Weymouth Beach Management Study

Dorset Council

Weymouth Beach Management Plan

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SCH3228

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Contents

Executive Summary

This Weymouth Beach Management Plan (BMP) covers the southern part of the Weymouth Bay coastline in Dorset, from the Pavilion Peninsula to the Greenhill Groyne; a total frontage length of approximately 2km. This BMP defines the flood and coastal erosion risk management (FCERM) activities required along this section of coast over the next 5 years – the BMP review period – in the context of the longer-term strategic plan for managing these risks.

The long-term approach to coastal flood and erosion risk management along the study frontage is to Hold the Line for the next 100 years, as defined by the South Devon & Dorset Shoreline Management Plan (Halcrow, 2011). To further develop plans on how best to implement this policy, Weymouth & Portland Borough Council (WPBC) – now Dorset Council (DC) – working with the Environment Agency (EA), commissioned JacksonHyder to produce the *Weymouth Bay Coastal Processes Stud*y. This study was completed in March 2018 and identified the long-term coastal flood and erosion risk management approach for the Weymouth town centre and harbour area, including the BMP frontage.

This BMP has undertaken further analysis, drawing on more recent work by others, to refine the preferred long-term approach to coastal flood and erosion risk management. Full details of the refined long-term management approach are provided in **Appendix A**. The following provides a summary of the key points:

1) Undertake beach recycling and re-profiling for FCERM purposes when the defined trigger levels are reached. **Table EX-1** summarises these trigger levels and the response to be taken when they are reached. Further details are provided in **Section 3.4**, **Section 5.2** and **Section 5.3** of this BMP.

Table EX-1 Beach management trigger levels and intervention responses

Beach Trigger Level	Trigger Level Description	Reason Defined	Intervention
Action Level 1	Beach levels adjacent to seawall are within 0.3 m of the seawall crest over a 100 m length. This equates to the following levels in each section: Pavilion Peninsula to Jubilee Clock: +2.85 m AOD Jubilee Clock to Pier Bandstand: +3.3 m AOD Pier Bandstand to Greenhill Groyne: +3.6 m AOD	Beach level adjacent to seawall too high >> wave run-up / wind-blown sand risk	Assess situation with Weymouth Town Council Beach Manager and take account of beach levels required for amenity use of areas at time trigger identified. Implement beach recycling / reprofiling to lower the profile to the design profile.
Action Level 2	Beach levels adjacent to seawall are the following distances from the seawall crest: Pavilion Peninsula to Jubilee Clock: 1.15 m drop (or +2.0 m AOD) Jubilee Clock to Pier Bandstand: 0.9 m drop (or +2.7 m AOD) Pier Bandstand to Greenhill Groyne: 0.9 m drop (or +3.0 m AOD)	Beach level adjacent to seawall too low >> wave overtopping risk	Increase frequency of monitoring to determine whether the beach profile continues to lower and/or steepen or recovers naturally. If levels do not recover naturally within a season, implement beach recycling / reprofiling to reconstruct the design profile.
Crisis Level	Beach levels adjacent to seawall are the following distances from the seawall crest:	Toe exposed >> seawall	Immediate action to provide support to the wall and then implement beach recycling /

Beach Trigger Level	Trigger Level Description	Reason Defined	Intervention
	Pavilion Peninsula to Jubilee Clock: 2.5 m drop (or +0.6 m AOD) Jubilee Clock to Pier Bandstand: 1.2 m drop (or +2.4 m AOD) Pier Bandstand to Greenhill Groyne: 1.0 m drop (or +2.9 m AOD)	undermining risk	reprofiling to reconstruct the design profile.

It should be noted that these activities driven by trigger levels being exceeded are in addition to planned annual beach recycling and re-profiling between the Pavilion Peninsula and Jubilee Clock, which is undertaken for amenity purposes.

It should also be noted that no beach recharge is proposed for the immediate future, but this could be introduced in the future if further evidence indicates it as being required and appropriate to do so.

2) In the immediate future (2020/21) undertake localised repairs to damaged sections of the seawall between the Pier Bandstand and Greenhill Groyne where there is no toe protection or footing (to secure asset whilst longer-term measures are developed).

3) In parallel to (2) above, undertake further ground investigation (including boreholes and trial pits) to inform and develop the design of steel sheet pile toe-protection for the sections of the seawall between the Pier Bandstand and Greenhill Groyne, to be implemented in 2024/25.*

4) Full replacement of the seawall and promenade between the Pier Bandstand and Greenhill Groyne is expected to be required in 2034/35, when the current wall is expected to reach the end of its residual life. In replacing this wall, the overall level of the wall will not need to be raised from current level, as this section of wall is predominantly providing coastal erosion protection.*

5) Full replacement of the remaining sections of seawall and promenade between the Pavilion Peninsula and Pier Bandstand (including Brunswick Terrace) is expected to be required around 2065 when the current wall is expected to reach the end of its residual life. In doing so, this may include raising of the overall level of the promenade incorporating both (a) more substantial toe protection, and (b) provision of a single set-back defence along the length of this frontage that incorporates ramp access over the wall and at the transition point at the north end of Brunswick Terrace.

**due to the relative proximity of works proposed under (3) and (4) above, it may be appropriate to undertake both these items at the same time to provide a single-business case.*

Figure EX-1 illustrates the location and extent of the various works described in (3) to (5) above. It should be noted that the timing (and scope) of the above works may also be varied if there is opportunity to integrate these elements into a wider regeneration scheme for Weymouth Seafront.

Figure EX-1 Spatial plan for the Preferred Option.

1. Introduction

1.1 Background and BMP area

This Weymouth Beach Management Plan (BMP) covers the southern part of the Weymouth Bay coastline in Dorset, from the Pavilion Peninsula to the Greenhill Groyne; a total frontage length of approximately 2km (see **Figure 1-1**).

Note, recommendations for future actions are made throughout the BMP, and are identified with **bold underlined text**. These are also summarised in an Action Plan presented in **Section 6**.

The BMP frontage includes both Weymouth Town Beach and Greenhill Beach, and is backed by the promenade/seawall, which protects the town centre area of Weymouth against the risk of coastal flooding and erosion. This frontage is backed by extensive urban development including key local highway routes, listed building, hotels and other facilities that support the important local tourism economy and local/visitor recreational activities. The beach itself is also used by local businesses who licence kiosks over the spring/summer period, and for a wide range of events that occur throughout the year. Future management of the beach and seawall along the study frontage therefore needs to also reflect the needs of these various uses, not solely the needs of flood and coastal erosion risk management (FCERM). It also needs to complement beach management activities along the northern part of Weymouth Bay (i.e. north of the Greenhill Groyne) as defined by the Environment Agency's *Preston Beach Management Plan* (Environment Agency, 2016).

Figure 1-1 Study extent and key features

The long-term approach to coastal flood and erosion risk management along the study frontage is to Hold the Line for the next 100 years, as defined by the South Devon & Dorset Shoreline Management Plan

(Halcrow, 2011) – see also **Section 1.7.1**. To further develop plans on how best to implement this policy, Weymouth & Portland Borough Council (WPBC) – now Dorset Council (DC) – working with the Environment Agency (EA), commissioned the *Weymouth Bay Coastal Processes Stud*y. This study was undertaken by JacksonHyder and completed in March 2018 and identified the long-term coastal flood and erosion risk management approach for the Weymouth town centre and harbour area. For the present study frontage, the recommended management approach from the *Weymouth Bay Coastal Processes Stud*y over the next century is as follows:

- Along the southern part of the frontage between the Pavilion Peninsula and the Pier Bandstand where flood risk is the concern, construct new defences to reduce wave overtopping (that leads to flood risk). To be implemented over two phases over the next 100 years, ultimately leading to the raising of the overall level of the promenade/seawall by 0.5m and the construction of a set-back wall on the landward side of the promenade/seawall to provide a single consistent flood barrier. This can be raised further if required.
- Construct scour protection to the lengths of the promenade/seawall between the Jubilee Clock and the Greenhill Groyne, where the toe of the wall is identified as being very shallow.

This recommended management approach has been further developed as part of preparing this new Weymouth BMP, such that it provides a clear and realistic plan for managing the beach profile and seawall along the Weymouth seafront as part of coastal flood and erosion risk management activities over the next 5 years. This is defined within the context of the longer-term, sustainable and integrated plan for managing these risks over the next 100 years as identified by the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018), and the preferred approach set-out in this BMP provides both:

i. Refinement of the timing of the phases to implement the preferred long-term approach, giving regard to any funding constraints and trigger levels for implementing the long-term option (see **Section 1.1.1**); and

ii. Identification of beach management activities required in the next 5 years along with trigger levels for intervention, in order to ensure beach profiles are retained at levels that reduce wave overtopping and limit the undermining risk to the seawall (see **Section 3**, **Section 4** and **Section 5**).

1.1.1 Summary of refined long-term management approach for the BMP frontage

Refinements to the preferred long-term management approach set out the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018) have been informed by new information that has become available since that preferred approach was defined, and re-assessment of the flood and erosion risks along the BMP frontage as set-out in the baseline assessments completed as part of developing this BMP. **Appendix A** provides a full report on the options appraisal process undertaken. The refined long-term management approach derived from this appraisal process is summarised as follows:

1) **Undertake beach recycling and re-profiling for FCERM purposes when defined trigger levels are reached** (see **Section 3.4**). This is in addition to planned annual beach recycling and re-profiling between the Pavilion Peninsula and Jubilee Clock which is undertaken for amenity purposes.

   No beach recharge is proposed for the immediate future, but this could be introduced in the future if further evidence indicates it as being required and appropriate to do so.

2) In the immediate future (2020/21) **undertake localised repairs to damaged sections of the seawall between the Pier Bandstand and Greenhill Groyne where there is no toe protection or footing** (to secure asset whilst longer-term measures are developed).

3) In parallel to (2) above, **undertake further ground investigation (including boreholes and trial pits) to inform** and **develop the design of steel sheet pile toe-protection for the sections of the seawall between the Pier Bandstand and Greenhill Groyne, to be implemented in 2024/25.***

4) Full replacement of the seawall and promenade between the Pier Bandstand and Greenhill Groyne is expected to be required in 2034/35, when the current wall is expected to reach the end of its residual life. In replacing this wall, the overall level of the wall will not need to be raised from current level, as this section of wall is predominantly providing coastal erosion protection.*

5) Full replacement of the remaining sections of seawall and promenade between the Pavilion Peninsula and Pier Bandstand (including Brunswick Terrace) is expected to be required around 2065 when the current wall is expected to reach the end of its residual life. In doing so, this will include raising of the overall level of the promenade incorporating both (a) more substantial toe protection, and (b) provision of a single set-back defence along the length of this frontage that incorporates ramp access over the wall and at the transition point at the north end of Brunswick Terrace.

**due to the relative proximity of works proposed under (3) and (4) above, it may be appropriate to undertake both these items at the same time to provide a single-business case.*

The timing (and scope) of the above works may also be varied if there is opportunity to integrate these elements into a wider regeneration scheme for Weymouth Seafront.

This BMP sets out the coastal flood and erosion risk management activities required along the frontage in the next 5 years to deliver on the refined long-term approach described above.

1.2 Purpose of the BMP

The coastline covered by this BMP is the responsibility primarily of Dorset Council and Weymouth Town Council *(NB: prior to 1st April 2019 it was solely the responsibility of Weymouth & Portland Borough Council).* In addition, Channel Coastal Observatory (CCO) undertakes coastal monitoring of the area as part of the South East Regional Coastal Monitoring Programme (SERCMP), whilst immediately to the north of the BMP area, the Environment Agency operate and maintain the Preston Beach frontage including the Greenhill Groyne.

The purpose of this BMP, which has been developed utilising best practice contained in the CIRIA Beach Management Manual, 2nd Edition (CIRIA, 2010), is to inform, guide and assist the responsible authorities and organisations in managing the beach and hard coastal defences along the BMP area, and to ensure that the risk of coastal flooding and erosion to properties and other assets along the BMP frontage continues to be managed sustainably, whilst recognising and managing the environmental and amenity implications of doing so.

The BMP sets out the plan for monitoring and intervention to maintain the beach and associated hard coastal defences to ensure they continue to provide adequate coastal flood and erosion risk management to the BMP area in the immediate future, whilst also identifying measures to develop and implement more sustainable longer-term solutions to the management of these issues in line with the preferred long-term strategic approach (refer to **Section 1.1.1**).

The BMP includes recommendations for further studies and investigations to refine the preferred long-term option and lead to its implementation (see **Section 1.1.1**). The **BMP itself should be reviewed every 5 years** – the BMP review period – or as and when future significant changes occur to the coastal flood and erosion risk management approach along the frontage.

1.3 Characteristics of the BMP area

1.3.1 Physical setting

The coastline between Redcliff Point and the Nothe Headland, including the length of Weymouth Bay within which the BMP frontage is located, is predominantly made up of cliffs consisting of both resistant rock (e.g. Portland Limestone) and less resistant lithologies (e.g. Kimmeridge and Oxford Clays). The varying resistance of the cliffs has resulted in the occurrence of differential erosion, which has formed the present configuration of the shoreline with a series of headlands and embayments. Weymouth Bay, which extends from Redcliff Point in the north, to the Nothe Headland in the south is one of those embayments. The Wey Estuary enters the sea along the northern side of the Nothe Headland via Weymouth Harbour.

Weymouth Bay formed when sea level rise during the Holocene marine transgression (c.10,000 years BP) led to the inundation of the River Wey's low relief valley (Halcrow, 2002). The valley is carved through

Oxford Clay and bounded by hard limestone cliffs (that now form the headlands of Redcliff Point and The Nothe). A spit-barrier beach also formed across what was the Wey Estuary as a result of the landward migration of sediments combed from the sea bed during the sea level rise. This barrier-beach enclosed the estuary from the north at Bowleaze Cove towards the south, leaving a small entrance channel between the southern end of the barrier and The Nothe headland. The enclosure also led to the infilling of the estuary with sediment. Both the infilled estuary and the spit-barrier beach have been 'fixed' in position in recent centuries by the development of Weymouth, and now form the main low-lying part of the town (Halcrow, 2011). Other small rivers, such as the Preston Brook and River Jordan were also enclosed at the northern end of Weymouth Bay by these same processes. The River Jordan now discharges to the sea at Bowleaze Cove, whilst the Preston Brook drains into the Lodmoor Nature Reserve. The relict shingle ridge which exists to the north of the BMP frontage along Greenhill Beach is considered to be all that remains of the actively retreating shingle barrier from the last ice age. As this is well constrained by both the prevailing wave conditions and the beach control structures, both formal at Greenhill Groyne and less formally at Jubilee Clock and Pier Bandstand areas, it is unlikely that significant loss of material will take place.

A significant control to shoreline behaviour along the length of Weymouth Bay is provided by the Isle of Portland. The island was once separated from the mainland only to be re-attached by the formation of Chesil Beach during the Holocene marine transgression in a similar evolutionary process to that which formed the barrier beach across Weymouth Bay. The presence of the Isle of Portland and Chesil Beach provides shelter to this section of coast from direct exposure to the dominant south-westerly waves.

Latterly the sheltering effect of Chesil Beach has been augmented by construction of the Portland Harbour Breakwaters in the latter half of the 19th century and early 20th century. Previous studies have assessed that the construction of the Portland Harbour Breakwaters had the effect of further reducing the impacts of refracted waves from south-west and westerly directions and giving enhanced influence to waves generated over easterly and south-easterly fetches on sediment transport processes along Weymouth Bay, with the net result being a change in the delicate balance of net shoreline sediment transport within the bay and greater erosion in the northern part of the bay along the Preston Beach frontage (New Forest District Council (2017), citing Joliffe (1976); HR Wallingford, 1996).

Incoming south-westerly waves diffract around the Isle of Portland and in turn assist in a localised littoral drift reversal from east to west between White Nothe to Weymouth Bay. The process is aided by the presence of a number of shallow banks on the seabed to the east of Portland Bill, most notably The Shambles bank. These banks are present due to the circulatory tidal currents that are generated by tidal flow around Portland Bill and in turn cause refraction of waves as they approach the inshore (New Forest District Council, 2017). These offshore banks themselves are thought to have little interaction with the coast (Halcrow, 2002), although the *SCOPAC Sediment Transport Study* (New Forest District Council, 2017) suggests that there may be some sand transport along the seabed towards these offshore banks by tidal flows, with material moving from the inshore areas to be deposited in these possible sediment stores, though this is an unproven theory. The Shambles is the only significant feature of the offshore area, which is steeply sloping between White Nothe and Ringstead Ledge, before becoming more gently sloping within the Weymouth Bay embayment and Portland Harbour.

1.3.2 Environmental setting

The BMP area is directly within, or within 2km of, the following environmentally designated areas:

- Isle of Portland to Studland Cliffs Special Area of Conservation (SAC).
- Dorset & East Devon UNESCO World Heritage Site (the 'Jurassic Coast').
- South Dorset Coast and Portland Harbour Shore Sites of Special Scientific Interest (SSSIs).
- Dorset Area of Outstanding Natural Beauty (AONB).
- Lodmoor SSSI, Lodmoor RSPB Nature Reserve, Lodmoor Country Park, and Lodmoor North and Overcombe Sites of Nature Conservation Importance (SNCIs).
- South West Coast Path and English Coast Path National Trails.
- Weymouth Bay is identified as being a 'Sensitive Marine Area'.

- Weymouth Bay is also within both The Eastern Channel Marine Natural Area and the South Dorset Coast Maritime Natural Area, both of which designations extend seawards from the Mean Low Water mark.

In addition to the above, there are also a range of historic environment features and assets within and around the BMP area, including a Scheduled Monument, and many Listed Buildings and the Weymouth Town Centre Conservation Area.

Further detail and discussion of the environmental characteristics relating to the BMP area are provided in **Section 2.7**.

1.3.2.1 History of coastal flooding and erosion

There are very few accounts of coastal flooding and/or erosion events occurring via this open-coast frontage of Weymouth.

The first documented report of a storm event that is known to have caused flooding occurred on the 2nd February 1802. This storm caused waves to overtop the shingle spit, destroyed a number of bathing machines and flooded the streets of the lower parts of the town (Dorset Coast Forum, 2010).

The most notable historic event occurred in November 1824, when an event known as "the Great Gale" or "the Great Storm" occurred. A witness account of the event recorded that *"…Melcombe* (this area of Weymouth is Melcombe Regis) *was nearly swept from the face of the Earth by a tremendous and terrific hurricane, the wind howled in yelling gusts, the sea roared in a most horrible and frightful manner … The sea broke over the narrows in a strong and dreadful current, two individuals who were at that moment crossing* (the current Lennox Street) *were swept away… whole rows of houses that fronted the foaming, raging, billows, were completely inundated; the pride of Melcombe, its beautiful esplanade, was nearly all demolished, the stone posts and chains, (which amount now to 336 stone posts, and 4620 feet of iron chain,) were rent up and entirely broken, the piers (over which the surges rolled in an awful and sublime manner) also were demolished, vessels, boats, and small craft, were either driven into the centre of the town, sunk, destroyed, or carried out to sea."* (Source: 'The History & Antiquities of the Borough & Town of Weymouth & Melcombe Regis' by George Ellis, 1829, in the Dorset County Museum; quoted in Dorset Coast Forum, 2010).

There are no more recent accounts coastal flooding events as a result of storms causing wave overtopping of the seafront at Weymouth since this 1824 storm, possibly because a larger seawall was constructed after 1824 (completed by 1859 – see ***Section 3.2*** below). Most recent issues during storm events are occasional nuisance wave overtopping and spray along the Promenade, such as occurred on 5th February 2014 (see **Figure 1-2**). Such events have also been known to cause damage to the seaward face of the seawall, especially around the section that protrudes seawards around the Jubilee Clock.

There are no documented records of erosion events along the higher ground at Greenhill, which has been protected against erosion for around the last 150 years by the seawall and promenade that extends along the base of this raised area.

Figure 1-2 Wave overtopping on Weymouth Esplanade by the Jubilee Clock during 5th February 2014 storm (image taken from Appendix E of JacksonHyder, 2018)

1.3.3 Coastal defences

1.3.3.1 Defence history

The area of Weymouth which is fronted by the beach and Promenade that is the focus of this beach management study, has developed over many centuries. Development has gradually built on the long sand and shingle spit that was naturally found here across the mouth of the River Wey, which extends south-west from higher ground at Greenhill forming a natural barrier between the sea and "backwater" (i.e. estuary of the River Wey). This gradual development of the town also involved reclaiming land from the sea and extending development. Coastal defences in the form of seawalls were built in a northwards direction from Weymouth Harbour towards Greenhill and then onwards still to Overcombe, along Preston Beach and Lodmoor.

This gradual development of Weymouth and its impact both on the open coast and harbour areas is illustrated in a number of historic maps and documented in local history books. A summary of this information has been produced as part of developing this BMP, and is provided in **Appendix B** for reference.

1.3.3.2 Existing defences

The present day coastal defences along the study frontage are comprised of the following elements:

- Beach comprised of sand and shingle with sediment grading varying from north (coarser) to south (finer);
- Seawall and promenade made up of a mixture of masonry blockwork and concrete;
- Greenhill rock groyne; and
- Pavilion peninsula steel sheet pile wall with concrete capping.

Each are described in more detail in **Section 3**.

1.3.3.3 Current condition of defences

The current condition of the seawall/Promenade that forms the primary coastal defence along the BMP frontage is assessed as being in POOR condition. **Section 3.3.1** provides further details.

1.3.4 Amenity value

The study area is focused on Weymouth Beach, which for amenity management purposes is considered in two sub-sections: (i) Weymouth Central Beach, and (ii) Greenhill Beach. The following provides details of these two areas.

1.3.4.1 Weymouth Central Beach

The following is largely based on information contained in the *Draft Weymouth & Portland Integrated Beach Management Plan* (Weymouth & Portland Borough Council, 2010), with additional more recent information cited where appropriate.

Weymouth Central Beach (see **Figure 1-3**) stretches approximately 1.3km north from the Pavilion Theatre to the Pier Bandstand. Beach Material consists of soft fine sand for the first 75% of its length gradually merging to small grade shingle by its end at the Pier Bandstand (the transition being in the vicinity of the Jubilee Clock). Generally considered to be the main resort beach in Weymouth, its amenity status makes it an extremely popular destination for visitors and residents with a focus on the family market.

The beach is serviced by numerous on-street parking facilities as well as two main car parks situated at the southern end and 150m due west from the centre of the beach. Access to the beach is from the backing Promenade (The Esplanade) which has 18 sets of either steps, slipways or a combination of both (Weymouth & Portland Borough Council, 2017).

Weymouth Central Beach currently accommodates 9 commercial catering outlets and 12 attraction sites under licence to the Council. In addition, a further 5 retail outlets are situated along the Weymouth central area. These are situated both on the beach in seasonal kiosks, and along the Promenade / Esplanade in permanent buildings. Beach huts are also offered for daily/weekly or seasonal hire at the northern end of Weymouth central, also under licence to the Local Authority. Both the seasonal kiosks and beach huts are removed from the beach each Autumn and return for Easter each year. Access to the kiosks on the beach is down the access steps/ramps and across the sand/shingle.

Weymouth Central Beach at its southern-most end is the widest beach area in this study area and therefore is the venue for many of the seafront's major events and festivals, including the annual beach moto-x event that sees the beach sediment used to construct a race track complete with obstacles. There are three Public Entertainment licensed areas along this stretch in total. In addition, the southern-most section of the beach is designated as the area where dogs are allowed on the beach from Good Friday to 31st October each year (Weymouth & Portland Borough Council, 2017).

Weymouth Central Beach is actively managed by Weymouth Town Council as a resort beach with the associated services one would expect with an open space of this capacity including toilets (including two locations where toilets are located beneath the promenade, accessed by steps), waste arrangements, fresh water, comprehensive signage, deckchairs, sunbeds, beach showers, lost children and first aid services, and information points (signage). A lifeguarding service is also provided by the RNLI for parts of each year. In 2018, this consisted of daily lifeguard cover from 5 May to 30 September, between the hours of 10am to 6pm (RNLI website (a)).

Weymouth Central Beach has had many annual accolades for its management, cleanliness, information provision and safety since 1993, including Blue Flag, Seaside Awards and Quality Coast Awards. In addition, it has been recognised as one of the top ten beaches in the UK in numerous such lists published annually.

Weymouth Central Beach is exclusively a bathing beach with no unauthorised vessels allowed within the bathing zone and those vessels permitted within the zone (patrol/safety purposes) are restricted to 8 knots and must have guarded propellers (see **Figure 1-4**).

The South West Coast Path (a National Trail) is designated along the length of the Promenade that backs the Weymouth Central beach area.

Figure 1-3 Weymouth Central Beach (from Weymouth & Portland Borough Council, 2010)

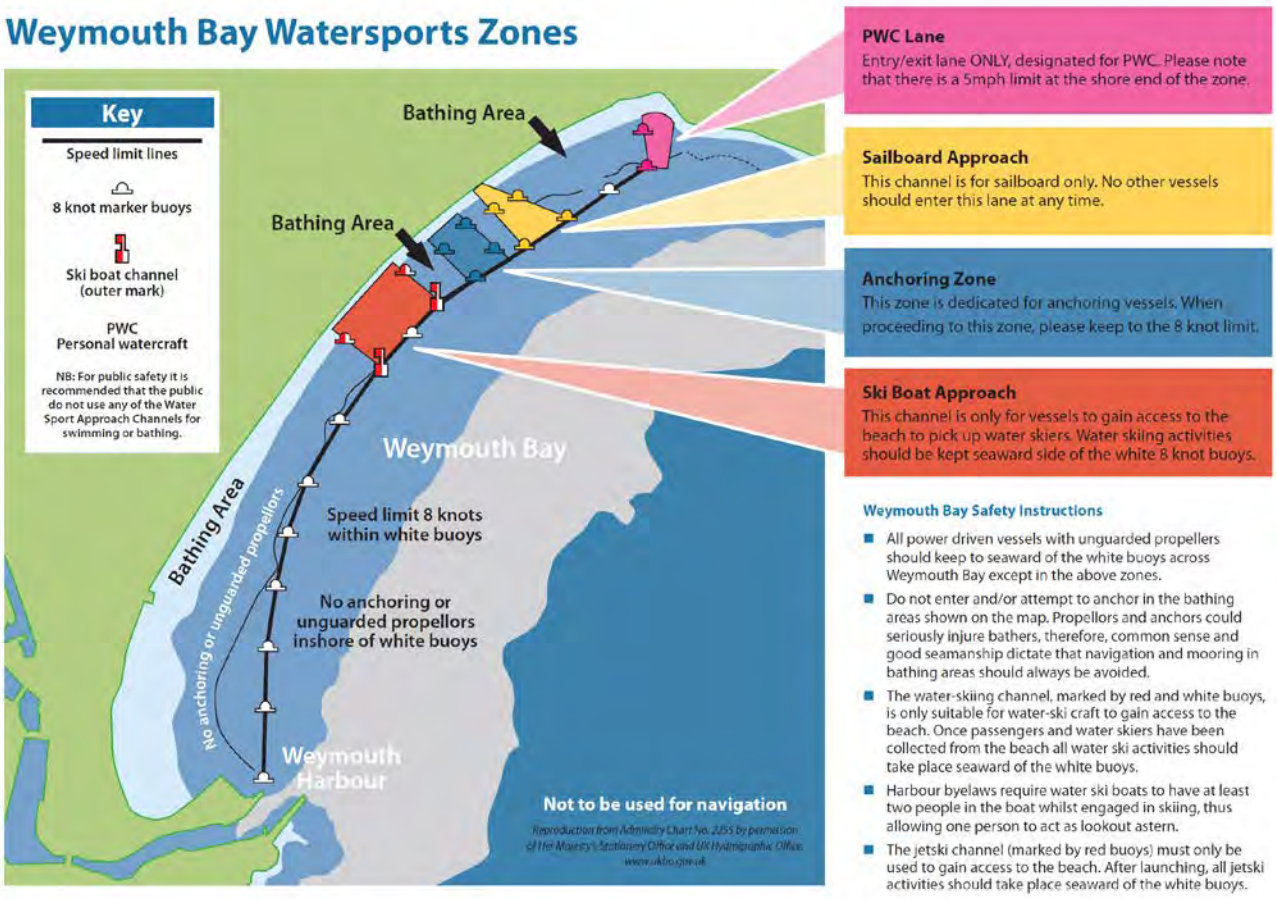


Figure 1-4 Bathing and water sports zoning map as defined by Weymouth Harbour Authority (Weymouth & Portland Borough Council, 2014a)

1.3.4.2 Greenhill Beach

The following is largely based on information contained in the *Draft Weymouth & Portland Integrated Beach Management Plan* (WPBC, 2010), with additional more recent information cited where appropriate.

Greenhill Beach (see **Figure 1-5**) stretches north for approximately 1km from the Pier Bandstand to the Greenhill Groyne opposite Lodmoor Country Park. The beach is made up of shingle for its full length and is noticeably steeper and narrower than Weymouth Central Beach further south. The full length of the beach is backed by the promenade which continues from Weymouth Central Beach northwards towards Preston Beach. Backing the promenade is a range of private properties (residential properties and hotels), public open space (e.g. Greenhill Gardens) and chalets.

Greenhill Beach currently accommodates 1 seasonal catering outlet with a further seasonal café in the adjacent Greenhill Gardens with year-round catering outlets at Greenhill Chalets and the Pier Bandstand. Also housed in the Pier Bandstand is a restaurant and amusement arcade. Beach huts are available for daily, weekly or seasonal hire and chalets are currently available on the promenade and adjoining parks on longer licence. The huts and beach kiosk are removed from the beach each Autumn and return for Easter each year. Access to these, and the rest of the beach is from the promenade down stone or timber steps and across the shingle.

Public tennis courts, a bowls club and putting green are also situated adjacent to Greenhill Beach immediately landwards of the promenade and beach. All facilities at present are under licence or lease to the Borough Council.

Greenhill Beach has traditionally been utilised by the local market with a wide mix of young and old users and although less busy than the main resort beach of Weymouth Central is serviced by toilets, waste arrangements, fresh water, comprehensive signage and first aid in peak season. A lifeguarding service is also provided by the RNLI for parts of each year. In 2018, this consisted of daily lifeguard cover from 7 July to 2 September, between the hours of 10am to 6pm (RNLI website (b)).

Greenhill is exclusively a bathing beach with no unauthorised vessels allowed within the bathing zone and those vessels permitted within the zone (patrol/safety purposes) are restricted to 8 knots and must have guarded propellers (see **Figure 1-4**). In the summer months (July/August) two swimming pontoons (rafts) are placed in position by Weymouth Town Council, shown on **Figure 1-5**.

The South West Coast Path (a National Trail) is designated along the length of the promenade that backs the Greenhill Beach area.

Figure 1-5 Greenhill Beach safety information map (from https://www.love-weymouth.co.uk/things_to_do/weymouth/attractions-places-to-visit/greenhill-beach-gardens/; 20-11-2018)

1.3.5 Land ownership

From the *Draft Weymouth & Portland Integrated Beach Management Plan* (WPBC, 2010), it is understood that all areas that are the focus of this beach management study are privately owned by WPBC* – now Dorset Council – with the exception of the tidal areas between the Mean High Water Mark (MHWM) and Mean Low Water Mark (MLWM) are owned by Crown Estates but managed under lease by Weymouth and Portland Borough Council. For the purpose of this document, this area is from the Pavilion Peninsula to the Greenhill Groyne (and northwards to the limits of Bowleaze Beach outside of the study frontage). Typically referred to as the "FORESHORE LEASE", the current Foreshore Lease expires 30th September 2037.

The Foreshore Lease allows Dorset Council to undertake public activities on the beach under in accordance with a number of conditions including that Dorset Council maintain the beach to a good standard (e.g.

cleaning and pollution control) and obey the common new and old laws imposed by the EU and UK governments. The Foreshore Lease also does not allow Dorset Council to alter the beach or install new structures without consent of the crown.

It should be noted that there are several exemptions in the Foreshore Lease to accommodate intakes, pier and outfalls.

In addition, the Foreshore Lease stipulates covenants regarding access and vehicular usage amongst other more specific issues. The Foreshore Lease should be consulted as part of detailed planning for any future flood and coastal erosion risk management (FCERM) activities along the frontage to ensure works do not impinge on these covenants.

* As of 1st April 2019, WPBC ceased to exist, being replaced by Dorset Council. Weymouth Town Council was also formed at this time. The Foreshore Lease is now in the name of Dorset Council, with some aspects sub-leased to Weymouth Town Council. The latest version of the Foreshore Lease should be referred to by users of this BMP to ensure the latest position is understood.

As land owner, Dorset Council has a statutory obligation under Common Law and a duty of care for the management of the Seafront environment. Various legal responsibilities and acts of Parliament relate to the areas under consideration in this beach management study, including:

- Health and Safety at Work Act 1974
- Occupiers Liability Act 1957
- Common Law Right of Navigation
- Bye Laws made under the Public Health Act 1936 / 1961 - Section 76, 231*
- European Habitats Directive
- EC Bathing Water Directive
- Good Rule and Government Bye Laws (1975)*
- Seashore and Promenade Bye Laws amended 1976 / 1985 / 1996*
- Dogs on Seashore Bye Law 1996*
- Dogs (Fouling of Land) Act 1996*
- Weymouth Harbour Bye Laws*
- Environment Protection Act 1990.

Section 1.7.5 *provides additional information on local byelaws.*

In addition to the above land ownership, the following also have interests in the area that need to be considered when planning and implementing future FCERM activities:

- The Port of Weymouth Harbour Area covers all of Weymouth Bay including study area (see also **Figure 1-4** above).
- Weymouth Sailing Club holds a Marine Licence until end of January 2031 for “Fixed Racing Marks” located from the outer edge of Weymouth Bay (in line between the Stone Pier and Redcliff Point) seawards.
- Weymouth Bay is within a Military Practice Area that covers most of the UK’s portion of the English Channel.

1.3.6 Highways, services and utilities

The area of the beach, promenade and Esplanade contains many infrastructure assets.

The main highway along the study area is the B3155. Along the southern part of the study area this road, also known in this area as “The Esplanade”, runs parallel to the promenade from the Pavilion Peninsula to the Pier Bandstand. From the Pier Bandstand northwards, it runs inland behind the seaward row of properties and above the slope of Greenhill Gardens and tennis courts to the Sea-life Centre and beyond. Dorset County Council’s highways team has confirmed that highway drainage along the promenade drains into soakaways situated within the promenade (personal comms, 2018). Dorset County Council’s highways team should be engaged at the time of planning any works along the promenade to confirm current details.

From services searches undertaken by WPBC in October 2018 for this study, the following utilities are located along the study frontage, and so are important to consider when planning and implementing future FCERM activities in this area:

- **BT / telecoms:** Located on and within the promenade is a number of cables, boxes, cabinets and poles operated by BT Openreach that provide telecommunications infrastructure to buildings located on the Promenade and on the beach. These are most prevalent in the area from the Pier Bandstand/south end of Brunswick Terrace to the Pavilion Peninsula.
- **Gas:** Southern Gas Networks (SGN) operate the gas network in the area. This includes low pressure gas main (part of the wider network for Weymouth) running beneath the highway of The Esplanade and Brunswick Terrace, and again beneath the B3155 highway running above the slope of Greenhill Gardens and tennis courts to the Sea-life Centre.
- **Electric:** The electricity network in the area is operated by Scottish and Southern Electricity Networks (SSEN). This network comprises by High-Voltage (HV) and Low-Voltage (LV) cables.

  HV cables run beneath the landward edge of the promenade from Bond Street to the Pavilion Peninsula (the cable turns inland at Bond Street). North of Bond Street the HV cable runs beneath the main road network behind the promenade and above Greenhill Gardens.

  Along the length of the study frontage, LV cables are located beneath both the promenade and backing highways, serving various buildings and other infrastructure such as street lights.
- **Water:** The water company for this area is Wessex Water. Along the length of the beach management study area, largely beneath the highways that back the beach and promenade, there is a variety of main water pipes, public sewers and highway drains that form part of the wider water and wastewater network for Weymouth.

  In addition, services data shows two lengths of private water mains buried beneath the upper part of the beach at (a) between the Pier Bandstand and Jubilee Clock, and (b) fronting the Greenhill Chalets.

In addition to the above utilities and services, the frontage also contains a range of additional infrastructure features such as:

- Lamp posts (various)
- Laser posts
- Utility cabinets (various)
- CCTV
- Shelter and Palm Tree up-lights
- Telephone boxes
- Parking metres
- Advertising columns
- Palm trees
- Beach showers.

These infrastructure assets were last mapped in full for WPBC in July 2012 by P. Dean Associates.

Given that there are so many infrastructure assets along the frontage, and that they are likely to change over time as new infrastructure is installed / old infrastructure is removed, the above information should be treated as a guide to what is present only. **As part of future studies to develop detailed scheme designs to implement preferred FCERM solutions along the study frontage, new up-to-date services searches should be completed to ensure a current and accurate record is used to inform those designs at the time they are prepared.**

1.4 Issues and considerations for beach management

1.4.1 Predictions of future shoreline change

Under a scenario of continuing with the present management approach (the WPM scenario), whereby it is assumed that the current coastal defences are maintained over the longer term along the BMP frontage, then the continued presence of the promenade/seawall that runs behind the beach along the length of the frontage will inhibit any roll-back of the beach in response to sea level rise. As a consequence, this will lead to narrowing of the foreshore and lowering of the beach against the seawall by the process of coastal squeeze and require greater armouring of the shoreline and/or artificial increase of the beach volume to manage the increased risk of coastal flooding that would arise otherwise under this scenario.

If continuation of the present management approach were not to occur, and an approach of no active intervention was adopted (the NAI scenario), then the process of foreshore narrowing and beach lowering would occur as sea levels rise as described above. However, at some point in the future without maintenance or strengthening of the seawall along under this scenario, the defences would eventually degrade and fail (probably catastrophically during a storm event), leading to increased risk of coastal flooding along the southern part of the frontage, and coastal erosion of the raised land along the Greenhill section.

The following sections provide further assessment of the implications of future coastal change under both the WPM and NAI scenarios for the study frontage.

1.4.1.1 Implications for coastal flood risk

The most recent assessment of the impact of wave overtopping along the BMP frontage was done by JBA (2019b). This assessed the number of residential and commercial properties at risk of flooding via wave overtopping of the existing promenade/seawall defence levels in the present day and in 2065 (allowing for sea level rise), for the 1:50, 1:100 and 1:200 year extreme events. It also assessed the impact on numbers of properties at risk if assume the current profile is retained in 2065, and if the beach profile is lowered in the present day. **Table 1-1** summarises the numbers of properties at risk under the range of scenarios for the 1:200 year event only, which are also illustrated in **Figure 1-6a** and **Figure 1-6b**.

Table 1-1 Number of properties at risk of flooding from wave overtopping along the study frontage under the 1:200 year extreme event (excluding still water flooding from harbour frontage)

Year	Return Period	Beach State	Residential Properties	Commercial Properties	Total Properties
Present Day	1:200	Current profile	321	47	368
2065	1:200	Current profile	402	77	479
Present Day	1:200	Eroded beach profile	401	58	459
Present Day	1:200	No beach	404	58	463

From **Table 1-1** it is clear that under the NAI scenario where the beach is not managed to retain the current profile levels, there is an increased risk of flooding to properties as a result of increased wave overtopping. The results presented by JBA (2019b) also show that all of the residential properties at risk are as a result of

wave overtopping of the Jubilee Clock to Pier Bandstand section of the frontage, whilst the commercial properties are at risk from this section and the section to the south (Jubilee Clock to Pavilion Peninsula). Only one commercial property is at risk of flooding in present day between the Pier Bandstand and Greenhill Groyne.

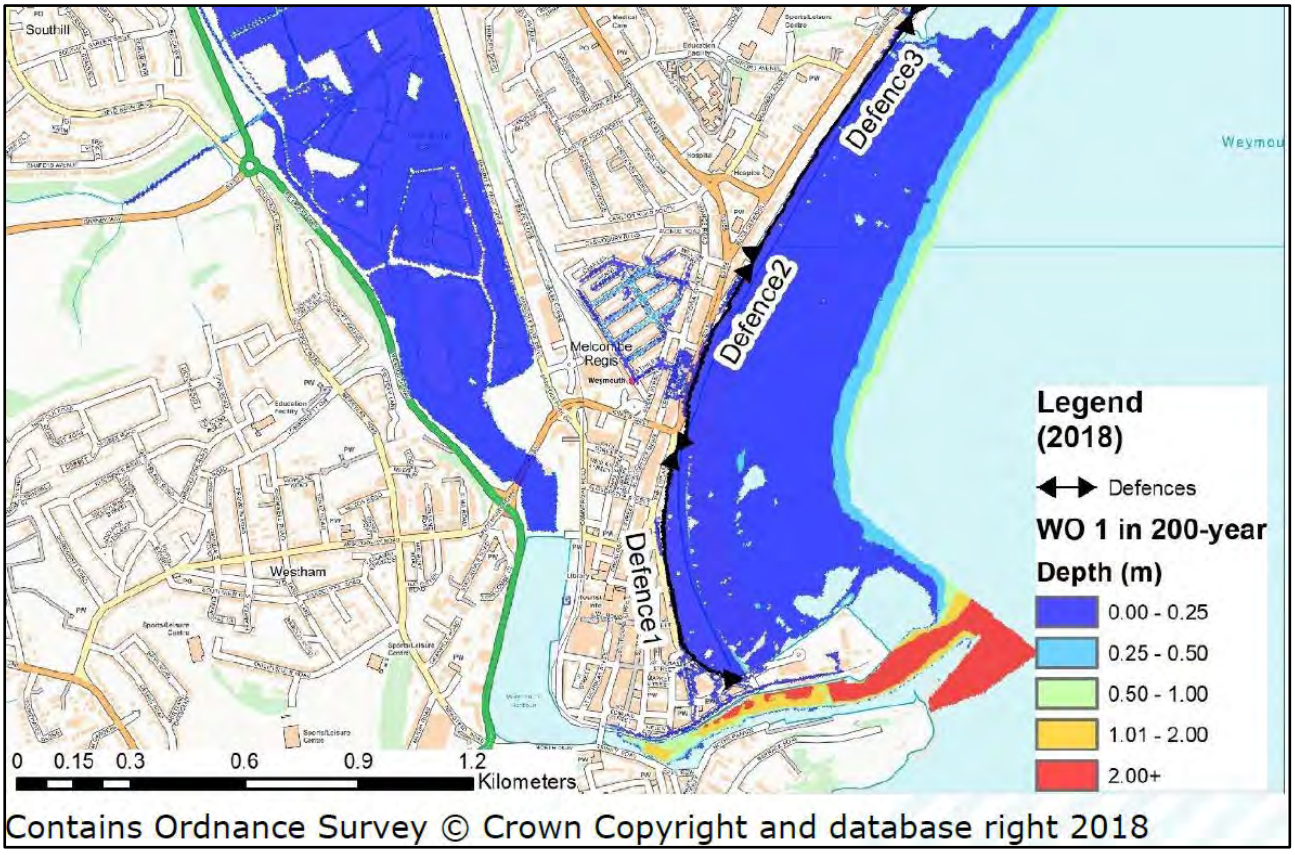


Figure 1-6a Present day (2018) wave overtopping (along BMP frontage) scenario flood depths (from JBA, 2019b).

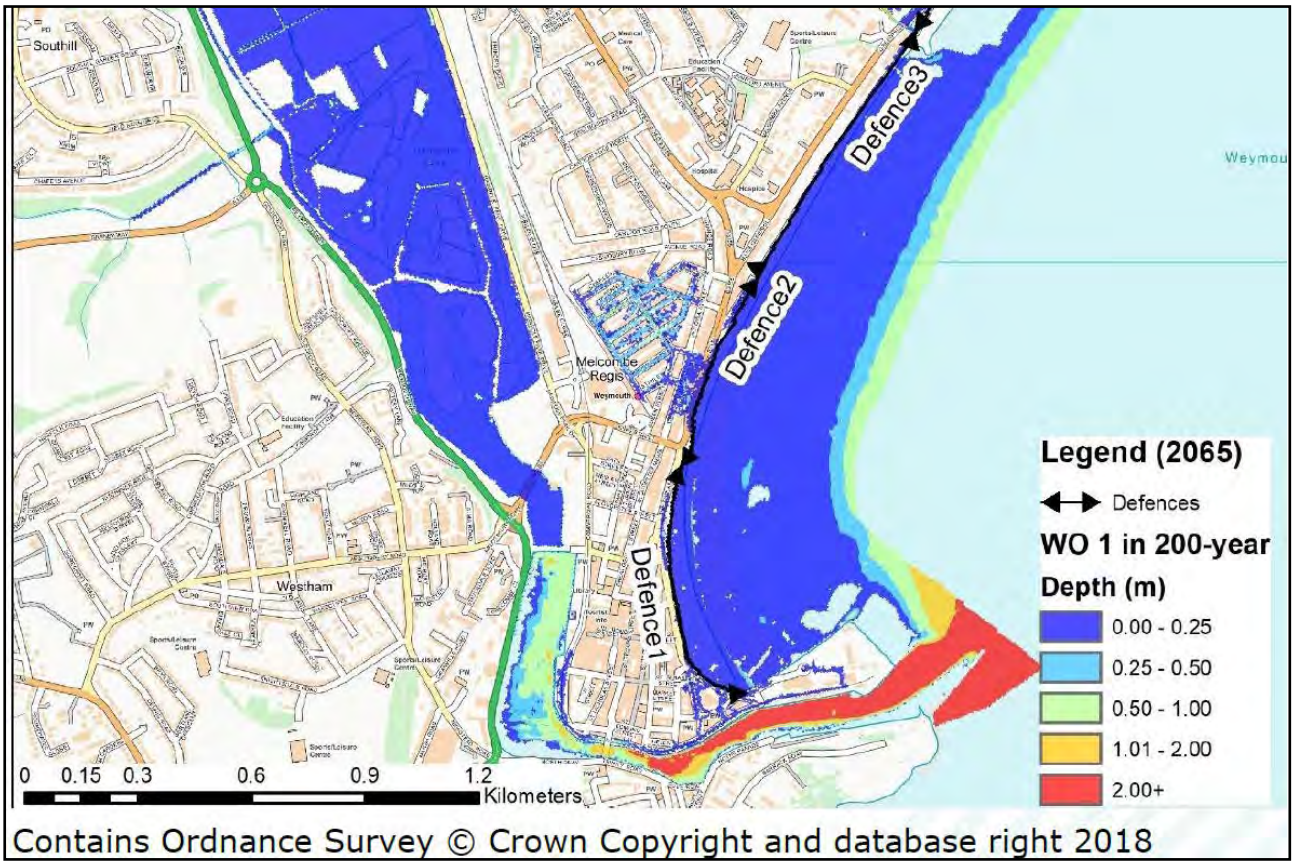


Figure 1-6b Climate change (2065) wave overtopping (along BMP frontage) scenario flood depths (from JBA, 2019b).

1.4.1.2 Implications for coastal erosion risk

Under the WPM scenario, coastal defences would be retained so there would be no risk of coastal erosion along the entire frontage, and in particular the Greenhill section of the frontage.

However, under the NAI scenario, once defences had eventually failed, coastal erosion along the Greenhill section would occur. The potential magnitude of erosion that could occur along this section once defences have failed has been assessed as part of this study, utilising available data from analogue sites nearby and expert judgement. Full details are provided in Annex A of **Appendix C.**

In summary, once defences have failed and allowing for both sea level rise and a period of initial coastal catch-up (where an atypically high rate of erosion occurs for a period of time while the shoreline morphology readjusts following defence failure), it is assessed that erosion along the Greenhill frontage could occur at a rate of between 0.5 to 1.0m/year. This suggests that following failure of defences under the NAI scenario, erosion could be expected in 50 years of between 25 and 50m, and in 100 years of between 50 and 100m.

Figure 1-7 illustrates what is located within each of these risk bands: 25m, 50m and 100m landwards from the edge of the current seawall between Greenhill Groyne and the Pier Bandstand. This shows that erosion of 25m would result in loss of the promenade/seawall as well as the majority properties (residential and commercial) located between the beach and the B3155 road that runs parallel to the shore. This road, and access to properties landward of it, would be lost if 50m of erosion were to occur. 100m of erosion would cause loss of even more properties landwards of the B3155 road.

Figure 1-7 Map showing what could be at risk of coastal erosion within 25m, 50m and 100m erosion risk zones along Greenhill Beach section of the study frontage.

1.4.1.3 Implications for usable dry beach area

Under the WPM scenario and assuming no recharge of the beach occurs, as sea levels rise the beach area will narrow as it is squeezed against the backing promenade/seawall. This will not only impact FCERM performance of the beach as part of the overall coastal defence system along the BMP frontage (see also **Sections 1.4.1.1 and 1.4.1.2**), it will also reduce the amount of each area available for amenity and recreational use. This in turn will have an economic impact on the local area as the tourism attraction provided by the beach will be reduced.

In order to assess the potential scale of impact on beach area from sea level rise (see also **Section 2.4**), a range of typical tide levels and extreme water levels have been mapped over the present beach topography using LiDAR data for present day and allowing for a range of sea level rise scenarios to 2115 (see **Table 1-2**).

Table 1-2 Water levels used to assess impact of sea level rise on beach area along the study frontage.

Water Level Descriptor	Water Levels (mOD) [UKCP09 sea level rise scenario – see also Section 2.4]					
	Present day	2025 [medium, 95%]	2055 [medium, 95%]	2115 [medium, 95%]	2115 [upper end]	2115 [H++]
MHWN	0.47	0.53	0.72	1.22	1.54	2.72
MHWS	1.17	1.23	1.42	1.92	2.24	3.42
EWL 1 in 1 year	1.81	1.87	2.06	2.56	2.88	4.06
EWL 1 in 50 year	2.17	2.23	2.42	2.92	3.24	4.42

These water level contours applied to the present beach topography have then been used to (i) calculate the area of the beach between the water level and backing promenade/seawall, and (ii) identify what features (e.g. concessions, beach huts etc.) would be impacted by narrow beach areas; this has been assessed for three zones along the frontage:

- Zone 1 = Pavilion Peninsula to Jubilee Clock
- Zone 2 = Jubilee Clock to Pier Bandstand
- Zone 3= Pier Bandstand to Greenhill Groyne.

The impact of sea level rise for each water level case in each of Zones 1, 2 and 3 is presented in **Table 1-3.** From this it is evident that purely in terms of beach area change the impacts of sea level rise will become ever greater over time, particularly in the period of 50 to 100 years hence.

Table 1-4 presents the number of current beach features that would be impacted by sea level rise. In all three zones, the majority of the present beach features are only likely to be impacted in the longer-term (2115) and under higher sea level rise rate scenarios. Those features that could be impacted are beach huts, concessions and existing use areas all of which generate revenue income for Weymouth Town Council. The majority of features counted in **Table 1-4** are beach huts that would be lost.

In order to assess the implications of reduced beach area on available space for beach users, assessment of beach carrying capacity has been made assuming that each beach user desires 7.1m^2 of beach area (based on research on Bournemouth Beaches by Cao, 2015). **Table 1-5** presents the results of this analysis. From this analysis it is evident that as a result of sea level rise, particularly in the period of 50 to 100 years hence, that if no beach recharge occurs (and/or other measures) to retain beach volumes, then the available beach area for beach users will significantly reduce and likely provide a much less attractive resource to draw visitors to the area compared to present day.

Table 1-3 Beach areas between each water level and the backing promenade/seawall in each sea level rise scenario

Zone 1 - Beach Area (m²) between water level and promenade/seawall in each UKCP09 sea level rise scenario (see also Table 2-1)										
	Present Day	**2025 (medium, 95%)**		**2055 (medium, 95%)**		**2115 (medium, 95%)**		**2115 (upper end)**		**2115 (H++)**	
Water Level Descriptor	**Beach area above water level (m²)**	**Beach area above water level (m²)**	***% change from present***	**Beach area above water level (m²)**	***% change from present***	**Beach area above water level (m²)**	***% change from present***	**Beach area above water level (m²)**	***% change from present***	**Beach area above water level (m²)**	***% change from present***
MHWN	46972	45819	-2%	41899	-11%	32489	-31%	24922	-47%	5612	-88%
MHWS	33243	32321	-3%	29374	-12%	20400	-39%	19002	-43%	973	-97%
EWL 1 in 1 year	20883	20600	-1%	19838	-5%	10936	-48%	3015	-86%	513	-98%
EWL 1 in 50 year	19391	19059	-2%	15500	-20%	2771	-86%	1308	-93%	448	-98%
Zone 2 - Beach Area (m²) between water level and promenade/seawall each UKCP09 sea level rise scenario (see also Table 2-1)											
MHWN	12440	11990	-4%	10661	-14%	8026	-35%	7254	-42%	3206	-74%
MHWS	8205	7993	-3%	7505	-9%	6049	-26%	5016	-39%	750	-91%
EWL 1 in 1 year	6413	6225	-3%	5581	-13%	3737	-42%	2681	-58%	716	-89%
EWL 1 in 50 year	5282	5062	-4%	4190	-21%	2457	-53%	777	-85%	704	-87%
Zone 3 - Beach Area (m²) between water level and promenade/seawall each UKCP09 sea level rise scenario (see also Table 2-1)											
MHWN	20234	19691	-3%	18046	-11%	14691	-27%	13476	-33%	4875	-76%
MHWS	14951	14654	-2%	13884	-7%	10134	-32%	8149	-45%	845	-94%
EWL 1 in 1 year	11155	10555	-5%	9221	-17%	6062	-46%	3803	-66%	119	-99%
EWL 1 in 50 year	8547	8203	-4%	7025	-18%	3497	-59%	1525	-82%	54	-99%

Table 1-4 Number of current beach features that would be impacted by narrowing beach in each sea level rise scenario

Zone 1 - Number of Current Beach Features that would be impacted by narrowing beach in each UKCP09 sea level rise scenario (see also Table 2-1)						
Water Level Descriptor	**Present Day**	**2025 (medium, 95%)**	**2055 (medium, 95%)**	**2115 (medium, 95%)**	**2115 (upper end)**	**2115 (H++)**
MHWN						17
MHWS					1	22
EWL 1 in 1 year				5	19	22
EWL 1 in 50 year	1	1	3	20	22	22
Zone 2 - Number of Current Beach Features that would be impacted by narrowing beach in each UKCP09 sea level rise scenario (see also Table 2-1)						
MHWN				1	1	2
MHWS	1	1	1	1	1	7
EWL 1 in 1 year	1	1	1	2	2	7
EWL 1 in 50 year	1	1	2	3	7	7
Zone 3 - Number of Current Beach Features that would be impacted by narrowing beach in each UKCP09 sea level rise scenario (see also Table 2-1)						
MHWN						1
MHWS						76
EWL 1 in 1 year					33	77
EWL 1 in 50 year				41	75	77

Table 1-5 Beach carrying capacity changes in each zone (number of beach users that can use available beach area each sea level rise scenario)

Zone 1 - Beach Carrying Capacity (number of beach users that can use available beach area each UKCP09 sea level rise scenario (see also Table 2-1))										
	Present Day	**2025 (medium, 95%)**		**2055 (medium, 95%)**		**2115 (medium, 95%)**		**2115 (upper end)**		**2115 (H++)**	
Water Level Descriptor	**Beach carrying capacity (no. people)**	**Beach carrying capacity (no. people)**	***% change from present***	**Beach carrying capacity (no. people)**	***% change from present***	**Beach carrying capacity (no. people)**	***% change from present***	**Beach carrying capacity (no. people)**	***% change from present***	**Beach carrying capacity (no. people)**	***% change from present***
MHWN	6616	6453	-2%	5901	-11%	4576	-31%	3510	-47%	790	-88%
MHWS	4682	4552	-3%	4137	-12%	2873	-39%	2676	-43%	137	-97%
EWL 1 in 1 year	2941	2901	-1%	2794	-5%	1540	-48%	425	-86%	72	-98%
EWL 1 in 50 year	2731	2684	-2%	2183	-20%	390	-86%	184	-93%	63	-98%
Zone 2 - Beach Carrying Capacity (number of beach users that can use available beach area each UKCP09 sea level rise scenario (see also Table 2-1))											
MHWN	1752	1689	-4%	1502	-14%	1130	-35%	1022	-42%	452	-74%
MHWS	1156	1126	-3%	1057	-9%	852	-26%	706	-39%	106	-91%
EWL 1 in 1 year	903	877	-3%	786	-13%	526	-42%	378	-58%	101	-89%
EWL 1 in 50 year	744	713	-4%	590	-21%	346	-53%	109	-85%	99	-87%
Zone 3 - Beach Carrying Capacity (number of beach users that can use available beach area each UKCP09 sea level rise scenario (see also Table 2-1))											
MHWN	2850	2773	-3%	2542	-11%	2069	-27%	1898	-33%	687	-76%
MHWS	2106	2064	-2%	1955	-7%	1427	-32%	1148	-45%	119	-94%
EWL 1 in 1 year	1571	1487	-5%	1299	-17%	854	-46%	536	-66%	17	-99%
EWL 1 in 50 year	1204	1155	-4%	989	-18%	493	-59%	215	-82%	8	-99%

1.4.2 Uncertainties relating to coastal process understanding

1.4.2.1 Beach response to storm events

Whilst significant, net drift of sediment is not the principal problem along the study frontage. Rather, it is the short-term response of the beaches along the study frontage to wave forcing and the subsequent gross drift, both cross and longshore, during a storm event that can lead to the defences behind the beach being at greater risk. This is the main uncertainty relating to coastal processes along the study frontage and better understanding is needed of how the beach responds to storms, and in particular a sequence of storms, both in the present-day and in future, allowing for sea level rise and climate change impacts.

Whilst it is evident from the data that storm events lead to both a cross-shore response moving material temporarily down the profile and alongshore the coastline during a storm, it is uncertain as to what scale of extreme wave and water level event is likely to cause draw-down of beach material to the extent that it poses an increased risk of wave overtopping (and so flooding) and/or undermining of sections of the promenade/seawall (particularly in the area north of Pier Bandstand where the wall toe is relatively shallow). It is also uncertain how sea level rise and climate change will impact on this risk, and at what point in the future these factors will lead to a significant change in risk from that posed presently.

In addition, whilst it is evident from data that some sediment movement back up and onto the beach occurs post storm, there is a lack of information on how fast that process occurs. Therefore, it is questionable if natural recovery of beach can be relied upon to restore the beach profile in a suitable time frame and to sufficient levels to provide suitable coast protection.

To overcome this uncertainty, JBA (2019a) recommends the following actions be considered to increase understanding of the storm response of the beach:

- More regular monitoring of beach levels (pre- and post-storm) to allow for a more accurate model calibration and validation (see also **Section 4.1.1**).
- Further assessment of the extreme conditions within Weymouth Bay should be assessed with new modelling using more recent advances in joint probability modelling (e.g. the Environment Agency's State of the Nation Project) to update data used by JacksonHyder (2018) and subsequently by JBA (2019a). *NB: this could be combined with modelling how sea level rise may alter wave transformation and tidal currents that drives sediment transport processes in Weymouth Bay.*
- Consideration of additional joint-probability extreme events (e.g. assess a range of higher wave height and lower water level combinations) to better understand the potential beach profile changes during different extreme events in present day and allowing for sea level rise.
- Consideration of 2D modelling of extreme events to better represent and understand the variation in the beach response along the study frontage (e.g. use XBeach in 2D mode not 1D mode).

1.4.2.2 Beach narrowing due to sea level rise

Of concern under an ongoing sea level rise scenario is that the effective width of the shingle beach in particular will reduce over time as the beach is squeezed against the promenade/seawall. As the shingle between the Jubilee Clock and Greenhill Groyne is relatively constrained, it is likely to be rebuilt following storms as part of the beaches natural response post storm, though possibly at a lower level against the seawall. However, there is much uncertainty about this. There is also uncertainty about the extent and timing of the risk, which is linked to the rate of sea level rise that occurs and if sedimentation can keep pace.

This narrowing will impact on both:

- the FCERM performance of the beach – a narrower beach will be more susceptible to profile changes during extreme events (see **Section 1.4.2.1**).
- the amenity value of the beach with potential implications for the wider economic well-being of Weymouth, which is heavily reliant on the tourism industry.

Ongoing monitoring of the beach will show changes happening to the beach and if, and at what rate, the beach may be narrowing (see **Section 4.1**).

1.4.2.3 Beach recycling impacts on beach volumes

Although beach recycling logs have been captured for the past few years (when recycling has occurred along the southern part of the frontage each spring), there remains uncertainty about how reliable these logs are and therefore it is difficult to assess the full impacts of recycling activities on beach volumes. As such, a number of future beach recycling events should be supported by pre- and post- recycling profile surveys (ideally laser scans) and robust recording (and auditing) of recycling logs to validate the information being recorded (see **Section 4.1.3**).

1.4.3 Environmental considerations

The following environmental considerations for future coastal flood and erosion risk management activities along the Weymouth Beach Management Study frontage have been identified:

- Construction works proposed below the Mean High Water Springs (MHWS) mark will require an application for a marine licence (refer to **Section 1.6.1**).
- Construction works above the MHWS mark may require planning authority permission to be sought (refer to **Section 1.6.4**).
- Further, more detailed consideration of UXO risks will be needed before any intrusive works or construction activity, and some form of risk reduction measures, such as geophysical works, may be required (refer to **Section 2.7.8.3**).
- Access and noise/visual disturbance to recreational users in the vicinity of any future management beach management activities, as the beach is used extensively for amenity purposes – all works will need to be programmed to minimise the impact on amenity users by avoiding the peak holiday season, where possible. Also, there is a need to ensure safe public access during recycling/re-profiling works (refer to **Section 2.7.10**).
- Access and noise/visual disturbance to residents/local businesses is likely to be the main issues throughout any period of future construction works. Noise sensitive receptors include the users of the Esplanade and beach (refer to **Section 2.7.10**). Possible wildlife including migratory fish species in Weymouth Harbour and other fauna are also sensitive to noise and will need to be taken into consideration (refer to **Section 2.7.4**).
- Impacts will be short term during construction only, and will be addressed through construction method statements and agreed with the Environmental Health Officer (EHO). Any adverse impacts on noise through construction will need to be minimised and mitigated to reduce noise impacts where possible.
- Air quality impacts of future coastal flood and erosion risk management activities relating to vehicle emissions are expected to be short term during the construction phase(s). These could include increased emissions due to traffic delays or traffic on diversion routes and construction vehicle movements. In addition to vehicle emissions, there is potential for dust emissions generated during construction activity. Potential impacts on air quality will need to be addressed through construction and method statements associated with any future works (refer to **Section 2.7.9**).
- Impact of beach management activities on internationally and nationally designated sites – need to avoid disturbance to notable and protected habitats and species. Potential requirement for Habitats Regulations Assessment to assess impacts of beach management activities on the integrity of the international conservation site (refer to **Sections 2.7.1 to 2.7.4**). Further surveys of the marine environment may be required to assess the significance of any impacts on marine species and habitats to support such assessments.
- Maintaining an existing coastal defence structure within its footprint may be considered permitted development (legal consultation required) but upgrading outside the existing footprint will likely require consent from the following organisations: Local Planning Authority, Environment Agency (environmental permitting) and the MMO (refer to **Section 1.6**).

- Future upgrading of the coastal defences along the study frontage would provide opportunities to also improve the wider seafront public realm environment by:
  - Improving the pedestrian connectivity with Weymouth Town Centre and creating small public space at important thresholds.
  - Using finishes and materials sympathetic to the historic nature and character of the Weymouth Town Centre Conservation Area), Nothe Fort Scheduled Ancient Monument and UNESCO World Heritage Site, in order to reduce the impact to the local visual amenity and landscape/townscape character.
- All BMP activities will need to comply with the requirements of the South West River Basin Management Plan, and a Water Framework Directive Assessment will be required (refer to **Section 2.7.3.1**).

1.4.4 Public health and safety

With regard to the asset condition data reported in **Section 3.3.1** from WPBC visual inspections, there are currently public health and safety concerns around a number of beach access points along the frontage (i.e. slipways and steps) that are considered to be in a poor condition and in need of repairs.

Future visual inspection of the assets will continue to include assessment of the condition of public safety aspects, including access points (slipways and steps), handrails and paving along the promenade, and obstructions along the beaches etc. This requirement is thus included in the recommended monitoring and maintenance regime presented in **Section 4** and **Section 5** of this BMP.

1.5 Management and Funding

1.5.1 Responsibilities for management activities along BMP area

Responsibility for the management and operation of activities along the Weymouth BMP frontage varies depending upon the activity. **Table 1-6** summarises the roles and responsibilities.

Table 1-6 Assigned responsibilities for management operations along the Weymouth Beach Management Study frontage.

Management Operation		Assigned Responsibility
1a	Operations to maintain beach profile for FCERM function	Dorset Council
1b	Operations to maintain beach profile for amenity	Weymouth Town Council
2	Cleaning/clearance of beach, promenade, steps, revetment, planters for amenity	Weymouth Town Council
3	All maintenance of Greenhill Gardens Sluices Outfall	Dorset Council
4	Structural maintenance of Greenhill Groyne rock armour	Environment Agency
5	All structural maintenance of promenade, seawall, beach access structures, benches and planter boxes.	Dorset Council
6	Structural maintenance of sheet-pile wall along Pavilion Peninsula.	Dorset Council
7	All maintenance of shrubs and other plants in planter boxes	Weymouth Town Council
8	Maintenance of services to kiosk areas	Weymouth Town Council
9	Litter clearance/rodent infestation	Dorset Council / Weymouth Town Council
10	Monitoring of beach movement (and other coastal processes)	Dorset Council / Channel Coastal Observatory

Management Operation		Assigned Responsibility
11	Maintenance of seats/shelters, litter bins etc	Dorset Council
12	Flood warning and response actions	Environment Agency
13	Emergency planning	Dorset Council
14	Monitoring and management of amenity / environmental aspects of the beach area and promenade	Weymouth Town Council

Actual ownership of the assigned responsibility for each management activity identified in **Table 1-6** is in some cases held by different departments within the identified organisation. Therefore, in order to support **Table 1-6** and to provide clarity on who should be contacted for each item, **Appendix D** provides contact details for each management operation.

1.5.2 Funding of future FCERM Activities

Appendix E provides a review of the economic case and associated funding implications for FCERM activities along the BMP frontage.

The key finding from this review is that, assuming a 50-year appraisal period, that of the order of £5.5m to £7.0m may be available directly from FCERM-GIA to fund FCERM activity along the beach management study frontage, without the need for additional Partnership Funding contributions.

In order to implement FCERM activities, particularly capital works in the future (refer to **Section 1.1.1**), some level of partnership funding contribution is expected to be required. **Appendix E** also therefore identifies that although there are a range of potential beneficiaries and so a number of potential partnership funding sources, the most likely viable funding will be derived from the following:

- Environment Agency / Defra (FCERM-GIA);
- Weymouth & Portland Borough Council, including use of council resources and development levies (e.g. Community Infrastructure Levy);
- Wessex Regional Flood and Coastal Committee (Local Levy Funding);
- Dorset Local Enterprise Partnership (if it is possible to link FCERM works to wider regeneration and growth); and
- Other Government Departments (e.g. Housing Infrastructure Fund from the Department for Communities and Local Government).

In order to provide improved assessment of the economic case for long-term FCERM investment along the BMP frontage, there are a range of activities that could be undertaken including:

- Improvements to the underlying wave modelling and overtopping analysis that provides inputs to the coastal flood modelling and so flood damages calculated;
- Refinement of the flood damages to include:
  - Capping values,
  - Inclusion of basements and other factors (e.g. traffic and emergency services disruptions),
  - Flood damages extended to year 100 with supporting modelling of wave/water level climate and overtopping analysis (including impacts of climate change and sea level rise over 100 years using recently updated guidance (i.e. UKCP18 in place of UKCP09),
  - Further assessment of flood risk from (i) wave overtopping only and (ii) where the overlaps are in terms of property at risk from both the open coast (beach management study) frontage and from the harbour frontage;

- Refinement of the valuations assumed for properties at risk of erosion, as well as inclusion of infrastructure costs of erosion (e.g. re-routing infrastructure; road diversions etc);
- Refinement of the assessment of amenity loss and gain to provide a more robust assessment by undertaking a site-specific investigation (e.g. contingent valuation survey) of visitors, supported by further capture of actual visitor numbers to the beach and esplanade area; and
- Revision of the assessment to include allowance for the additional damages arising from loss of annual revenue to WPBC from concessions etc. along the frontage if the beach area narrows and/or there are reduced visitors using these facilities, so they are no longer viable to run. Other wider tourism industry losses could be assessed (reduced level of enjoyment leading to reduced visitor spend in the wider local economy).

It should be noted that a peer review of the *Weymouth Bay Coastal Processes Study* by WSP (2019) included updated economic assessment that provided consideration of some of the above items for the entire Weymouth Seafront and Harbour area combined, and identified that doing so provides a much improved economic case for future FCERM investment in this area.

1.6 Licences, approval and consents

There are no current activities licensed for flood and coastal erosion risk management purposes along the beach management study frontage as the only activities currently undertaken are beach recycling and re-profiling operations by either Dorset Council (when for FCERM purposes) or Weymouth Town Council (for amenity purposes), which are exempt from requiring a Marine Licence. However, going forwards, in order to undertake any future capital scheme along the frontage, a range of licences, approvals and consents would likely be required, including:

- Marine Licence under the Marine and Coastal Access Act 2011, including Water Framework Directive Assessment
- Habitats Regulations Assessment Screening exercise
- SSSI Assent from Natural England
- Planning Application under the Town and Country Planning Act 1990.

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

Discussions should be held with the relevant consenting organisations in a timely manner to ensure that all requirements of licence/consent applications are confirmed and addressed in order to minimise the risk of delays in being able to implement works. These discussions should also assess the applicability of progressing a licence application through the streamlined process defined in the *Coastal Concordat for England* published in November 2013 (Defra, 2013).

1.6.1 Marine License

No Marine Licence is currently held for beach management activities along the frontage, as the current activities of occasional beach recycling and re-profiling are exempt from requiring such a licence.

If future construction works are proposed to occur below the MHWS mark, then this will require an application for a marine licence from the Marine Management Organisation (MMO). At present no Marine Licence is held to facilitate any potential future beach management capital works. It should be noted that the MMO guidance is that beach recycling and re-profiling activities within the same sediment cell are exempt from the need for a Marine Licence. However, there is still a need to notify the MMO of a licence exempt activity notified via the MMO website (see https://www.gov.uk/guidance/make-a-marine-licence-application). Should the MMO not agree with the exemption they will notify the applicant (usually within a week).

It is therefore recommended that initial consultation is undertaken with the MMO to notify them of any proposed beach recycling and re-profiling works along the BMP frontage to determine whether or not a Marine Licence is required. The notification should include details of the period over which it will take place,

the location of movement along the beach and cross the beach, whether movement will be above/below MHWS, and likely volumes.

The MMO must be engaged when planning any future capital works along the frontage.

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

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

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

1.6.2 Habitats Regulations Assessment Screening

Consideration of areas designated under the Conservation of Habitats and Species Regulation 2010 directly within or within close proximity to the study area is required for any proposed works to coastal defence assets or recycling works area. In this case, the key features of concern will be the Isle of Portland to Studland Cliffs SAC, and the Chesil Beach and The Fleet SAC and SPA. This will be undertaken initially through a Habitat Regulation Assessment (Stage 1) Screening exercise, in which the potential for likely significant effects to the designated features of the SAC will be established in consultation with the Competent Authority and Statutory Nature Conservation bodies. The Competent Authority for this would be the MMO. Statutory Nature Conservation bodies would include Natural England.

Should this screening exercise identify any likely significant effects, then the next stage of assessment (an “Appropriate Assessment”) will be required.

1.6.3 SSSI Assent

The study area is outside of any SSSI, and as such 'assent’ from Natural England to undertake beach recycling works along the beach management study frontage is not likely to be required. However, this should be confirmed with Natural England (particularly if a Marine Licence is also not required).

1.6.4 Planning Application

Current beach management activities do not require any planning consent. As such there is no current planning consent in place that needs to be referred to.

Future construction works / any capital scheme may require some form of planning consent from Dorset Council. It is recommended that the local planning officer be consulted at the time when the works/ a capital scheme is being developed to determine the most appropriate route for planning consent.

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

1.6.5 Other consents

The tidal areas between the Mean High Water Mark (MHWM) and Mean Low Water Mark (MLWM) are owned by Crown Estates but managed under lease by Dorset Council. Typically referred to as the "FORESHORE LEASE", the current Foreshore Lease expires 30th September 2037. The Foreshore Lease:

- allows Dorset Council to undertake public activities on the beach in accordance with a number of conditions, including that Dorset Council maintain the beach to a good standard (e.g. cleaning and pollution control) and obey the common, new, and old laws imposed by the EU and UK governments.
- does not allow Dorset Council to alter the beach or install new structures without consent of the Crown.

It should be noted that there are several exemptions in the Foreshore Lease to accommodate works to intakes, Pier and outfalls. In addition, the Foreshore Lease stipulates covenants regarding access and vehicular usage amongst other more specific issues.

The Foreshore Lease should be consulted as part of detailed planning for any future coastal flood and erosion risk management activities along the frontage to ensure works do not impinge on these covenants. See also **Section 1.3.5**.

No other consents are in place.

1.7 Linkages to other relevant documents

1.7.1 Shoreline Management Plan Policy (2011)

The current Shoreline Management Plan (SMP) policies relating to the BMP area are defined in the South Devon and Dorset SMP (Halcrow, 2011), which was adopted by the Environment Agency and WPBC (now Dorset Council) in 2011. **Table 1-7** summarises the adopted SMP policies for the section of Weymouth Bay in which the BMP frontage is located (5g16) and the policy unit immediately to the north of it (5g15).

Table 1-7 SMP policies relevant to the Weymouth BMP frontage (from Halcrow, 2011)

Policy Unit	Short Term (to 2025)	Medium Term (to 2055)	Long term (to 2105)
5g15 - Furzy Cliff to Preston Beach (Rock Groyne)	Undertake maintenance of the existing defences to continue to afford protection to the key transport link and assets, through a hold the line policy.	Continue to maintain existing defences, to afford protection to the key transport link and assets, through hold the line.	Construct new defences in a more sustainable set-back position, through implementing managed realignment.
5g16 - Preston Beach (Rock Groyne) to Weymouth (Stone Pier) (includes Weymouth Harbour)	Undertake maintenance and improvement of the existing defences to continue to provide protection to Weymouth, through Hold the Line.	Undertake maintenance and improvement of the existing defences to continue to provide protection to Weymouth, through Hold the Line.	Undertake maintenance and improvement of the existing defences to continue to provide protection to Weymouth, through Hold the Line.

The key point from the SMP (Halcrow, 2011) is that the policy is for Weymouth seafront to continue to be defended against the risk of coastal flooding and erosion, by maintenance and upgrade of defences over time. This will be supported by management of the beach along this frontage, possibly including beach recharge in the future; the SMP identified that Weymouth Bay, and especially the southern part of it, will be one of only a very small number of areas where beach recharge could be sustainable in the longer-term in the face of future sea level rise, providing not only a natural flood and erosion defence buffer, but also a greater amenity benefit for tourism when other locations in the region will have reduced/no beach levels for this purpose as a result of coastal squeeze.

1.7.2 Weymouth Bay Coastal Processes Study (2018)

In 2010, the *Weymouth Flood Risk Management Strategy* (Royal Haskoning, 2010) identified the preferred long-term solution over the next 100 years to address the coastal flood and erosion risks around Weymouth Harbour and along Weymouth seafront. Of relevance to this beach management study, the strategic approach was defined as:

- Construct new defences along the Esplanade frontage to reduce wave overtopping (that leads to flood risk).
- Construct a cut-off wall to prevent groundwater flooding under the defences.

In order to progress further development and refinement of the strategic option, the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018) was commissioned by WPBC in a project also involving the Environment Agency. The scope of the project included assessment of future management options for the Weymouth Beach and Harbour frontage. Following an options appraisal process, this project concluded the preferred management regime for economic, technical and environmental reasons along the Weymouth Beach frontage that is the focus of this study, is as follows:

- Along the Esplanade, over a number of phases, raise the overall level of the promenade by 0.5m, and construct a set-back wall on the landward side of the promenade that provides a single consistent flood barrier. This can be raised further in the future if required.
- No cut-off wall is considered to be required, based on capture and analysis groundwater monitoring data as part of the *Weymouth Bay Coastal Processes Study*.

1.7.3 Preston Beach Management Plan (2016)

The Preston Beach Management Plan (Environment Agency, 2016) guides beach management activity along the northern part of Weymouth Bay, extending northwards from the Greenhill Groyne. Management activities defined in the Preston Beach Management Plan are primarily for ongoing regular beach recycling activities along the frontage, as well as ongoing maintenance of the Greenhill Groyne. No future beach recharge along Preston Beach is currently envisaged.

1.7.4 Weymouth & Portland Planning Policy

The following section summarises local planning policies that are relevant for coastal flood and erosion risk management activities defined in this BMP.

1.7.4.1 West Dorset, Weymouth & Portland Local Plan (Adopted 2015)

West Dorset District Council and Weymouth & Portland Borough Council have prepared a joint Local Plan. The *Local Plan* was adopted by WPBC in October 2015 and contains policies and proposals for development in the area. It sets out the vision, objectives and spatial strategy for the area up to 2031. WPBC's vision for the area is to make it *"a place where people of all ages will be engaged with their local community, [and] feel a real sense of belonging and civic pride."* It also identifies the relationship with the sea as being an important part of the areas identity and so the vision also wants *"to keep the individual identities of the communities that make up our area, linking to our maritime heritage and the beautiful coastal and rural landscape, but always looking to the future."*

Relevant policies for this BMP aligned to the vision contained in the *Local Plan* are:

- ECON 5 (Tourism Attractions and Facilities).
- ENV 1 (Landscape, Seascape and Sites of Geological Interest).
- ENV 2 (Wildlife and Habitats).
- ENV 3 (Green Infrastructure Network).
- ENV 4 (Heritage Assets).

- ENV 5 (Flood Risk).
- ENV 6 (Local Flood Alleviation Schemes).
- ENV 7 (Coastal Erosion and Land Instability).
- ENV 16 (Amenity).
- SUS 2 (Distribution of Development).
- WEY 1 (Weymouth Town Centre Strategy); *NB: also Weymouth Town Centre Master Plan Supplementary Planning Document*.
- WEY 8 (Lodmoor Gateway and Country Park Area).
- WEY 14 (Bowleaze Cove).
- WEY 16 (Lorton Valley Nature Park).

1.7.4.2 Weymouth Town Centre Master Plan (2015)

The Weymouth Town Centre Master Plan (WPBC, 2015) sets out a vision for regeneration of the Weymouth Town Centre area, including the seafront area between the Pier Bandstand and the Pavilion Peninsula. Of particular relevance to this beach management study, the promenade area is to continue to be maintained and enhanced to encourage pedestrian traffic along its length, whilst the road behind the promenade between Jubilee Clock and the Pavilion Peninsula is identified as being an area for overall traffic improvements.

1.7.4.3 Joint Local Plan Review for West Dorset, Weymouth & Portland – Coastal Change Background Paper (2017)

A coastal change background paper was produced by West Dorset District Council and Weymouth & Portland Borough Council in 2017 to support the West Dorset, Weymouth & Portland Local Plan Review. It provides a general overview of issues relevant to coastal change with recommendations for defining much of the Dorset Coast as a Coastal Change Management Area. It is a working document which will be updated as evidence is acquired and the consultation process proceeds.

Of relevance to this BMP, the paper suggests that the Weymouth Beach area subject of this study is one of three locations excluded from the proposed Coastal Change Management Area designation, as put forward by the local plan, for the reason that the SMP policy here is to “Hold The Line” (see **Figure 1-8**).

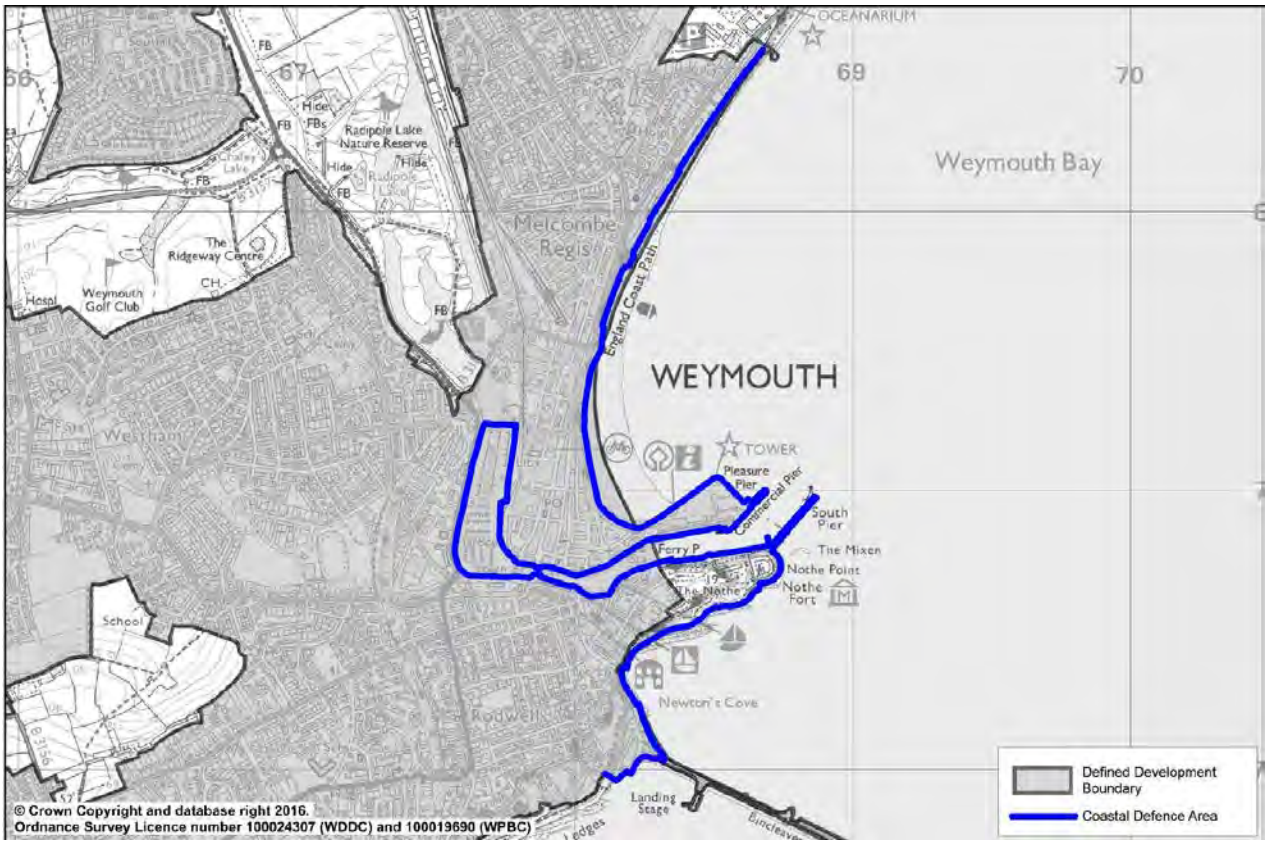


Figure 1-8 Area of coastline at Weymouth to be excluded from CCMA (from West Dorset, Weymouth & Portland, February 2017)

1.7.5 Weymouth Beach Byelaws

There are a range of local byelaws in place for Weymouth Beach and Esplanade / promenade, covering:

- Erection of booths, tents etc.
- Performances
- Games
- Selling and hawking
- Begging and touting
- Noisy instruments
- Dogs barking / Dogs on beach
- Riding and driving of animals (e.g. horses) on the beach
- Riding of bicycles along the promenade
- Use of BBQs on the beach
- Metal detecting.

These byelaws are made by WPBC by under powers conferred by Sections 82 and 83 of the Public Health Acts (Amendment) Act 1907 and are described in full in document "7631 Byelaw The Seashore and Promenades" (WPBC, 1976). Additional information is also available online at https://www.visit-dorset.com/things-to-do/weymouth-beach-p802723.

1.7.6 South West River Basin Management Plan (2009)

The *South West River Basin Management Plan* (Environment Agency, 2009) was prepared under the Water Framework Directive (WFD) as a product of the first of a series of six-year planning cycles. It contains actions to improve the ecological status of water bodies in river basin catchments, including coastal waters out to 1 nautical mile. The study area lies within one such WFD Coastal Water Body and so activities need to comply with the requirements of this plan.

The Coastal Water Body within which Weymouth Bay is located is defined as “heavily modified” in terms of its hydro-morphological status, and has a “good” overall ecological status (JacksonHyder, 2019).

1.7.7 South Inshore and Offshore Marine Plan (2018)

The study area lies within the South Inshore and Offshore Marine Plan area. This Marine Plan was published by the Marine Management Organisation (MMO) on 18th July 2018. Full copies are available online at https://www.gov.uk/government/publications/the-south-marine-plans-documents.

The Marine Plan is a statutory planning document used to guide licence and consent decisions within the marine environment up to the MHW mark including beach management activities. Particular policies to note in this regard are:

- Policy S-CO-1: Proposals will minimise their use of space and consider opportunities for co-existence with other activities.
- Policy S-INF-1: Appropriate land-based infrastructure which facilitates marine activity (and vice versa) should be supported.
- Policy S-AGG-4: Where proposals require marine aggregates as part of their construction, preference should be given to using marine aggregates sourced from the south marine plan areas. If this is not appropriate, proposals should state why.
- Policy S-TR-1: Proposals supporting, promoting or facilitating tourism and recreation activities, particularly where this creates additional utilisation of related facilities beyond typical usage patterns, should be supported.
- Policy S-TR-2: 2 Proposals that enhance or promote tourism and recreation activities will be supported. Proposals for development must demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate significant adverse impacts on tourism and recreation activities.
- Policy S-CC-2: Proposals should demonstrate for the lifetime of the proposal that: 1) they are resilient to the effects of climate change 2) they will not have a significant adverse impact upon climate change adaptation measures elsewhere. In respect of 2) proposals should demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate the significant adverse impacts upon these climate change adaptation measures.
- Policy S-CC-3: Proposals in the south marine plan area and adjacent marine plan areas that are likely to have a significant adverse impact on coastal change should not be supported.
- Policy S-ML-1: Public authorities should ensure adequate provision for and removal of beach and marine litter on amenity beaches.
- Policy S-DEF-1: Proposals in or affecting Ministry of Defence Areas should only be authorised with agreement from the Ministry of Defence.

The South Inshore and South Offshore Marine Plans are expected to be reviewed every six-years.

1.7.8 Jurassic Coast World Heritage Site Management Plan, 2014-2019

The UNESCO Dorset and East Devon Coast World Heritage Site Management Plan (Jurassic Coast, 2014) defines a number of aims and objectives for the long-term sustainable management of the site. The aim is ‘to protect the Site’s Outstanding Universal Value (OUV) and setting’.

In line with this aim, the management plan sets out a range of policies covering all aspects of coastal management. The following policies are of particular relevance to the future management of the BMP area:

- Policy 1.1: Protect the OUV of the Site through prevention of developments that might impede natural processes, or obscure the exposed geology, as set out in the GCR / SSSI details, now and in the future.
- Policy 1.2: Where developments affecting the Site or setting do take place, avoid or at least mitigate negative impact on the natural processes of erosion and exposed geology.
- Policy 1.3: Oppose developments in the Site's setting that may warrant a future need for coastal defences, particularly in light of potential sea level rise and extreme weather events.
- Policy 1.4: Protect the landscape character, natural beauty and cultural heritage of the Site and setting from inappropriate development.
- Policy 1.5: Ensure that the 'South Devon and Dorset', and 'Two Bays' Shoreline Management Plans continue to take full account of the OUV of the Site and the specific geological and geomorphological features in the GCR sites when defining actions for coastal defences.
- Policy 2.14: Promote research that informs conservation and sustainable management of the Site and furthers the advancement of science that underpins its OUV.

Although not within the World Heritage Site directly, potential future FCERM activities at Weymouth will still need to consider the potential landscape setting implications of them.

1.7.9 Dorset Coast Strategy 2011-2021

The *Dorset Coast Strategy* (Dorset Coast Forum, 2011) is a high level non-statutory document that provides a framework for how members of the Dorset Coast Forum, of which Dorset Council and the Environment Agency are members, can improve the planning and management of the Dorset Coast and inshore waters.

The goals of the strategy include establishing integrated coastal policy; identifying strategic opportunities for resource development; engaging and developing participation of a wide range of partners; and identifying solutions for sustainable coastal development, management and access.

These goals should be considered in all management decisions in this BMP area.

1.7.10 Dorset Coastal Pollution Clearance Plan

There are both local and regional (County) Emergency Plans in place to cope with pollution incidents, depending on the nature and severity of the incident, as follows:

1) The *Weymouth Harbour Oil Spill Contingency Plan* (2014b) is owned by Dorset Council and reviewed every 5 years in consultation and with the knowledge of all parties concerned. The current plan was published January 2014 and is available online from http://www.weymouth-harbour.co.uk/downloads/ (accessed: 21-11-2018). *NB: This plan is to be reviewed and updated in 2019, therefore the reader should ensure they access the latest version if they need to refer to this document.*
2) The *Dorset Coastal Pollution Clearance Plan* (Dorset County Council Emergency Planning Service, 2010) defines the details of the shoreline clean-up operational procedures to be followed in the event of a coastal/marine pollution incident from Oil, Inert, Hazardous and Noxious Substances (HNS). This includes any substance that is liable to create hazards to human health, harm to living resources and marine life, to damage amenities or to interfere with other legitimate uses of the coast line. This plan is a joint emergency planning procedure developed in conjunction with Dorset County Council, Weymouth and Portland Borough Council, the Coastguard, Fire Brigade, Police, Port Heath Officers and other Borough / District Authorities.

Both the above emergency plans detail the procedures to be followed when a pollution incident occurs, including:

- Initial cascade procedures,
- Pollution officers, contacts and notification procedures,

- Action plans,
- Roles and responsibilities,
- Available resources,
- Method of clean-up, and
- Technical information.

2. Supporting Information

2.1 Wave and wind climate

2.1.1 Typical waves

Weymouth Bay is orientated largely on a north-east/south-west axis and faces a south-east direction, with a beach azimuth of around 135°; a more south-east/north-west orientation (see also **Figure 1-1** above). As such, and as illustrated by the wave rose for the Weymouth wave buoy in **Figure 2-1**, waves approach the shoreline from a more southerly to south-easterly direction rather than the more predominant south-westerly waves that typify the wave climate of the English Channel. This is because Weymouth Bay is largely sheltered by the Isle of Portland from south-westerly wave conditions, with additional sheltering provided to much of the southern part of the bay by the Portland Harbour breakwaters. That said, diffraction and refraction around the Isle of Portland can still affect the central and north-eastern parts of Weymouth Bay and therefore Greenhill Beach. This is also illustrated in the wave rose in **Figure 2-1**, which shows a strong southerly component. Further information is provided in **Appendix C**.

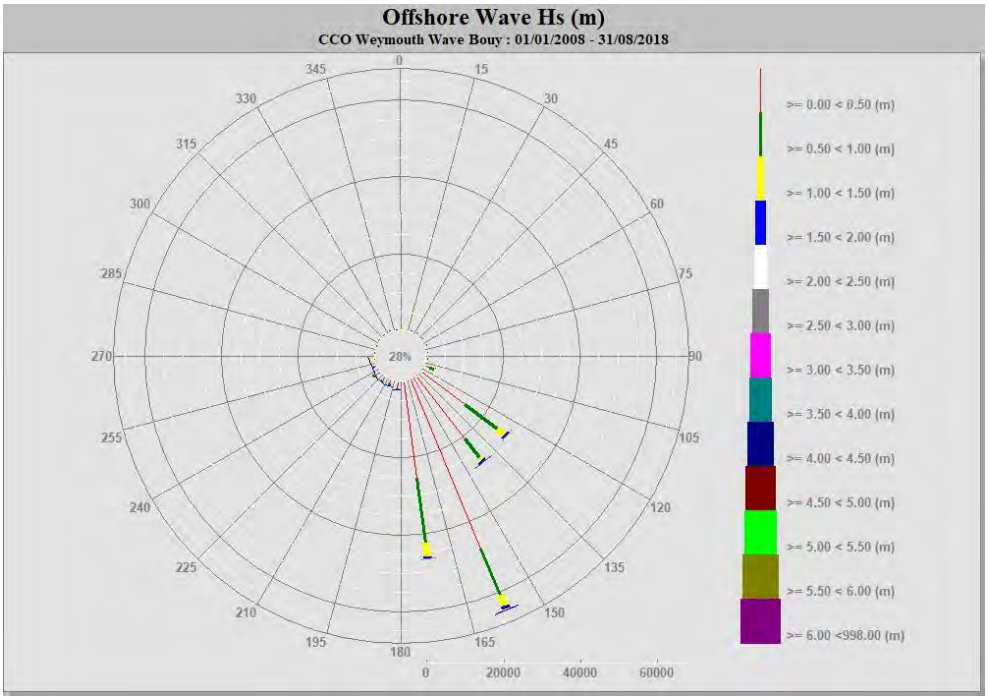


Figure 2-1 Wave rose from CCO Weymouth Bay Waverider Buoy located offshore of the study frontage on about the -10mCD contour, covering the period 01/01/2008 to 31/08/2018. Up-to-date real-time data for this wave buoy is available online at http://www.coastalmonitoring.org/data_management/real_time_data/charts/?chart=84 (accessed: 23-11-2018).

2.1.2 Extreme waves

Extreme waves can occur during storm events. Storm waves can be generated either locally at the site and have relatively short wave periods, or far from the site by storms in the Atlantic Ocean, or possibly even as a result of tsunami generated by events distant from site. It is these more distant sources of extreme waves that cause long-period swell waves. This differentiation between locally generated and swell waves draws into focus the importance of having a good understanding of bi-modal wave characteristics along the study frontage. This was also identified as a lesson for future beach modelling / design for the adjacent Preston Beach in the north end of Weymouth Bay by Burgess et al (2014).

Information on extreme wave heights along the BMP frontage is limited. Various studies over the years have calculated extreme waves along the study frontage, transforming offshore wave data to the nearshore area in Weymouth Bay using numerical models (refer to **Appendix C**). The most recent study to calculate extreme wave data along the study frontage at Weymouth by means of numerical modelling, is the

Weymouth Bay Coastal Processes Study (JacksonHyder, 2018; Appendix E). This extreme wave data was generated as part of a joint-probability analysis (combining extreme waves and water levels – see **Section 2.2.1**) at nine points around Weymouth Bay on about the -2mOD bathymetry contour, with points 1 to 7 being along the frontage that is subject to this study (see **Figure 2-2**). The resulting joint-probability extreme data is presented in **Section 2.3** below.

Figure 2-2 Location of extreme wave data extraction points 1 to 7 for the study frontage from the Weymouth Bay Coastal Processes Study (JacksonHyder, 2018; Appendix E). *See Section 2.3 also.*

2.1.3 Winds

Understanding the wind climate along the study frontage is important as easterly winds drive wind-waves into Weymouth Bay. Winds also transport finer sand sediment to the upper part of the beach and onto the land area behind the beach, particular in the southern part of the frontage between the Jubilee Clock and Pavilion Peninsula. However, there are no wind records available in the immediate vicinity of the study frontage. The nearest available wind records in the wider area are as follows:

- Portland Harbour meteorological observation station is operated as part of the South-East Regional Coastal Monitoring Programme. This station is sited on the Weymouth and Portland National Sailing Academy (WPNSA) building and posts real-time data every 10 minutes to the channel coast website (http://www.channelcoast.org/data_management/real_time_data/charts/?chart=96&tab=met&start=1390176000&end=1392595200&disp_option=1&datum=chart; accessed: 23-11-2018) as well as providing an archive of records back to 1st December 2006.
- Wind records are recorded at Portland Port (at a point on the Portland Harbour Breakwaters) for Portland Harbour Authority by Richard Paul Russell Ltd. Very recent (and live) wind record data can be obtained by capturing it directly from the Portland Harbour Authority website at http://www.weather-file.com/portland/ (accessed: 23-11-2018).

It should be noted that the WPNSA device is considered to not be an ideal site as there is some sheltering effect for the anemometer; although it is not too bad and certainly clear to the south-west direction. The wind

readings from the WPNSA device are less than those measured by Portland Port (Personal communication, 2015).

Additional wind data may be available from the Met Office but has not been obtained for this study.

2.2 Water level climate

2.2.1 Tidal information

Tide levels for Weymouth Bay are assumed to be the same as those for Portland, which is the nearest location available in the Admiralty Tide Tables (ATT) produced by the UK Hydrographic Office (UKHO, 2015) as reported in the Preston BMP (Environment Agency, 2016). The tide levels are provided in **Table 2-1**.

Table 2-1 Tide Levels for Portland to be assumed for Weymouth Bay (UKHO, 2015). Note that the levels in the ATT are in metres Chart Datum (mCD). These are converted in the table below to metres Ordnance Datum (mOD) by applying the adjustment -0.93m to the mCD values.

Tidal Condition	Tide Level (mOD)	Tide Level (mCD)
Highest Astronomical Tide (HAT)	+1.57	+2.50
Mean High Water Spring (MHWS)	+1.17	+2.10
Mean High Water Neap (MHWN)	+0.47	+1.40
Mean Sea Level (MSL)	+0.07	+1.00
Mean Low Water Neap (MLWN)	-0.13	+0.80
Mean Low Water Spring (MLWS)	-0.83	+0.10
Lowest Astronomical Tide (LAT)	-1.13	-0.20

The tidal ranges at Portland, as stated in the ATT 2015 (UKHO, 2015), are as follows:

- Spring Tide Range = 2.0m.
- Neap Tide Range = 0.6m.

Historical information on tidal conditions at Weymouth from the National Tide and Sea Level Facility (NTSLF) network can be obtained through the British Oceanographic Data Centre (BODC) website (http://www.bodc.ac.uk/data/online_delivery/ntslf/processed/; accessed: 23-11-2018). The NTSLF website also provides real-time tide gauge data for Weymouth (http://www.ntslf.org/data/uk-network-real-time; accessed: 23-11-2018).

The ATT is published each year and contains the tidal forecast for that year at the main Ports (Portland in this case). However, tide forecasts up to 7 days into the future are available from the UKHO *EasyTide* website – http://www.ukho.gov.uk/easytide/EasyTide/SelectPort.aspx; accessed: 23-11-2018) allowing the user to obtain the tide times for Weymouth.

Tide levels should be always checked and recorded when planning to undertake surveys (i.e. to define the time of low water to enable the topographic survey to include as much of the beach as possible and when undertaking maintenance works).

2.2.2 Extreme water levels

Extreme water levels have been calculated for the study frontage by a number of studies in the past. However, the most recent calculations, and the ones to be adopted for this study, are those provided in the Environment Agency's *Coastal Flood Boundary Conditions for UK Mainland and Islands* (Environment Agency, 2011a). These extreme water levels were also used in the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018), and are presented in **Table 2-2** for point 4734.

These extreme tide levels were calculated for a base date of year 2008. To align to the other extremes data presented in this baseline report that is taken from the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018), the values in **Table 2-2** have been increased to a base date of 2015 by applying +0.037m sea level rise based upon the medium emissions 95%ile relative sea level rise calculated from UKCP09 data. This same approach to sea level rise has also been used to provide future extreme water level values for 2025, 2055 and 2115 as presented in **Table 2-2**. **Section 2.4** provides further details on sea level rise.

It should be noted that the Coastal Flood Boundary Conditions Dataset has been updated recently, therefore revised sea-levels should be used in future studies or scheme development to update the data below, which will also need to account for new sea level rise allowances (see **Section 2.4**).

Table 2-2 Extreme Tide Levels for Weymouth Beach in 2015 from (Environment Agency, 2011a), and future levels allowing for sea level rise assuming the UKCP09 medium emissions 95%'ile rate (refer to Section 2.4).

Return Period (1 in X years) [APO]	Extreme Water Level at Weymouth Beach (mOD)			
	Year: 2015	Year: 2025	Year: 2055	Year: 2115
1 [100%]	1.81	1.87	2.06	2.56
2 [50%]	1.88	1.94	2.13	2.63
5 [20%]	1.96	2.02	2.21	2.71
10 [10%]	2.03	2.09	2.28	2.78
20 [5%]	2.09	2.15	2.34	2.84
25 [4%]	2.11	2.17	2.36	2.86
50 [2%]	2.17	2.23	2.42	2.92
75 [1.3%]	2.21	2.27	2.46	2.96
100 [1%]	2.23	2.29	2.48	2.98
150 [0.7%]	2.27	2.33	2.52	3.02
200 [0.5%]	2.29	2.35	2.54	3.04
250 [0.4%]	2.31	2.37	2.56	3.06
300 [0.3%]	2.33	2.39	2.58	3.08
500 [0.2%]	2.37	2.43	2.62	3.12
1000 [0.1%]	2.43	2.49	2.68	3.18
10000 [0.01%]	2.62	2.68	2.87	3.37

2.3 Joint probability extreme waves and water levels

The *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018; Appendix E) provides the most recent assessment of extreme wave and water level climate along the study frontage. This data was generated using numerical modelling for seven points along the study frontage (see **Figure 2-2** above), with models run for present day and future scenarios, allowing for the impact of sea level rise on the extreme water level component which directly influences wave height in the nearshore area of Weymouth Bay. **Table 2-3** presents the joint probability extreme wave and water-level conditions for points 1 to 7 along the study frontage for the present day (2015) scenario only; conditions for future scenarios are provided in Section 4 of **Appendix C**.

NB: It should be noted that any future work should make use of the latest, best available joint probability modelling (e.g. the Environment Agency's State of the Nation Dataset) to update the assessment of the extreme conditions within Weymouth Bay that is presented in this section of this report (JBA, 2019a).

Table 2-3 Joint probability extreme wave and water level data for resultant waves from the south-east for present day (year 2015) from JacksonHyder (2018; Appendix E). Data shown is, extreme water level (EWL), significant wave height (Hs) and peak wave period (Tp) at seven nearshore locations along the study frontage in Weymouth Bay (see Figure 2-2).

Joint Return Period (1 in X years) [AEP %]	EWL (mOD)	Point 1		Point 2		Point 3		Point 4		Point 5		Point 6		Point 7	
		Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)
1 [100%]	1.81	1.00	8.87	1.33	8.92	1.57	8.91	1.66	8.84	1.76	8.84	1.92	8.85	2.17	8.87
2 [50%]	1.88	1.01	8.89	1.35	8.94	1.59	8.93	1.69	8.85	1.79	8.85	1.95	8.86	2.19	8.88
5 [20%]	1.97	1.02	8.91	1.38	8.96	1.63	8.94	1.73	8.87	1.83	8.86	1.99	8.87	2.23	8.89
10 [10%]	2.03	1.02	8.92	1.40	8.97	1.65	8.96	1.76	8.88	1.86	8.87	2.02	8.88	2.25	8.90
25 [4%]	2.11	1.03	8.95	1.42	8.99	1.68	8.97	1.79	8.89	1.90	8.89	2.05	8.89	2.28	8.91
50 [2%]	2.18	1.03	8.97	1.44	9.01	1.71	8.99	1.83	8.91	1.93	8.90	2.08	8.90	2.31	8.92
75 [1.3%]	2.21	1.04	9.03	1.45	9.07	1.72	9.05	1.84	8.97	1.95	8.96	2.10	8.97	2.33	8.99
100 [1%]	2.24	1.05	9.03	1.46	9.08	1.73	9.06	1.86	8.98	1.97	8.97	2.12	8.97	2.34	8.99
200 [0.5%]	2.30	1.05	9.07	1.48	9.11	1.76	9.09	1.89	9.01	2.00	9.00	2.14	9.00	2.36	9.02
1000 [0.1%]	2.44	1.07	9.16	1.52	9.20	1.82	9.18	1.95	9.10	2.07	9.09	2.21	9.09	2.43	9.11

2.4 Climate change and sea level rise projections

Information on the impacts of climate change is available from *Advice for Flood and Coastal Erosion Risk Management Authorities* (Environment Agency, 2011b). This is the latest guidance and highlights that the main risk of climate change in relation to beach management is from sea level rise. This guidance is due to be updated in 2019 (see **Box 2-A** below).

The guidance suggests that predictions of the future rate of sea level rise for the UK coastline should be taken from UKCP09. Data downloaded from UKCP09 provides sea level rise from 1990. Anticipated rates of relative sea level rise and surge estimates over three time-periods are presented in **Table 2-4** from a base date of 2015 (to align with other data presented in this report drawn from JacksonHyder, 2018). The following estimates are presented in the table:

- Lower End Estimate: this is the low emissions scenario, 50% frequency, taken from the UKCP09 User Interface.
- Change Factor: this is the medium emissions scenario, 95% frequency, taken from the UKCP09 User Interface.

- Upper End Estimate: these are generic values of sea level rise provided in the climate change guidance; they are 4mm (up to 2025), 7mm (2026 to 2050), 11mm (2051 to 2080), and 15mm (2081 to 2115).
- H++ Scenario: these are generic values of sea level rise provided in the climate change guidance; they are 6mm (up to 2025), 12.5mm (2026 to 2050), 24mm (2051 to 2080), and 33mm (2081 to 2115).
- Upper End Estimate + Surge Estimate: This is the upper end estimate plus the upper end surge estimate. The surge estimate are generic values provided in the climate change guidance; they are 20cm (up to the year 2020's), 35cm (up to the year 2050's), and 70cm (up to the year 2080's). With regard to the surge increase, the uncertainty with surge increase is even greater than for sea level rise.

The guidance recommends that in planning future coastal management options, the Change Factor (medium 95% frequency scenario) be used as the preferred scenario. All other scenarios are included to demonstrate the sensitivity of decision making through time and can be used to refine the options to prepare for a wider range of future change.

Table 2-4 Relative sea level rise estimates for Weymouth Beach (see text above for explanation of terms used in this table).

Time period	Various estimates of relative sea level rise and surge (mm/year)				
	Lower End Estimate	Change Factor	Upper End Estimate	H++ Scenario	Upper End Estimate + Surge Estimate
2015 to 2025	0.03	**0.06**	0.04	0.06	0.24
2015 to 2055	0.14	**0.25**	0.27	0.49	0.62
2015 to 2115	0.41	**0.75**	1.07	2.25	1.77

A number of previous studies have assessed the likely significant impacts of climate change upon Weymouth Beach, most notably the SCOPAC *Preparing for the Impacts of Climate Change report* (Halcrow *et al*, 2001) and *Futurecoast* (Halcrow, 2002). These studies concluded that climate change is likely to result in changes to key forcing conditions, notably rising sea levels and changes in wave direction and wave height, and that such changes could have significant implications for physical conditions at the shoreline. Along the study frontage, this is likely to lead to narrower beaches as the presence of the promenade/seawall prevents their natural movement landwards that would otherwise occur. This in turn will lead to greater amounts of wave overtopping of the promenade during storm events and so increased risk of coastal flooding.

In addition, with promenade/seawall crest levels ranging from between +3.15mOD to +3.55mOD, then depending on the rate of sea level rise, the promenade/seawall level could even be exceeded by extreme still water levels during storm events over the next century or so increasing the extent of flooding in Weymouth Town beyond.

BOX 2-A: 2018 UK Climate Projections Update

In November 2018, an update to the UKCP09 sea level rise projections was published by the Met Office (Met Office, 2018).

This update, referred to as UKCP18, includes update projections of sea level rise around the coast of the UK for a range of climate change scenarios. The data published in November 2018 indicates that for the Weymouth Bay area the rate of sea level rise will be higher than predicted in UKCP09, but not by a large amount (perhaps 10cm or so more sea level rise over the next century). The UKCP18 reports also note that the UKCP09 H++ scenario for low probability, high impact sea level rise is "still a reasonable plausible high-end scenario based on current interpretation of the evidence".

These new projections will, in due course, be reflected in updated guidance for FCERM studies to replace *Advice for Flood and Coastal Erosion Risk Management Authorities* (Environment Agency, 2011b). Future studies will need to review UKCP18 data and new guidance based upon it to ensure the latest sea level rise information is used to inform FCERM decisions. However, at the time of undertaking this study the UKCP09 guidance and data is still to be followed and, based on the UKCP18 information summarised above, it is not likely to significantly impact assessments made in this study.

2.5 Sediment dynamics

2.5.1 Sediments

The shoreline of Weymouth Bay is comprised of a barrier beach derived of largely of shingle and of post glacial origin. The historical drift direction (since the last ice age) would have been to the west as the barrier had formed across both the Lodmoor and the Wey Rivers (hence the westerly deflected and drowned river valley of Radipole Lake). Wave energy within the bay reduces from east to west and hence the ability of waves to transport larger sediment sizes reduces in this direction also. Consequently, the grading of beach sediment along the shoreline of the bay varies from east to west; transitioning at approximately in the vicinity of the Jubilee Clock from the remains of an original narrow shingle beach to a wide sandy beach and intertidal sand flats in front of the main promenade/seawall and the town (DHI, 2017).

The section south of the Jubilee Clock is predominantly composed of fine sand (see **Figure 2-3**). Offshore of these sections the sand is typically even finer. As you progress along the frontage north of the Jubilee Clock, the shingle upper beach starts to appear with a strong demarcation often seen on the surface of the beach from the Jubilee Clock northwards (see **Figure 2-4**). The esplanade also sticks further out onto the beach at this location, providing a control on the movement of shingle south with a similar effect to a groyne, particularly on the upper beach. Subject to the prevailing conditions, shingle material can be found south of this bulge in the esplanade and is often found below a surface layer of sand (see **Figure 2-5**). Continuing northwards, the shingle component dominates the upper beach and becomes narrower and steeper, particularly from the Pier Bandstand to the Greenhill Groyne, with the finer sand material constrained in the lower foreshore (see **Figure 2-6**); as with the esplanade around the Jubilee Clock, the Pier Bandstand also sticks further out onto the beach at this location, providing a control on the movement of shingle south with a similar effect to a groyne. The shingle along the study frontage is typically a grey cherty flint, suggesting a derivation from cretaceous rocks. It shows no signs of inclusion of the lighter, recharged shingle placed on Preston Beach north of the Greenhill Groyne (DHI, 2017).

There is very little quantifiable information about sediment grading along the study frontage. The only information on this found in the available literature is from a study by HR Wallingford in 1989 that analysed sediment grading along six cross-sections across Weymouth Beach (see **Figure 2-7**). This showed grain sizes south of the Jubilee Clock as having a range of median sediment sizes of between 0.12 and 0.16mm; and north of the Jubilee Clock to the Pier Bandstand as being between 0.12mm and 11mm. No data was collected for the Greenhill section. From inspection of a range of historic photos of the beach, it is likely that the above sediment grading ranges have not altered all that much since 1989. However, it would be helpful to future studies to capture new sediment grading data along the full length of the study frontage.

Figure 2-3 View of the wide, sandy beach and inter-tidal zone at the southern end of the study frontage, looking north from the Pavilion Peninsula (23-11-2018; photos by A. Frampton).

Figure 2-4 Views looking south (left) and north (right) along the section of beach between the Jubilee Clock and Pier Bandstand showing the shingle upper beach leading to a sandier lower beach and foreshore (23-11-2018; photos by A. Frampton).

Figure 2-5 The beach area immediately south of the Jubilee Clock promenade/seawall promontory showing evidence of shingle having been transported around the promontory from the beach to the north of it (23-11-2018; photos by A. Frampton).

Figure 2-6 Views along the Greenhill Beach section of frontage to north (left) and south (right) showing the narrower and steeper shingle upper beach (compared to beach shown in Figure 6-2) leading to flatter and sandier foreshore (23-11-2018; photos by A. Frampton).

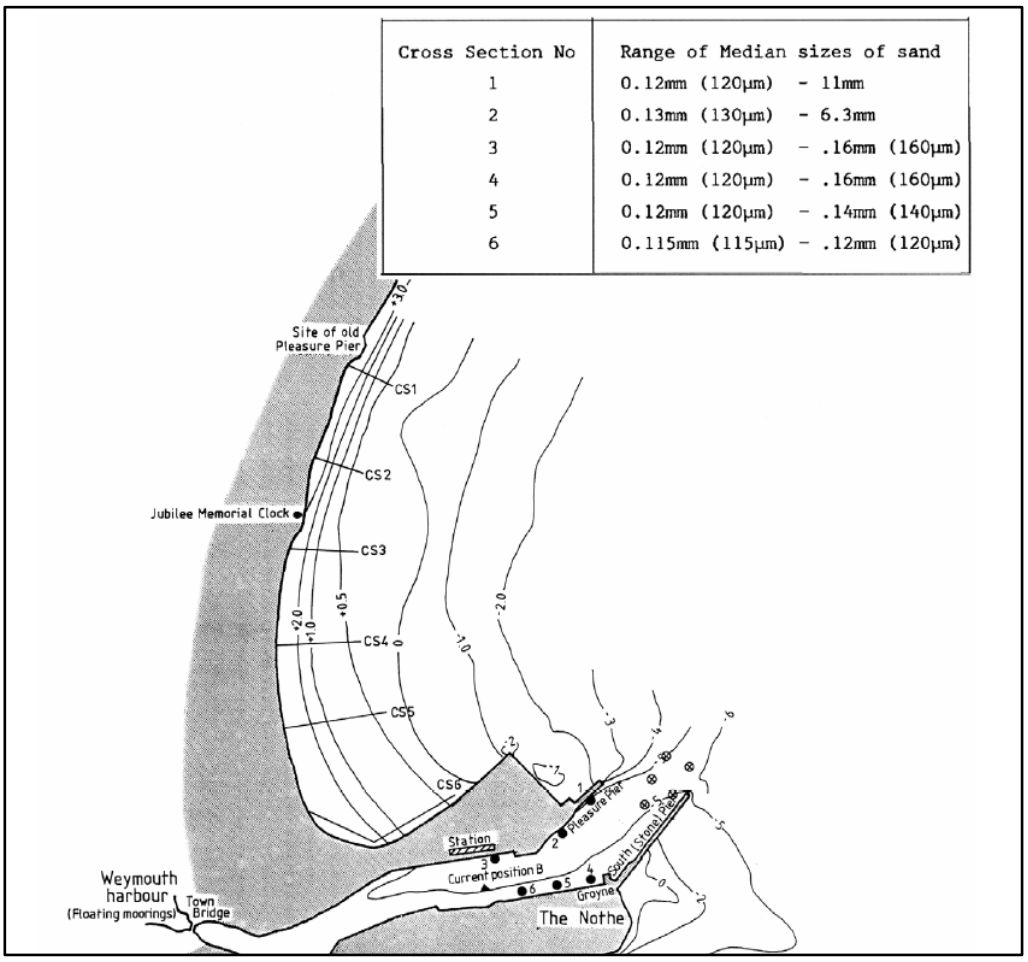


Figure 2-7 Sediment sampling data along the Weymouth Beach Management Study frontage captured for a study by HR Wallingford in 1989 (cited in HR Wallingford, 2007).

2.5.2 Sediment transport pathways

A number of studies have investigated the sediment transport pathways along the study frontage (and within the wider Weymouth Bay). However, there are still many uncertainties on the gross sediment drift driven by events and longer-term net drift directions and on the presence of a divergence along the frontage. The *Expert Geomorphological Assessment* (DHI, 2017) completed for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018) collates much of the evidence, and uses this to present a conceptual model of Weymouth Bay to aid with understanding of the existing coastal geomorphology in the area. This conceptual model (see **Figure 2-8**) shows the features, linkages and contemporary stores of material that are known to exist. Further information is provided in Section 6 of **Appendix C**.

The conceptual model identifies the key morphological features as:

- More resilient geology at Portland, Weymouth Bay (The Nothe and Redcliff Point), and White Nothe constrains evolution along the coast by providing hard control points.
- Between these locations there are areas of cliff comprised of Kimmeridge and Oxford Clays that demonstrate complex landsliding characteristics, particularly between Furzy Cliff (north-eastern end of Weymouth Bay) and White Nothe. The activity of the landslides are episodic and controlled by groundwater conditions more than marine action (though this is also an important factor in the cliff stability) (New Forest District Council, 2017). These cliffs do not provide much sediment to the beach system and not on a regular basis.
- The River Wey, which discharges to the sea through Weymouth Harbour mouth at the southern end of the beach study area, is an in-filled estuary with a small tidal prism that has been completely modified by human intervention. The Wey exerts only a very limited and localised influence on the open coast of Weymouth Bay. The River Jordan, which discharges to the sea at Bowleaze Cove at the north end of the bay, has even less influence on the open coast.
- Between Overcombe and Weymouth Harbour, the coastline is artificially fixed by the presence of seawalls. These seawalls are fronted by a largely artificial mixed sand-shingle beach between Bowleaze Cove and Greenhill Groyne (the result of a beach recharge scheme in 1995/6). Along the study frontage, between Greenhill Groyne and Pavilion Peninsula, the beach is natural and grades from shingle along Greenhill Beach to sand south of the Jubilee Clock.
- Fronting the length of the shingle/sand beaches is a sandy foreshore, which includes nearshore sand bars.
- The only formal beach control structure along the shoreline is the Greenhill Groyne, which holds the beach in place locally in this area. Further shoreline control is provided by the Pier Bandstand, the “bump” in the promenade/seawall around the Jubilee Clock, and the Pavilion Peninsula; all of which not designed as beach control structures but have a similar impact. These anthropogenic controls on the beach are likely to be key components in the long-term stability of the beach.

The conceptual model shows the linkages inferred from previous studies (and described above), in addition to newly identified pathways. The key points to note are:

- There is potential for sediment transport into Weymouth Bay from the east (i.e. from between White Nothe and Redcliff Point). However, the actual sediment transport is very small (if any) due to the presence of secondary headlands that intercept sediment (in particular Redcliff Point), as well as a limited contemporary sediment supply to the foreshore from the erosion of cliffs in Ringstead Bay to the east of Weymouth Bay (Halcrow, 2002). As a result, Weymouth Bay is largely closed to new sediment inputs. As a result, over time the movement of material both alongshore (during ‘normal’ wave and tide conditions) and onshore-offshore (which is the significant process during storm events) has resulted in the beaches in the northern part of the bay being gradually eroded and losing volume (Posford Duvivier, 2001). This process is observed by gradual loss of volume recorded in the regional coastal monitoring data.
- Finer material comes from offshore and is attracted into the south-west corner of Weymouth Bay along an offshore route as the relative energy of both waves and tides reduces. The importance of this pathway for the morphology of the beach is that it controls the sediment available in the nearshore

region for bar formation and the overall elevation of the shore platform from the beach out to approximately the -6mCD contour. This in turn has an impact on the waves arriving at shore. The sensitivity of the beach to small changes in wave direction has been highlighted (DHI, 2017).

- The southerly transport of finer sand sediment within Weymouth Bay allows the formation of nearshore bar features which provide a natural basis for supporting the upper beach. These bars also impact wave energy reaching the shoreline and so influence sediment transport.
- Along the shoreline within Weymouth Bay, the beach sediment size increases from fine sands in the southern end of the bay to shingle sized sediment in the northern end of the bay. This is due to the variability in wave energy along the shoreline. This grading of beach sediment is accompanied by an increase in steepness and reduction in width of the foreshore slope towards the northern end of the bay.
- The beaches of the central and northern parts of Weymouth Bay have a history of sediment loss and beach narrowing in front of the seawall, and storm events in particular cause sediment to be drawn-down the beach profile to the nearshore area, from where it does not readily return to the beach in post-storm conditions (if it returns at all). The shingle areas along the study frontage (between the Jubilee Clock and Greenhill Groyne) are likely to be the most effective at stopping wave overtopping, but will continue to be squeezed against the promenade/seawall as sea levels rise; thus becoming less effective in doing so over-time. However, the rapid reduction in wave energy as you progress to the south means that the sand section of the frontage between the Jubilee Clock and Pavilion Peninsula is at relatively low risk other than under very infrequent storm conditions.
- The sand beach to the southern end of the bay shows anaerobic conditions, indicating that material here is relatively immobile (Halcrow, 2002). This may also be a function of the sand accumulation that occurs in the south end of the bay, a process that has been aided over the decades by the gradual increase in length and size (by land reclamation) of the northern jetty at the entrance to Weymouth Harbour. This process of accumulation is added to by the southerly drift of sand along the frontage and has resulted in the shallowing of the nearshore slope and the occasional need to undertake maintenance dredging at the mouth of Weymouth Harbour (New Forest District Council, 2017).
- The impact of Weymouth Harbour on the wider system is likely to be relatively limited. Both the inner and the outer harbour are accreting with much finer material, either fluvial in origin or dominated by suspended sediment from the coastal zone, with some of the more coastal fine sands likely to be seen in the entrance to the harbour. Tidally the entrance forms no strong barrier to sediment transport and the control is more formed by the presence of the headland at the Nothe and the piers.

What is not indicated in the DHI (2017) conceptual model, but which are also worth noting are:

- In March of each year, along the section from Jubilee Clock to Pavilion Peninsula, sand is moved by Weymouth Town Council from the inter-tidal area to the upper parts of the beach to build-up the dry-beach area for amenity purposes.
- Gradual loss of sand occurs from the southern section of the beach due to removal of wind-blown sand that encroaches onto the promenade/seawall and road behind the beach (and is then removed from the system as waste – not replaced on the beach).

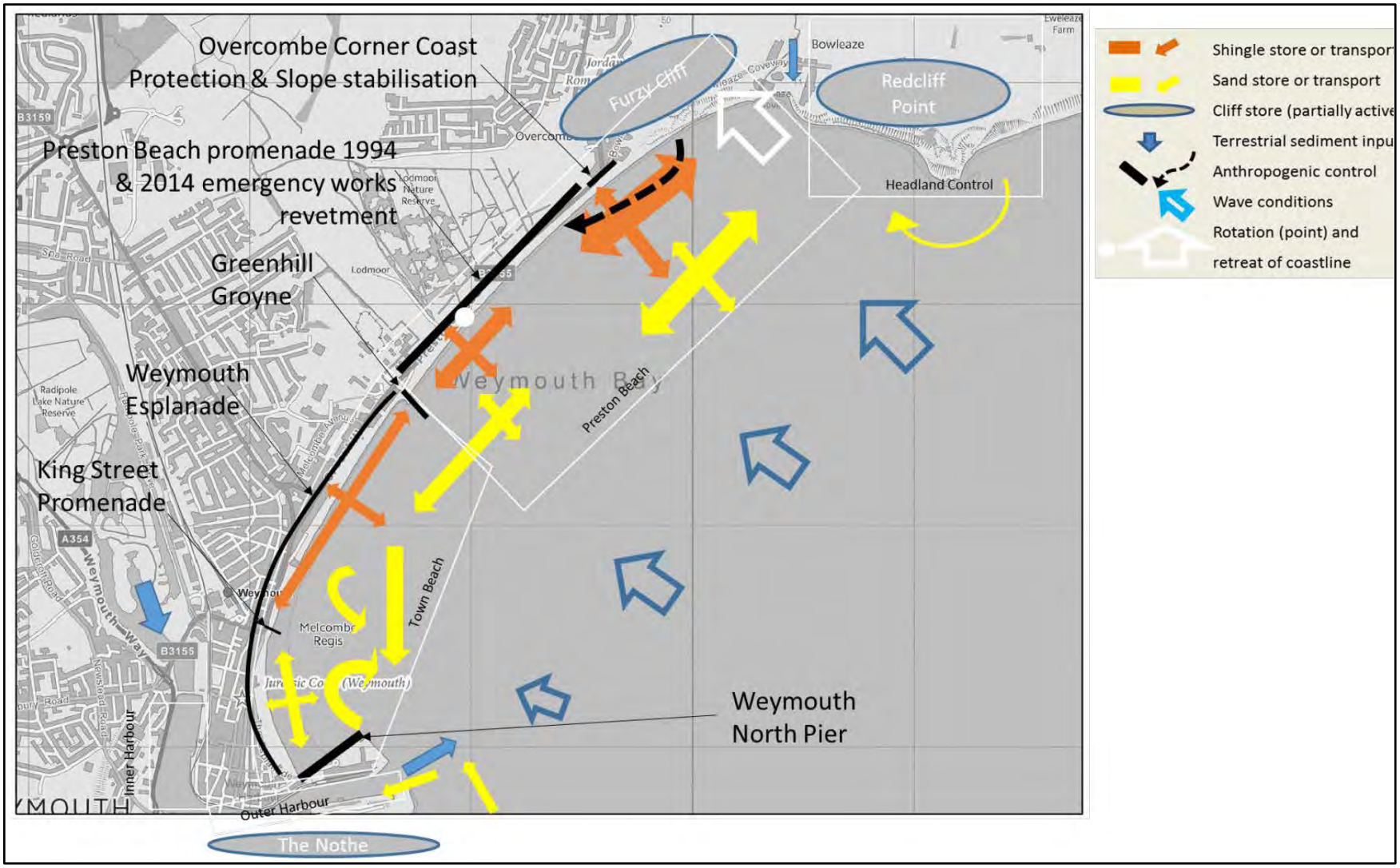


Figure 2-8 Conceptual model of the sediment transport processes operating in Weymouth Bay (DHI, 2017).

2.6 Shoreline evolution

There have been many studies over the years that describe how the shoreline of Weymouth Bay has evolved over geological time-scales, and a useful summary of the longer-term evolution of the shoreline is provided in Section 7 of **Appendix C**.

This section focusses on the key present day, contemporary processes driving current and future shoreline evolution along the BMP frontage, derived from analysis of monitoring data and numerical modelling.

2.6.1 Beach profile analysis of contemporary shoreline changes

Beach profiles along the study frontage have been monitored consistently as part of the South-East Regional Coastal Monitoring Programme (SERCMP) since 2003; this includes both planned surveys twice per year and additional post-storm surveys (typically within 24 hours of a storm event).

Prior to this, beach profile surveys were carried out by WPBC. This section draws upon the available beach profile survey data to provide assessment of contemporary changes in the beach area specifically.

2.6.1.1 Beach cross-sectional area changes

Changes in the Cross-Sectional Area (CSA) for each profile location observed between spring 2003 and spring 2017 are presented in the SERCMP Annual Report 2017 (CCO, 2017). These changes are presented in **Figure 2-9** and reflect CSA trends above a baseline level of MHWS (-0.83mOD).

From these changes over the past 14 years, it is evident that most of the frontage has accreted by at least 10% of CSA over the period, and at least double that immediately north of the Pier Bandstand (profile 5g00320) and immediately south of the Jubilee Clock promontory (profiles 5g00324 and 5g00326). There has been relatively little change between the Jubilee Clock and the Pier Bandstand (profile 5g00322). Whilst erosion appears to have occurred along the more southern and central part of Greenhill Beach (profiles 5g00316 and 5g00318); CCO (2017) states that the 2003 CSA values for these profiles was relatively high and may account for the decrease in CSA seen here as more recent years (e.g. spring 2016 to spring 2017) has seen accretion in these profiles.

Figure 2-9 CSA changes for profiles monitored as part of the SERCMP between spring 2003 and spring 2017 for the area between Greenhill Groyne and the Pavilion Peninsula (from Channel Coastal Observatory, 2017).

2.6.1.2 Beach volume changes

The beach profile data collected by the SERCMP and Dorset Council has been analysed as part of this study using Jacobs' SANDS Asset Management System to assess changes in beach volume along the study frontage. This analysis was carried out using both the same master profile as described above for CSA (i.e. MLWS, -0.83mOD), and using a master profile of MHWS (+1.17mOD). The outputs are provided in **Figure 2-10** and **Figure 2-11** respectively, and present the volume changes above both master profiles for:

i. the study frontage as a whole,

ii. the sand beach section between the Pavilion Peninsula and Jubilee Clock (profiles 5g00330 to 5g00322), and

iii. the section of beach between the Jubilee Clock and Greenhill Groyne (profiles 5g00322 to 5g00311 (located immediately north of the Greenhill Groyne – not shown on **Figure 2-9** above).

From **Figure 2-10** and **Figure 2-11**, it is evident that overall along the whole study frontage that there has been a net trend of accretion in volume since 1995 (first survey date), though this is largely driven by accretion of the sand beach section as there has steady increase in beach volume to present day. The shingle section of beach north of the Jubilee Clock promontory has, overall, experienced relatively little net change in volume over the past 20 years or so.

In viewing this data, it is important to note the following limitations in the analysis:

- Not all profiles extend to MLWS so the volume variations shown in **Figure 2-10** should be treated with caution. However, all profiles extend to at least MHWS and as the trends shown in **Figure 2-11** are similar to those in **Figure 2-10**, some confidence can be given to the volume analysis.
- Analysis of volumes to a fixed horizontal baseline such as MHWS or MLWS provides basis for relative volume changes but does not indicate actual sediment volume along the frontage. To achieve that a new "master profile" would need to be defined that better reflects the bed levels beneath the beach.
- The impacts of annual recycling of the sand section of beach each spring are not factored into the analysis of the southern section of beach.

  In this area in March of each year, sand is moved from the inter-tidal area to the upper parts of the beach to build-up the dry-beach area for amenity purposes. Beach recycling logs of this activity have only been kept since 2016 and contain limited information. A pre- and post-recycling survey by CCO in March 2017 provides the only, albeit limited, quantifiable information about the amounts of sediment placed in the upper beach, with a net increase of about +2,500m^3 above the MHWS master profile level between profiles 5g00330 and 5g00326 resulting from the recycling works that year.
- The impacts of occasional re-modelling of the sand section of the beach for events such as the annual beach moto-x is not made, although sand is built up and then re-distributed in the same area and so impacts are likely negligible compared to other factors.
- No account for gradual loss of sand from the southern section of the beach due to removal of wind-blown sand that encroaches onto the promenade/seawall and road behind the beach (and is then removed from the system as waste – not replaced on the beach) is made due to lack of data on the typical volumes removed as waste each year.

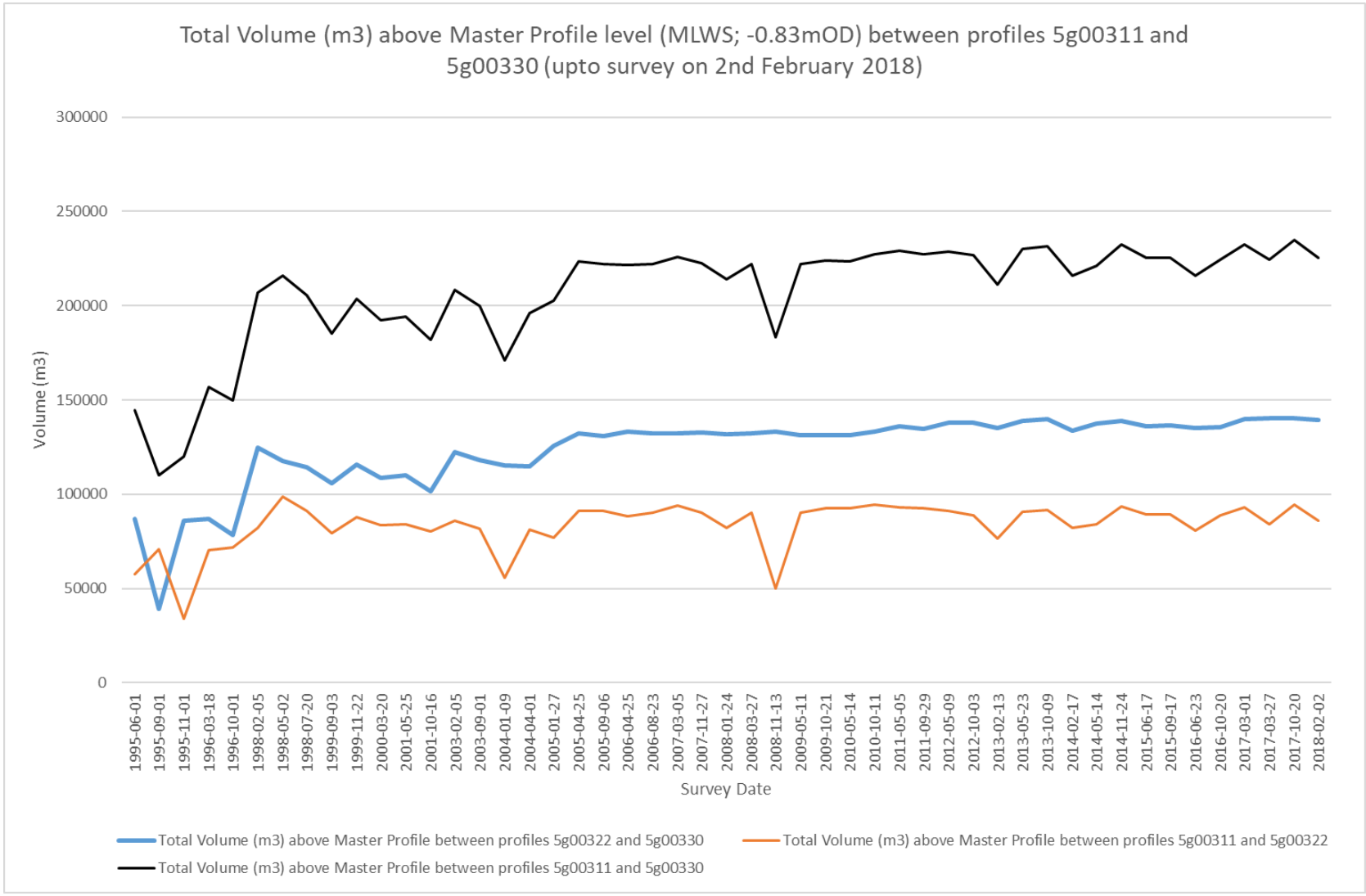


Figure 2-10 Volume changes above MLWS along study frontage between June 1995 and February 2018.

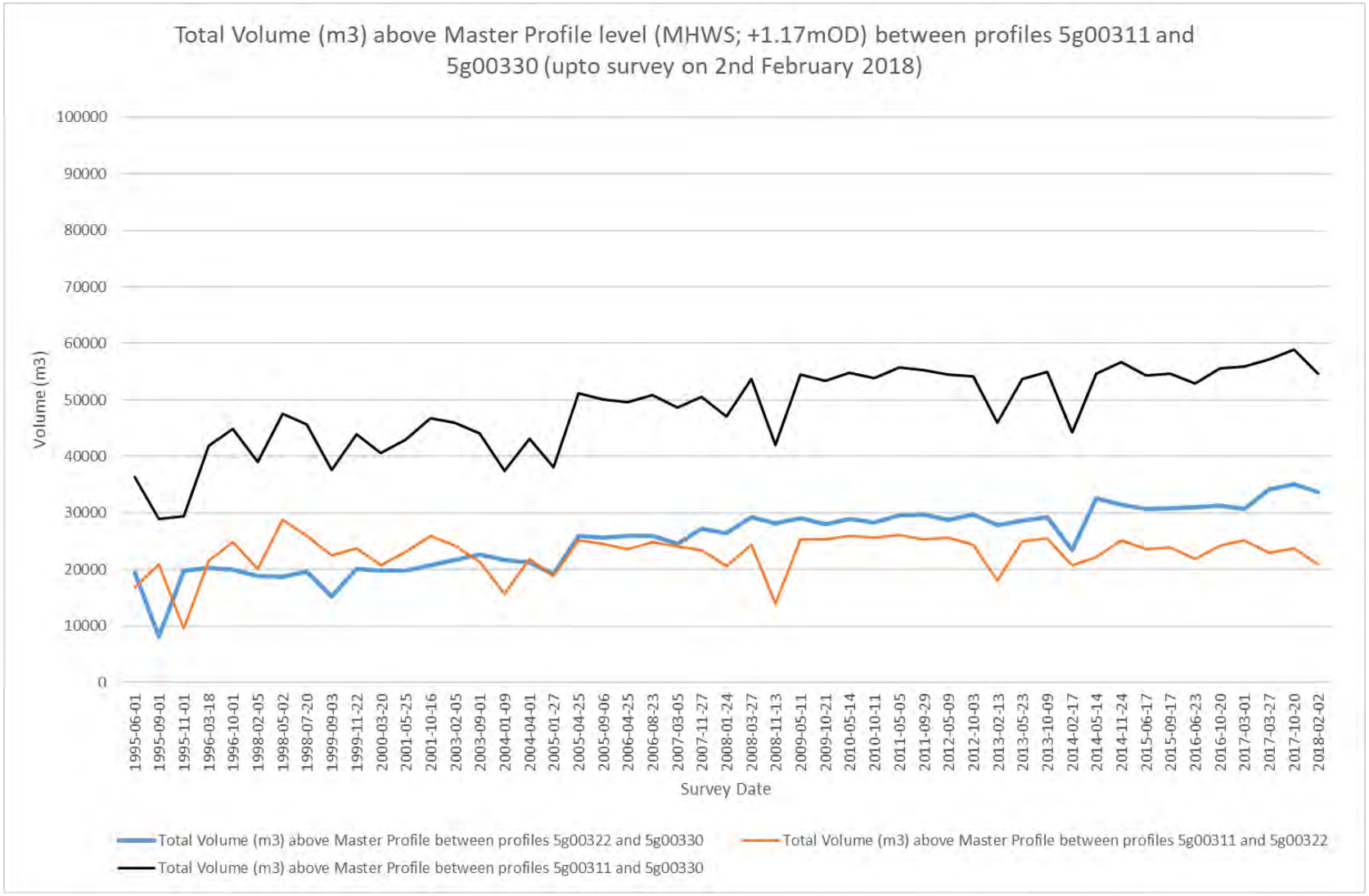


Figure 2-11 Volume changes above MHWS along study frontage between June 1995 and February 2018.

2.6.1.3 Beach profile storm response

2.6.1.3.1 Review of beach profile post-storm survey data

As part of the SERCMP, post-storm surveys can be 'called out' by the Environment Agency or Dorset Council to capture in a quantifiable way, changes to the beach along the study frontage following storm events. For the study frontage however, only two post-storm surveys have been undertaken.

The first post-storm survey was captured in February 2014 following a series of large storm events from the south-west that impacted many areas along the coast of England and Wales that winter. Beach profiles were surveyed for all profile locations (see **Figure 2-9** above). Comparison to the previous survey (which was conducted in October 2013) indicates that over the entire study frontage between 10,000 and 15,000m^3 of sediment was moved from the beach area above MHWS and MLWS respectively. Review of the beach profiles for this event shows the following:

- Along the Greenhill Beach section (profiles 5g00312 to 5g00318) the profile typically shows draw-down of beach (shingle) sediment from the upper profile to the lower profile.
- Between the Pier Bandstand and Jubilee Clock (profile 5g00322) negligible change is evident as a result of the storm events.
- The sand beach south of the Jubilee Clock (profiles 5g00324 to 5g00330) show negligible change in the uppermost part of the profile adjacent to the seawall, but does show evidence of draw-down of sediment from the upper to mid-section of beach (around MHW level) towards the lower part of the profile (around MLW mark).

The second post-storm survey was captured on 7th March 2018 after an easterly storm event a few days previously, although only profiles south of the Pier Bandstand were surveyed (from 5g00322 to 5g00330). The impacts of this storm can therefore only be considered for this area, and when compared to the previous survey captured on 2nd February 2018 shows that the volume of sediment lost above the MHWS level was about 5,000m^3. Review of the beach profiles for this event shows the following:

- Between the Pier Bandstand and Jubilee Clock (profile 5g00322) negligible change is evident as a result of the storm event along most of the profile, although a small reduction in profile levels is evident in the area between MHW and MLW levels.
- The sand beach south of the Jubilee Clock (profiles 5g00324 to 5g00330) shows negligible change in the uppermost part of the profile adjacent to the seawall, but does show evidence of draw-down of sediment from the upper to mid-section of beach (above the MHW level) towards the lower part of the profile (around MLW mark). This led to cliffing of the sand beach evident in the profile, best illustrated in **Figure 2-12**.

Figure 2-12 Photo of storm impacts on the sand section of beach in early March 2018 (photo copyright Dorset Echo, 2018).

2.6.1.3.2 XBeach modelling of beach response to extreme conditions

The beach along the study frontage forms a significant part of the coastal defence system, and so the beach levels and profile before and during extreme events are controlling factors on the overtopping severity. JBA (2019a) undertook a limited beach-profile response modelling exercise using the XBeach suite of numerical models to provide assessment of how the beach responds to extreme events and how this may impact overtopping rates of the promenade/seawall. This analysis utilised a limited number (three) of joint extreme wave and water levels conditions representing the 1:50, 1:100 and 1:200 year return period events that give the worst-case wave overtopping conditions from the *Weymouth Bay Coastal Processes Study* outputs (see **Section 2-3**). The analysis was split into two parts using different models of the XBeach suite reflecting the variation in sediment grading along the frontage.

The JBA (2019a) report provides full details of this work. The following are the key conclusions from this report:

- The variation in wave height for each of the three return period conditions modelled is so small that the erosive response of the beach profile is very similar for each event, and, while erosion of the beach face exists, sediment is deposited at the toe of the wall for all scenarios. This is likely attributed to the high still-water level and relatively low wave height combination used, promoting onshore transport for the preferred model set-up.
- Modelling showed a general reduction in the steepness of beach profiles, though no significant differences between the three return period conditions modelled are visible. A trend of erosion was seen on the upper beach, and accumulation of the lower beach [indicating sediment draw-down].

- Modelling outputs do demonstrate the differences in controlling mechanism for worst case wave-overtopping (still-water level) and erosion of the beach (wave height), and that the combination of events and results available for and modelled in this study are unlikely to result in the worst-case beach profile that would lead to greater overtopping severity.

In viewing these results, it is important to recognise the limitations in the modelling approach taken, summarised by JBA (2019a) as being:

- XBeach modelling was undertaken in 1D and assuming perpendicular wave approach;
- The timing and high energy events between the profiles used for model validation introduces a high degree of uncertainty. Particularly for profiles more influenced by accretion from longshore transport;
- Each model assumes a uniform sediment D_{50} across the entire profile. This contributes to the poor model performance for the northern sections where the beach is composite shingle (upper) and sand (surf-zone);
- An assumption of morphological response when wave height is greater than 2.25m was made for the validation and design boundary conditions;
- The design events are controlled by still-water level and have little variation in wave height. This results in very similar eroded beach profiles which are not believed to be representative of the extreme response.

Based on the work undertaken and the findings from it, JBA (2019a) recommend the following actions be considered to increase understanding of the storm response of the beach:

- More regular monitoring of beach levels (pre- and post-storm) to allow for a more accurate model calibration and validation;
- Given the recent advances in joint probability modelling (e.g. the Environment Agency's State of the Nation Project) it is recommended that further assessment of the extreme conditions within Weymouth Bay be undertaken;
- Consideration of additional joint-probability extreme events (e.g. high wave height and lower still-water level combinations) to better understand the extreme erosion potential along beach profiles;
- Consideration of 2D modelling of extreme events to better represent and understand the variation in the beach response along the study frontage.

2.6.1.4 Summary

Overall, although the quantifiable evidence from post-storm surveys is minimal and the findings from XBeach modelling by JBA are limited, overall the data available does confirm the analysis of previous studies that it is storm-driven gross transport of sediment cross-shore that poses the greatest risk of coastal flooding and erosion along the study frontage.

2.7 Environmental Characteristics

This section provides an overview of the environmental setting and identifies key environmental features within the vicinity of study area (refer to **Figure 1-1** above). The section draws much of its information from the Preliminary Environmental Information Report (PEIR) prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019), and is structured around a number of environmental topics as highlighted in the first column of **Table 2-5**. These follow the recommended structure contained in the Beach Management Manual (CIRIA, 2010). The second column in **Table 2-5** makes reference to the environmental aspects documented in Annex 4 of the European Union Directive 2011/92/EU '*on the assessment of the effect of certain public and private project on the environment*' (the EIA Directive). This is provided by way of cross-reference to the EIA requirements such that the information in this study (and the preceding *Weymouth Bay Coastal Processes Study*) is able to be developed further should the need arise at a future date, e.g. if future works are needed that are determined to present a significant scale or impact as to need a statutory Environmental Statement (ES) to accompany consent applications.

Table 2-5 A summary of environmental topic and cross-reference to EIA Directive topics

Environmental topics (with reference to CIRIA, 2010)	Reference Annex 4 of the EIA Directive
Geology and Geomorphology	Soil
Sediment quality	Soil
Water quality	Water
Ecology	Flora and Fauna
Fisheries	Material Assets
Navigation	Material Assets
Landscape setting	Landscape
Archaeology and Cultural Heritage	Material Assets
Air quality	Air
Noise	Population
Amenity value	Population

2.7.1 Geology & geomorphology

There are no designated sites within the study area that are designated for their geological or geomorphological characteristics, although there are some features within 2km of the study area that are designated for such features, including:

- Dorset and East Devon UNESCO World Heritage Site.
- South Dorset Coast SSSI
- Geological Conservation Review (GCR) site 1863 (Furzy Cliff to Peveril Point).

None of the geological or geomorphological features of these sites are predicted to be impacted by future coastal risk management measures along the southern end of Weymouth Bay that is the focus of this beach management study. As such, the following provides an overview of the geology and geomorphology of the study area only, which underpins ecological and other environmental interests as described in other sections of this report.

2.7.1.1 Geology

The PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019) summarised the geology of the study area as follows:

- The British Geological Survey (BGS) geological map of West Fleet and Weymouth (Sheet 341 & 342) shows alluvium and Oxford Clay outcropping in the proposed site area, in some localities the Oxford Clay deposits are up to 150m thick, but the extent of weathering around the Weymouth outcrop is unknown.
- A site investigation along Preston Beach (to the north-east of the study area) in 1994 identified variable thicknesses of beach deposits underlain by alluvium, sand and gravels and then by Oxford Clay, which generally included at least a 1m thick weathered horizon.
- A site investigation at the Ferry Terminal (Pavilion Peninsula at the southern end of the study area) in 2001 identified made ground that consisted of cohesive and granular composition, this is underlain by alluvial deposits which also vary in consistency and are underlain by Oxford Clay.

- Previous intrusive investigative works at Weymouth Pavilion identified made ground (hard standing, granular & cohesive) underlain by sandy gravels with reworked Oxford Clay with un-weathered Oxford Clay beneath.
- BGS public boreholes enable an overall understanding of the geological conditions around Weymouth. These show alluvial deposits have been identified in the majority of boreholes but the composition varies between cohesive and granular, sand and gravel deposits have also been identified to the north east and south of the study area.
- The extent of sand and gravels seems to peter out to the north/north-east with a covering of cohesive alluvium which potentially offers a natural inhibitor to groundwater flow.
- The channel bed in the harbour appears to be alluvial deposits / Oxford Clay.

2.7.1.2 Geomorphology

A number of studies have investigated the alongshore and nearshore sediment transport pathways along the study frontage (and within the wider Weymouth Bay) that give rise to the geomorphological characteristics of the area. Refer to **Section 2.5.2** for details.

2.7.2 Sediment quality

Sediment along the study frontage is largely natural, having never undergone any beach recharge from external sources. Some finer sediment accumulating in the southern end of the study area may, however, include non-native sand derived from the Preston Beach area in the northern part of Weymouth Bay, that section having been recharged with a shingle-sand sediment mix (ratio approximately 75 % shingle, 25% sand) in 1995/6 (refer also to Environment Agency, 2016). No recent sediment grain size analysis nor chemical analysis of beach sediments samples along the study area has been reported in available literature since this data. Refer to **Section 2.5.1** for further details.

2.7.3 Water quality

2.7.3.1 Water Framework Directive

The Water Framework Directive (WFD) (2000/60/EC) was given effect in the UK by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The WFD was put in place to:

- Enhance the status, and prevent further deterioration of aquatic ecosystems and associated wetlands which depend on the aquatic ecosystems;
- Promote the sustainable use of water;
- Reduce pollution of water, especially by ‘priority’ and ‘priority hazardous’ substances; and
- Ensure progressive reduction of groundwater pollution.

The WFD set the objectives for all water bodies in Europe classified under the WFD and the requirement that they should reach at least “good” status (or potential) by 2015. To achieve this “good” status, the WFD required river basin districts, each with their own management plan, to be established. For this study area, the relevant management plan is the South West River Basin Management Plan (RBMP). The first RBMP was published by the Environment Agency in 2009 and they are currently in the process of being updated (refer also to **Section 1.7.6**).

Water quality monitoring is undertaken to monitor compliance with WFD “good” ecological status in accordance with the requirements set out in the *South West RBMP*. Weymouth Bay is located within a designated Coastal Water Body that is defined as “heavily modified” in terms of its hydro-morphological status, and “good” in terms of its overall ecological status.

As part of the PEIR for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019), a WFD Assessment was completed for the preferred future management option along the study area and adjacent Weymouth Harbour area. Refinement of this WFD Assessment would be required at the point in the future

where more detailed designs are developed to implement the future coastal risk management approach along Weymouth Beach.

2.7.3.2 Designated bathing waters

The study area and wider Weymouth Bay is a designated bathing water area in accordance with the EU Bathing Water Directive 1976 (updated 2006). Water quality monitoring occurs at three locations around Weymouth Bay between 1st May and 30th September each year, as follows:

- **Weymouth Central** (within study area) – rated EXCELLENT in 2018; see bathing water profile online: http://environment.data.gov.uk/bwq/profiles/profile.html?site=ukk2206-20700 (accessed: 03-12-2018).
- **Weymouth Lodmoor** (located just north of Greenhill Groyne) – rated EXCELLENT in 2018; see bathing water profile online: http://environment.data.gov.uk/bwq/profiles/profile.html?site=ukk2206-20600 (accessed: 03-12-2018).
- **Bowleaze Cove** (located at the north end of Weymouth Bay) – rated EXCELLENT in 2018; see bathing water profile online: http://environment.data.gov.uk/bwq/profiles/profile.html?site=ukk2206-20400 (accessed: 03-12-2018).

2.7.4 Ecology

2.7.4.1 Statutory Designated Sites

There are no nature conservation designations directly within the study area. However, there are a number of nature conservation designations within 2 to 5km of the study area that will require consideration when planning and implementing future coastal flood and erosion risk management activities along the study area at Weymouth (see **Figure 2-13**). These are identified in the PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019) and described in **Table 2-6**.

Table 2-6 Statutory designated sites in vicinity of the study area (from PEIR prepared by JacksonHyder, 2019)

Designated Site	Interest Features
Chesil Beach and The Fleet SPA, SAC and Ramsar site	The SAC supports the following Annex I habitat types: coastal lagoon, annual vegetation on drift lines, perennial vegetation on stony banks and Mediterranean and thermo-Atlantic salt- tolerant scrub. The SPA supports a large assemblage of overwintering dark-bellied brent geese (*Branta bernicla*). The Ramsar site supports nationally scarce wetland plants and animals and provides an important nursery for bass (*Dicentrarchus labrax*).
Isle of Portland to Studland Cliffs SAC	Designated for supporting the following Annex I habitat types: Vegetated sea cliffs of the Atlantic and Baltic coasts and semi-natural dry grasslands and scrubland facies on calcareous substrates. In addition, the SAC also supports populations of Early Gentian (*Gentianella anglica*).
Crookhill Brick Pit SAC	Supports regionally-important breeding populations of great crested newt (*Triturus cristatus*)
Radipole Lake SSSI	Supports a variety of wetland habitats, including a lake and extensive reedbeds which have formed since the exclusion of tidal water in the 1920s. It supports a diverse assemblage of invertebrates and is considered to be of importance for birds as a breeding, wintering and passage site.
Lodmoor SSSI	Supports an area of reedbed and brackish grassland, which, has been excluded from regular tidal inundation since the 1920's. The SSSI is designated for supporting waders on passage and wildfowl in winter.

Designated Site	Interest Features
Portland Harbour Shore SSSI	The cliffs along the north-western shore of Portland Harbour, are considered to be of great geological importance.
Lorton SSSI	Designated for its geological interest and for supporting herb-rich neutral grassland habitat and semi-natural woodland.
South Dorset Coast SSSI	Internationally important geological interest with a rich range of habitats including, unimproved grassland and scrub and woodland.
Chalbury Hill and Quarry SSSI	Of geological importance and supports herb-rich calcareous grassland.

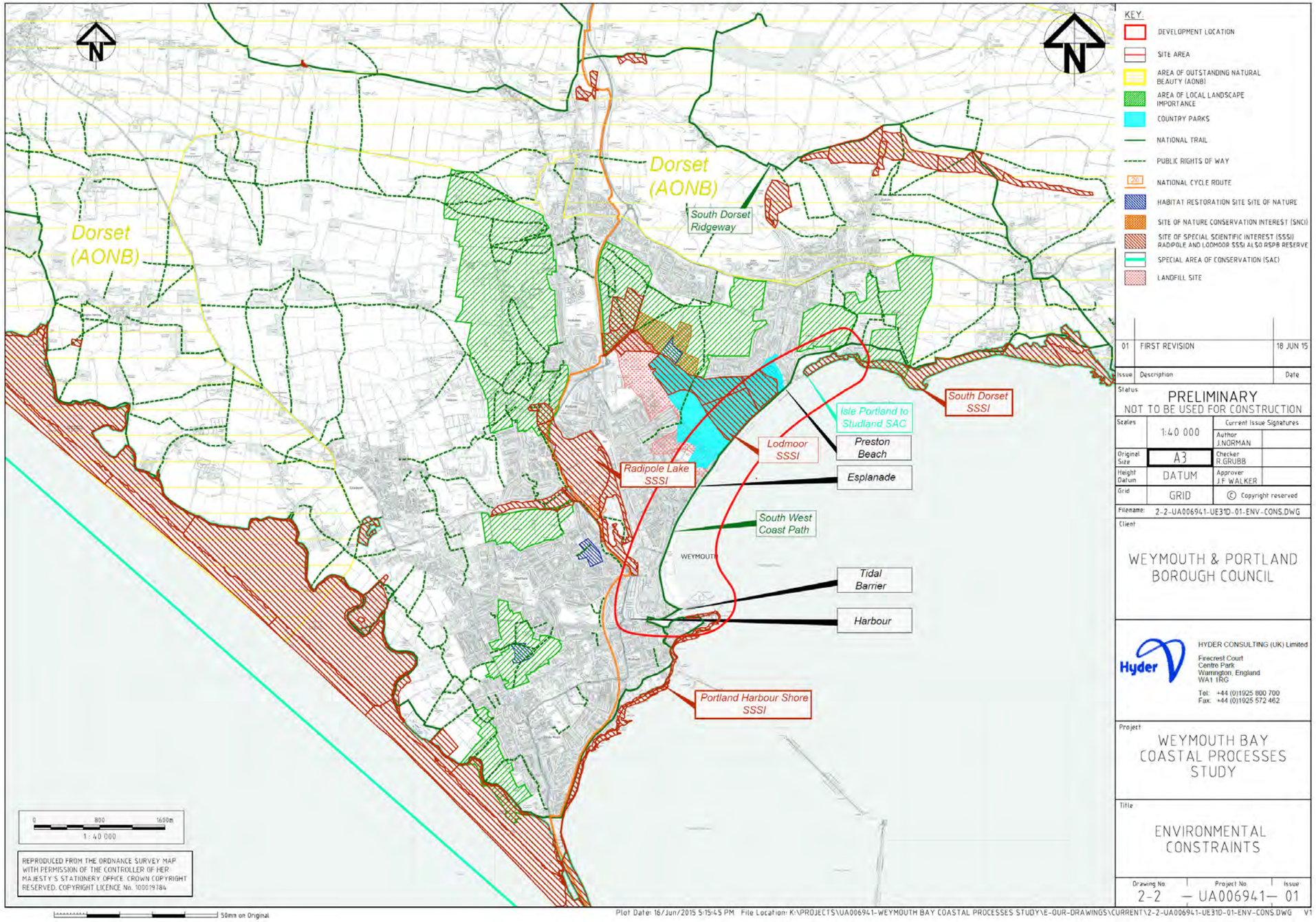


Figure 2-13 Map of nature conservation designations in vicinity of the study area in the southern portion of Weymouth Bay (from JacksonHyder, 2019).

2.7.4.2 Non-Statutory Designated Sites

The PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019) identifies 4 non-statutory designated SNCIs within 2km of the study area, namely:

- Melcombe Regis Cemetery SNCI
- Little Francis SNCI
- Lodmoor North SNCI
- Overcombe SNCI.

The PEIR considered that these non-statutory sites are unlikely to be directly affected by any coastal flood defence proposals along the Weymouth Beach study area due to the distance from the study area and the lack of direct impact pathways (JacksonHyder, 2019).

2.7.4.3 Biodiversity

The Dorset Biodiversity Strategy (Dorset Biodiversity Partnership, 2003) and Action for Biodiversity in the South West (South West Regional Biodiversity Partnership, 2004) are the relevant biodiversity plans for the study area. There is currently no local Biodiversity Action Plan (BAP).

The following sections summarise information about plants and habitats in the vicinity of the study area identified in the PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019), which itself drew upon data obtained from the Dorset Environmental Records Centre (DERC).

2.7.4.3.1 Plants and Habitats

DERC data shows several notable plant species recorded for sites within 1km of the study area. These include several species regarded as nationally scarce, namely Large-leaved Lime (*Tilia platyphyllos*), Yellow-vetch (*Vicia lutea*), and Curved Hard-grass (*Parapholis incurva*). None of the plant species were observed by JacksonHyder during a site walkover in May 2014 and it is considered unlikely they would be present within the immediate study area (JacksonHyder, 2019).

DERC data also records the marine species Eelgrass (*Zostera marina*), regarded as a scarce species in Dorset, being present within 1km of the study area. These records were associated with various coastal locations within Weymouth, including Castle Cove, Sandsfoot Beach and Newton's Cove. Areas of Eelgrass may be affected if future coastal flood and erosion risk management options involve the construction of nearshore/offshore structures.

2.7.4.3.2 Invasive Plant Species

DERC data shows several invasive plant species recorded as being located within 1km of the study area. These include records for Japanese Knotweed (*Fallopia japonica*), Virginia-Creeper (*Parthenocissus quinquefolia*), Canadian Waterweed (*Elodea canadensis*) and Japanese Rose (*Rosa rugosa*). None of the plant species were observed by JacksonHyder during a site walkover in May 2014 and it is considered unlikely they would be present within the immediate study area (JacksonHyder, 2019).

2.7.4.3.3 Terrestrial and Aquatic Invertebrates

DERC data shows numerous notable invertebrate species recorded as being located within 1km of the study area, the majority were associated with Radipole Lake and Lodmoor SSSI's. The PEIR (JacksonHyder, 2019) considered that invertebrate species within Radipole Lake and Lodmoor SSSI's are unlikely to be directly affected by the coastal flood and erosion risk management proposals for the study area due to the distance from the study area and the lack of a direct impact pathway.

2.7.4.3.4 Amphibians

DERC data shows one great crested newt record for Furzy Cliffs which is 2km north of the study area. As the study area is largely urban or marine with no areas of freshwater habitat suitable to support great crested newt, it is considered unlikely that they would be present within the immediate study area (JacksonHyder, 2019).

2.7.4.3.5 Reptiles

DERC data shows one adder (*Vipera berus*) record from Furzy Close, Weymouth located within 1km of the study area. As the study area is largely urban or marine with no areas of habitat suitable to support reptiles they are unlikely to be present within the immediate study area (JacksonHyder, 2019).

2.7.4.3.6 Birds

DERC data shows a large number of notable bird species being recorded within the vicinity of the study area, the majority of which were associated with Weymouth Bay, Portland Harbour and Lodmoor SSSI.

The PEIR (JacksonHyder, 2019) assessed that bird species within Radipole Lake SSSI and Lodmoor SSSI are unlikely to be directly affected by the planned future coastal flood and erosion risk management activities for the study area, due to the distance from the study area and the lack of a direct impact pathway. However, the PEIR did note that bird species using the marine environment could potentially be affected by planned future coastal flood and erosion risk management activities dependent on the location and scale of future works.

2.7.4.3.7 Mammals

- **Bats**

DERC data indicates a number of bat species recorded as being located within 1km of the study area, the vast majority of which were associated with Horse Lynch Plantation (which is located adjacent to Lodmoor SSSI) and Radipole Lake SSSI. This includes records for Daubenton's bat (*Myotis daubentonii*), serotine (*Eptesicus serotinus*), noctule bat (*Nyctalus noctula*), common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*) and long-eared bats (*Plecotus* sp.).

DERC data also shows ten bat roost sites within 1km of the study area, all located within the urban area of Weymouth. Records for these roost sites include common pipistrelle, noctule bat, serotine and a long-eared bat species.

The PEIR (JacksonHyder, 2019) identified no structures considered suitable for roosting bats as being in close proximity (50m) to the study area, and that the planned future coastal flood and erosion risk management activities for the study area are unlikely to affect bat species.

- **Otter and Water Vole**

DERC data includes records for both otter (*Lutra lutra*) and water vole (*Arvicola amphibius*) within 1km of the study area. The vast majority of these records were associated with Radipole Lake and Lodmoor SSSI's. The immediate environs of the study area is marine with no vegetation or suitable burrowing opportunities for water voles or potential resting or lying-up sites for otters. The PEIR (JacksonHyder, 2019) considered that otters and water voles within Radipole Lake and Lodmoor SSSI's are unlikely to be directly affected by planned future coastal flood and erosion risk management activities for the study area due to the distance from the study area and the lack of a direct impact pathway.

2.7.4.3.8 Marine Species

Marine records for Weymouth Bay were provided by the DERC for the *Weymouth Bay Coastal Processes Study* PEIR (JacksonHyder, 2019). The majority of the records were associated with algae, marine

polychaete worms, crustacean, gastropod and marine bivalve species. No records of marine mammals were provided. The PEIR should be referred to for further details on the DERC data.

The PEIR assessment of the marine data determined that the majority of species recorded are common and widespread, and no significant areas of marine conservation importance have been identified. However, the PEIR does identify two species of Principal Importance for conserving biodiversity in England (listed on Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006), namely Atlantic Mackerel and Peacocks Tail. In addition, eelgrass (which grows on sandy sea beds) is an uncommon species in Dorset.

If any future coastal flood and erosion risk management solutions involve structures being located within the marine environment (for example offshore breakwaters), then there is the potential to affect marine species. The significance of this impact would be dependent upon the location and scale of the proposals. Further surveys of the marine environment may be required to assess the significance of any impacts on marine species and habitats.

2.7.5 Fisheries

The study area is within the Southern Inshore Fisheries and Conservation Authority's (IFCA) district. The main commercial fishery activity in the area is conducted by the fishing fleet based in Weymouth Harbour. The main fishery activity along the beach itself is recreational sea angling, although this is only allowed during the winter months.

There are no designated shellfish areas in vicinity of the study area. The closest area is Portland Harbour and The Fleet, about 2km to the south of the study area.

2.7.6 Navigation

The southern end of the study area is the entrance to Weymouth Harbour, which is an active port for commercial shipping (including fisheries) and recreational shipping. Safe navigation into and out of the harbour is an important consideration for future coastal flood and erosion risk management activities.

There are no other significant navigation issues in the vicinity of the study area as it is beyond the routes of commercial and other vessels transiting the English Channel further offshore. The nearshore area is, however, used by local (private) recreational boats, personal water craft, windsurfers, kite surfers and sea kayakers (though some of these activities along the study area are restricted during certain times of the year to provide safe bathing areas from the beach).

2.7.7 Landscape setting

The study area is directly within the Weymouth Town Centre Conservation Area, whilst within 2 to 5km of the study area are the following landscape designated areas:

- Dorset AONB.
- Purbeck Heritage Coast; and
- Weymouth Lowlands NCA 138.

A number of the above landscape designations are represented on **Figures 2-14 and 2-15** below. Future coastal flood and erosion risk management activities will have to consider the landscape impacts on these designations. In addition, the Dorset and East Devon Coast UNESCO World Heritage Site (WHS) is within 2km of the study area (see **Figure 2-16** below). The WHS Management Plan 2014 to 2019 refers to the 'immediate setting of the WHS' and 'important views and other areas of attributes that make the site what it is'. The WHS Management Plan refers to the need to protect this setting and highlights that the 'Outstanding Universal Value as a cultural phenomenon that means our experience of the Site and its setting is part of this equation, and it is not just protection for the intrinsic value of the geology'. As such, future coastal flood and erosion risk management activities will also need to consider impacts on setting of the WHS.

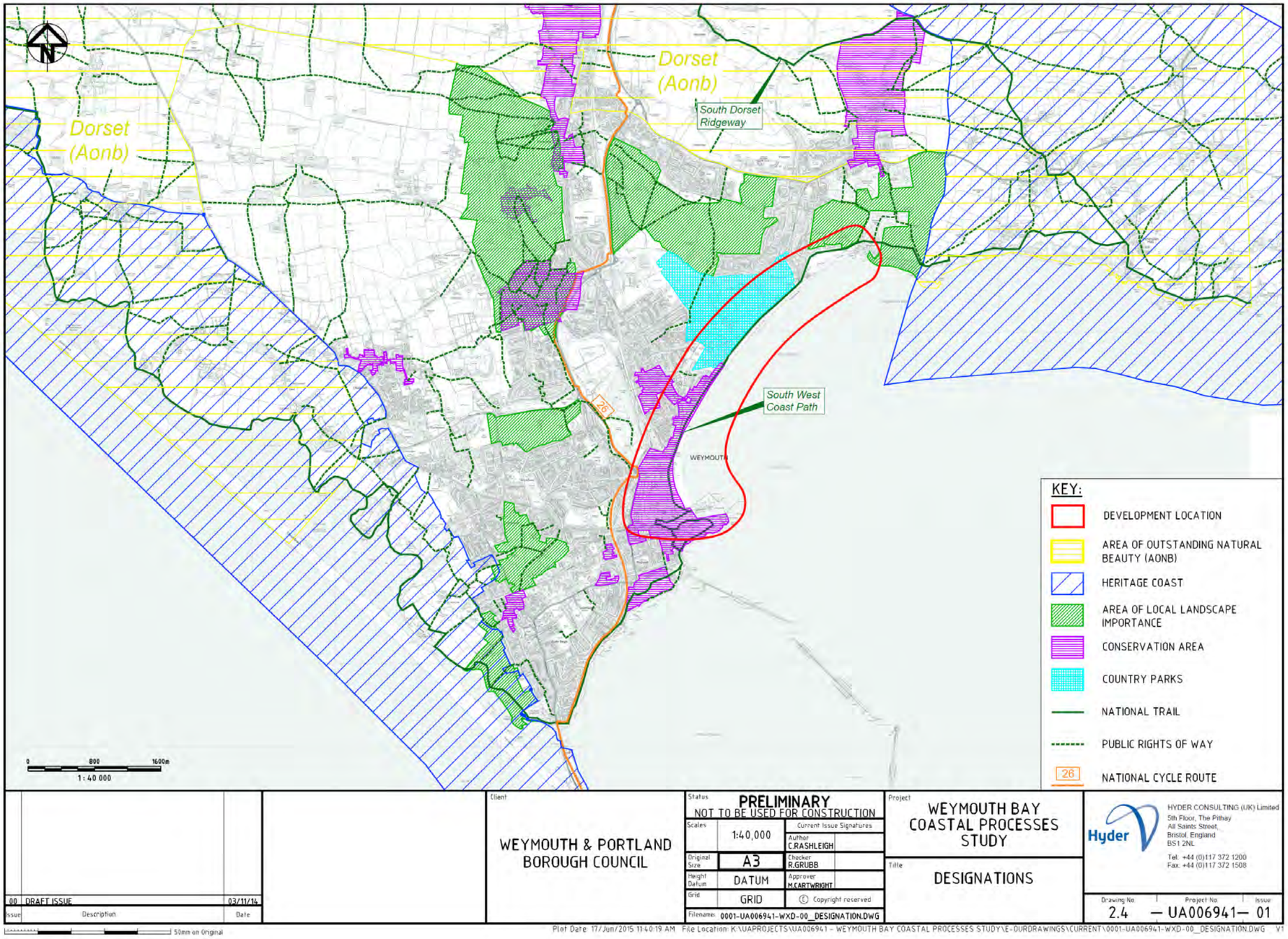


Figure 2-14 Landscape designations in the vicinity of the study area in the southern portion of Weymouth Bay (from JacksonHyder, 2019).

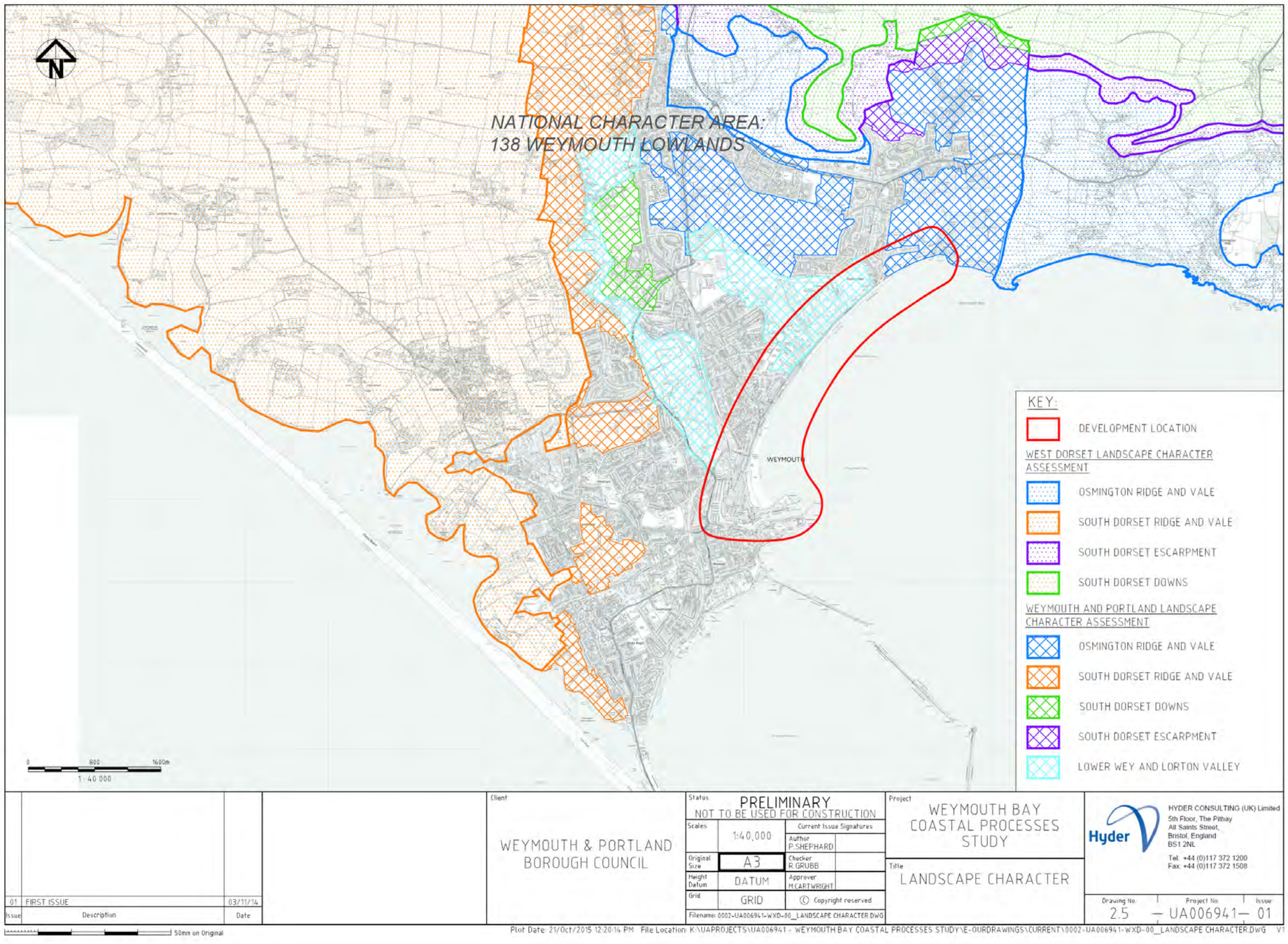


Figure 2-15 Landscape character areas in the vicinity of the study area in the southern portion of Weymouth Bay (from JacksonHyder, 2019).

2.7.8 Archaeology and cultural heritage

2.7.8.1 Designated sites

The study area fronts Weymouth town centre, within which there are many Listed Buildings designated; this area is also the Weymouth Town Centre Conservation Area. In addition, just to the south of the study area is the Nothe Fort – a Scheduled Ancient Monument (see **Figure 2-16** below).

2.7.8.2 Non-designated sites

Figure 2-16 shows that there are numerous non-designated sites/monuments recorded in the Dorset Historic Monument Record (HER), both on land and in the nearshore area of Weymouth Bay. These are sites of archaeological interest but do not hold a formal designation. There are no reported Protected Wrecks in the vicinity of the study area.

There are also a number of war memorials along the promenade within the study area recognising the contributions of armed forces during both the first and second world wars.

2.7.8.3 Unexploded ordnance

The Weymouth area was extensively bombed during World War 2 and an Unexploded Ordnance (UXO) desk study was completed as part of the Geotechnical Investigations for the *Weymouth Bay Coastal Processes Study*. This found the site to have a low to moderate risk of encountering unexploded ordnance whilst drilling boreholes. It also noted that further consideration of UXO risks will be needed before any intrusive works or construction activity, and some form of risk reduction measures, such as geophysical works, may be required (JacksonHyder, 2018; Appendix B).

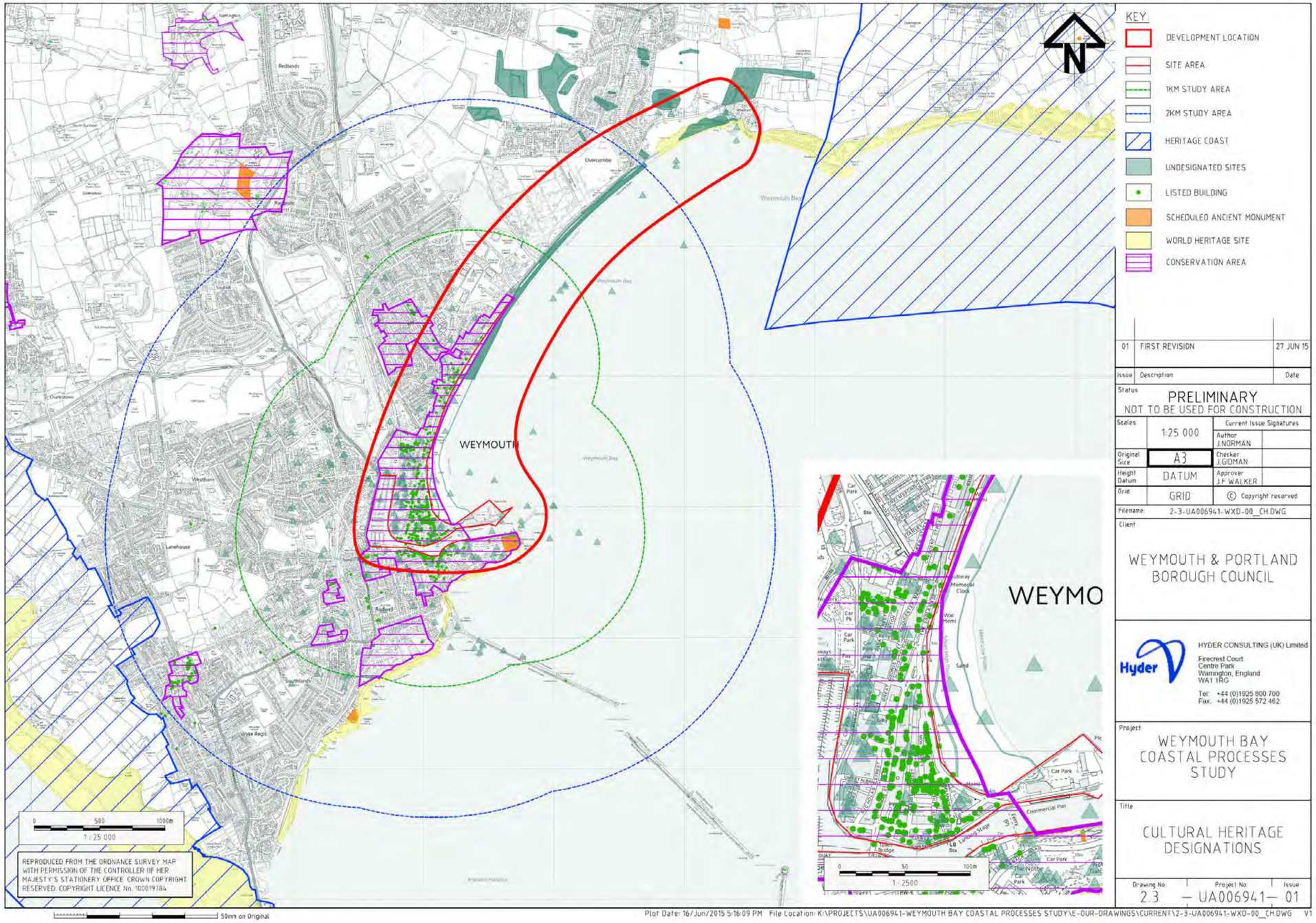


Figure 2-16 Historic environment designations in the vicinity of the study area in the southern portion of Weymouth Bay (from JacksonHyder, 2019).

2.7.9 Air quality

There are no Air Quality Management Areas in the study area. However, the PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019) notes that the only major source of air pollution within Weymouth is considered to be Nitrogen Dioxide (NO2) from vehicles. The local authority monitors NO2 at 25 sites throughout Weymouth and Portland, and monitors particulate matter (PM10) at one location in Weymouth. The worst affected area is Boot Hill, Rodwell Road (A354) in the West of Weymouth, coinciding with the busiest road in Weymouth. This area is not directly within the study area. There are no other locations within Weymouth which have exceeded any air quality objectives for PM10 or NO2.

The potential impacts of the future coastal flood and erosion risk management activities upon air quality relating to vehicle emissions are expected to be short term during the construction phase(s). These could include increased emissions due to traffic delays or traffic on diversion routes and construction vehicle movements. In addition to vehicle emissions, there is potential for dust emissions generated during construction activity. Potential impacts on air quality will need to be addressed through construction and method statements associated with any future works.

2.7.10 Noise

No baseline data on existing background noise level has been sourced for this study nor the recent *Weymouth Bay Coastal Processes Study*. This may be required prior to any future coastal flood and erosion risk management activities occurring, depending on their scale and scope to produce elevated levels of noise.

The study area is urbanised and experiences high volumes of traffic and people, especially during the summer months. The assessment made in the PEIR prepared for the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2019) identifies that local traffic, from cars and boats, is likely to be the main source of noise throughout any period of future construction works. Noise sensitive receptors include the users of the Esplanade and beach. The residents along the Esplanade will also be affected. Possible wildlife including migratory fish species in Weymouth Harbour and other fauna, such as marine mammals, are also sensitive to noise and will need to be taken into consideration. Impacts will be short term during construction only and will be addressed through construction method statements and agreed with the Environmental Health Officer (EHO). Any adverse impacts on noise through construction will need to be minimised and mitigated to reduce noise impacts where possible.

3. Scheme Design

3.1 Existing coastal defences

The present day coastal defences along the study frontage are comprised of the following elements:

- Beach;
- Seawall and promenade;
- Greenhill groyne; and
- Pavilion peninsula.

Each are described in more detail in **Sections 3.1.1 to 3.1.4**.

For reference, **Figure 3-1** indicates where the photos presented in Figures 3-2 to 3-19 are located along the study frontage.

Figure 3-1 Approximate location of photos presented in Figures 3-2 to 3-19.

3.1.1 Beach

The beaches along the study frontage vary in their sediment composition and geometry as the beach progresses from north to south.

The northern end of the study frontage between the Greenhill Groyne and Pier Bandstand is Greenhill Beach, comprised of a shingle beach with berms and cusps and with a relatively steep beach slope (compared to the beach in the southern part of Weymouth Bay (see **Figure 3-2**)). The transition in beach slope occurs around the Pier Bandstand area.

Figure 3-2 Views along Greenhill Beach (23-11-2018; photos by A. Frampton).

The sediment grading becomes more mixed shingle-sand and overall shallower gradient between the Pier Bandstand and Jubilee Clock, with more shingle in the upper slope and sand in the lower slope (see **Figure 3-3**).

Figure 3-3 Views along the section of beach between Pier Bandstand and Jubilee Clock (23-11-2018; photos by A. Frampton).

South of the Jubilee Clock to the Pavilion Peninsula the beach is largely comprised of sand and the gradient is even shallower as the beach area widens (see **Figure 3-4**). In this area wind-blown sand accumulates at the top of the beach and is often blown onto the land behind, necessitating the placement during winter months of sand netting along the railings of the seaward edge of the promenade (see **Figure 3-5**). Sand once blown off the beach is removed from the system by street cleaners as it is considered to be contaminated and so cannot be placed back on the beach.

Figure 3-4 Views along the sandy southern-most section of beach (23-11-2018; photos by A. Frampton).

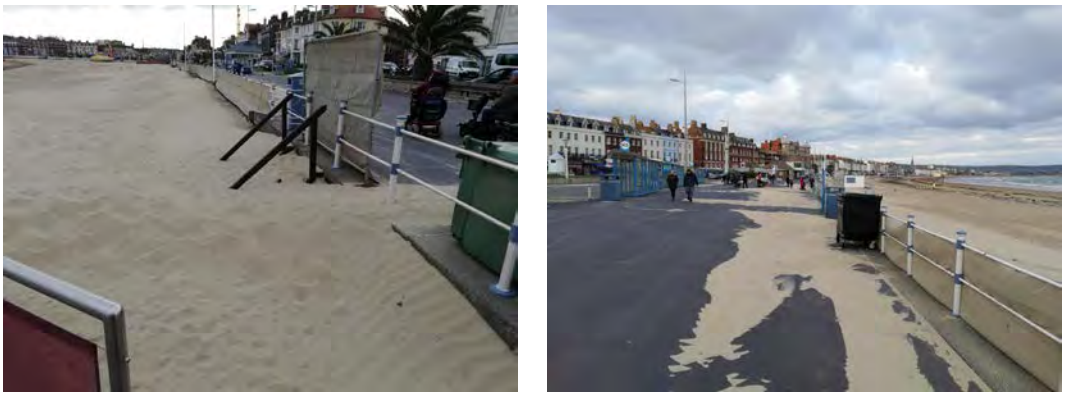
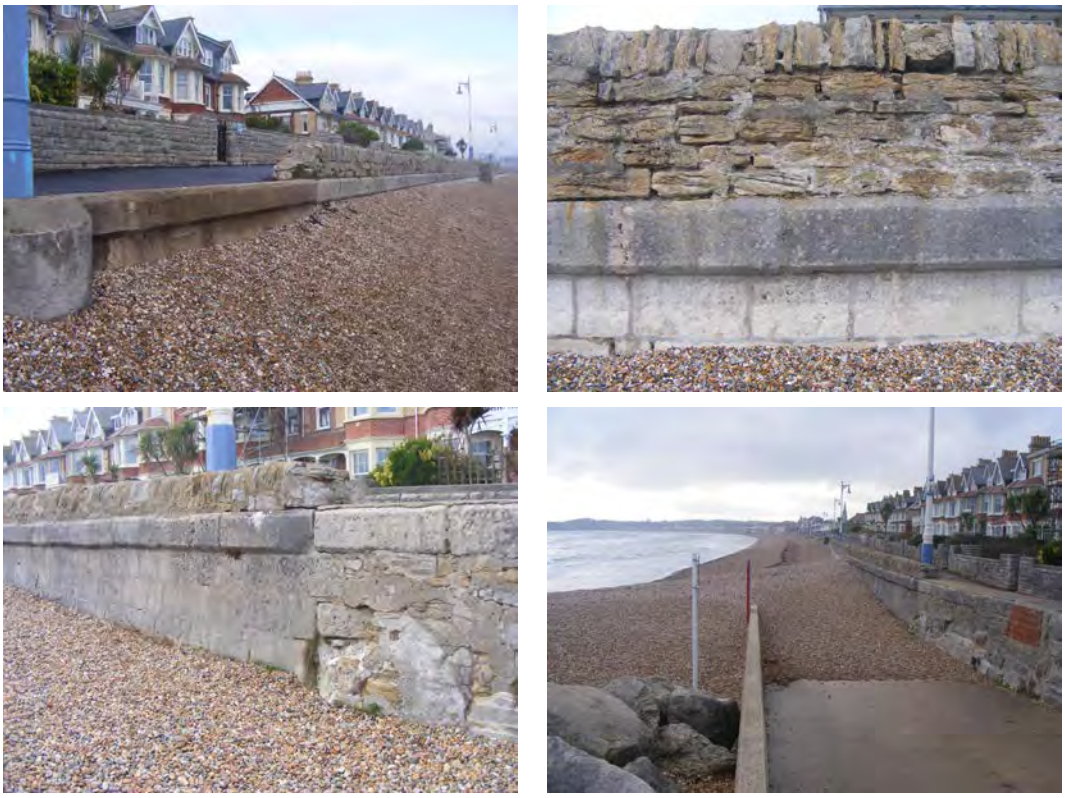


Figure 3-5 Evidence of wind-blown sand pushed up against the promenade/seawall, covering access step; also shown is sand netting placed along railings in this area each autumn/winter to reduce amount of sand blowing further landwards and evidence of wind-blown sand on the promenade (14-12-2018; photos by A. Frampton).

3.1.2 Seawall and Promenade

As described in **Appendix B**, the majority of the present seawall and promenade was constructed using masonry blocks during the mid-19th century. This wall is still the basis for the current promenade and is still visible in parts, particular towards the Pavilion Peninsula and along the northern part of the Greenhill Beach section towards the Greenhill Groyne (see **Figure 3-6**); though in places some concrete patch-repairs are evident (see **Figure 3-7**).



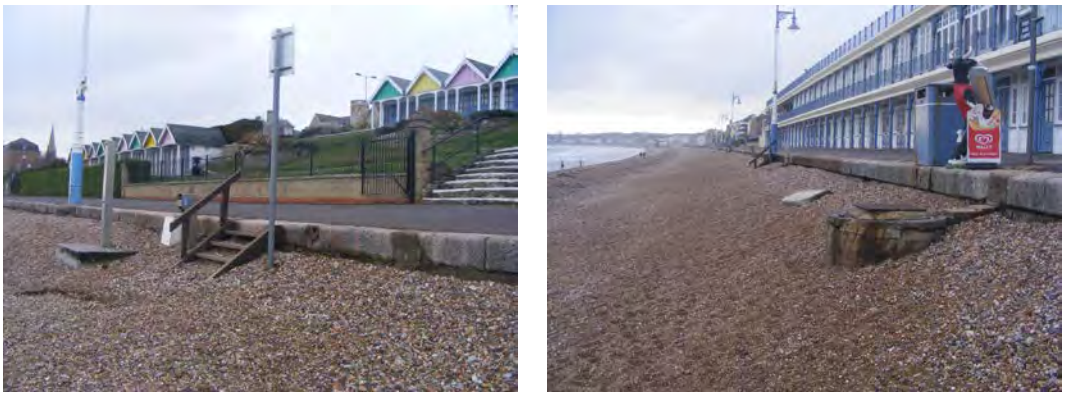


Figure 3-6 Photos of the promenade/seawall along the Greenhill Beach section of frontage, between Greenhill Groyne and Greenhill Gardens (23-11-2018; photos by A. Frampton).

Figure 3-7 Photos of the promenade/seawall along the Greenhill Beach section of frontage, between Greenhill Groyne and Greenhill Gardens, showing several areas where the seaward edge and face of the wall have previously been repaired using concrete (23-11-2018; photos by A. Frampton).

The main modifications since the mid-19th century have been:

- The wall from about adjacent the Alexandra Gardens north to the Jubilee Clock has had concrete placed over the underling masonry block wall. The concrete includes the same bull-nose feature at the crest as the wall around the Jubilee Clock (see **Figure 3-8**), therefore it is assumed this was constructed around the same time in the 1920s, but no information has been found to confirm if this was the case.

Figure 3-8 (left) photo of the concrete wall that runs for most of the length of the frontage south from Jubilee Clock to the Pavilion Peninsula; (right) photo of older masonry block wall not replaced with concrete in vicinity of Alexandra Gardens where it transitions to the steel sheet pile wall of the Pavilion Peninsula (23-11-2018; photos by A. Frampton).

- Seaward advancement of the wall around the Jubilee Clock in in the 1920s. This section of seawall is fronted by a concrete wall with a slight bull-nose at the crest (see **Figure 3-9**). There is evidence of patch-repairs to this section of the wall, which is a focus for wave energy and overtopping during storm events due to its protrusion out into the bay (see **Figure 3-10**).

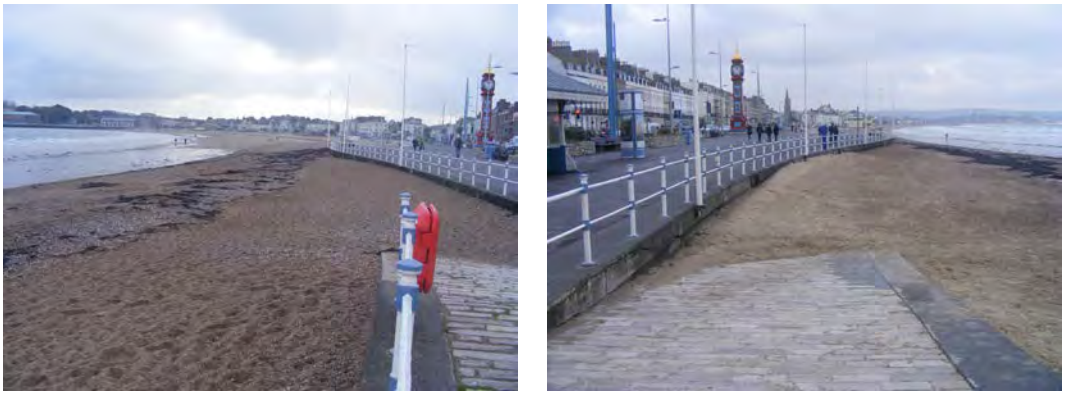


Figure 3-9 Views from north and from south of the Jubilee Clock promenade/seawall extension constructed in the 1920's (23-11-2018; photos by A. Frampton).

Figure 3-10 Evidence of concrete patch repairs to parts of the concrete wall that fronts the Jubilee Clock section of promenade (23-11-2018; photos by A. Frampton).

- Between the Pier Bandstand and Jubilee Clock, the masonry block wall face is evident, but has been topped by a concrete skim as part of constructing the promenade surface above (see **Figure 3-11**).

Figure 3-11 Photos of the promenade and masonry block wall between Jubilee Clock and Pier Bandstand, showing concrete topping original masonry blocks (23-11-2018; photos by A. Frampton).

- Construction of the Pier Bandstand in 1938/39 built out the promenade in this area into the sea. Although largely demolished in 1986 the most landward part of this structure is still present. Its seaward edge is formed of a concrete return wall (see **Figure 3-12**) that protrudes across the beach into the inter-tidal zone, such that at high-tides it effectively divides Greenhill Beach to the north from Weymouth Beach to the south. On the southern end of the wall, beach levels have lowered to expose the top of the foundation steel sheet piles (see **Figure 3-13**).

Figure 3-12 Photos of the Pier Bandstand seawall and how it protrudes into the intertidal area of the beach (see bottom left photo in particular) (23-11-2018; photos by A. Frampton).

Figure 3-13 Tops of sheet piles exposed at southern end of the Pier Bandstand (23-11-2018; photos by A. Frampton).

- Along the part of Greenhill Beach between the southern end of Greenhill Gardens and Pier Bandstand, the promenade has been extended seawards and is much wider than the promenade further north. Here the seaward face of the promenade is concrete not masonry block (see **Figure 3-14**); in 2014 a major repair was made to the corner of this section of wall following undermining during storm events in early 2014. It appears to have been constructed around the same time as the Pier Bandstand in the late 1930s, but no information has been found to confirm if this was the case. The concrete is in poor condition (see **Figure 3-15**).

Figure 3-14 Concrete wall constructed as part of previous widening of the promenade between Greenhill Gardens and Pier Bandstand (23-11-2018; photos by A. Frampton).

Figure 3-15 Poor condition of concrete including evidence of voids along parts of the concrete wall between Greenhill Gardens and Pier Bandstand (23-11-2018; photos by A. Frampton).

- Along many parts of the frontage, the promenade surface is noticeably uneven and in places has been re-surfaced (see **Figure 3-16**). This uneven nature suggests underlying issues of unstable ground beneath the surface of the promenade, possibly in part indicated by the presence of the voids evident on the wall face (see **Figure 3-17**).

Figure 3-16 Photos showing uneven surface along parts of the promenade, and recent repairs (top left) (23-11-2018; photos by A. Frampton).

Figure 3-17 Evidence of voids behind damage in the seaward face of the seawall (23-11-2018; photos by A. Frampton).

There is no detailed information about the seawall construction in the form of engineering drawings etc. As such, information about key dimensions of the seawall and promenade is derived from recent topographic survey data and trial pit investigations undertaken for the *Weymouth Bay Coastal Processes Study* (Appendix C of JacksonHyder, 2018). Drawing from this report, the following summarises what is known about the key dimensions of the seawall along this study area:

- The seaward edge of the promenade (i.e. seawall edge crest level) ranges between +3.03mOD and +3.95mOD.
- Trial pits dug at the top of the beach adjacent sections of the seawall found that:
  - Along Greenhill Beach the toe of the wall is very shallow and not very far below the surface of the beach (between 10mm and 400mm) with no foundation or footing evident and voids present behind the concrete facing of the wall, with the concrete itself being extensively cracked (refer also to **Figure 3-15** above).

- Immediately south of the Pier Bandstand the concrete faced wall has a toe level approximately 1.6m below the beach surface with a 500mm wide footing evident at the base of the wall.
- South of the Pier Bandstand, three trial pits dug to a depth of 1.7m did not reach / locate the toe of the seawall. A fourth trial pit opposite Bond Street was abandoned at a shallow depth without encountering the toe of the wall, due to encountering electricity cables when digging.

3.1.3 Greenhill groyne

The northern control point on the study frontage is the Greenhill Groyne maintained by the Environment Agency (see **Figure 3-18**). This is a rock groyne constructed in 1995/6 as part of the Preston Beach Sea Defence Scheme, which also incorporates the Greenhill Gardens Sluices Outfall. The outfall is maintained by Dorset Council and is the discharge point for drainage channels that run through the land behind the defences.

The groyne was designed to act as a terminal groyne preventing alongshore transport of beach sediment from north (Preston Beach) to south (Greenhill and Weymouth Beaches). This appears to have been successful as there is no evidence of shingle material from Preston Beach south of the groyne (the Preston Beach shingle is a different colour and lithology than the natural shingle material for Weymouth Bay which is to be found along Greenhill Beach).

Ongoing maintenance of the Greenhill Groyne is the responsibility of the Environment Agency and is guided by the *Preston Beach Management Plan* (Environment Agency, 2016).

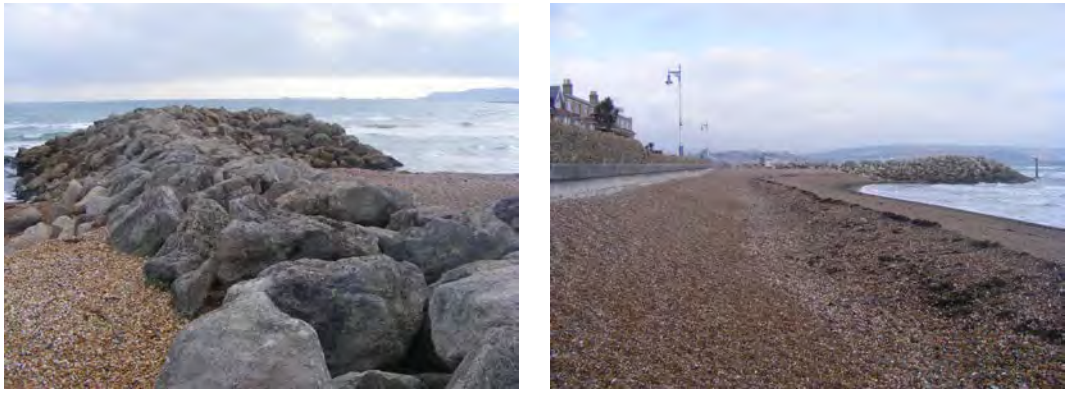


Figure 3-18 Photos of the Greenhill Groyne along length of the structure (left) and in profile viewed from Greenhill Beach (right) (23-11-2018; photos by A. Frampton).

3.1.4 Pavilion peninsula

The southern control point on the study frontage is the Pavilion Peninsula, which forms the northern arm of Weymouth Harbour entrance. As described in **Appendix B**, this feature has been modified and extended into Weymouth Bay over the past few centuries. The current form was completed in the late 1970s. The sheet-pile wall that forms the southern edge boundary of the study (see **Figure 3-19**), acts to trap sediment in this southern part of Weymouth Bay. The current condition of this wall is rated as “poor”, being described by Ramboll (2012) as follows:

This length of wall comprises of Larssen LX 3/20 piles dating from 1977. A 500mm thick concrete coping is continuous along the top of the piles. The wall is tied back with anchors at the 4.06m centres, 2m below the coping. The retained height varies from 2m to 6m. There is evidence of ALWC at MLWS. Significant section loss was recorded along the length of the wall including holes and perforations close to bed level. Upper areas of piles are severely de-laminated and blistered.

Despite the poor condition of the piles the estimated factors of safety are still adequate at the time of inspection. Due to the position of the anchors, retained height and the nature of the ground conditions the wall is not believed to encounter significant stresses. The most likely mechanism of failure would be through

instability caused by the gradual scour of the passive bed material in front of the wall. No visual evidence of global instability was evident at the time of inspection. Geotechnical analysis with software package WALLAP indicates a factor of safety of 1.1 against global instability which is very close to critical. Monitoring of scour and movement of the piles is recommended.

The wall is maintained by Dorset Council. Plans to regenerate the Pavilion Peninsula in the coming years means that a wall of some form is expected to remain in this area to act as a control on the southern end of Weymouth Bay well into the future. This will require replacement of the wall, or works to address the issues identified by Ramboll in 2012.

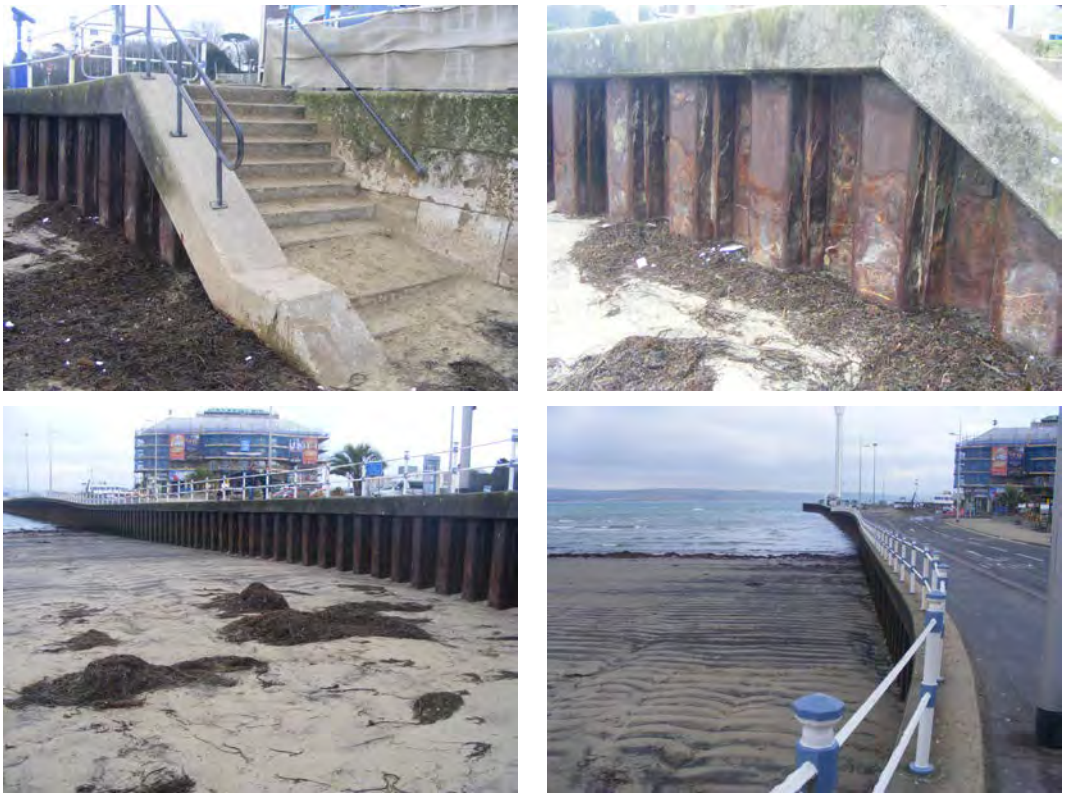


Figure 3-19 Photos of the sheet pile wall at the Pavilion Peninsula (23-11-2018; photos by A. Frampton).

3.2 Standard of protection

A review of a number of previous studies has been completed to make assessment of the SoP that is provided by existing defences along the study frontage. This review is provided in full in **Appendix F**. The following sections summarise the findings of the assessment, providing the estimated SoP against wave overtopping and undermining.

3.2.1 Wave overtopping risk

Over the past 12 years there have been five studies that have calculated wave overtopping discharge rates along all or parts of the study frontage. As the majority of these discharge rates have all been derived using EurOtop 2007, for consistency of comparison they have each been compared to the EurOtop 2007 tolerable discharge rates for structural stability of seawalls to assess the SoP based on each study's stated findings.

This review has shown that each of the five previous studies derives a wide range of SoP for structural safety, ranging from less than 1:1 year to greater than 1:200 year. This wide variety in assessment is due to various approaches having been utilised to calculate wave overtopping, as well as different input data (both defence dimensions assumed and wave/water level data).

Of particular note should be the outputs from the *Weymouth Bay Coastal Processes Study* (JacksonHyder, 2018) and *Weymouth Inundation Modelling Report* (JBA, 2019b). Both these studies used essentially the same input data but a different method of analysis (EurOtop empirical in 2018 versus EurOtop neural network in 2019). The 2018 assessment gives a 1:100 year SoP for the section between Pavilion Peninsula and Jubilee Clock, and about 1:1 year (or less) for the section from the Jubilee Clock and Greenhill Groyne. The 2019 study gives a greater than 1:200 year SoP along the entire study frontage.

In terms of which is most appropriate to use as a basis for making future beach management decisions, the JBA (2019b) assessment is considered to be more realistic based on historical behaviour. There has been no observed scale of overtopping along the study frontage that corresponds with the assessment of SoP outlined in the JacksonHyder (2018) analysis. As such, the SoP along the study frontage is considered to be >1:200 year at the present time and will remain at this level until about 2065, allowing for sea level rise rates defined by UKCP09 (see JBA, 2019b). This SoP assumes the current beach profile dimensions are maintained as follows:

- Pavilion Peninsula to Jubilee Clock (based on CCO profile 5g00326):
  - promenade crest = 3.15mODN
  - berm included
  - beach slope = 0.1
  - beach toe level = -0.84mODN.
- Jubilee Clock to Pier Bandstand (based on CCO profile 5g00322):
  - promenade crest = 3.55mODN
  - berm included
  - beach slope = 0.1
  - beach toe level = -0.87mODN.
- Pier Bandstand to Greenhill Groyne (based on CCO profile 5g00316):
  - promenade crest = 3.92mODN
  - berm included
  - beach slope = 0.14
  - beach toe level = -0.90mODN.

3.2.2 Seawall undermining risk

Based on review of a combination of trial pit data (from JacksonHyder, 2018) and post-storm survey data (from CCO and Dorset Council monitoring) the risk of seawall undermining is assessed as follows:

- The seawall between Pavilion Peninsula and Jubilee Clock appears to be of low vulnerability and at low risk of undermining.
- The seawall between Jubilee Clock and Pier Bandstand appears to be of medium vulnerability and at medium risk of undermining.
- The seawall between Pier Bandstand and Greenhill Groyne appears very vulnerable and at high risk of undermining.

It is important to note that a significant number of uncertainties exist with this assessment, in particular:

- There is a lack of accurate toe levels in places which means the assessment is based on a limited number of trial pit locations. Further trial pit investigations to be collected for informing scheme design (see **Section 1.1.1**) would provide additional data for more refined assessment.
- The timing of when risk will increase is uncertain due to limited data on how beach profiles respond to storm events (both survey and modelling data is limited) and how this will change in the future due to

SLR. Further capture of data as described in **Section 1.4.2.1** would support improvements in understanding to reduce this uncertainty.

3.3 Current condition of defences

3.3.1 Defence condition assessment

Dorset Council undertake regular visual inspection of their assets along the study frontage, though not to the same method/definition defined in the *Condition Assessment Manual* (Environment Agency, 2012). The most recent assessment by Dorset Council of the various coastal defence elements, as well as access features includes steps and slipways, is summarised in **Table 3-1**.

Table 3-1 Dorset Council defence condition information for Weymouth Beach study area (information from Dorset Council (then as WPBC), provided 01-11-2018).

Coastal Asset	Element	Sub-Element	Inspection frequency	Last inspection	Condition Score	Priority Score	Defects	Notes
Weymouth Esplanade	Slipway	Block paving	Annual	11/08/2017	C Poor	2 Essential	Concrete edging missing in places, stone sets need repointing.	
Weymouth Esplanade	Slipway	Concrete	Annual	11/08/2017	B Satisfactory	4 Long term		
Weymouth Esplanade	Surfacing	Tarmac	Annual	11/08/2017	B Satisfactory	3 Desirable	Entire length of promenade beginning to show signs of movement beneath surface layer, severe depressions near Greenhill Sluices repaired as an emergency in September 2018	Manhole repairs carried out in June 2018.
Weymouth Esplanade	Steps	Concrete	Annual	11/08/2017	C Poor	3 Desirable	Concrete spalling in places.	Suggest repairs as part of big package of work.
Weymouth Esplanade	Railings	Metal	Annual	11/08/2017	B Satisfactory	3 Desirable	Paintwork chipped in places.	
Weymouth Esplanade	Seawalls	Masonry	Annual	11/08/2017	C Poor	3 Desirable	Concrete render missing in places with voids evident at eastern end.	Beach Manager generally sorts out minor repair work. Suggest package of works to address concrete along entire length.
Weymouth Beach	Beach	Shingle	Annual	13/09/2018	B Satisfactory	3 Desirable	Narrow towards Greenhill gardens	BMP to help inform desired profiles and identify work
Weymouth Beach	Beach	Sand	Annual	13/09/2018	A Good	4 Long term		BMP to help inform desired profiles and identify work

3.3.2 Residual life estimate

Using the condition grading information in **Table 3-1**, the residual life of the seawall/promenade has been assessed by:

1) Converting WPBC condition gradings to Environment Agency Condition Assessment Manual (2012) condition grading; and
2) Estimating residual life using the guidance on determining asset deterioration and the use of condition grade deterioration curves (Defra / Environment Agency, 2009) (available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291126/scho0509bqat-e-e.pdf; accessed: 21-01-2019).

The following sections present the residual life assessment findings. Full details are provided in **Appendix F**.

3.3.2.1 Pavilion Peninsula to Jubilee Clock

Under a scenario of ongoing maintenance, the residual life of the seawall between Pavilion Peninsula to Jubilee Clock is calculated as:

- Best estimate from Grade 3 to Grade 5 is 50 years
- Fastest estimate from Grade 3 to Grade 5 is 20 years
- Slowest estimate from Grade 3 to Grade 5 is 90 years.

Under a scenario of no maintenance (i.e. no active intervention), the residual life of the seawall between Pavilion Peninsula to Jubilee Clock is calculated as:

- Best estimate from Grade 3 to Grade 5 is 45 years
- Fastest estimate from Grade 3 to Grade 5 is 15 years
- Slowest estimate from Grade 3 to Grade 5 is 90 years.

3.3.2.2 Jubilee Clock to Pier Bandstand

Under a scenario of ongoing maintenance and a scenario of no maintenance (i.e. no active intervention), the residual life of the seawall between Jubilee Clock to Pier Bandstand is calculated to be the same, as:

- Best estimate from Grade 3 to Grade 5 is 45 years
- Fastest estimate from Grade 3 to Grade 5 is 30 years
- Slowest estimate from Grade 3 to Grade 5 is 90 years.

3.3.2.3 Pier Bandstand to Greenhill Groyne

Under a scenario of ongoing maintenance and a scenario of no maintenance (i.e. no active intervention), the residual life of the seawall between Pier Bandstand and Greenhill Groyne is calculated to be the same, as:

- Best estimate from Grade 4 to Grade 5 is 15 years
- Fastest estimate from Grade 4 to Grade 5 is 5 years
- Slowest estimate from Grade 4 to Grade 5 is 30 years.

3.3.2.4 Limitation / assumptions

It is important to note that the above residual life assessment is based on the condition grade estimated at seven seawall locations only. The number of (and location of) the seawall locations may not sufficiently represent the seawalls in each section, hence this assessment provides a very crude means of determining residual life. A better and more accurate assessment could be undertaken given additional seawall condition data collected by an experienced surveyor using EA condition grades as defined in the EA Condition Assessment Manual (2012) – see **Section 4.2**.

3.4 Trigger levels

In order to guide when intervention is required to manage the beach along the BMP frontage for FCERM purposes, the following trigger levels have been defined:

- **Action level 1** – High beach level against seawall posing wave run-up risk. This trigger level prompts a response in order to lower the beach crest level, mitigating risk of flooding from wave run-up and potential loss of sediment from wind-blown sand moving landward of the defence line.
- **Action level 2** – Low beach level against seawall posing wave overtopping risk. This trigger level prompts a response to a low beach level being reached which poses an increased risk of wave overtopping that can lead to coastal flooding. will be to increase frequency of monitoring to establish whether recovery of the beach is occurring or whether the crisis level is reached.
- **Crisis level** – Low beach level against seawall posing undermining risk. existing seawall toe level which if exceeded would pose significant risk of undermining.

Table 3-2 summarises these trigger levels and what the respective levels to be monitored against. The management responses to be taken should any of these levels be reached are described in **Section 5-2** and **Section 5-3**. **Appendix A** provides further details about how these trigger levels have been defined.

Table 3-2 Beach management trigger levels.

Beach Trigger Level	Trigger Level Description
Action Level 1	Beach levels adjacent to seawall are within 0.3 m of the seawall crest over a 100 m length. This equates to the following levels in each section: • Pavilion Peninsula to Jubilee Clock: +2.85 m AOD • Jubilee Clock to Pier Bandstand: +3.3 m AOD • Pier Bandstand to Greenhill Groyne: +3.6 m AOD
Action Level 2	Beach levels adjacent to seawall are the following distances from the seawall crest: • Pavilion Peninsula to Jubilee Clock: 1.15 m drop (or +2.0 m AOD) • Jubilee Clock to Pier Bandstand: 0.9 m drop (or +2.7 m AOD) • Pier Bandstand to Greenhill Groyne: 0.9 m drop (or +3.0 m AOD)
Crisis Level	Beach levels adjacent to seawall are the following distances from the seawall crest: • Pavilion Peninsula to Jubilee Clock: 2.5 m drop (or +0.6 m AOD) • Jubilee Clock to Pier Bandstand: 1.2 m drop (or +2.4 m AOD) • Pier Bandstand to Greenhill Groyne: 1.0 m drop (or +2.9 m AOD)

4. Monitoring Programme

Over the next 5 years, a comprehensive monitoring programme is recommended to be undertaken in order to provide a greater level of quantitative field data. This will aid improved understanding of the coastal processes operating along the Weymouth BMP frontage and wider Weymouth Bay, as discussed in **Section 1.4.2**. This improved quantitative data may also allow improved application of analytical techniques by providing more information with which to test existing and/or develop new methods.

The following sections discuss the recommended monitoring requirements over the next 5 years with this objective in mind. In doing so, it incorporates the ongoing monitoring undertaken by the Channel Coastal Observatory (CCO) as part of the South-East Regional Coastal Monitoring Programme (SERCMP), who already carry out two annual beach profile surveys (and post-storm surveys when needed), a 5-yearly bathymetry survey have a wave buoy deployed offshore of the BMP area at about the -10mCD bathymetry contour (refer to **Section 2.1.1**), and undertake aerial LiDAR and aerial photography on a frequent basis. **The continuation of this monitoring programme is vital to improving the understanding of the coastal processes that lead to coastal flood and erosion risks along the BMP area.**

4.1 Beach monitoring

4.1.1 Beach profile surveys

Beach profile surveys are routinely captured along the study frontage two times per year by the Channel Coastal Observatory (CCO) as part of the SERCMP. These interim profiles are spaced every 200m and are a sub-set of baseline profile surveys captured once every 5 years at 100m intervals (see **Figure 4-1**). The majority of these profiles have also been used at various times to capture post-storm surveys however not all profiles have been surveyed every time following each storm event (see **Table 4-1**).

Table 4-1 Beach profile locations surveyed as part of the SERCMP along the study frontage

Profile ID	Easting	Northing	Baseline Survey	Interim Survey	Post-Storm Survey
5g00311	368690.671	80598.151	Yes	Yes	Sometimes
5g00312	368626.974	80520.608	Yes	Yes	Sometimes
5g00313	368566.870	80441.068	Yes	No	No
5g00314	368510.206	80358.826	Yes	Yes	Sometimes
5g00315	368455.536	80277.667	Yes	No	No
5g00316	368400.790	80194.028	Yes	Yes	Sometimes
5g00317	368352.623	80106.402	Yes	No	No
5g00318	368299.676	80021.832	Yes	Yes	Sometimes
5g00319	368253.616	79933.561	Yes	No	No
5g00320	368211.137	79843.868	Yes	Yes	Sometimes
5g00321	368152.335	79748.095	Yes	No	No
5g00322	368118.266	79654.082	Yes	Yes	Sometimes
5g00323	368098.031	79557.885	Yes	No	No
5g00324	368068.914	79460.704	Yes	Yes	Sometimes

Profile ID	Easting	Northing	Baseline Survey	Interim Survey	Post-Storm Survey
5g00325	368044.244	79364.455	Yes	No	No
5g00326	368033.364	79265.431	Yes	Yes	Sometimes
5g00327	368040.956	79166.060	Yes	No	No
5g00328	368060.353	79068.191	Yes	Yes	Sometimes
5g00329	368082.305	78970.610	Yes	No	No
5g00330	368142.469	78896.870	Yes	Yes	Sometimes
5g00331	368245.898	78868.856	Yes	No	No

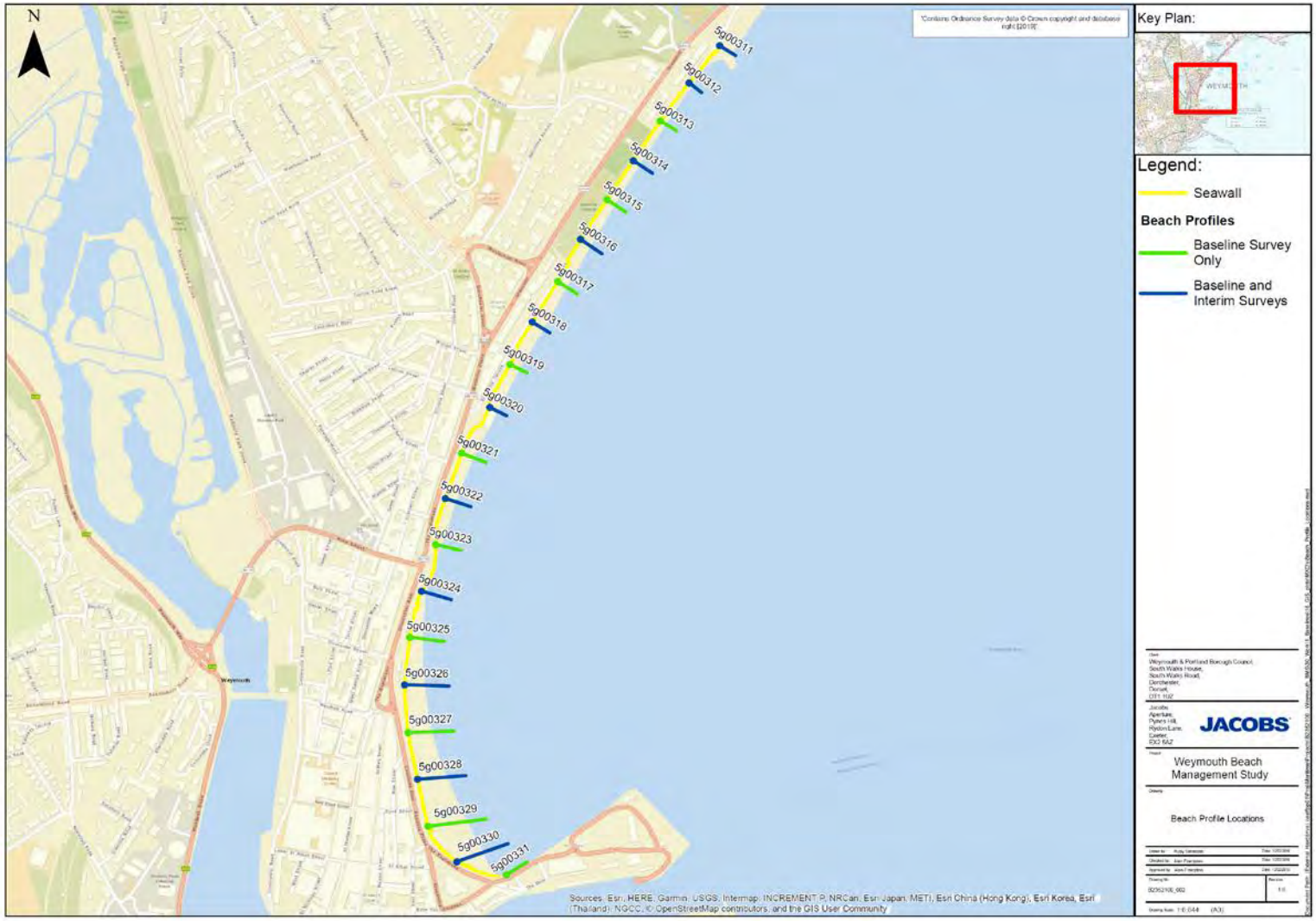


Figure 4-1 Beach profile locations monitored as part of the South-East Regional Coastal Monitoring Programme.

4.1.2 Master profile survey

In order to ensure **to improve the accuracy of beach cross-sectional area and volumes analysis to give closer to actual available sediment volumes above the geological bed level, a survey of underlying bed level could be undertaken if budget and opportunity arises to do so** (e.g. as part of a wider campaign of capturing greater amount of ground information along the frontage to inform scheme design – see **Section 1.1.1**).

This would involve undertaking a penetrative survey, possibly including boreholes to identify the level of the underlying bedrock layer that, in turn, will provide a definitive 'Master Profile' for use in beach profile analysis and will allow more accurate estimates of beach volumes to be carried out.

4.1.3 Beach recycling logs and survey

Since 2016, for each of the beach recycling events undertaken annually during March along the sand section of the beach between the Pavilion Peninsula and the Jubilee Clock, beach recycling logs have been prepared to record the area and volume of sand from where it is moved from and placed. The volume of sediment moved is indicated by the number of dumper truck loads moved (with each load being in the region of 25t of sediment each time, or about 12m^3 per load).

The March 2017 recycling event was supported by a pre- and post- recycling beach profile survey by CCO. This indicates that about 2,500m^3 of sand was placed on the beach above the level of MHWS; however, the recycling logs for this period would suggest that almost 5,000m^3 of sand was moved. As such, the recycling logs, whilst useful to record each recycling event, cannot currently be relied upon alone to provide accurate data to inform beach volume analysis. **Further capture of beach profile survey data immediately pre- and post- recycling events would aide development of confidence margins that can be applied to recycling log data in future** (refer also to **Section 5.4.1**).

4.1.4 Bathymetric survey

Routine bathymetric surveys are undertaken about every 5 years as part of the SERCMP. The last bathymetry survey by the SERCMP for Weymouth Bay was undertaken in 2008/2009 as part of a joint-multibeam survey with other organisations. Prior to this, single-beam bathymetry data was captured by the SERCMP in each of the years 2004 to 2006. The next SERCMP bathymetric survey for Weymouth Bay area has not yet been programmed.

In addition to the SERCMP bathymetry surveys, WPBC has also on occasion commissioned bathymetric surveys following storm events. The last such survey of this nature in Weymouth Bay was in March 2014, following the series of storm events over the winter of 2013/2014.

4.1.5 Sediment sampling

No routine sediment sampling is undertaken along the beach or nearshore area, and none is recommended to be undertaken in the coming five years.

4.1.6 Walkover survey

Visual walkover inspections should be undertaken by Dorset Council to monitor beach crest level. One walkover survey should be undertaken every month during the winter (October to March) and one survey every two months during the summer (April to September). Throughout the year, additional walkover surveys will need to be carried out prior to and immediately after storm events, as required. When undertaking these inspections, a key consideration will be the level of the beach in relation to the trigger levels defined in **Section 3.4**.

4.1.7 Video monitoring

Whilst there are a number of local webcams available to view online that cover parts of the study frontage, no video monitoring is currently undertaken to provide quantifiable information of changes to the beach state along the study frontage. This situation is to remain over the next five years.

4.1.8 Aerial photography and LiDAR

Aerial photography and LiDAR surveys flown regularly by CCO as part of the SERCMP. LiDAR and non-rectified aerial photography is flown annually. Ortho-rectified aerial photography is flown every five years. This data is available through the CCO website (www.coastalmonitoring.org).

4.2 Structure monitoring

4.2.1 Visual inspection

Visual inspection of the various hard structures along the frontage has historically occurred annually, undertaken by WPBC. Details of what is inspected and when is provided in **Section 3.3.1**.

This **annual visual inspection of all of the structures along the BMP frontage will continue to occur during the spring of each year to allow any maintenance works required to be identified and completed prior to the busy summer period**, thus avoiding impacting on the amenity use of the beach. These inspections should be undertaken by Dorset Council as the relevant asset operator.

Visual inspections to monitor structures after storm events should also occur, since damage to the structures is most likely to occur during storms.

Each inspection (routine or post-storm) should be recorded in a consistent way in a defence inspection log (see **Appendix G** for key information to be collected as a minimum). Monitoring of the coastal structures should be, where possible, undertaken in combination with the visual walkover inspection of the beach as described in **Section 4.1.6**, particularly following storm events.

With reference to **Section 3.3.1**, for consistency of approach and recording, and in anticipation of a consistent Dorset-wide coastal asset data system being developed, **it would be beneficial for Dorset Council to move to undertaking these inspections using the methodology defined in the Environment Agency's *Condition Assessment Manual* (Environment Agency, 2012**). This would also have the advantage of ensuring captured data is in a format typically required when requested for national scale studies; it would also align to the recommendation in **Section 4.2.2** to align to the three-tiered approach to asset inspection. In order to enable this change in methodology, Dorset Council will need to ensure these visual inspections are undertaken by experienced engineers.

4.2.2 Detailed inspection

No regular detailed inspections of the various hard structures along the frontage currently occurs.

The future need for detailed inspections will be guided by visual inspection findings (see **Section 4.2.1**), and progress firstly to non-intrusive investigations and then (if necessary) intrusive investigations. This is in line with the Environment Agency's *Asset Inspection Guidance* (Environment Agency, 2014), which defines a 3-tiered approach to targeting asset inspections as follows:

- Tier 1 inspection is the default level, routine visual inspection (see **Section 4.2.1**). Tier 1 inspections identify areas of concern that would prompt Tier 2 and 3 inspections and investigations to seek more detailed information than is routinely collected as Tier 1 inspections.
- Tier 2 inspections are non-intrusive investigations carried out by an appropriate expert (e.g. ground penetrating radar surveys etc.)

- Tier 3 inspections are intrusive investigations into the make-up of the asset (e.g. investigation of ground condition and/or structural assessment).

4.3 Environmental monitoring

The only regular environmental monitoring currently undertaken in the vicinity of the Weymouth beach management study area is in regard to monitoring:

- Water quality compliance to standards defined in the South West River Basin Management Plan and in accordance with the requirements of the EU Water Framework Directive (refer to **Section 2.7.3.1**).
- Water quality for bathing waters, in accordance with the requirements of the EU Bathing Water Directive (refer to **Section 2.7.3.2**).
- Air quality monitoring at a number of point locations within the Weymouth area (refer to **Section 2.7.9**).

In addition, regular monitoring of coastal processes is undertaken by CCO as part of the SERCMP. This largely consists of bi-annual beach profile surveys (see **Section 4.1**) and wave climate data from a wave buoy located offshore of Weymouth Bay (see **Section 2.1**). Tide levels area also captured by a primary tide gauge in Weymouth Harbour as part of the National Tide and Sea Level Facility (see **Section 2.2**).

Continuation of this environmental monitoring will be important to provide evidence for monitoring and assessing potential environmental impacts of future capital works along the frontage (refer to **Section 1.1.1**).

4.4 Physical conditions

4.4.1 Sea conditions

In order to understand the movement of the beach material, it is important to understand the forcing mechanisms. At present, the only equipment deployed to achieve this is the CCO wave buoy in the northern part of Weymouth Bay which provides data since the end of 2006; further details are to be found online at: http://www.coastalmonitoring.org/data_management/real_time_data/charts/?chart=84 (date accessed: 03-01-2019).

4.4.2 Storm events

The movement of material along and across the study frontage is significantly increased during storms as a result of increased wave action. In order to understand the effect of storm waves on beach response, details of the storm conditions (waves, winds and water levels) can be obtained from the following sources:

- **Wave data**

  The CCO wave buoy located in the northern part of Weymouth Bay is the main source of locally available wave data for storm events (see **Section 2.1.2**).

  Additional information on the offshore wave climate should also be recorded from other data sources such as near real time data from the *National Data Buoy Centre* and the *Cefas Wavenet* websites. These websites provide data for a number of locations between the Atlantic and the English Channel that are relevant to Weymouth Bay, and recording of this information will allow assessment of any linkages between offshore and nearshore wave climate to be made once a sufficient data set is collected.

- **Wind data**

  Local wind gauge data is available from the CCO website for a meteorological station located on the Weymouth & Portland National Sailing Academy (WPNSA) (refer to **Section 2.1.3**).

- **Water level data**

  Details of the water level conditions can be provided from the Weymouth tide gauge data, which is part of the National Tide and Sea Level Facility (NTSLF). This information is available via the UK Tide Gauge Network pages of the British Oceanographic Data Centre website (see **Section 2.2.1**).

4.5 Warning & Emergency Procedures

4.5.1 Flood warning and response procedures

NB: the following is based upon information provided by the Environment Agency in December 2018.

The following gives an overview of the Environment Agency's flood warning procedures applicable to the Weymouth Beach Management Study area. Full details of the up-to-date flood warning procedures are to be found in the Environment Agency's *Wessex South Flood Warning Procedures Manual*. The current procedures are kept electronically on the Environment Agency's "Blandford" server, or in hard copy form in the incident room of the Environment Agency's Blandford office. They can also be accessed through the Environment Agency's incident management toolbox.

Three levels of warning are issued:

3) A **Flood Alert** indicates that flooding is possible. The criteria along the study frontage at Weymouth are used to trigger the wider East Coast of Dorset Flood Alert (111WACECD). This alert gives an indication to professional partners and members of the public that there is the possibility of flooding along the coast. The key risk areas would be seawalls, promenades and harbours in the flood warning area. Flooding of property is not expected at this time. On the issue of the flood alert current actions would be for the Environment Agency's Flood Incident Duty Officer (FIDO) to request that the Environment Agency's Operations Delivery team initiate a tide watch and record any observations of flooding.

4) A **Flood Warning** indicates that flooding is expected. This warning goes to professional partners and members of the public who are at risk. The community is registered on an "opt out" system. There are several Flood Warning Areas (FWAs) for the study frontage, as follows (see also **Figure 4-2**):

    - 111FWTWEYS001: Weymouth Seafront at The Esplanade (18 properties).
    - 111FWTWEYS002: Weymouth Seafront at Chelmsford St, Crescent St, Derby St, and Stanley Street in Weymouth (294 properties).
    - 111FWTWEYS003: Weymouth Seafront at Weymouth Town (766 properties).

    In these three FWAs there is a total of 1,078 properties. When the flood warning is issued the Environment Agency's Flood Warning Duty Officer (FWDO) would discuss conditions with professional partners. Depending on conditions the FIDO would request that the Environment Agency's Operations Delivery team initiate a tide watch and record any observations of flooding of other significant issues.

5) The **Severe Flood Warning** indicates that there is a risk to life. Automated flood warnings are issued when defined thresholds are reached, as per above for Flood Warnings. A severe flood warning threshold forecast would trigger a FAStCON with professional partners to discuss the situation and determine actions to respond to the situation as it develops, informed by additional information from on-site observations.

The issuing of flood warnings by the Environment Agency is currently based upon the following information:

- Forecast data from the National Flood Forecasting System (NFFS) including forecast wave height, wave period, wave direction, wind speed, wind direction and total tide height. Wave data is much more important for flood warning along Weymouth Seafront than tide height.
- On-site observations by Environment Agency's Operations Delivery team.

Currently, flood warnings are based on the 'pre-conditions' for a large flood event being reached. Decisions are made based on a set of condition tables that take into consideration forecast astronomical tide, wave height, wave period, wave direction, wind direction and total water level. Data gathered from future storms will be used to improve the accuracy of the warnings and refine further the flood warning criteria.

The monitoring regime set out in **Section 4** of this BMP will also provide improved information for understanding the whole beach system. In doing so, it is anticipated that this will also allow the relationship

between certain wave conditions and water levels being reached and the associated consequences to be better defined to improve 'accuracy' of flood warnings.

Figure 4-2 Flood Warning Areas along the Weymouth beach management study frontage (NB: shown are not just those for "Weymouth Seafront" but also those for "Weymouth Harbour" (map of FWAs from Environment Agency's "EasiMap2" system; produced 05-12-2018).

4.5.2 Pollution incidents

Pollution incidents can occur at varying scales. Minor pollution such as litter and small debris are typically dealt with by Weymouth Town Council. Larger pollution incidents are dealt with by Dorset Council, guided by Section 4 of the Dorset Coastal Pollution Clearance Plan (Dorset County Council Emergency Planning Service, 2010; see also **Section 1.7.10**).

4.6 Data storage and analysis

Having collected the beach monitoring data, it is important that all of the information is stored and analysed to allow decisions to be made with respect to ongoing maintenance and future management of the area covered by this BMP.

Following each scheduled twice-yearly beach profile survey and any intervening post-storm or other surveys completed by CCO or the Environment Agency, the information collected should be uploaded for storage and analysis to a database system that is compatible with that used by the SERCMP and the Environment Agency – in this case Jacobs' SANDS software is used – and copied to the CCO/Environment Agency as appropriate.

After each beach profile survey, Dorset Council should analyse the data to assess the changes in beach volumes and movements of material (i.e. identify areas of erosion/accretion). The results of this analysis should be summarised in a brief beach survey report to include summary of profile changes, volume changes, crest height, and crest width. Assessment of beach levels in relation to the trigger levels discussed in **Section 3.4** should also be undertaken in order to provide a record of the logic for undertaking further maintenance to the beach and/or coastal defences along the BMP frontage.

Additional beach monitoring data, obtained from sources such as the post-storm visual walkover inspections (with associated storm event data – see **Section 4.4.2**) or beach recycling logs (see **Section 4.1.3**), as well as information about the condition of structures (see **Section 4.2**) should also be stored in the same database. The database should include photographs taken during each survey.

This information should be used in compiling future annual beach monitoring reports such as those produced by CCO (examples of which are available from www.coastalmonitoring.org).

5. Maintenance Regime

This section describes the maintenance regime that is necessary to ensure that the beach and defences along the BMP frontage continue to provide adequate coastal flood and erosion risk management for the area in the immediate future, in line with the long-term FCERM approach set out in **Section 1.1.1**.

5.1 Ongoing works

5.1.1 Beach

The main ongoing works to the beach itself only occur south of the Jubilee Clock. In this area, beach recycling and re-profiling occurs each March in order to build-up the sand beach ahead of the start of the busy tourism season (i.e. to increase the "dry beach" area available). See also **Section 4.1.3**.

In addition, the sand from south of the Jubilee Clock is used to form the course for the annual beach Moto-X event held each October. The beach is re-profiled following the event.

5.1.2 Structures

Ad hoc maintenance works have historically occurred to the various structural elements along the study frontage as they are identified during visual inspection.

Future maintenance works to the various coastal defence elements along the BMP frontage will continue to be guided by ongoing inspection (refer to **Section 4.2**). When either routine inspection or rapid assessment following a storm event identifies a defect in the defence, be it a crack in the defence or damage to public safety aspects of the defence (e.g. buckled hand railings or trip hazards etc.) then the following steps are to be followed:

1) Increased defect monitoring – should any defects be identified then it may be appropriate to implement an increased level monitoring rather than immediately undertaking remedial works. This could also involve the use of additional monitoring devices such as crack gauges. This step would only occur if the identified defect is not considered an immediate safety risk (i.e. this step is optional and may or may not occur prior to Step 2).
2) Remedial works – once an identified defect is considered to be in need of remedial work, then the design of remedial works should be undertaken and an appropriate repair specification generated. To ensure consistent information on repairs undertaken is recorded, a defence repair record template is provided in **Appendix H**.

5.2 Action level works

If the Action trigger levels defined in **Section 3.4** are reached, then the following responses are to be taken:

- **Action Level 1:**
  a) Assess situation with Weymouth Town Council Beach Manager and take account of beach levels required for amenity use of areas at time trigger identified.
  b) Implement beach recycling / reprofiling to lower the profile to the design profile* and so reduce the risk of wave run-up and/or wind-blown sand encroaching onto the promenade.
- **Action Level 2:**
  a) Increase frequency of monitoring to determine whether the beach profile continues to lower and/or steepen or recovers naturally.
  b) If levels do not recover naturally within a season, implement beach recycling / reprofiling to reconstruct the design profile*.

*the design profile for each part of the BMP frontage are taken to be the profile used in the overtopping calculations in the recent work by JBA (2019b), as illustrated in Figures 5-1 to 5-3 below (see also Appendix J).

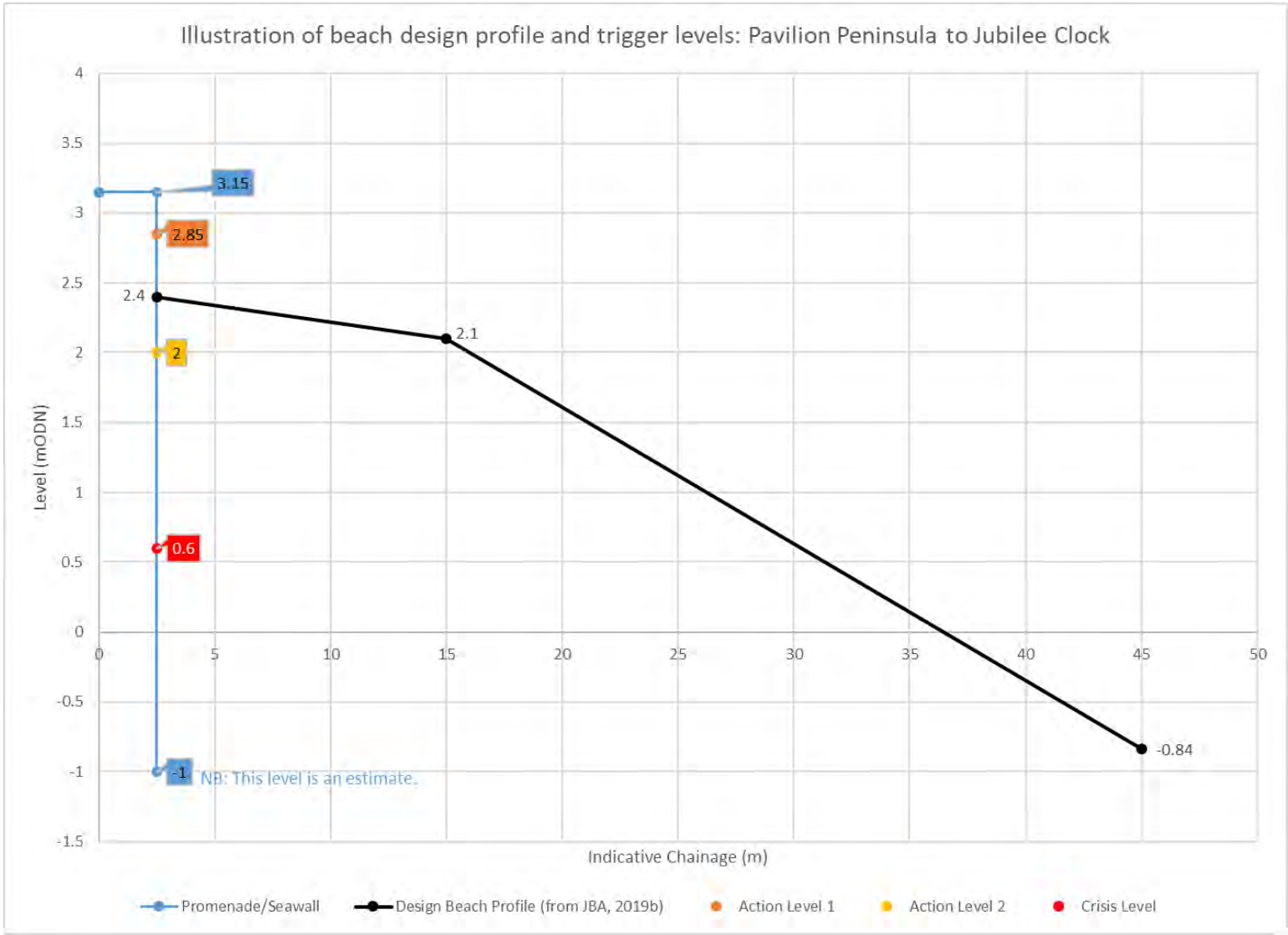


Figure 5-1 Design profile and trigger levels for Weymouth Town Beach between Pavilion Point and Jubilee Clock

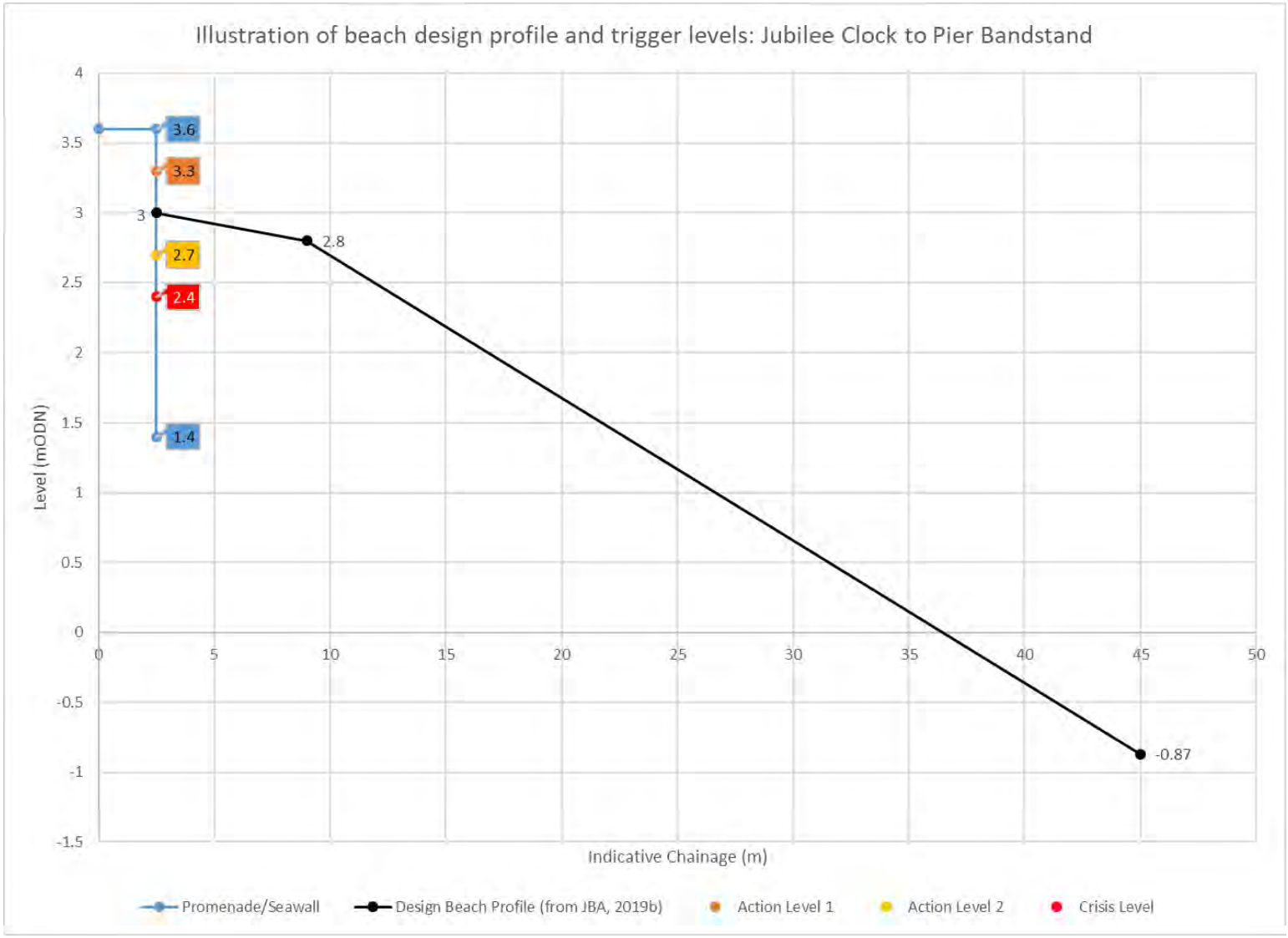


Figure 5-2 Design profile and trigger levels for Weymouth Town Beach between Jubilee Clock and Pier Bandstand

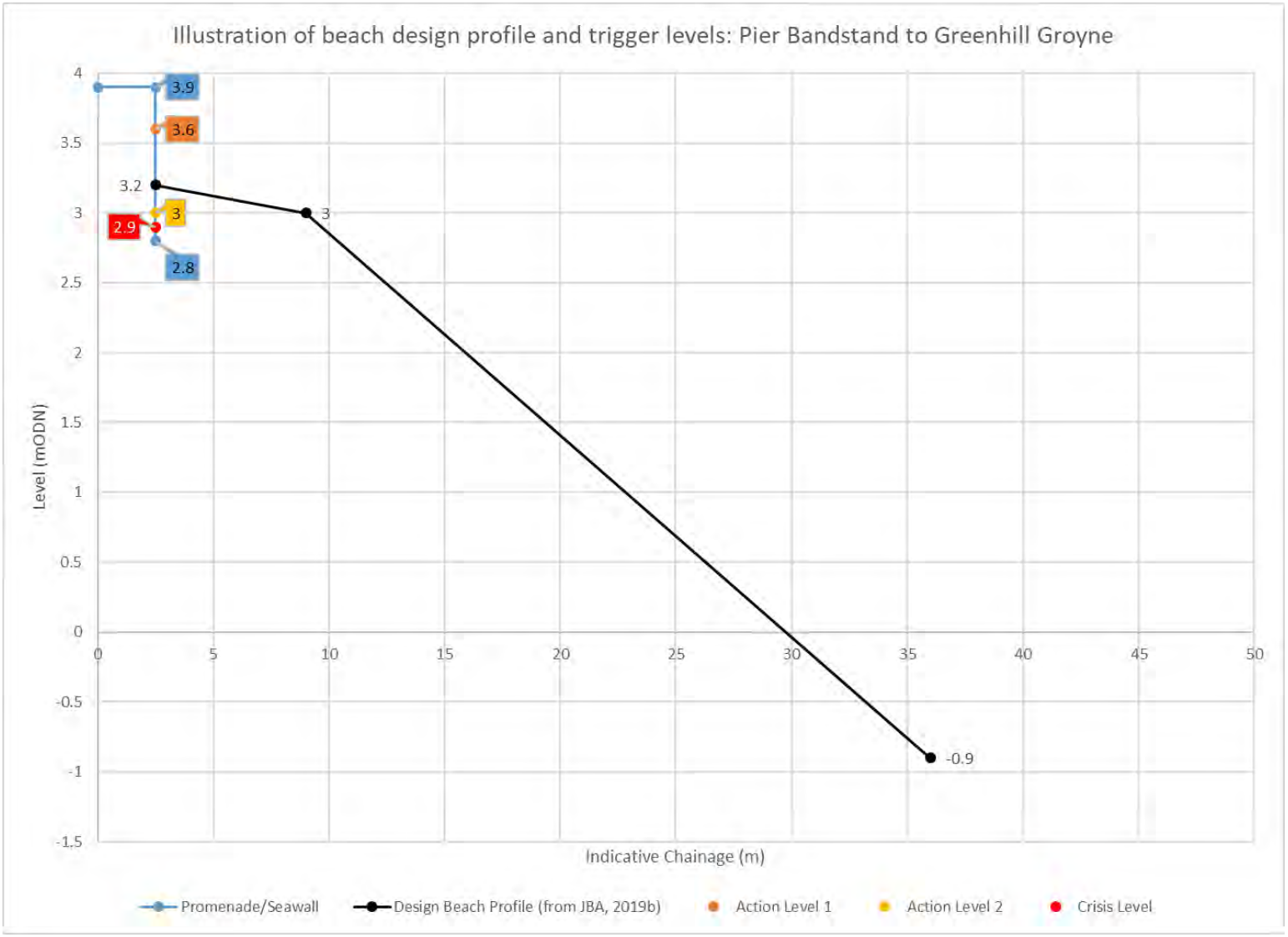


Figure 5-3 Design profile and trigger levels for Greenhill Beach between Pier Bandstand and Greenhill Groyne

5.3 Crisis level works

If the Crisis trigger levels defined in **Section 3.4** are reached, then immediate action is to be taken to provide support to the wall and then implement beach recycling / reprofiling to reconstruct the design profile (see **Figures 5-1 to 5-3** above).

5.4 Implementation requirements

5.4.1 Beach recycling and re-profiling

The current practice of occasional beach recycling and re-profiling along the southern section of the frontage between Pavilion Peninsula and the Jubilee Clock occurs in response to the following:

- Planned annual recovery (each March) of sediment from the inter-tidal zone to build-up the upper part of the beach.
- Reactive recycling of sand from the upper parts of the beach when wind-blown sand accumulates to a level that it spills over the seaward edge of the seawall and onto the promenade (where it causes access issues along the promenade and can also be blown further inland). Failure to recycle could promote wave run-up along the beach profile directly onto the promenade, creating an increased flood risk.
- Post-storm reactive recovery of sediment from areas of accretion to areas of erosion.

Whenever beach recycling and re-profiling activities occur, beach recycling logs are to be kept that record the locations of where sediment is between, and approximately how much sediment is moved (e.g. number of dumper loads); a beach recycling log template for consistent record keeping is provided in **Appendix I**. This information helps to inform analysis of beach volume changes. See also **Section 4.1.3** and **Section 2.6.1**.

5.4.2 Beach recharge

There are no current plans to implement any form of beach recharge along the frontage as the standard of protection is assessed as being >1:200 years at the present time and in 2065, assuming the current beach profile is retained. As such beach recharge is not likely to be required for coastal flood risk management purposes based on the current data; although there are a number of uncertainties and limitations associated with the present data. See **Appendix A** for further details.

Should those plans change in the future, it is likely that material will be delivered via the sea. While the methods of delivery will need to be appraised at the time, the delivery may involve use of a pipeline across the seabed (as was used to recharge Preston Beach in 1995 (Environment Agency, 2016)).

5.4.3 Structure maintenance and repair

The maintenance and repair of the seawalls, promenade and other coastal defences structures are undertaken on an ad hoc basis, guided by regular visual inspections. The approach to implementing maintenance and repairs is guided by the issue(s) to be addressed at the time, and as such, there are no routine planned activities that occur to these features.

For any future maintenance works, the nature of the works will guide what plant is needed.

5.4.4 Plant requirements

The current practice of occasional beach recycling and re-profiling along the southern section of the frontage between Pavilion Peninsula and the Jubilee Clock utilises the following plant:

- 2 x 22-ton excavator;
- 2 x 22-ton bulldozer; and
- 3 x Dump truck.

The continued use of this equipment is sufficient and appropriate for these operations.

For any future capital works, the nature of the works will guide what plant is needed.

5.4.5 Access for works

For beach recycling and re-profiling activities, access to the beach area is available as follows:

- Between the Pavilion Peninsula and the Pier Bandstand, there are a number of access ramps from the Promenade onto the beach that the plant described in **Section 5.4.4** is capable of using (there are no known issues with the size and weight of the plant used). These access ramps can be accessed via dropped kerbs from the highway that runs directly landwards of the promenade surface.
- Between the Pier Bandstand and Greenhill Groyne, there are fewer access ramps. The main access ramp is at the northern most end by the Greenhill Groyne, accessed again via the promenade.

For any future capital works, the above access points will be adopted. However, there is no area close to the frontage that could serve as a compound to provide direct access to the beach. Access to the frontage from any compound for capital works located elsewhere will use the local road network; as such this will need to be carefully planned to minimise impacting other users and manage risks of multiple hazards.

5.4.6 Public access, amenity and safety

Beach management activities are planned to avoid the peak holiday season, weekends and public holidays (except in extremis). This minimises the impact of works on beach users and reduces the minor risk to public safety that such work poses.

In order to ensure the safety of the public whilst works are being carried out, restrictions on public access to the areas of the beach being worked on should be implemented, with alternative routes provided if possible. Previous experience elsewhere has shown that closing the beach entirely is impractical, and it is suggested that a banksman is present with each machine, and that spare personnel along with signage is employed to direct public access to safe sections of the promenade and beach during works.

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

5.4.7 Notifying others

When undertaking beach recycling and re-profiling works, or other maintenance works, the local community and local business are notified of works a few days ahead of them commencing. This includes utilising news items in the local media.

When any future capital works occur along the frontage, a much greater effort will be undertaken to communicate plans to a wider group of stakeholders. Therefore, in addition to communicating effectively with the public (see also **Section 5.4.6**), it is recommended that explicit notification of any future capital works (including contact details should there be any queries) should be provided to the following organisations/groups depending upon the location where capital works are occurring:

- Natural England (in relation to nature conservation and coastal access interests).
- World Heritage Site (in relation to nature conservation interests).
- South West Coast Path (in relation to coastal access interests).

- Dorset Historic Environment Officer (in relation to historic environment interests).
- Environment Agency (in relation to FCERM and funding).
- The Marine Management Organisation (only if beach recharge or major scheme and works occurring below MHW level).
- The Crown Estate (only if a major scheme).
- Sea Life Centre (only if works are to be within 500m of the Greenhill Gardens sluices and occur below the level of MHW).
- Local businesses and those people who have a day to day interest in what is happening along the frontage where works are to occur, i.e. any businesses/user groups that may be affected.
- Local residents directly affected by any road or access closures along the frontage when works occur.

6. Action Plan

This section provides a summary of the recommendations made throughout the rest of this BMP in the form of an action plan. The action plan is presented in **Table 6-1** and identifies actions by type as being either for 'Management', 'Monitoring', 'Maintenance' or 'For Future Studies/Research'.

It is intended that this Action Plan be used to guide future investment in this area which will ultimately enable more appropriate, effective and efficient maintenance practices to be established and implemented along the BMP area.

Table 6-1 Weymouth Beach Management Plan: Action Plan

Action No.	Action Description	Who by?	Date action First Defined?	When by?	Related BMP Section(s)	Current Status
MANAGEMENT ACTIONS						
MAN_001	Undertake further ground investigation (including boreholes and trial pits) to inform future scheme design and refinement of trigger levels for undermining risk (i.e. Crisis Level defined in **Section 3.4**).	Dorset Council	July 2019	2022	1.1.1, 3.2.2, 3.4	Not Started
MAN_002	Develop the design of steel sheet pile toe-protection for the sections of the seawall between the Pier Bandstand and Greenhill Groyne, to be implemented in 2024/25. Development of the design is to include consideration of: • Various environmental considerations defined in **Section 1.4.3**. • Licence and consent requirements described in **Section 1.6** • Conducting new up-to-date services searches to ensure a current and accurate record is used to inform those designs at the time they are prepared (refer to **Section 1.3.6**).	Dorset Council	July 2019	2024	1.1.1	Not Started
MAN_003	Review and update the BMP every 5 years.	Dorset Council	July 2019	July 2024	1.2	Not Started
MONITORING ACTIONS						
MON_001	Support the continuation of the South East Regional Coastal Monitoring Programme (SERCMP), which is vital to improving the understanding of the coastal processes that lead to coastal flood and erosion risks along the BMP area	Dorset Council	July 2019	Ongoing	4	Active
MON_002	To improve the accuracy of beach cross-sectional area and volumes analysis to give closer to actual available sediment volumes above the geological bed level, a survey of underlying bed level could be undertaken if budget and opportunity arises to do so.	Dorset Council	July 2019	If opportunity arises	4.1.2	Not Started
MON_003	Continue to capture beach recycling logs when beach recycling / re-profiling works are undertaken. To be supported by further capture of beach profile survey data immediately pre- and post- recycling events would aide development of confidence margins that can be applied to recycling log data in future.	Dorset Council	July 2019	Annual	4.1.3, 5.4.1	Active
MON_004	Visual walkover inspections should be undertaken by Dorset Council to monitor beach crest level. One walkover survey should be undertaken every month during the winter (October to March) and one survey every two months during the summer (April to September). Throughout the year, additional walkover surveys will need to be carried out prior to and immediately after storm events, as required. When undertaking these inspections, a key consideration will be the level of the beach in relation to the trigger levels defined in **Section 3.4**.	Dorset Council	July 2019	Monthly (minimum)	4.1.6	Active
MON_005	Annual visual inspection of all of the structures along the BMP frontage will continue to occur during the spring of each year to allow any maintenance works required to be identified and completed prior to the busy summer period. Visual inspections to monitor structures after storm events should also occur. Each inspection (routine or post-storm) should be recorded in a consistent way in a defence inspection log.	Dorset Council	July 2019	Annually, each spring	4.2.1	Active
MON_006	For consistency of approach and recording, and in anticipation of a consistent Dorset-wide coastal asset data system being developed, move to undertaking these inspections using the methodology defined in the Environment Agency's *Condition Assessment Manual* (Environment Agency, 2012).	Dorset Council	July 2019	2020 onwards	4.2.1	Not Started
MON_007	The future need for detailed inspections will be guided by visual inspection findings.	Dorset Council	July 2019	As required	4.2.2	Not Started

Action No.	Action Description	Who by?	Date action First Defined?	When by?	Related BMP Section(s)	Current Status
MON_008	Continuation of this environmental monitoring will be important to provide evidence for monitoring and assessing potential environmental impacts of future capital works along the frontage.	Dorset Council	July 2019	As required	4.3	Active
MON_009	After each beach profile survey, Dorset Council should analyse the data to assess the changes in beach volumes and movements of material (i.e. identify areas of erosion/accretion).	Dorset Council	July 2019	Twice per year (minimum)	4.6	Not Started
MAINTENANCE ACTIONS						
MAI_001	Undertake beach recycling and re-profiling for FCERM purposes when defined trigger levels are reached.	Dorset Council	July 2019	As required	1.1.1, 3.4, 5.2, 5.3	Active
MAI_002	Undertake localised repairs to damaged sections of the seawall between the Pier Bandstand and Greenhill Groyne where there is no toe protection or footing.	Dorset Council	July 2019	2020/21	1.1.1	Not Started
MAI_003	Future maintenance works to the various coastal defence elements along the BMP frontage will continue to be guided by ongoing inspection.	Dorset Council	July 2019	As required	5.1.2, 5.4.3	Active
MAI_004	When maintenance works are undertaken, the plant requirements and access arrangements defined in **Section 5.4.4** and **Section 5.4.5** respectively are to be followed.	Dorset Council	July 2019	As required	5.4.4, 5.4.5	Active
MAI_005	In order to ensure the safety of the public whilst works are being carried out, restrictions on public access to the areas of the beach being worked on should be implemented, with alternative routes provided if possible.	Dorset Council	July 2019	As required	5.4.6	Active
MAI_006	When undertaking beach recycling and re-profiling works, or other maintenance works, the local community and local business are notified of works a few days ahead of them commencing.	Dorset Council	July 2019	As required	5.4.7	Active
FOR FUTURE STUDIES/RESEARCH						
FUT_001	To overcome uncertainty, the following actions should be considered to increase understanding of the storm response of the beach: • More regular monitoring of beach levels (pre- and post-storm) to allow for a more accurate model calibration and validation (see also **Section 4.1.1**). • Further assessment of the extreme conditions within Weymouth Bay should be assessed with new modelling using more recent advances in joint probability modelling (e.g. the Environment Agency's State of the Nation Project) to update data used by JacksonHyder (2018) and subsequently by JBA (2019a). *NB: this could be combined with modelling how sea level rise may alter wave transformation and tidal currents that drives sediment transport processes in Weymouth Bay – see **Action No. FUT_002**).* • Consideration of additional joint-probability extreme events (e.g. assess a range of higher wave height and lower water level combinations) to better understand the potential beach profile changes during different extreme events in present day and allowing for sea level rise. • Consideration of 2D modelling of extreme events to better represent and understand the variation in the beach response along the study frontage (e.g. use XBeach in 2D mode not 1D mode).	Dorset Council	July 2019	2024	1.4.2.1	Not Started
FUT_002	In order to provide improved assessment of the economic case for long-term FCERM investment along the BMP frontage, there are a range of activities that could be undertaken including: • Improvements to the underlying wave modelling and overtopping analysis that provides inputs to the coastal flood modelling and so flood damages calculated (*possibly do in combination with aspects of **Action No. FUT_001***).	Dorset Council	July 2019	2024	1.5.2	Not Started

Action No.	Action Description	Who by?	Date action First Defined?	When by?	Related BMP Section(s)	Current Status

	• Refinement of the flood damages to include:
	  • Capping values,
	  • Inclusion of basements and other factors (e.g. traffic and emergency services disruptions),
	  • Flood damages extended to year 100 with supporting modelling of wave/water level climate and overtopping analysis (including impacts of climate change and sea level rise over 100 years using recently updated guidance (i.e. UKCP18 in place of UKCP09),
	  • Further assessment of flood risk from (i) wave overtopping only and (ii) where the overlaps are in terms of property at risk from both the open coast (beach management study) frontage and from the harbour frontage.
	• Refinement of the valuations assumed for properties at risk of erosion, as well as inclusion of infrastructure costs of erosion (e.g. re-routing infrastructure; road diversions etc).
	• Refinement of the assessment of amenity loss and gain to provide a more robust assessment by undertaking a site-specific investigation (e.g. contingent valuation survey) of visitors, supported by further capture of actual visitor numbers to the beach and esplanade area.
	• Revision of the assessment to include allowance for the additional damages arising from loss of annual revenue to WPBC from concessions etc. along the frontage if the beach area narrows and/or there are reduced visitors using these facilities, so they are no longer viable to run. Other wider tourism industry losses could be assessed (reduced level of enjoyment leading to reduced visitor spend in the wider local economy).					

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Glossary of terms

Term	Definition
Action Level	One of two trigger levels, this is the trigger level below Crisis Level. This is usually a predetermined value where the monitored beach parameter falls to within range of the Action Level, but has not resulted in systematic failure of the function being monitored, e.g. recession of a beach crest eroding to within 10m of an asset, where it has been predetermined that an extreme storm event could result in recession of 5m. The Action Level in this example is therefore a 5m buffer. Increased monitoring would be required when an Action Level is compromised and intervention undertaken if deemed necessary. Managing Action Levels can be planned in advance.
Accretion	Accumulation of sediment due to the natural action of waves, currents and wind.
AONB	Area of Outstanding Natural Beauty. Designated by the former Countryside Agency (now Natural England). The purpose of the AONB designation is to identify areas of national importance and to promote the conservation and enhancement of natural beauty. This includes protecting its flora, fauna, geological and landscape features. This is a statutory designation.
APO	Annual probability of occurrence.
Appropriate Assessment (AA)	Appropriate Assessment: Regulation 48 of the Habitats Directive (92/43/EEC) requires that an Appropriate Assessment is undertaken for plans or projects that may have a likely significant effect on a European site (e.g. sites designated as SPA or SAC), where the plan is not directly associated with the management of the site. The purpose of AA is to determine whether the plan or project will have an adverse effect on the integrity of the site, either alone or in combination with other plans, programmes and projects.
ATT	Admiralty Tide Table.
BAP	Biodiversity Action Plan. A strategy for conserving and enhancing wild species and wildlife habitats in the UK.
Beach	A deposit of non-cohesive material (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively 'worked' by present day hydrodynamic processes (i.e. waves, tides and currents) and sometimes by winds.
Beach Plan Shape	The shape of the beach in plan; usually shown as a contour line, combination of contour lines or recognizable features such as beach crest and/or the still water line
Beach Profile	Cross-section perpendicular to the shoreline. The profile can extend seawards from any selected point on the landward side or top of the beach into the nearshore.
Beach recharge (nourishment)	Artificial process of replenishing a beach with material from another source.
Beach recycling/re-profiling	The movement of sediment along a beach area, typically from areas of accretion to areas of erosion, and shaping the beach profile to have a desired crest height, width and slope.
Berm	A ridge located to the rear of a beach, just above mean high water. It is marked by a break of slope at the seaward edge.

Term	Definition
Bimodal wave period	Related to frequency distribution of waves, for each bimodal wave periods two wave peaks are observed.
BMP	Beach Management Plan. It provides a basis for the management of a beach for coastal defence purposes, taking into account coastal processes and the other uses of the beach.
Breaching	Failure of the beach head allowing flooding by tidal action.
CCO	Channel Coastal Observatory. Based at University of Southampton, responsible for the South-East Strategic Regional Coastal Monitoring Programme.
CIRIA	Construction Industry Research and Information Association.
Climate Change	Long term changes in climate. The term is generally used for changes resulting from human intervention in atmospheric processes through, for example, the release of greenhouse gases to the atmosphere from burning fossil fuels, the results of which may lead to increased rainfall and sea level rise.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by a fixation of the high water mark.
Crest	Highest point on a beach face, breakwater or seawall.
Crest level/height	The vertical level of the beach relative to mOD.
Crest width	The horizontal distance of the beach measured from the seaward edge of the promenade to the point where the beach slope angle drops down towards the sea.
Crisis Level	One of two trigger levels, this is the trigger level at which the function being monitored, such as the stability of the beach and/or any backing structures (seawall/promenade), could be compromised and emergency remedial action becomes necessary, e.g. as in the case described under Action Level above, the beach crest recedes to within 4m of an asset that requires protection, where it has been predetermined that an extreme event could result in 5m of recession.
DCC	Dorset County Council. Has a variety of roles including emergency planning, Lead Local Flood Authority and highways authority. Also host the UNESCO World Heritage Site management team. *NB: As of 1st April 2019, DCC ceased to exist, as it became part of the new Dorset Council.*
Defra	Department for Environment, Food and Rural Affairs (formerly known as MAFF)
Dorset Council	Unitary Authority created on 1st April 2019, taking on many of the duties previously held by DCC and WPBC.
Drift reversal	A switch of an indigenous direction of littoral transport.
EA	Environment Agency. UK non-departmental government body responsible for delivering integrated environmental management including flood defence, water resources, water quality and pollution control.
Erosion	Wearing away of the land, usually by the action of natural forces.

Term	Definition
Flood and Coastal Erosion Risk Management (FCERM)	Flood and coastal erosion risk management addresses the scientific and engineering issues of rainfall, runoff, rivers and flood inundation, and coastal erosion, as well as the human and socio-economic issues of planning, development and management.
Flood Zone	A geographical area officially designated subject to potential flood damage. The Environment Agency uses Flood Zone 2 and Flood Zone 3.
FWA	Flood Warning Area.
Geomorphology/ morphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Hard defence	General term applied to impermeable coastal defence structures of concrete, timber, steel, masonry etc, which reflect a high proportion of incident wave energy.
Heritage Coast	A Heritage Coast is a strip of UK coastline defined by Natural England as having notable natural beauty or scientific significance.
Hold the Line	An SMP policy to maintain or change the level of protection provided by defences in their present location.
IPCC	Inter-Governmental Panel on Climate Change.
Joint probability	The probability of two (or more) things occurring together.
Joint Probability Analysis (JPA)	Function specifying the joint distribution of two (or more) variables.
Joint return period	Average period of time between occurrences of a given joint probability event.
LiDAR	Light Detection and Ranging. This is an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground.
Listed Building	A building or other structure officially designated as being of special architectural, historical or cultural significance.
Locally generated (wind) waves	Locally generated short period and irregular waves created by the flow of air over water.
Longshore transport	Movement of material parallel to the shore, also referred to as longshore drift.
mCD	metres Chart Datum. Approximately the lowest astronomical tidal level, excluding the influence of the weather.
MMO	Marine Management Organisation. An executive non-departmental public body established and given powers under the Marine and Coastal Access Act 2009. Responsible for managing activities in the marine environment including marine licensing and marine planning.
mOD	metres Ordnance Datum. A universal zero point used in the UK, equal to the mean sea level at Newlyn in Cornwall.
Managed Realignment	An SMP policy allowing the shoreline to move backwards or forwards, with management to control or limit movement. This includes reducing erosion or building new defences on the landward side of the original defences.
Management Unit (MU)	The BMP frontage is split into 3 Management Units (MU's) within which slightly different management approaches are required.

Term	Definition
MCZ	Marine Conservation Zone designated under the provisions of the Marine and Coastal Access Act 2009.
Met Office	UK Meteorological Office.
Natural England	A non-departmental public body of the UK government responsible for ensuring that England's natural environment, including its land, flora and fauna, freshwater and marine environments, geology and soils, are protected and improved. It also has a responsibility to help people enjoy, understand and access the natural environment.
No Active Intervention	An SMP policy that assumes that existing defences are no longer maintained and will fail over time or undefended frontages will be allowed to evolve naturally.
Non-designated archaeological sites	Historical and archaeological structures, features and finds, as well as buildings and landscapes of historical or architectural interest within a given county or unitary authority area that are contained in the Historic Environment Record (formerly Sites and Monuments Register (SMR)) but which are not cited under statutory designations such as Listed Building or Scheduled Monument.
Overtopping	Water carried over the top of a coastal defence due to wave run-up exceeding the crest height.
Policy Unit	A Policy Unit relates to the policy area defined by the Shoreline Management Plan (SMP).
Return Period	A statistical measurement denoting the average probability of occurrence of a given event over time.
SAC	Special Area of Conservation. This designation aims to protect habitats or species of European importance and can include Marine Areas. SACs are designated under the EC Habitats Directive (92/43/EEC) and will form part of the Natura 2000 site network. All SACs sites are also protected as SSSI, except those in the marine environment below the Mean Low Water (MLW).
Scheduled Monument	Scheduled Monument: formerly referred to as Scheduled Ancient Monuments. Scheduled Monuments are nationally important archaeological sites which have been awarded scheduled status in order to protect and preserve the site for the educational and cultural benefit of future generations. The main legislation concerning archaeology in the UK is the Ancient Monuments and Archaeological Areas Act 1979. This Act, building on legislation dating back to 1882, provides for nationally important archaeological sites to be statutorily protected as Scheduled Monuments.
SCOPAC	Standing Conference On Problems Associated with the Coastline. A group of local authorities and other organisation with responsibility for coastal management along the central southern coast of England.
Scour	Removal of underwater material by waves or currents, especially at the toe of a shore protection structure.
Sea level change	The rise and fall of sea levels throughout time in response to global climate and local tectonic changes.
Seawall	Massive structure built along the shore to prevent erosion and damage by wave action.
SERCMP	South-East Regional Coastal Monitoring Programme (see CCO).

Term	Definition
Sediment transport	The movement of a mass of sedimentary material by the forces of currents and waves.
Sensitive Marine Area	A generic term used to describe nationally important locations around our coast which require a cautious and detailed approach to management. They are identified by English Nature for their important benthic populations, spawning or nursery areas for fish, fragile intertidal communities, or breeding, feeding, and roosting areas for birds and sea mammals. This is a non-statutory designation
Significant wave height	The average height of the highest of one third of the waves in a given sea state.
SMP	Shoreline Management Plan. It provides a large-scale assessment of the risks associated with coastal processes and presents a policy framework to manage these risks to people and the developed, historic and natural environment in a sustainable manner.
SNCI	Site of Nature Conservation Importance. These sites are defined by the Wildlife Trusts and Local Authorities as sites of local nature conservation interest. These are non-statutory but form an integral part of the formulation of planning policies relating to nature conservation issues.
SPA	Special Protection Area. These are internationally important sites, being set up to establish a network of protected areas of birds
SSSI	Sites of Special Scientific Interest. These sites, notified by English Nature, represent some of the best examples of Britain's natural features including flora, fauna, and geology. This is a statutory designation
Standard of Protection (SoP)	The extreme event return period above which significant damage and possible failure of flood or erosion defences could occur. It can be is expressed in terms of "1 in X year return period" or as "annual probability of exceedance (%)".
Standard of Service	The adequacy of defence afforded to a specific area from flooding or erosion, measured in terms of the extreme event that causes a critical condition (e.g. breaching / overtopping) to be reached. It is normally associated with a particular epoch, or date (e.g.2019 or 2050) and is expressed in terms of "1 in X year return period" or as "annual probability of exceedance (%)".
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Sustainability (in coastal flood and erosion risk management)	The degree to which coastal flood and erosion risk management options avoid tying future generations into inflexible or expensive options for flood defence. This usually includes consideration of other defences and likely developments as well as processes within catchments. It will take account of long term demand for non-renewable materials.
Swell waves	Remotely wind-generated waves (i.e. Waves that are generated away from the site). Swell characteristically exhibits a more regular and longer period and has longer crests than locally generated waves.
SWL	Still water level. The level that the sea surface would assume in the absence of wind and waves.
Thermohaline Circulation	Large-scale circulation in the ocean that transforms low-density upper ocean waters to higher-density intermediate and deep waters and returns those waters back to the upper ocean. The circulation is asymmetric, with conversion to dense waters in restricted regions at high latitudes and the

Term	Definition
	return to the surface involving slow upwelling and diffusive processes over much larger geographic regions. The THC is driven by high densities at or near the surface, caused by cold temperatures and/or high salinities, but despite its suggestive though common name, is also driven by mechanical forces such as wind and tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Toe level	The level of the lowest part of a structure, generally forming the transition to the underlying ground.
Trigger level	Refers to levels that if reached, trigger a response. See Alarm Level and Crisis Level.
UKCP09 / UKCP18	UK Climate Projections 2009 / 2018. Research giving predictions of how future climate change may affect the UK.
Wave climate	Average condition of the waves at a given place over a period of years, as shown by height, period, direction etc.
Wave diffraction	Process affecting wave propagation, by which wave energy is radiated normal to the direction of wave propagation into the lee of an island, breakwater or headland.
Wave direction	Direction from which a wave approaches.
Wave height	The vertical distance between the crest and the trough.
Wave hindcast	In wave prediction, the retrospective forecasting of waves using measured wind information.
Wave period	The time it takes for two successive crests (or troughs) to pass a given point.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.
Wave reflection	The part of an incident wave that is returned (reflected) seaward when a wave impinges on a beach, seawall or other reflecting surface.
WFD	Water Framework Directive. A European Directive that aims to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater.
World Heritage Site	A place of outstanding universal value. Designated by UNESCO (United Nations Educational, Scientific and Cultural Organisation).
WPBC	Weymouth & Portland Borough Council. Coastal Operating Authority as defined under the Coast Protection Act 1949 with permissive powers to provide defence against coastal erosion. *NB: As of 1st April 2019, WPBC ceased to exist, as it became part of the new Dorset Council.*
Weymouth Town Council	Town Council formed on 1st April 2019 as part of the creation of Dorset Council, taking on some of the functions that were previously the responsibility of WPBC.

Appendix A. Future Management Regime Options Assessment

Appendix B. History of Coastal Defences

Appendix C. Coastal Processes Understanding Baseline

Appendix D. Contact Details

Appendix E. Economics Baseline

Appendix F. Current Defences Performance Assessment

Appendix G. Defence Inspection Record Proforma

Appendix H. Defence Repair Works Proforma

Appendix I. Beach Recycling Log Template

Appendix J. Design Profile and Trigger Level Diagrams

Appendix K. Best Practice Guide for Public Engagement when undertaking beach maintenance works