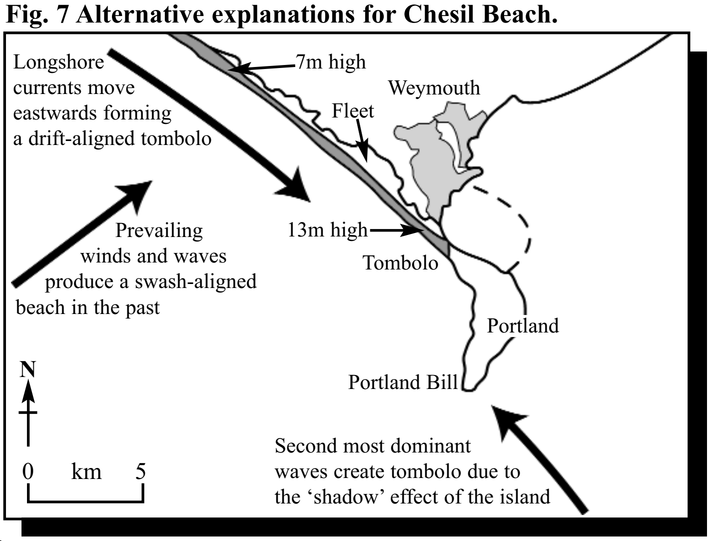


At Spurn Head, the spit is growing south-westwards into the Humber Estuary. From its root at Kilnsea to its ***distal*** *end at Spurn Point, it is currently about 6 km long - growing in length by about 10cm per year. Research shows that Spurn has a growth cycle of about 250 years. After this period of time the sea, driven by winter storms, will break through the narrow neck and cause the spit to become detached and destroyed. A number of temporary breaches have occurred during the 1990s.*

- **Tombolos** are formed when spits extend from the coast to an island. Alternatively they may form in the 'shadow' of wave refraction caused by an offshore island. Lindisfarne (Northumberland) and Loch Eriboll (Scotland) are such examples.

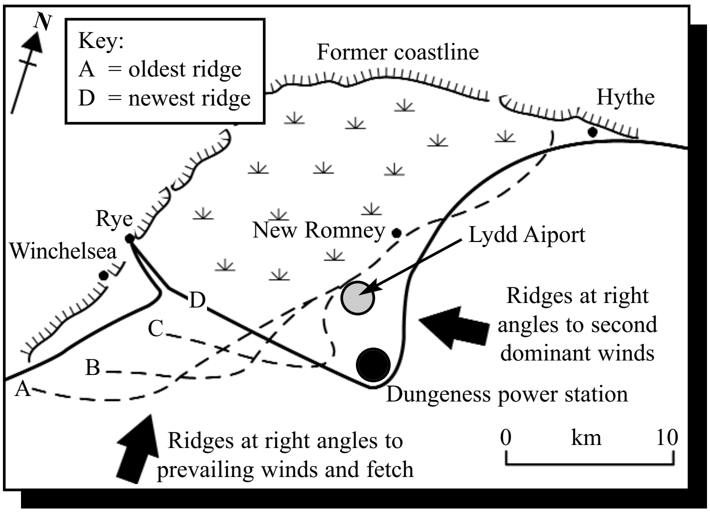
  Chesil Beach (Dorset) links the Isle of Portland to the mainland. This shingle ridge is 30 km in length and reaches up to 13 m high. Behind the beach is a lagoon or lake called The Fleet. This beach has been studied a great deal. Not only does the height of the shingle ridge increase in height eastwards, but the size of the shingle also appears to get larger - from pea-size up to cricket ball. Even smaller sediments seem to move westwards. However modern theories suggest that its origins may well be similar to those of the barrier beaches of the USA and Start Bay (Devon), particularly as Chesil Beach faces south-west (almost swash-aligned).

Fig. 7 Alternative explanations for Chesil Beach.



- **Cuspate forelands** are triangular-shaped features which may have resulted from changes in the growth and direction of spits. Dungeness in Kent is the most famous foreland in the UK and the ridges do suggest a migrating spit-like formation - but the triangular shape is less easily explained. The simple idea that forelands are formed when spits from two directions meet is rarely true. The reality of such features is almost always complex. Some of the evidence about how Dungeness has grown is shown in *Fig. 8*. Even larger versions of this landform are found along the coast of Carolina, USA.

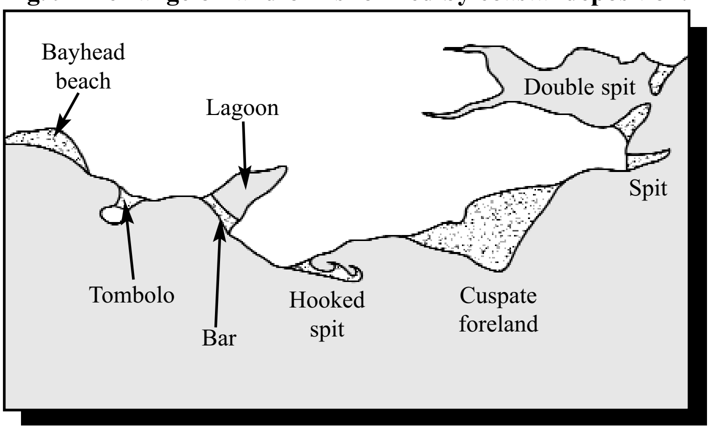
Fig. 8 How Dungeness may have formed.



Summary

Traditionally in geography, landforms which exhibit similar features have been bracketed together and given the same explanation. *Fig. 9* shows the range of features involved. Recent research suggests that we may have to revise our views of how some coastal features originated. It seems likely that many were made following the ice age, when material from offshore was progressively brought inland by wave swash, assisted by rising sea levels. Landforms such as bars, forelands, and even the tombolo at Chesil, are probably **fossil** 'swash-aligned' landforms which today are undergoing relatively minor 'drift' modification.

Fig. 9 The range of landforms formed by coastal deposition.



Further research

Bishop and Prosser (1997) Landform Systems, Collins, pages 86 - 98.
Cook et al. (2000) Geography in Focus, Causeway Press, chapter 11.
Geo Factsheets – Numbers 119 (Geography of coastal sand dunes), 124 (Saltmarshes) and 141 (The Holderness Coast).

Useful websites

www.learn.co.uk (lots of ideas inc. coastal deposition)
www.geography.learnontheinternet.co.uk

Exam Questions

1. *Fig. 1* is a sketch of coastal depositional features near the mouth of the Mawddach Estuary. Choose one of the landforms shown.
   Name of landform ____________________
   (a) Describe its physical features. *(3 marks)*
   (b) Explain how it may have formed. *(4 marks)*
   (c) Choose one of the ecosystems shown
   Name of ecosystem ____________________
   Describe two threats to it. *(2 marks)*

2. *Table 1* gives data about beach height and beach material, from a survey along a beach.

Table 1 Fieldwork data recorded along a beach.

Sites sampled in order	Height of beach (m)	Shingle diameter (cm)	Roundness index (%)
1	5.5	8.4	18
2	7.5	8.5	20
3	8.0	7.7	26
4	11.5	8.1	38
5	11.0	6.1	23
6	7.5	5.8	15
7	10.0	6.2	21
8	10.5	7.2	30
9	10.0	7.5	27
10	11.0	6.2	35
11	14.0	6.5	44
12	12.5	5.8	41
13	18.0	4.8	62
14	13.5	5.0	71
15	15.0	5.8	65

   (a) Explain how this data might have been collected using fieldwork. *(4 marks)*
   (b) Describe the trends in this data. *(3 marks)*
   (c) Explain the probable processes causing these trends. *(4 marks)*

3. Answer one of these questions: *(10 marks)*
   Either (I): Using examples, explain why beaches vary (i) between summer and winter (in the same location) and (ii) from one location to another.
   Or (II): Referring to a named stretch of coastline, suggest why there is often a range of features formed by coastal deposition.

Answer Guidelines

1. Note: Spit, beach and sand dunes are landforms.
   a. Description should include size, shape, what it's made of.
   b. Think about drawing a simple annotated diagram to help your explanation.
   c. You can choose either sand dunes or salt marsh. Be precise – avoid statements like trampling / pollution.

2. a. Be sure to cover all measurements.
   b. Do the general trends first, then look for any anomalies.
   c. Try to think of a range of processes such as wave action. Name precise processes such as attrition.

3. Try to make a brief plan and include examples:
   I (i) Think about nature of storms and then incidence.
   (ii) Think about the systems diagram and the sources of sediment supply.
   II Be careful to take a short sketch with several named features, e.g. for Holderness you could do Spurn Head in detail, the sand dunes on the spit, the Humber Estuary salt marshes, and a beach such as the managed one at Hornsea. Include an annotated sketch map.

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Curriculum Press. *Unit 305B, The Big Peg, 120 Vyse Street, Birmingham B18 6NF*
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