

# **Folkestone Harbour - Harbour Plots**

## **Flood Risk Assessment**

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## Glossary

| Term                                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Catchment Flood Management Plan (CFMP) | A CFMP is a large scale strategic planning framework for the integrated management of flood risks to people, natural and developed environment in a sustainable manner.                                                                                                                                                                                                                                                |
| Coastal Defence                        | To provide protection from coastal erosion and/or tidal flooding.                                                                                                                                                                                                                                                                                                                                                      |
| Design Flood Event                     | This is a flood event of a given annual flood probability which is generally taken as river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), plus an appropriate allowance for climate change. |
| Discharge                              | The rate of flow of water measured in terms of volume per unit time.                                                                                                                                                                                                                                                                                                                                                   |
| Flood Resilience                       | Improving flood resistance, e.g. reducing the risk of properties against flooding events.                                                                                                                                                                                                                                                                                                                              |
| Flood Risk                             | The level of risk to personal safety and damage to property resulting from flooding due to the frequency or likelihood of flood events.                                                                                                                                                                                                                                                                                |
| Flood Risk Assessment (FRA)            | An assessment of the flood risks to the proposed development over its expected lifetime and the possible flood risks to the surrounding areas, assessing flood flows, flood storage capacity and runoff.                                                                                                                                                                                                               |
| Flood Risk Management (FRM)            | Managing and/or reducing flood risk to people, property and the environment.                                                                                                                                                                                                                                                                                                                                           |
| Flood Zones                            | The statistical chance of a flood event occurring in any one year, stated as a percentage. NPPF identifies three flood zones; Zone 1 – Low Probability, Zone 2 – Medium Probability and Zone 3 – High Probability.                                                                                                                                                                                                     |
| Fluvial Flooding                       | Related or connected to a watercourse (river or stream).                                                                                                                                                                                                                                                                                                                                                               |
| Groundwater Flooding                   | Water occurring below ground in natural formations (typically rocks, gravels and sands).                                                                                                                                                                                                                                                                                                                               |
| Mitigation                             | Actions taken to reduce either the probability of flooding or the consequences of flooding or a combination of the two.                                                                                                                                                                                                                                                                                                |
| Residual Risk                          | The risk that remains after risk management and mitigation measures have been implemented.                                                                                                                                                                                                                                                                                                                             |
| Risk                                   | Risk is the probability that an event will occur and the impact (or consequences) associated with that event.                                                                                                                                                                                                                                                                                                          |
| Runoff                                 | Water flow over surfaces to the drainage system. Runoff occurs if the ground is impermeable or if permeable ground is saturated.                                                                                                                                                                                                                                                                                       |
| Shoreline Management Plan (SMP)        | SMPs are strategies for managing flood and erosion risk for a particular stretch of coastline.                                                                                                                                                                                                                                                                                                                         |
| Surface Water Flooding                 | Surface water flooding occurs when the volume of water is unable to filtrate through the ground to enter drainage systems, and therefore runs quickly off land and results in localised flooding. This type of flooding is usually associated with intense rainfall.                                                                                                                                                   |
| Sustainable Drainage Systems (SuDS)    | SuDS are used as a strategy to manage surface water in a sustainable manner or least damaging solution through management practices and physical structures.                                                                                                                                                                                                                                                           |
| Sustainable Development                | Development which meets the needs of the present without compromising the ability of future generations to meet their own needs.                                                                                                                                                                                                                                                                                       |
| Water Table                            | The top surface of the saturated zone within the aquifer.                                                                                                                                                                                                                                                                                                                                                              |

# Abbreviations

| Term | Definition                         |
|------|------------------------------------|
| AEP  | Annual Exceedance Probability      |
| CC   | Climate Change                     |
| EA   | Environment Agency                 |
| FHDC | Folkestone Hythe District Council  |
| FRA  | Flood Risk Assessment              |
| LLFA | Lead Local Flood Authority         |
| SuDS | Sustainable Drainage Systems       |
| LPA  | Local Planning Authority           |
| NPPF | National Planning Policy Framework |
| SDC  | Shepway District Council           |
| SFRA | Strategic Flood Risk Assessment    |

# 1 Executive Summary

This site-specific Flood Risk Assessment (FRA) has been prepared by Buro Happold on behalf of The Folkestone Harbour Development Company as part of the Reserved Matters Planning Application for the proposed residential development at Plots F1, G1 and H and landscape proposals at Plots F2 and G2, Folkestone Seafront, Folkestone. Outline planning application ref: Y17/1099/SH was obtained for the wider 23 hectares development of which this application is for Plots F1, F2, G1, G2 and H, as shown in Figure 2-1.

This FRA will focus on Plots F1, G1 and H as this is where the residential development is proposed. Plots F2 and G2 are proposed to be landscaping only, therefore Plots F1, G1 and H are hereafter referred to as the 'proposed development'.

| Subject                             |                               | Findings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Site Description</b>             |                               | <p>The site is located on Folkestone Seafront, Folkestone, Kent and is approximately 2.5ha. It is located to the east of the OPA development site, to the east of Plot E1 and south of Folkestone Harbour. The English Channel is to the south and east of the site.</p> <p>The site was previously occupied by industrial premises and an amusement park. In 2017, the unused hardstanding was removed to allow for the preparation of the new development in the form of the creation of an extended shingle beach. At present, Plots F1 and F2 are largely shingle beach, with an area of hardstanding to the north used for parking. Plots G1, G2 and H are hardstanding and include areas of parking and small businesses.</p> |
| <b>Proposed Development</b>         |                               | The proposed development consists of 405 residential units as well as supporting facilities and amenities for residents. Across the 3 plots of F1, G1 and H there are fourteen buildings which contain apartments and duplexes ranging from 1 beds to 4 beds. The design also contains commercial, leisure and public amenities.                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Existing Flood Risk</b>          | <b>Fluvial and Coastal</b>    | <p>The coastal environment is the primary source of flood risk to the development. The present day 1 in 200yr coastal extreme still water level is +4.80mOD and is projected to increase to +5.77mOD by the year 2115 due to sea level rise with a potential to be as much as +6.10mOD.</p> <p>The Pent River is the only river in the vicinity of the site. The EA Flood Maps indicate that the fluvial flood risk coming from the Pent River is localised around the river, before entering the sea via the north of the harbour, demonstrating that fluvial flood risk to the site is low.</p>                                                                                                                                   |
|                                     | <b>Groundwater</b>            | <p>Present day groundwater levels range between +0.56mOD and +3.44mOD and are understood to be hydraulically linked to the coastal environment due to the high permeability of the soils under the site. On this basis groundwater levels are expected to increase to as much as +4.41mOD by 2115 during normal conditions.</p> <p>Groundwater is not expected to breach the surface across the life of the development and so the risk from groundwater flooding is considered to be low for above ground structures.</p>                                                                                                                                                                                                          |
|                                     | <b>Surface Water</b>          | The Surface Water Flood Risk Maps for Planning indicate the majority of the site to be at very low flood risk (less than 0.1% chance of flooding each year) with just two localised areas of low (between 0.1% and 1% chance of flooding each year) to medium (between 1% and 3.3% chance of flooding each year) flood risk to the south-east of Plot G1 and to the north-west of Plot F1.                                                                                                                                                                                                                                                                                                                                          |
|                                     | <b>Sewers and Water Mains</b> | There are no recorded incidents of flooding due to sewers and water mains within the area of the site and historic flooding from this source has not occurred since the flood alleviation schemes implemented in 1998/1999 by SDC. Based on the available information it is considered that the site is at low risk from flooding from sewers and water mains.                                                                                                                                                                                                                                                                                                                                                                      |
|                                     | <b>Artificial Sources</b>     | The Reservoir Flood Risk Map for Planning shows that risk from reservoir flooding in the vicinity of the site originates from the Hart Reservoir, to the north-west of the site, with the water flowing along the Pent River and discharging into the Inner Harbour, north of the site. The Site is therefore not at risk from reservoirs or artificial sources.                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Sitewide Flood Risk Strategy</b> |                               | Plot F1 is reliant upon the flood risk mitigation measures implemented at the site level. These are summarised below:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|                                   |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                   |                                 | <ol style="list-style-type: none"> <li>1. The shingle beach forms the primary flood defence to the site. This consists of a design beach crest of +6.5mOD, a minimum crest width of 14m and shingle dunes rising to +7.5mOD prior to the back of the unmaintained active zone (see below)</li> <li>2. The beach is separated into two active zones. A maintained active zone, 14m wide behind the design beach crest and an unmaintained active zone, 25.8m wide behind the design beach crest. All buildings are to be located behind the unmaintained active zone.</li> <li>3. To maintain the sea defence capability of the shingle beach, the beach is regularly maintained in accordance with the Folkestone Seafront Beach Management Plan.</li> <li>4. Minimum threshold levels of +6.5mOD for residential buildings across the entire site in line with the OPA FRA. This level remains valid on the basis that the 2115 1 in 200yr flood level plus 600mm freeboard is +6.37mOD.</li> <li>5. Minimum threshold levels of +8.0mOD for residential buildings immediately behind the 30m unmaintained active zone with all buildings founded on piles to mitigate scour and wave overtopping risks from the highly mobile beach environment.</li> </ol> <p>Plots G1 and H are reliant upon the following flood risk mitigation measures proposed to be implemented at the site level:</p> <ol style="list-style-type: none"> <li>1. A sea defence in the form of a sloping rock revetment with a crest wall along the eastern edge of the South Quay to reduce wave overtopping to tolerable levels up to and including the design event 1 in 200yr plus climate change to 2115.</li> </ol> |
| <b>Sitewide Drainage Strategy</b> |                                 | <p>Given the permeable nature of the underlying soil, the site wide drainage strategy shall implement Sustainable Drainage Systems (SuDS) with a focus upon infiltration and attenuation. They shall be designed such that no flooding occurs at ground level for a 1 in 30 year event and shall not flood buildings for a 1 in 100 year event.</p> <p>All hardstanding is to have permeable paving with roof and podium areas utilising source control techniques e.g. green podium decks, infiltration cells and swales, to control surface water flow. To reduce the size of infiltration cells, it is recommended that spare capacity in the existing Southern Water network is utilised, subject to the water authority's approval.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Proposed Flood Risk</b>        | <b>Coastal</b>                  | <p>All entrances and thresholds into the buildings and the basements are at or above +6.5mOD. Along the southern edge of Plot F1, closest to the sea, the building has a threshold level of +7.5mOD. The bottom two floors are to have commercial uses, with residential uses located from the second floor upwards, this is therefore considered appropriate.</p> <p>The sequential approach has been applied to site all vulnerable development/land uses above this level. This is particularly important within the basements where only water compatible and less vulnerable land uses are located e.g. storage areas and car parking to reduce risk.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                   | <b>Groundwater</b>              | <p>The finished floor level for the basement is +2.8mOD. Given present day and future groundwater levels, the basement will require tanking to a minimum level of +6.10mOD to prevent percolation into the basement during future extreme coastal flood events as well as groundwater flooding during normal conditions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                                   | <b>Surface Water</b>            | <p>The proposed drainage strategy makes use of infiltration where available (in the SW corner) as a sustainable way of managing stormwater on site and at source. In addition to this, surface water will be discharged to public storm sewer at the NW corner of the plot to match existing connected catchment areas and new stormwater outfalls to sea at the East of the site.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Residual Flood Risk</b>        | <b>Coastal</b>                  | <p>Although the new sea defence is designed to restrict wave overtopping to tolerable levels established by best practice guidance, overtopping will still occur at low levels. Due to the very low anticipated volumes of overtopping there is not believed to be any risk to property with Plot G1, however there is a small residual risk to people as a result of wave overtopping risk to Plot G1. It should be noted that these volumes include sea level rise for the full design life and so the discharges will be significantly lower than shown for most of the intervening period, even for a 1 in 200yr event.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                   | <b>Flooding of the Basement</b> | <p>Located below the +6.5mOD minimum finished floor level threshold, the residual risk to the basements is that a larger storm event or percolation of groundwater through the basement walls may lead to flooding, and in some cases rapid inundation of the basement.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|                   |                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |                                          | Risks have been controlled by the provision of multiple access and egress routes out of the basement. Through this provision, the rapid of evacuation of the basement in a flood event mitigates the residual risk.                                                                                                                                                                                                                                                                                                                                          |
|                   | <b>Flood Warning and Evacuation Plan</b> | Although Plots F1, G1 and H, are at no risk of flooding from all sources up to and including the design flood event, a flood warning and evacuation plan has been written to provide details of how flood warnings will be issued to residents and detail the actions that users will need to take before and during a flood event to ensure safety, including identification of safe refuge areas. Should it be predicted that the design flood event could be exceeded, then there is safe access and egress from all exits of the site via Marine Parade. |
| <b>Conclusion</b> |                                          | Accounting for mitigation measures already incorporated within the design, the overall flood risk to the proposed development is Low for all sources of flooding. Future mitigation measures are proposed to reduce and manage residual risks.                                                                                                                                                                                                                                                                                                               |

## 2 Introduction

### 2.1 Background

This site-specific Flood Risk Assessment (FRA) has been prepared by Buro Happold on behalf of The Folkestone Harbour Development Company as part of the Reserved Matters Application (RMA) for the proposed residential development at Plots F1, G1 and H and landscape proposals at Plots F2 and G2, Folkestone Seafront, Folkestone. Outline planning application ref: Y17/1099/SH was obtained for the wider 23 hectares development of which this application is for Plots F1, F2, G1, G2 and H, as shown in Figure 2-1 and Figure 2-2 which shows the overall RMA Boundary.

This FRA will focus on Plots F1, G1 and H as this is where the residential development is proposed. Plots F2 and G2 are proposed to be landscaping only, therefore Plots F1, G1 and H are hereafter referred to as the 'proposed development'.

This assessment has been developed in accordance with the National Planning Policy Framework (NPPF) (December 2023) and the Planning Practice Guidance (PPG) (November 2023) and considers potential flood risk to the proposed development from the following sources: tidal, fluvial, surface water, sewer, groundwater, artificial sources and failure of drainage infrastructure.

In order to comply with the NPPF and PPG, this FRA will identify the potential flood risks and demonstrate any required appropriate flood mitigation measures to ensure that the risk to the site is acceptable for the level of development proposed.

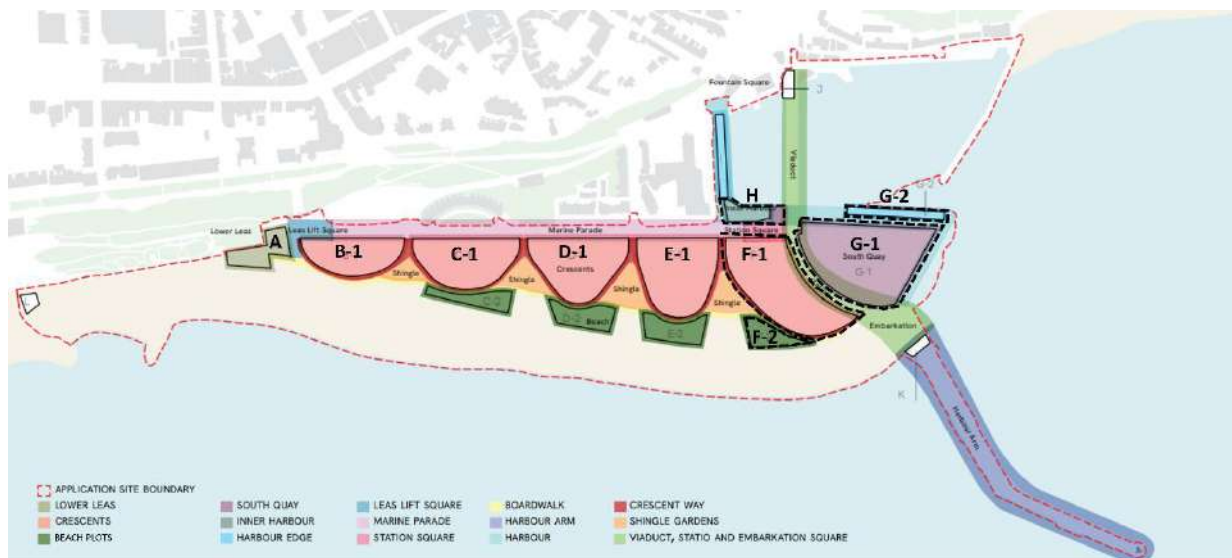


**Figure 2-1 Diagram of character areas showing location of Plots F1, G1 & H relative to the wider masterplan, extracted from the Folkestone Seafront Plot E1DAS (September 2023)**



**Figure 2-2 The Harbour Plan development plots and overall Reserved Matters Application (RMA) boundary shown, extracted from the Folkestone Seafront Harbour Plots DAS (March 2024)**

## 2.2 Site Description

The site is located on Folkestone Seafront, Folkestone, Kent. The site is located within the administrative boundary of Folkestone and Hythe District Council (FHDC), formerly named Shepway District Council (SDC).

As noted in Section 2.1, this FRA will focus on Plots F1, G1 and H as this is where the residential development is proposed. Plots F2 and G2 are proposed to be landscaping only.

Plot F1 is part of the Crescents Character Area, Plots G1 makes up part of the South Quay Character Area and Plot H makes up part of the Inner Harbour Character Area.

Plots F1, G1 and H represent approximately 2.5ha of the total 23ha development and is located to the east of the development site, to the east of Plot E1 and south of Folkestone Harbour, with Plot F1 bordered by the board walk on the southern edge. The English Channel is to the south and east of the site. The site was previously occupied by industrial premises and an amusement park. In 2017, most of the unused hardstanding was removed from Plot F1 to allow for the preparation of the new development. At present, Plot F1 is largely shingle beach, with an area of hardstanding to the north used for parking. Plots G1 and H are hardstanding and include areas of parking and small businesses.

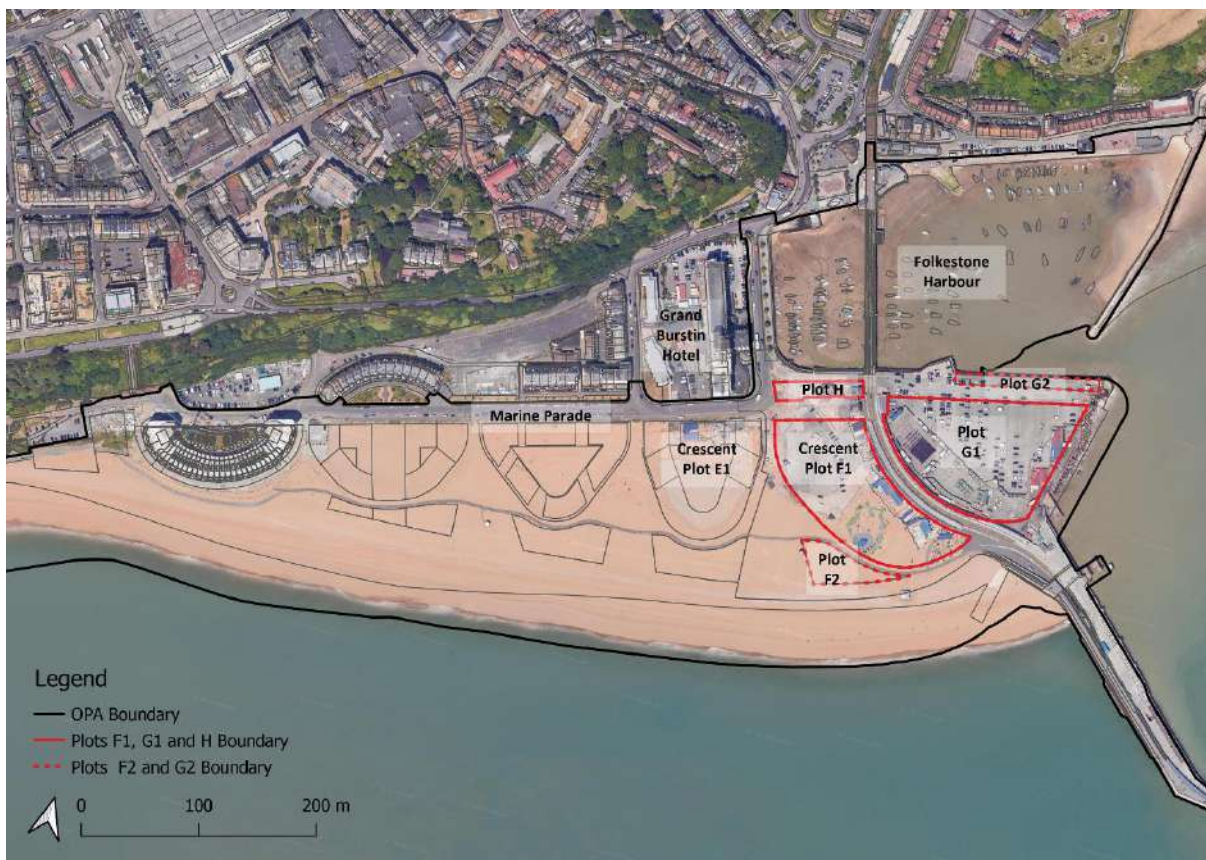


**Figure 2-3 Site boundary and location**

Figure 2-4 shows the existing site levels based on EA LiDAR topography based on 2022 data.

The existing beach topography on Plot F1 is a result of major beach re-levelling and replenishing works undertaken in 2017. The hardstanding on the Plot F1 boundary varies in level between around +5.9mOD to +6.5mOD. The remaining area of the Plot F1 boundary varies between around +6.8mOD and +7.5mOD. The topography of the Harbour is relatively flat with an average elevation of +6.2mOD.

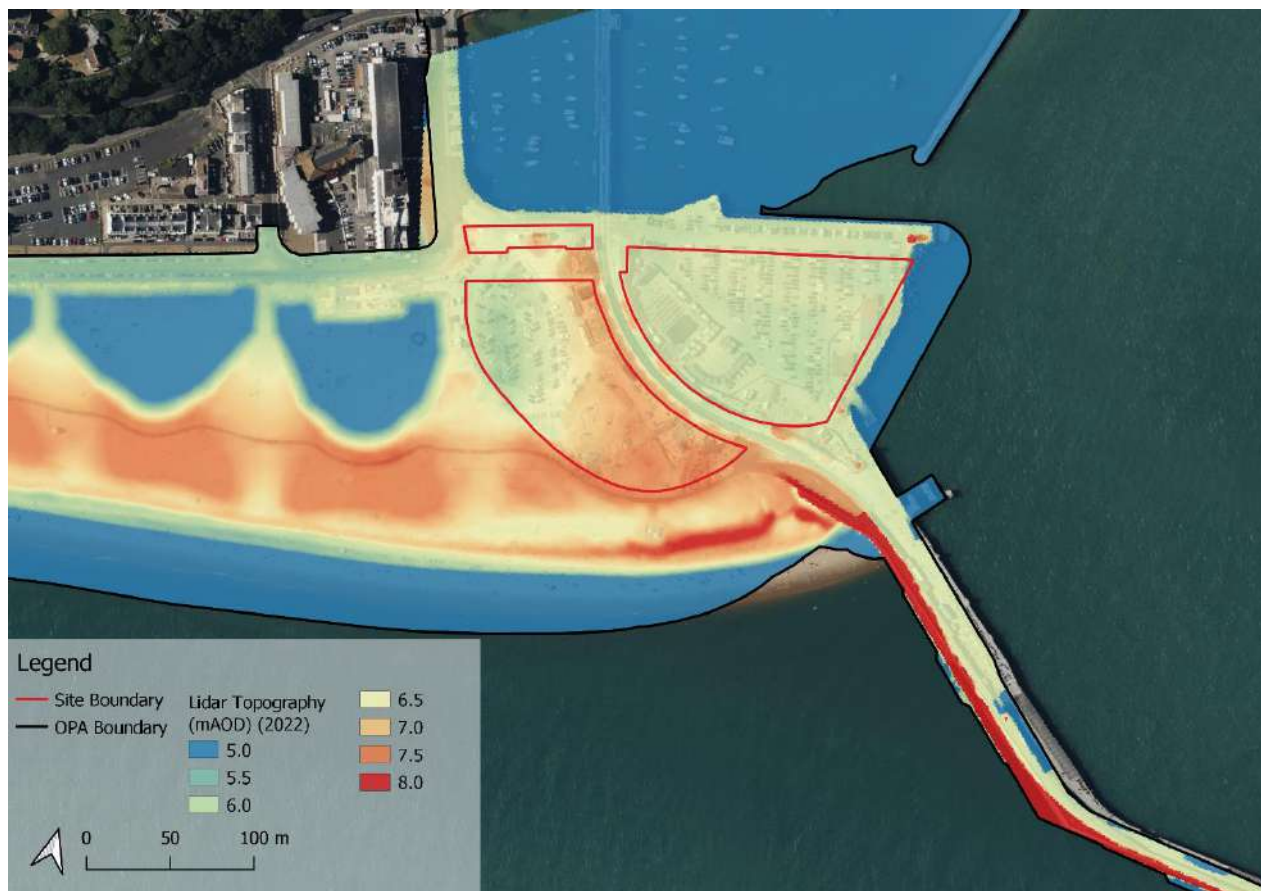


Figure 2-4 Existing site levels relative to Ordnance Datum (Lidar data, 2022, published by the Environment Agency)

## 2.3 Proposed Development

The proposed development consists of 405 residential units as well as supporting facilities and amenities for residents. Across the 3 plots F1, G1 and H there are fourteen buildings (shown in Figure 2-5) which contain apartments and duplexes ranging from 1 beds to 4 beds. The design also contains commercial, leisure and public amenities. There is a communal garden on Plot F-1 which is accessible through the communal cores and directly from some units. The basement contains most of the car parking, cycle parking, bin stores and plant rooms. The roofs have plant rooms and photovoltaic panels. The spatial split of residential, commercial, leisure and amenities, green spaces and parking is demonstrated in Figure 2-6.

There is extensive development of the public realm proposed, including landscaping and provision of amenity space. A new Sea Defence is to be constructed on the south-eastern side of the South Quay to protect Plot G1 from coastal flood risk. The historic station platform and course of the old railway line is to be maintained as a focal feature between Plots F1 & G1.



Figure 2-5 Illustrative ground floor plan extracted from Folkestone Harbour Landscape and Public Realm Strategy Report (document no. 8417-DAS-001) (Spacehub, January 2024)

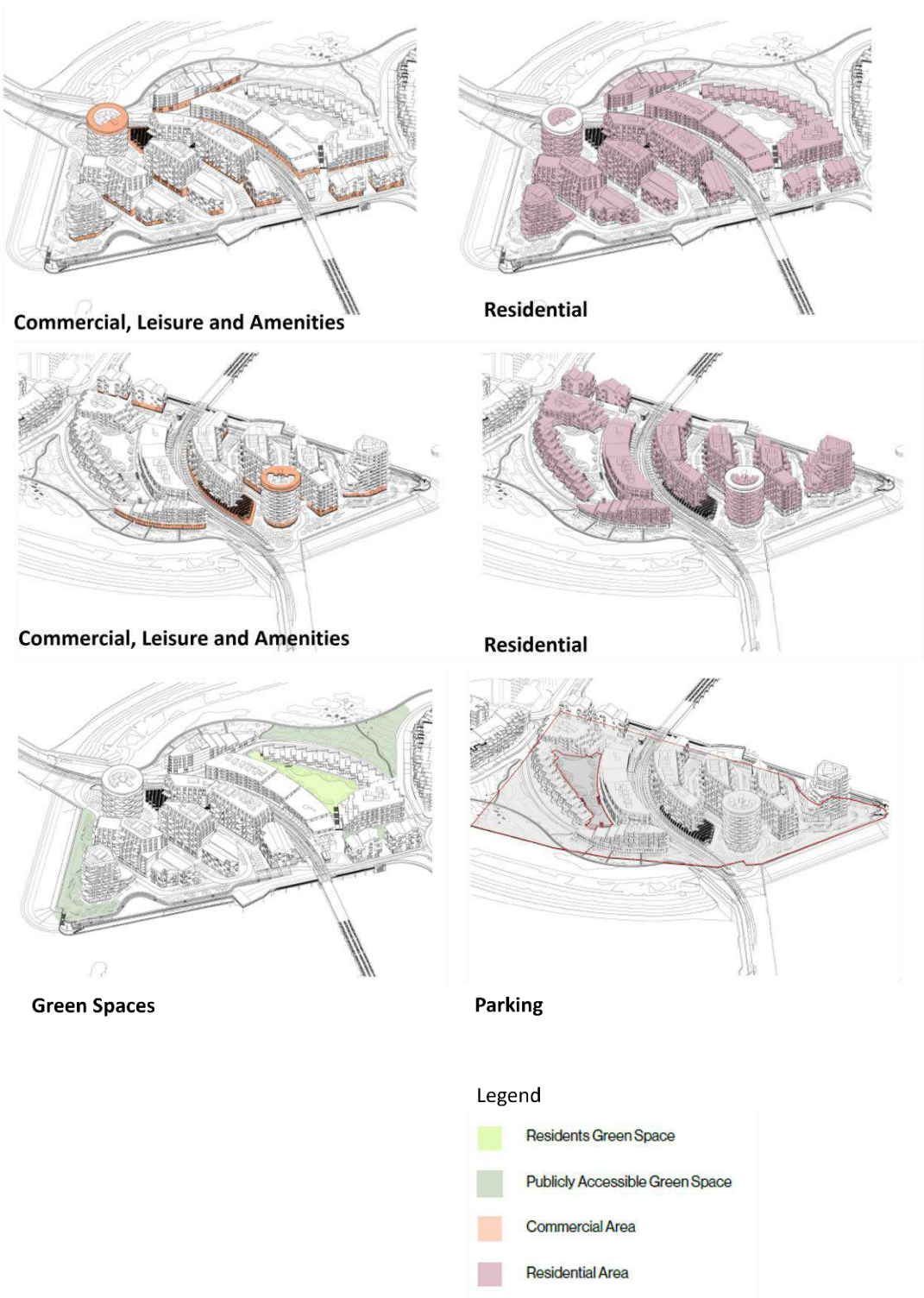


Figure 2-6 Building layout and amenities, extracted from the Folkestone Seafront Harbour Plots DAS (March 2024)

## 3 Planning Context

### 3.1 Overview

This site-specific FRA has been prepared in accordance with the policies, legislation and guidance applicable to the proposed development provided by UK national and local governments. This policy and guidance has been produced to inform flood related decision-making in all stages of development. The documents applicable to the proposed development are:

- National Planning Policy Framework (NPPF) (March 2012, Updated: December 2023);
- National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG) (November 2016, Updated: November 2023);
- Shepway District Council (SDC) Strategic Flood Risk Assessment (SFRA) (July 2015);
- Folkestone and Hythe District Council (FHDC) Core Strategy Review (March 2022);
- Folkestone and Hythe District Council (FHDC) Places and Policy Local Plan (September 2020);
- Folkestone to Cliff End Flood Risk Management Strategy (April 2021);
- Shepway District Local Plan Review (2006): Policies Applicable 2013 Onwards (undated);
- South Foreland to Beachy Head Shoreline Management Plan (April 2006); and,
- River Stour Catchment Flood Management Plan Summary Report (December 2009).

### 3.2 National Planning Policy Framework

#### 3.2.1 Flood Risk Assessment

The National Planning Policy Framework (NPPF) aims to avoid inappropriate development in areas at the highest risk of flooding. The Planning Practice Guidance (PPG) to the NPPF contains a series of tables that help identify the risk of flooding to a development, which are presented in Appendix A of this FRA. A summary is provided below:

- Table 1 (Appendix A) defines four Flood Zones based on the annual probability of river or sea flooding;
- Annex 3 (Appendix A) identifies specific land use types for each of the five flood risk vulnerability classifications (Essential Infrastructure, Highly Vulnerable, More Vulnerable, Less Vulnerable and Water Compatible Uses). For example, office buildings are classified as Less Vulnerable; and
- Table 2 (Appendix A) identifies where development is appropriate for each flood risk vulnerability classification and whether the Exception Test is required.

The Flood Zones are defined in the NPPF as follows:

**Flood Zone 1** Low Probability:

< 1 in 1,000 annual probability of river or sea flooding in any given year (<0.1% Annual Exceedance Probability (AEP)).

**Flood Zone 2** Medium Probability:

Between 1 in 100 and 1 in 1,000 annual probability of river flooding in any year (1% - 0.1% AEP), or  
Between 1 in 200 and 1 in 1,000 annual probability of sea flooding in any year (0.5% - 0.1% AEP).

**Flood Zone 3a** High Probability:

> 1 in 100 annual probability of river flooding in any year (>1% AEP), or > 1 in 200 annual  
probability of sea flooding in any year (>0.5% AEP).

**Flood Zone 3b** Functional Floodplain:

> 1 in 30 annual probability of flooding in any year (3.3% AEP).

### 3.2.2 Flood Risk & Vulnerability Classification

The PPG of the NPPF outlines the Vulnerability Classifications of land use types and building uses. The proposed development is comprised of residential development classified as *More Vulnerable*.

### 3.2.3 Climate Change

Allowances for the predicted effects of climate change (CC) should be considered when preparing site-specific flood risk assessments. This is the principal means of ensuring that a development is designed with appropriate resilience.

The NPPF guidance contains sensitivity ranges that are recommended to be applied to peak rainfall intensities, peak river flows, sea level rise, offshore wind speeds and extreme wave heights. The general trend is for each parameter to increase in the future, which in turn increases the risk of flooding to any site.

#### 3.2.3.1 Peak Rainfall Allowances

The following peak rainfall allowances should be considered for the site for a 1% annual exceedance rainfall event, based on being part of the Rother Management Catchment:

**Table 3-1 Rother management catchment 1% annual exceedance rainfall event allowances (EA, May 2022)**

| Period of CC                                                    | Central (50 <sup>th</sup> percentile) | Upper (95 <sup>th</sup> percentile) |
|-----------------------------------------------------------------|---------------------------------------|-------------------------------------|
| Total potential change anticipated for the '2050s' 2040 to 2069 | 20%                                   | 45%                                 |
| Total potential change anticipated for the '2080s' 2070 to 2115 | 20%                                   | 45%                                 |

#### 3.2.3.2 Sea Level Rise Allowances

Sea Level Rise guidance is issued by DeFRA/EA as part of the National Planning Policy Framework (NPPF) Guidance under guidance note "Flood Risk Assessments: Climate Change Allowances" <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>). The guidance was last updated in May 2022. The values to be adopted for the southeast region are summarised in Table 3-2.

**Table 3-2 Sea Level Rise allowances for each epoch in mm for each year (1981 to 2000 baseline) for the South East river basin district**

| Allowance      | 2000 to 2035 | 2036 to 2065 | 2066 to 2095 | 2096 to 2125 |
|----------------|--------------|--------------|--------------|--------------|
| Higher central | 5.7 mm/year  | 8.7mm/year   | 11.6mm/year  | 13.1mm/year  |
| Upper end      | 6.9mm/year   | 11.3mm/year  | 15.8mm/year  | 18.2mm/year  |

It is recommended by the guidance that both the central and upper-end allowances are assessed in order to understand the range of the impact. The guidance further notes that the following considerations be made to decide the allowances that are adopted to inform the flood risk management strategy for a development:

- Likely depth, speed and extent of flooding for each allowance of climate change over time, considering the allowances for the relevant epoch (2020s, 2050s and 2080s);
- Vulnerability of the proposed development types or land use allocations to flooding;
- ‘Built-in’ resilience measures used, for example, raised floor levels; and
- Capacity or space in the development to include additional resilience measures in the future, using a ‘managed adaptive’ approach.

### 3.2.3.3 Offshore Wind and Extreme Wave Height Allowances

From the NPPF Guidance documentation “Flood Risk Assessments: climate Change Allowances” (<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>), last updated in May 2022, offshore wind speeds and extreme wave height allowances shall be increased in accordance with Table 3-3.

**Table 3-3 Offshore wind speed and extreme wave height allowances for climate change (based on a 1990 baseline)**

| Allowance                     | 2000 to 2055 | 2056 to 2125 |
|-------------------------------|--------------|--------------|
| Offshore wind speed allowance | +5%          | +10%         |
| Extreme wave height allowance | +5%          | +10%         |

These allowances are to account for changes to the frequency, duration and severity of storms as well as increased water depths due to sea level rise allowing larger waves to break closer to the coast.

## 3.3 Local Planning Policy

A number of local planning policy documents exist and are of relevance to the site. The key Local Plans and Strategy documents are outlined and summarised below.

### 3.3.1 FHDC Core Strategy Review

The FHDC Core Strategy Review (March 2022) replaces the 2013 Core Strategy and is a long-term plan bringing together the aims and actions of the government, local councils, residents, businesses and voluntary groups, by managing development.

The Places and Policies Local Plan (PPLP) (September 2020) allocates approximately 1,600 dwellings across many small and medium-sized sites following the framework set by the 2013 Core Strategy (some of these sites now have planning permission). The PPLP also provides a new suite of development management policies and ensures that the

council has sufficient allocations to meet development needs to 2030/31. Local planning authorities are now required to review their plans at least once every five years and update them as necessary. The review of the 2013 Core Strategy has now been completed and this meets development requirements over a longer period to 2036/37. The development proposed in the PPLP has been taken into account in setting the development targets in the Core Strategy Review.

Within the Core Strategy Review, Folkestone makes up part of 'The Urban Area'. The document notes that within a short period of time, since the adoption of the 2013 Core Strategy, Folkestone has seen significant change. Core Strategy Review policies SS10 and SS11 set out the policy requirements for the delivery of Folkestone Seafront and Shorncliffe Garrison, both of which now have planning permission, with Shorncliffe Garrison now contributing significantly to the housing needs of the district.

The Folkestone Seaside falls within a Strategic Corridor where major strategically allocated development is due to be delivered. Policies place particular emphasis on "promoting the development of vacant previously developed land"; "securing new accessible public green space" and recognising "the strategic importance of the site its history and key role in the town's future". The Core Strategy also identifies the aspiration to stimulate the local housing market; attract commercial investors; reconnect the waterfront to the town and provide a mix of uses, beach and sea sport activities at the Pier head Quarter South of the Harbour.

*Policy CSD5: Water and Coastal Environmental Management* outlines the aims for developments with respect to sustainable water management and outlines which criteria should be met for development to be permitted. The key aims of water and coastal environmental management in Shepway the FDHC Core Strategy are as follows:

**Table 3-4 Key aims of water and coastal environmental management in FHDC Core Strategy**

| No | FHDC Core Strategy Aims                                                                                                                                                                                                                  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B1 | Expand green infrastructure and enhance its connectivity, making a positive contribution to managing the impacts of climate change through adaptation and mitigation.                                                                    |
| B3 | Achieve a net gain in biodiversity and geodiversity, particularly where of international and national significance, including a focus on Dungeness and Folkestone Warren.                                                                |
| B4 | Conserve and enhance sensitive landscapes, especially on the edge of settlements and within the Kent Downs Area of Outstanding Natural Beauty and its setting.                                                                           |
| B6 | Maintain the sense of openness and tranquillity of the countryside and undeveloped coast.                                                                                                                                                |
| B7 | Manage the district's coast to ensure resilience to climate change processes, reducing the risk to life and property from flood hazards, and actively managing coastal environments for green infrastructure and sustainable recreation. |
| C4 | Improve sports, recreational space, healthcare and other facilities and reduce relative disparities in the health of communities.                                                                                                        |
| D4 | Encourage healthier living by the generous provision of sports pitches, recreation facilities and land for locally-grown produce.                                                                                                        |
| D9 | Reduce waste from new homes and businesses and increase recycling rates significantly higher than in existing towns in Kent.                                                                                                             |

### 3.3.2 Folkestone to Cliff End Flood and Erosion Management Strategy

The Folkestone to Cliff End Flood and Erosion Management Strategy (EA, 2010) sets out the EA's plans to manage flood and erosion risk along the coastline. The strategy identifies schemes to protect over 20,000 residential and non-

residential properties that are at risk of flooding and erosion over the next 100 years. There are five priority schemes that when implemented will complete the chain of defences within the strategy area.

The strategy takes into account the South Foreland to Beachy Head SMP as well as responses to the public consultation carried out in 2008 and the interests of various stakeholder groups such as Natural England and English Heritage. The Operating Authorities for managing flood and erosion risk within the strategy area are the EA, Shepway District Council, the Ministry of Defence and British Energy. As of April 2008 the EA takes the lead for managing coastal flooding risk in England and allocates flood and coastal erosion risk management capital funding.

Actions to reduce or manage coastal erosion risks include:

- The Council have an active programme of capital coast protection and flood defence works.
- The £16 million coast protection scheme between Hythe and Folkestone was completed in 2004 and is now maintained to uphold 1 in 200 year event protection levels, where grant funding allows.
- Shingle is mechanically recycled along the Folkestone and Hythe frontage to counteract the natural eastward movement, with the aspiration of maintaining the standard of protection to prevent wave overtopping and to protect the sea wall.

The strategy identifies the OPA site as at risk from erosion. The document notes that SDC have made improvements to the seawalls, constructed a number of rock structures and added shingle to the beach. The defences have a design life of 50 years.

The approved strategy option for the application site is 'Hold the line – Maintain / improve'. This is to be achieved though maintaining the existing standard of protection through annual shingle recycling and improve the defences when they have reached the end of their design life by carrying out works to the promenade where necessary and raising beach levels. In order to improve the viability of the required work the EA look for additional contributions from private, public or voluntary organisations or communities who will benefit from the works.

### 3.3.3 South Foreland to Beachy Head Shoreline Management Plan

South Foreland to Beachy Head Shoreline Management Plan (April 2006) represents the relevant SMP for the site. A Shoreline Management Plan (SMP) provides a large-scale assessment of the risks associated with coastal evolution and presents a policy framework to address these risks to people and the developed, historic and natural environment in a sustainable manner. The SMP is a non-statutory, policy document for coastal defence management planning. It takes account of other existing planning initiatives and legislative requirements and is intended to inform wider strategic planning.

The shoreline in the OPA site boundary has been changing for centuries as part of a natural process whereby sea levels have slowly risen as a result of the relative drop in land level in consequence of the last ice age.

The SMP assigns a management policy to each reach along the coastline. The OPA site lies within Policy Unit '4c08 Folkestone and Sandgate', as shown in Figure 3-1. The long term plan is to protect the frontage of this regionally important town. The medium and long term policy plan for the area is to '**Hold the line**' – to maintain or upgrade the level of protection provided by defences. This is likely to involve continuing with current practises up until around the year 2055, after which an increase in engineering and management practises will be required to counter the effects of sea level rise.

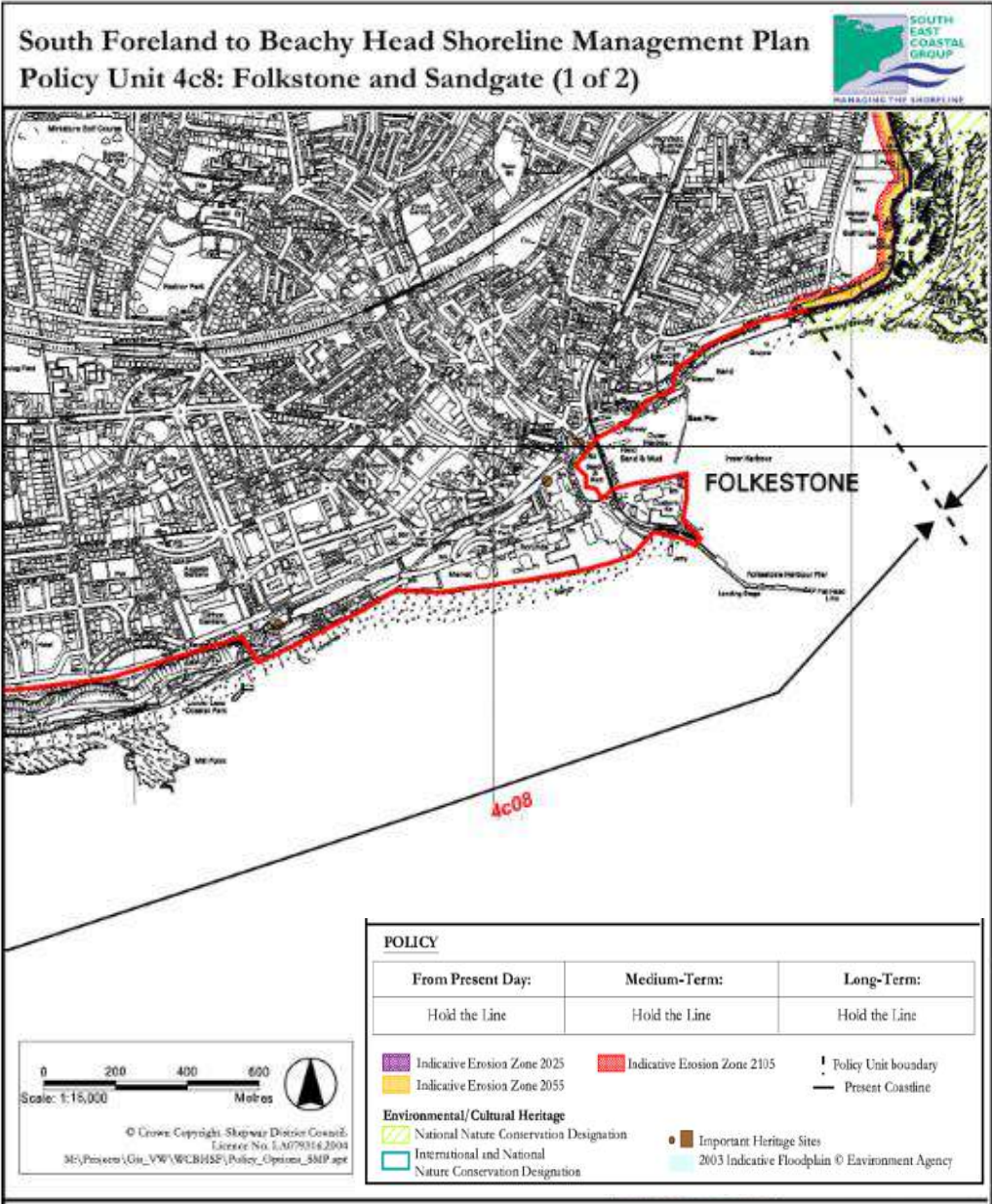


Figure 3-1 South Foreland to Beachy Head SMP Policy Unit 4c8 – Hold the Line

3.3.4 River Stour Catchment Flood Management Plan

The River Stour Catchment Management Plan (CFMP), Summary Report (EA, 2009) is one of 77 CFMPs assessing inland flood risk across all of England and Wales. It considers all types of inland flooding from rivers, groundwater, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding) which is covered by Shoreline Management Plans (SMPs). The role of CFMPs is to establish flood risk management policies which will deliver sustainable flood risk management for the long term.

Within the CFMP area, 83% of the area is agricultural land, with some amongst the most productive land in the country. There are also a number of historically important sites throughout the catchment. Ashford, Canterbury, Dover and Folkestone are recognised as potential development sites.

The CFMP makes note of the River Pent being a highly modified watercourse that flows through Folkestone, with flooding along the Pent being caused by poor urban drainage and high intensity storm events. It notes that there is also a risk of tide-locking in the future as a result of sea level rise. SDC has completed a series of flood defence schemes following extreme rainfall events in the late 1990s, significantly reducing the flood risk to Folkestone.

The OPA site has been identified as being in Policy Unit "Dour and Pent, sub-area 8" and has been assigned to Policy 4. Policy 4 relates to areas of "low, moderate or high flood risk where the flood risk is already being managed effectively but where further action may be needed to keep pace with climate change". The document notes that a System Asset Management Plan (SAMP) will be developed to ensure existing defences are in good condition and are able to accommodate increased flooding due to climate change and that a Pent fluvial study will also be undertaken to understand flood risk from the Pent in Folkestone.

### 3.4 Strategic Flood Risk Assessment

SFRAs are required to be carried out by Local Authorities to guide developers on the authority's strategies to avoid, reduce and manage flood risk.

The Shepway District Council SFRA (July 2015) considers the risk of flooding from the following potential sources:

- Fluvial (rivers);
- Tidal;
- Surface water;
- Groundwater; and
- Sewers.

The risk of flooding to the proposed development from each source listed above will be assessed in Section 4.

## 4 Appraisal of Existing Flood Risk

### 4.1 Overview

This section evaluates the sources of flood risk to the existing site. As noted in Section 2.1, this FRA will focus on Plots F1, G1 and H as this is where the residential development is proposed. Plots F2 and G2 are proposed to be landscaping only.

In this section the following sources of flood risk are evaluated:

- Historic Flooding
- Flooding from rivers (fluvial);
- Flooding from the sea (tidal);
- Flooding from surface water runoff (pluvial) and sewer surcharge;
- Flooding from groundwater; and
- Flooding from artificial sources.

### 4.2 National Planning Policy Framework

#### 4.2.1 Flood Risk Zone Classification

The EA 'Flood Map for Planning (Rivers and Sea)' indicates that the majority of the site lies in Flood Zone 1 (low probability of flooding), with the majority of Plot G1 and entirety of Plot H being within Flood Zone 1. Plot F1 shows around half of the site to be in Flood Zone 2 (medium probability of flooding) and Flood Zone 3 (high probability of flooding), as shown in Figure 4-1. A very small area to the north-east of Plot G1 is shown to be in Flood Zone 3.

These flood maps utilise EA models finalised in 2018, based on topographic data from 2015. It is noted that this data therefore pre-dates the earthworks contract undertaken in 2017, which marked a dramatic change in both the beach profile and the wider site topography.



**Figure 4-1 Flood zones (Flood Map for Planning (Rivers and Sea)) shown with the site boundary**

### 4.3 Historic Flooding

The SFRA notes a detailed history of flooding within Shepway's district that has been documented by the Council's Engineering Team and the Environment Agency which are captured in a table format along with the Historic Flood Map. There have been few historic flooding events recorded in the area, none of which are shown to be within the proposed development boundary.

The most significant flood event in the vicinity of the site have been from fluvial flooding caused by high intensity rainfall. On 12th August 1996 100mm of rainfall fell in a two-hour period causing surcharging of culverts associated with the River Pent with resultant overtopping. It was estimated by the Meteorological Office as being an event that had a return period greater than 1 in 500 years. The River Pent is a highly modified watercourse that flows through Folkestone. Flooding along the Pent has historically been caused by poor urban drainage and high intensity storm events. Shepway District Council has completed a series of flood alleviation schemes following the 1996 extreme rainfall event, significantly reducing the flood risk to Folkestone. There are no records of direct coastal flooding at the application site.

It is noted that the recorded historic flood events within the vicinity of the site are dated in the SFRA Historic Flood Map Table as either being in 1996 or 1997. The series of flood alleviation schemes implemented by SDC were completed in 1998/1999, following these works no historic events were recorded between 1997 and 2015 (the date of the SFRA).

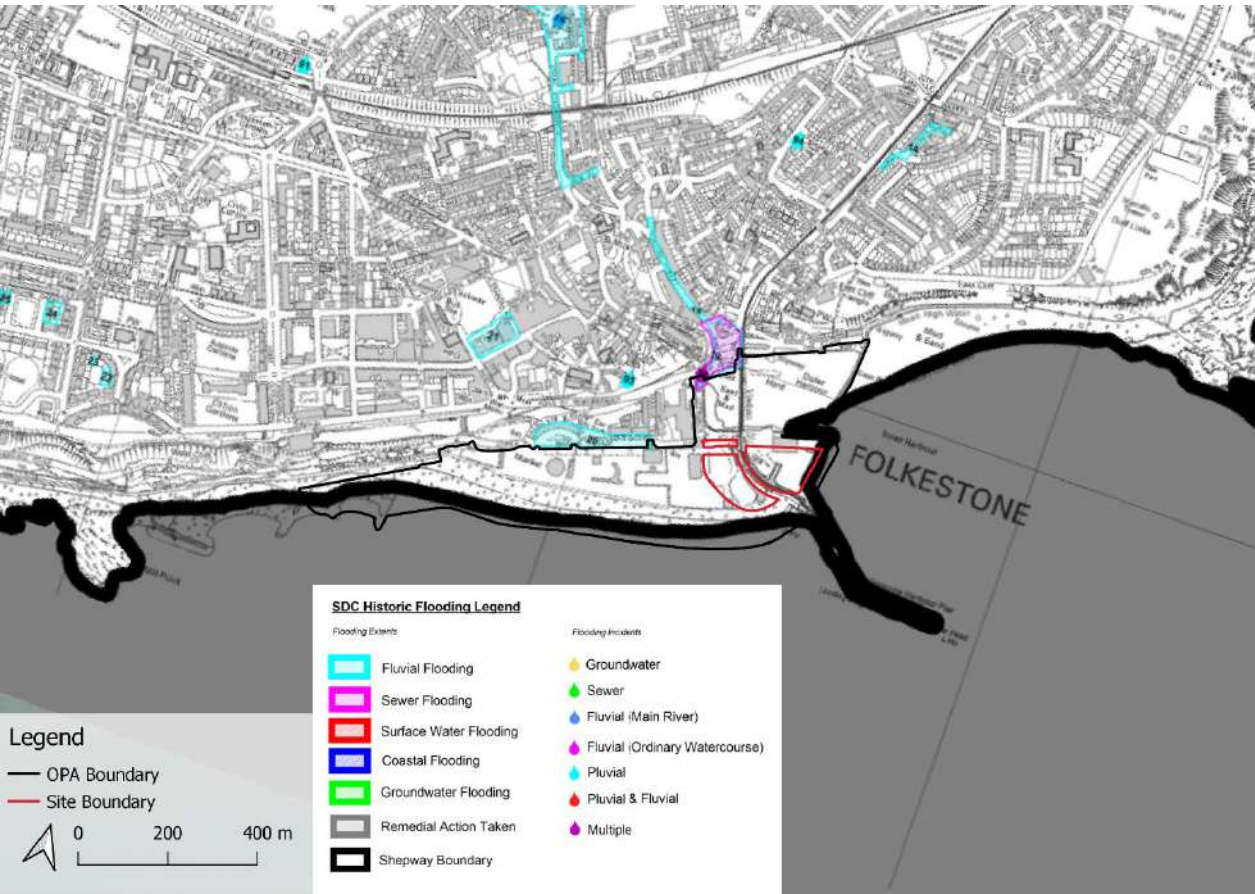


Figure 4-2 Extract from SFRA showing historic flooding with site boundary shown

4.4 Fluvial and Coastal Flooding

The following sub-sections outline the fluvial and coastal flood risk to the site, considering information available from the EA, SFRA and other relevant sources.

The SFRA includes Hazard Maps for both the current day (2015) and future climate change (2115) conditions. These Maps are based on breach and wave overtopping modelling undertaken as part of the SFRA. This mapping shows the site to be at no flood risk under present day or future conditions.

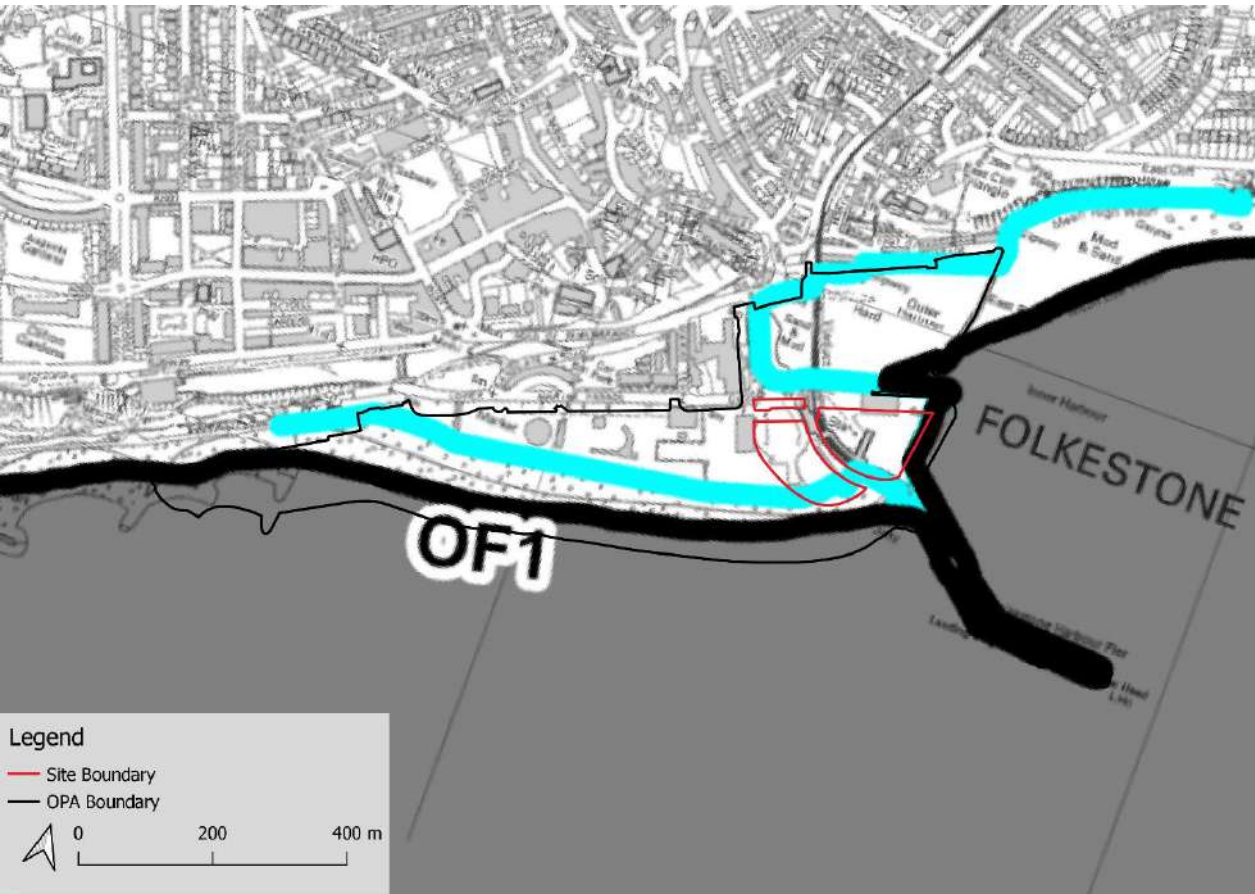


Figure 4-3 Extract from SFRA showing present day hazard map (2015) with site boundary shown

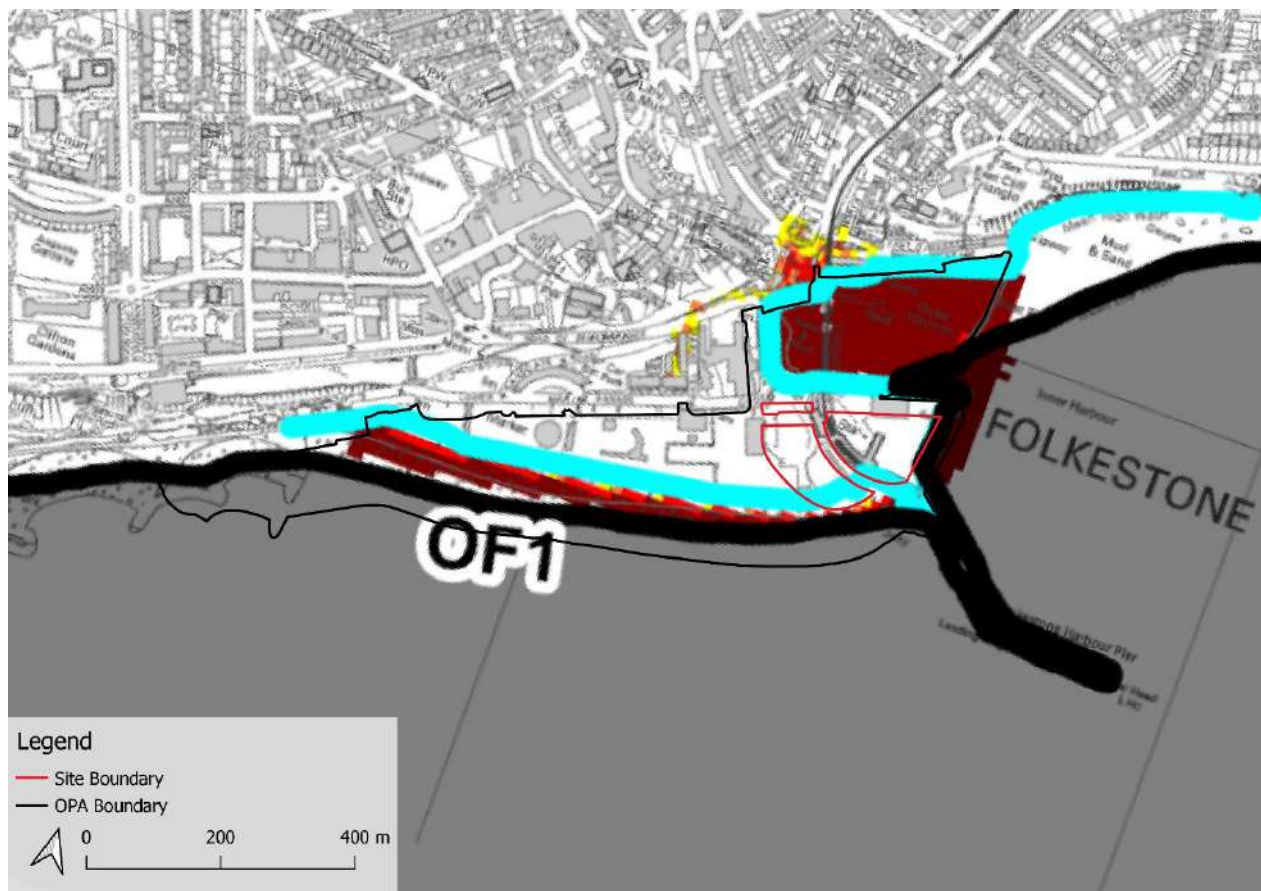


Figure 4-4 Extract from SFRA showing future day hazard map (2115) with site boundary shown

#### 4.4.1 Fluvial Flood Risk

Fluvial flooding occurs when sustained or intense rainfall events increase the flow in rivers causing the water level to rise above the level of the banks and into the surrounding areas.

The Pent Stream is the river in closest proximity to the site. As noted in the SFRA the Pent Stream is made up of four tributaries, referred to as Pent A, B, C and D which flow into the main Pent Stream (Figure 4-5). The Pent Stream is culverted in sections along its route adjacent to Bradstone Avenue and beneath Tontine Street before it discharges to the inner basin of Folkestone Harbour.

There is some evidence of fluvial flooding in the vicinity of the site, according to the SFRA Historic Flood Maps, although as noted in Section 4.3, these were in 1996 during the 1 in 500 year flood event. Following this event, flood alleviation works were undertaken by SDC.

The EA 'Flood Map for Planning (Rivers and Sea)' indicates that the fluvial flood risk coming from the Pent River is localised around the river, before entering the sea via the north of the harbour (Figure 4-6), and so is not considered a risk to the development site.

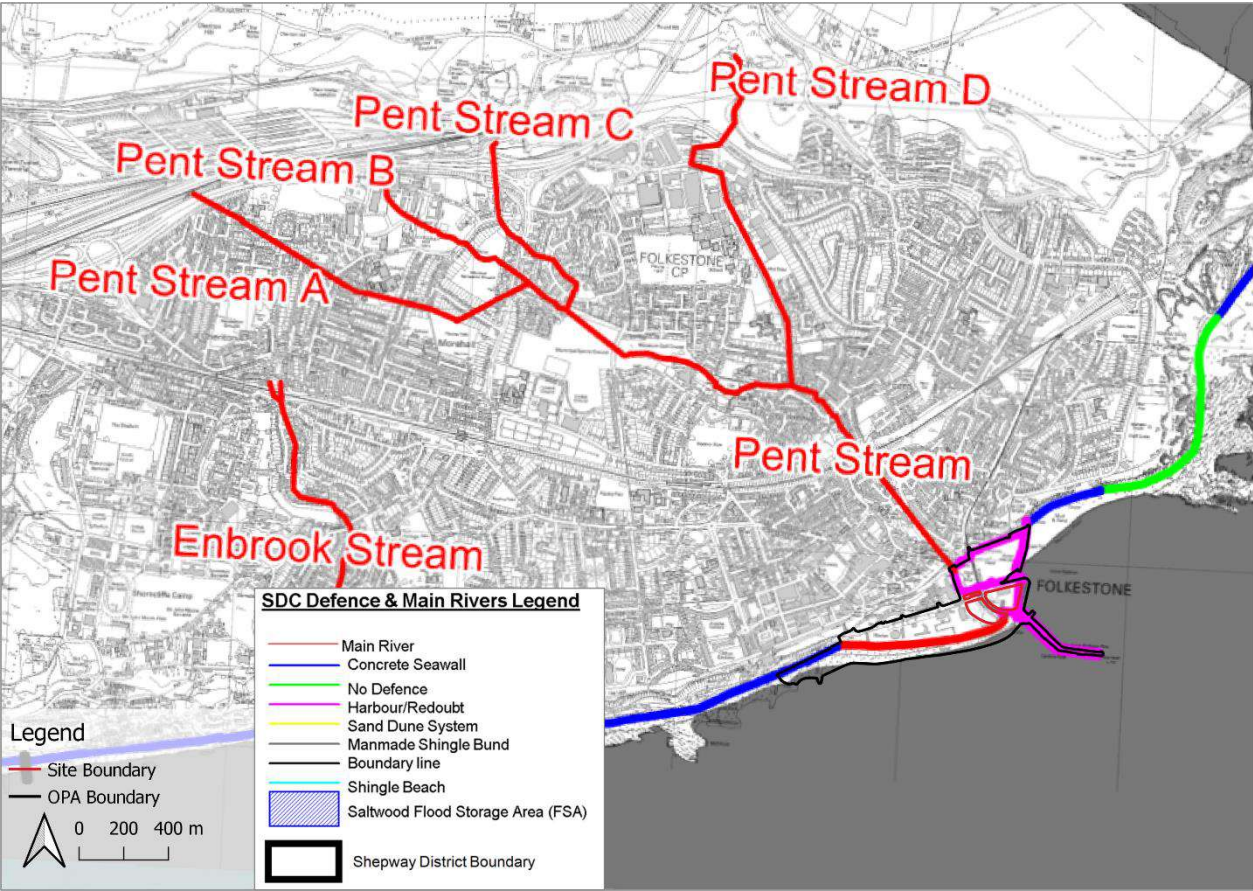


Figure 4-5 Extract from SFRA showing existing defence infrastructure and main rivers with site boundary shown



**Figure 4-6 Flood Zones (Flood Map for Planning (Rivers and Sea)) demonstrating fluvial flood risk**

#### **4.4.2 Coastal Flood Risk**

Coastal flooding typically occurs when storm surges result in localised but significant increases in sea levels, higher than usual tidal ranges. Storm surges are typically a result of the combined effects of high tides, low atmospheric and strong onshore winds. Coupled with wind and swell waves generated by the storm winds also from the low atmospheric events, this can lead to inundation and overtopping of sea defences, beaches and other features of the coastline.

Given the seafront location of the site, coastal flood risk is the dominant source of flood risk.

##### **4.4.2.1 Extreme Water Levels**

Utilising information from the UK Hydrographic Office to source tide levels, and the Environment Agency's 2018 Coastal Flood Boundary Dataset to source extreme water levels, Table 4-1 and

Table 4-2 provide a summary of water levels for the present day (2023) and future (2115) water level conditions.

**Table 4-1 Present day and 2115 future epoch tide levels**

| Tide Reference                                                     | Level (mOD)         |                     |           |
|--------------------------------------------------------------------|---------------------|---------------------|-----------|
|                                                                    | As published (2017) | Future Epoch (2115) |           |
|                                                                    |                     | Higher Central      | Upper End |
| Highest Astronomical Tide (HAT)                                    | +4.05               | +5.02               | +5.35     |
| Mean High Water Springs (MHWS)                                     | +3.45               | +4.42               | +4.75     |
| Mean High Water Neaps (MHWN)                                       | +1.95               | +2.92               | +3.25     |
| Mean Sea Level (MSL)                                               | +0.17               | +1.14               | +1.47     |
| Mean Low Water Neaps (MLWN)                                        | -1.65               | -0.68               | -0.35     |
| Mean Low Water Springs (MLWS)                                      | -3.25               | -2.28               | -1.95     |
| Lowest Astronomical Tide (LAT)                                     | -3.75               | -2.78               | -2.45     |
| NOTES:                                                             |                     |                     |           |
| (1) Sea level rise allowance 2017 to 2115 (Higher Central) = 0.97m |                     |                     |           |
| (2) Sea level rise allowance 2017 to 2115 (Upper End) = 1.30m      |                     |                     |           |

**Table 4-2 Present day and 2115 future epoch extreme water levels**

| Return Period                                                      | Level (mOD)         |                     |           |
|--------------------------------------------------------------------|---------------------|---------------------|-----------|
|                                                                    | As published (2017) | Future Epoch (2115) |           |
|                                                                    |                     | Higher Central      | Upper End |
| 1 in 1000 year (0.1% AEP)                                          | +5.01               | +5.98               | +6.31     |
| 1 in 200 year (0.5% AEP)                                           | +4.80               | +5.77               | +6.10     |
| 1 in 100 year (1% AEP)                                             | +4.70               | +5.67               | +6.00     |
| 1 in 75 year (1.33% AEP)                                           | +4.67               | +5.64               | +5.97     |
| 1 in 50 year (2% AEP)                                              | +4.61               | +5.58               | +5.91     |
| 1 in 20 year (5% AEP)                                              | +4.49               | +5.46               | +5.79     |
| 1 in 10 year (10% AEP)                                             | +4.39               | +5.36               | +5.69     |
| 1 in 1 year (63% AEP)                                              | +4.07               | +5.04               | +5.37     |
| NOTES:                                                             |                     |                     |           |
| (1) Sea level rise allowance 2017 to 2115 (Higher Central) = 0.97m |                     |                     |           |
| (2) Sea level rise allowance 2017 to 2115 (Upper End) = 1.30m      |                     |                     |           |

The design event for tidal flood risk is the 1 in 200 year (0.5% Annual Exceedance Probability) event. From Table 4-2 the future 2115 extreme water levels are:

- 1 in 200 year (Higher Central) = +5.77mOD
- 1 in 200 year (Upper End) = +6.10mOD

#### 4.4.2.2 Wave Heights and Joint Probability

Wave heights applicable to the development site have been sourced from work undertaken by Royal Haskoning DHV, employed by The Folkestone Harbour Development Company. In this study, offshore wave data was sourced from the UK MetOffice wave hindcast model. Combining these with the extreme water levels covered in Section 4.4.2.1, the joint

probability wave and water level events were calculated for a range of return period storms. These were then transformed from the offshore to the nearshore environment using the DHI modelling software MIKE21-SW-FM.

Table 4-3 to Table 4-5 provide a summary of the 1 in 1yr and 1 in 200yr present day and future epoch (2115) joint probability events from this work. The data is split into three locations:

- Mermaid Beach West (covers Plots A, B and C in Figure 2-1)
- Mermaid Beach East (covers Plots D, E and F in Figure 2-1)
- The Harbour (covers Plot G and H in Figure 2-1)

It should be noted that all parameters for the future epoch (2115) include the appropriate climate change allowances outlined in Section 3.2.3.

**Table 4-3 Mermaid Beach West joint probability event wave and water levels**

| JP | 2017 (Present Day) |          |           |            |           | 2115 (Future) |          |           |            |           |
|----|--------------------|----------|-----------|------------|-----------|---------------|----------|-----------|------------|-----------|
|    | WL<br>(mOD)        | 1 in 1yr |           | 1 in 200yr |           | WL<br>(mOD)   | 1 in 1yr |           | 1 in 200yr |           |
|    |                    | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |               | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |
| 1  | 3.16               | 3.39     | 8.98      | 5.08       | 10.83     | 4.13          | 3.75     | 9.04      | 5.71       | 11.25     |
| 2  | 3.50               | 3.09     | 8.43      | 4.92       | 10.34     | 4.47          | 3.40     | 8.97      | 5.55       | 11.06     |
| 3  | 3.64               | 2.72     | 8.16      | 4.65       | 10.13     | 4.61          | 3.01     | 8.35      | 5.18       | 10.43     |
| 4  | 3.79               | 2.32     | 7.53      | 4.27       | 9.51      | 4.76          | 2.56     | 7.73      | 4.78       | 10.14     |
| 5  | 4.01               | 1.73     | 6.90      | 3.69       | 8.96      | 4.98          | 1.92     | 6.91      | 4.08       | 9.30      |
| 6  | 4.10               | 1.48     | 6.31      | 3.44       | 9.04      | 5.07          | 1.63     | 6.56      | 3.80       | 9.09      |
| 7  | 4.42               |          |           | 2.57       | 7.77      | 5.39          |          |           | 2.85       | 8.08      |
| 8  | 4.52               |          |           | 2.33       | 7.52      | 5.49          |          |           | 2.57       | 7.73      |
| 9  | 4.56               |          |           | 2.18       | 7.45      | 5.53          |          |           | 2.41       | 7.59      |
| 10 | 4.64               |          |           | 2.00       | 7.00      | 5.61          |          |           | 2.20       | 7.46      |
| 11 | 4.70               |          |           | 1.85       | 7.01      | 5.67          |          |           | 2.04       | 7.02      |
| 12 | 4.73               |          |           | 1.74       | 6.89      | 5.70          |          |           | 1.93       | 6.91      |
| 13 | 4.83               |          |           | 1.49       | 6.30      | 5.80          |          |           | 1.64       | 6.56      |

**Table 4-4 Mermaid Beach East joint probability event wave and water levels**

| JP | 2017 (Present Day) |          |           |            |           | 2115 (Future) |          |           |            |           |
|----|--------------------|----------|-----------|------------|-----------|---------------|----------|-----------|------------|-----------|
|    | WL<br>(mOD)        | 1 in 1yr |           | 1 in 200yr |           | WL<br>(mOD)   | 1 in 1yr |           | 1 in 200yr |           |
|    |                    | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |               | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |
| 1  | 3.16               | 3.21     | 8.94      | 5.19       | 10.77     | 4.13          | 3.58     | 9.01      | 5.95       | 11.23     |
| 2  | 3.50               | 2.97     | 8.41      | 4.83       | 10.32     | 4.47          | 3.26     | 8.93      | 5.55       | 11.04     |
| 3  | 3.64               | 2.63     | 8.12      | 4.49       | 10.11     | 4.61          | 2.92     | 8.34      | 5.01       | 10.40     |
| 4  | 3.79               | 2.27     | 7.50      | 4.06       | 9.47      | 4.76          | 2.50     | 7.72      | 4.57       | 10.12     |
| 5  | 4.01               | 1.72     | 6.88      | 3.53       | 8.92      | 4.98          | 1.91     | 6.89      | 3.90       | 9.28      |
| 6  | 4.10               | 1.48     | 6.29      | 3.28       | 9.00      | 5.07          | 1.63     | 6.53      | 3.65       | 9.06      |
| 7  | 4.42               |          |           | 2.51       | 7.75      | 5.39          |          |           | 2.78       | 8.03      |
| 8  | 4.52               |          |           | 2.29       | 7.50      | 5.49          |          |           | 2.52       | 7.71      |

|    |      |  |  |      |      |      |  |  |      |      |
|----|------|--|--|------|------|------|--|--|------|------|
| 9  | 4.56 |  |  | 2.15 | 7.42 | 5.53 |  |  | 2.38 | 7.57 |
| 10 | 4.64 |  |  | 1.98 | 6.98 | 5.61 |  |  | 2.17 | 7.43 |
| 11 | 4.70 |  |  | 1.83 | 7.00 | 5.67 |  |  | 2.03 | 7.01 |
| 12 | 4.73 |  |  | 1.73 | 6.88 | 5.70 |  |  | 1.92 | 6.89 |
| 13 | 4.83 |  |  | 1.50 | 6.29 | 5.80 |  |  | 1.64 | 6.53 |

Table 4-5 Harbour joint probability event wave and water levels

| JP | 2017 (Present Day) |          |           |            |           | 2115 (Future) |          |           |            |           |
|----|--------------------|----------|-----------|------------|-----------|---------------|----------|-----------|------------|-----------|
|    | WL<br>(mOD)        | 1 in 1yr |           | 1 in 200yr |           | WL<br>(mOD)   | 1 in 1yr |           | 1 in 200yr |           |
|    |                    | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |               | Hs (m)   | Tp (secs) | Hs (m)     | Tp (secs) |
| 1  | 3.16               | 1.40     | 7.52      | 2.35       | 9.26      | 4.13          | 1.55     | 7.63      | 2.59       | 9.29      |
| 2  | 3.50               | 1.33     | 7.17      | 2.34       | 9.25      | 4.47          | 1.47     | 7.62      | 2.58       | 9.28      |
| 3  | 3.64               | 1.18     | 7.00      | 2.15       | 8.90      | 4.61          | 1.29     | 7.01      | 2.37       | 9.00      |
| 4  | 3.79               | 0.99     | 6.36      | 1.96       | 8.41      | 4.76          | 1.09     | 6.78      | 2.16       | 8.92      |
| 5  | 4.01               | 0.72     | 5.75      | 1.68       | 7.87      | 4.98          | 0.80     | 6.03      | 1.85       | 8.23      |
| 6  | 4.10               | 0.59     | 5.87      | 1.57       | 7.66      | 5.07          | 0.66     | 5.38      | 1.72       | 8.00      |
| 7  | 4.42               |          |           | 1.18       | 7.00      | 5.39          |          |           | 1.30       | 7.01      |
| 8  | 4.52               |          |           | 1.07       | 6.66      | 5.49          |          |           | 1.17       | 6.97      |
| 9  | 4.56               |          |           | 1.00       | 6.36      | 5.53          |          |           | 1.10       | 6.79      |
| 10 | 4.64               |          |           | 0.91       | 6.50      | 5.61          |          |           | 1.01       | 6.53      |
| 11 | 4.70               |          |           | 0.85       | 6.30      | 5.67          |          |           | 0.93       | 6.35      |
| 12 | 4.73               |          |           | 0.80       | 6.11      | 5.70          |          |           | 0.88       | 6.34      |
| 13 | 4.83               |          |           | 0.68       | 5.58      | 5.80          |          |           | 0.75       | 5.77      |

Where an assessment of wave overtopping is required, the values outlined within Table 4-3 to Table 4-5 shall be utilised.

#### 4.5 Surface Water Flooding

Surface water flooding occurs when intense rainfall is unable to naturally soak into the ground due to impermeable ground covering such as concrete or tarmac, or due to low permeability ground conditions preventing infiltration. This excess surface water can flow through built-up areas and open space and pond in lower-lying areas causing localised flooding.

The SFRA notes that surface water flooding can happen as a result of surface water being discharged into streams which are culverted and may become surcharged during extreme rainfall events.

The Surface Water Flood Risk Maps for Planning indicates the risk of localised (ponding) due to surface water runoff. The mapping shows that the majority of the site is shown to be at very low flood risk (less than 0.1% chance of flooding each year) with just two localised areas of low (between 0.1% and 1% chance of flooding each year) to medium (between 1% and 3.3% chance of flooding each year) flood risk to the south-east of Plot G1 and to the north-west of Plot F1.



Figure 4-7 Surface Water Flood Risk Maps for Planning (source UK GOV.UK) with site boundary shown

#### 4.6 Flooding from Sewers and Water Mains

In urban areas, rainwater is frequently drained into surface water sewers or sewers containing both surface and wastewater known as 'combined sewers'. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity.

The SFRA notes that 'many parts of Shepway are served by combined sewers and consequently there is an inherent risk that these could become surcharged during an extreme rainfall event.' The SFRA Historic Flood Maps indicate one sewer flood event in the vicinity of the site, recorded June 1997 as a result of surface water sewers being overwhelmed during flash floods.

However, there are no recorded incidents of flooding due to sewers and water mains within the area of the site. Based on the available information it is considered that the site is at low risk from flooding from sewers and water mains.

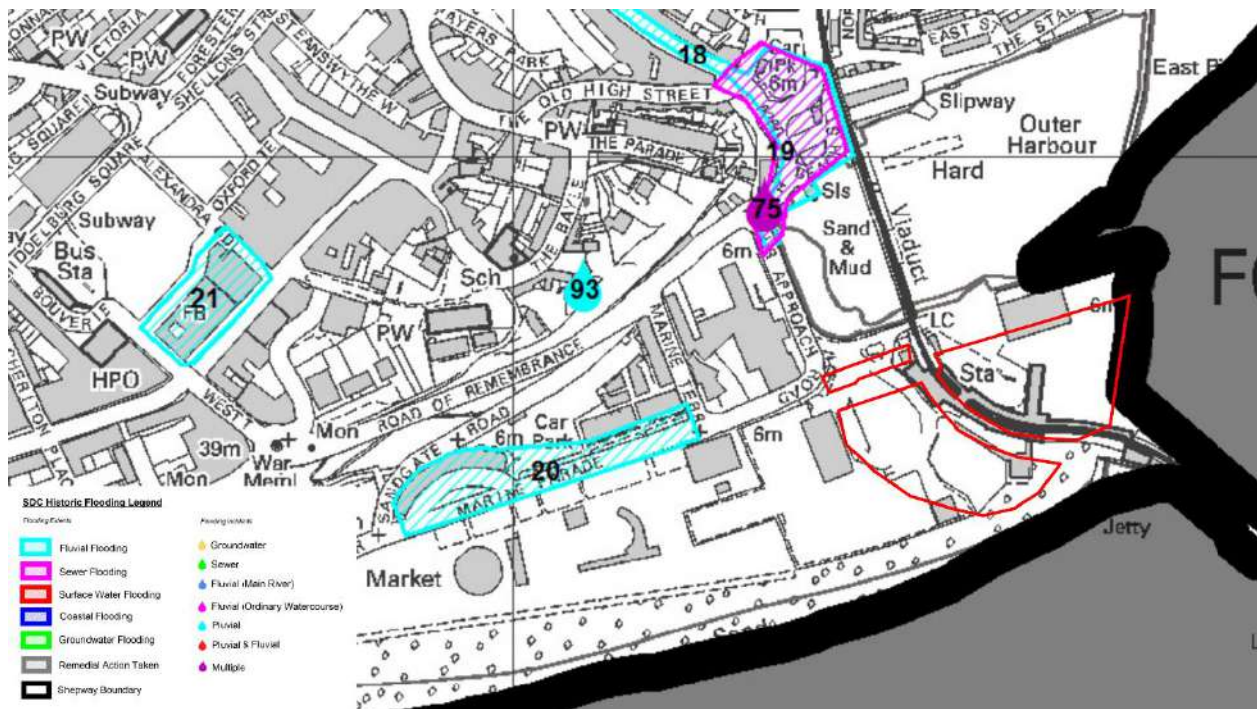


Figure 4-8 Extract from SFRA showing historic flooding of sewer flooding in the context of the site boundary

#### 4.7 Groundwater Flooding

The SFRA notes that the British Geological Society (BSG)'s datasets on groundwater flooding show the whole of the Shepway district to be located within a low risk area, noting that the mapping is high level and does not account for more localised causes of groundwater flooding.

The recent drift deposits within the lower-lying parts of the district area are typically marine alluviums and storm gravel beach deposits and as such have the potential to convey groundwater. The aquifer status of the various strata present on site has been determined with reference to the British Geological Survey geological and groundwater vulnerability maps and the Environment Agency website.

- The Storm Gravel Beach Deposits are classified as a Secondary Aquifer reflecting their permeable nature which is capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow. This stratum directly overlies the Folkestone Beds.
- The Folkestone beds are classified as a Principal Aquifer with a high leaching potential (assumed because of the urban setting).
- The Sandgate Beds are classified as a Secondary aquifer with a low leaching potential.

Due to the site's location immediately adjacent to the sea and the permeable nature of the Beach Gravel Deposits, the groundwater will be at the approximate level of the sea, will be subject to tidal influence and will be highly saline. This is evidenced by the groundwater levels recorded during the pre-development ground investigation undertaken in 2016. A summary of the groundwater levels from the investigation as given in Table 4-6. Given the more industrial past of the land to the east of the former railway station, the location of the boreholes relative to the station is also included.

**Table 4-6 Groundwater levels from 2016 pre-development ground investigation**

| Location | Relative to Railway Station | No. of water levels recorded | Response zone (mBGL) | Level (mOD)    |
|----------|-----------------------------|------------------------------|----------------------|----------------|
| BH02-W   | West                        | 5                            | 1 to 8               | +2.58 to +2.70 |
| BH04-W   | West                        | 5                            | 1 to 6               | +1.43 to +3.44 |
| BH06-W   | West                        | 5                            | 1 to 8               | +0.63 to +1.51 |
| BH07-W   | East                        | 5                            | 1 to 8               | +0.56 to +2.79 |
| BH09-W   | West                        | 5                            | 1 to 8               | +2.14 to +3.14 |
| BH10-W   | West                        | 5                            | 0.5 to 8.5           | +2.10 to +2.47 |
| BH12-W   | West                        | 5                            | 0.5 to 8.5           | +2.32 to +2.83 |
| BH17-W   | West                        | 5                            | 2 to 6               | +1.80 to +1.91 |
| BH19-W   | West                        | 5                            | 1 to 8               | +1.41 to +1.55 |

These groundwater levels indicate that groundwater levels to the west of the former railway station:

- can be a low as +0.63mOD or as high as +3.44mOD;
- have a typical low of +1.80mOD, a typical high of +2.5mOD and an average of +2.2mOD.

Groundwater levels to the east of the former railway station:

- can be a low as +0.56mOD or as high as +2.79mOD with an average of +1.68mOD

The issue with groundwater levels east of the former railway station is that only one location is available. However, noting this the values that are available are observed to be similar to and within the range of the values for the western side of the site. It is recommended that more site investigation is undertaken to validate this observation.

Sea levels during normal conditions range between +3.45mOD and -3.25mOD (Mean High Water Springs and Mean Low Water Springs respectively) with Mean Sea Level being +0.17mOD. This indicates that average groundwater levels within the soils under the site are higher than Mean Sea Level.

With the high hydraulic connectivity, groundwater levels are expected to rise with climate change induced sea level rise. However, this is not expected to cause normal groundwater levels to exceed +4.41mOD (+3.44mOD + 0.97m sea level rise allowance) within the design life of the development.

It is therefore concluded that the likelihood of surface flooding from groundwater sources is negligible.

#### **4.8 Flooding from Lakes, Reservoirs and Artificial Sources**

Non-natural or artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level. Flooding from these sources may occur as a result of the facility being overwhelmed and/ or as a result of dam or bank failure.

The SFRA identifies two sources of potential flooding; the Royal Military Canal and the Mill Leese Flood Storage Area. Both of which are not deemed to be a flood risk to the site.

The Reservoir Flood Risk Map for Planning shows that risk from Reservoir flooding in the vicinity of the site originates from the Hart Reservoir, to the north-west of the site, with the water flowing along the Pent River and outfalling into the Harbour (Figure 4-9). The Reservoir Flood Risk Map demonstrates the site to not be at flood risk from reservoirs.



Figure 4-9 Reservoir Flood Risk (source UK GOV.UK) with site boundary shown

## 5 Management of Sitewide Flood Risk

### 5.1 Overview

The primary risk of flooding to the OPA site is from the sea and in particular waves approaching the coastline from the southwest to southeast sector. As outlined in the OPA FRA, there are two potential flood mechanisms: exceedance of land levels by the still sea level, and wave run-up and/or overtopping. The below sections outline the flood risk management strategies proposed across the site to mitigate flood risk including the effects of climate change.

The key flood mitigation measures for the site are the natural shingle beach which protects the site from the southwest sector, and the construction of a new sea defence which protects the eastern flank of Plot G1 against waves from the southeast sector. Both measures provide a standard of protection of 1:200 year plus climate change up to 2115. The sea defence is designed to require minimal maintenance, whilst the beach requires periodic recycling works to redistribute the shingle to maintain the required beach profile. The methodology for the latter is set out in the Beach Management Plan and summarised in this report.

### 5.2 Flood Risk Strategy

#### 5.2.1 Beach Plots (including Plot F1)

Within the OPA FRA, the modelling undertaken to define to provide a 1 in 200 year defence standard up to the year 2115 for the properties along the beach were based on a water level of +5.80mOD. This water level represented the 'future 2115' 1 in 200 year event at the time of writing the original OPA FRA is 2012.

At the time, the published 1 in 200 year 'present day' extreme water level was +4.6mOD, indicating a sea level rise allowance to the year 2115 of 1.2m. By way of comparison back to the updated 2115 extreme water level of +5.77mOD from Table 4-2, there has been no meaningful change in water level. The modelling of the beach outlined in the OPA FRA therefore remains valid.

The flood risk management strategy associated with the beach area were as follows:

- The crest level of the beach shall be set at a value of +6.5mOD; and
- Shingle ridges behind the beach are to be included and shall have a crest level of +7.5mOD. Their primary function is to prevent any water that does overtop the beach crest from propagating into the development. Instead, overtopped water is encouraged to flow back towards the sea. Where gaps are required through the shingle ridges to provide access, these shall not have a crest level lower than +6.75mOD.

The mobile nature of the beach presents a specific risk to the development in the form of a highly variable environment. The OPA FRA defined the zone over which the beach is expected to be mobile as the 'active zone'. The width of the active zone was established through cross shore modelling of a typical cross section from the beach at Folkestone and was split into two key zones to account for different levels of risk:

1. **Unmaintained Active Zone** - a 30m wide zone of beach measured from a contour level of +5.9mOD. Through analysis of the beach cross sections surveyed by the Channel Coastal Observatory, this represented the natural crest of the beach from a period of time when no maintenance was being undertaken.

2. **Maintained Active Zone** – a 14m wide zone of defined from a contour level of +6.5mOD.

To enhance the level of protection the beach was raised to +6.5mOD. This had two effects. It reduced the width of the active zone and provided resilience to the beach against larger storms. The maintained active zone represented the case where the beach was nourished and actively maintained.

The location of the active zones relative to the development masterplan are shown in Figure 5-1.

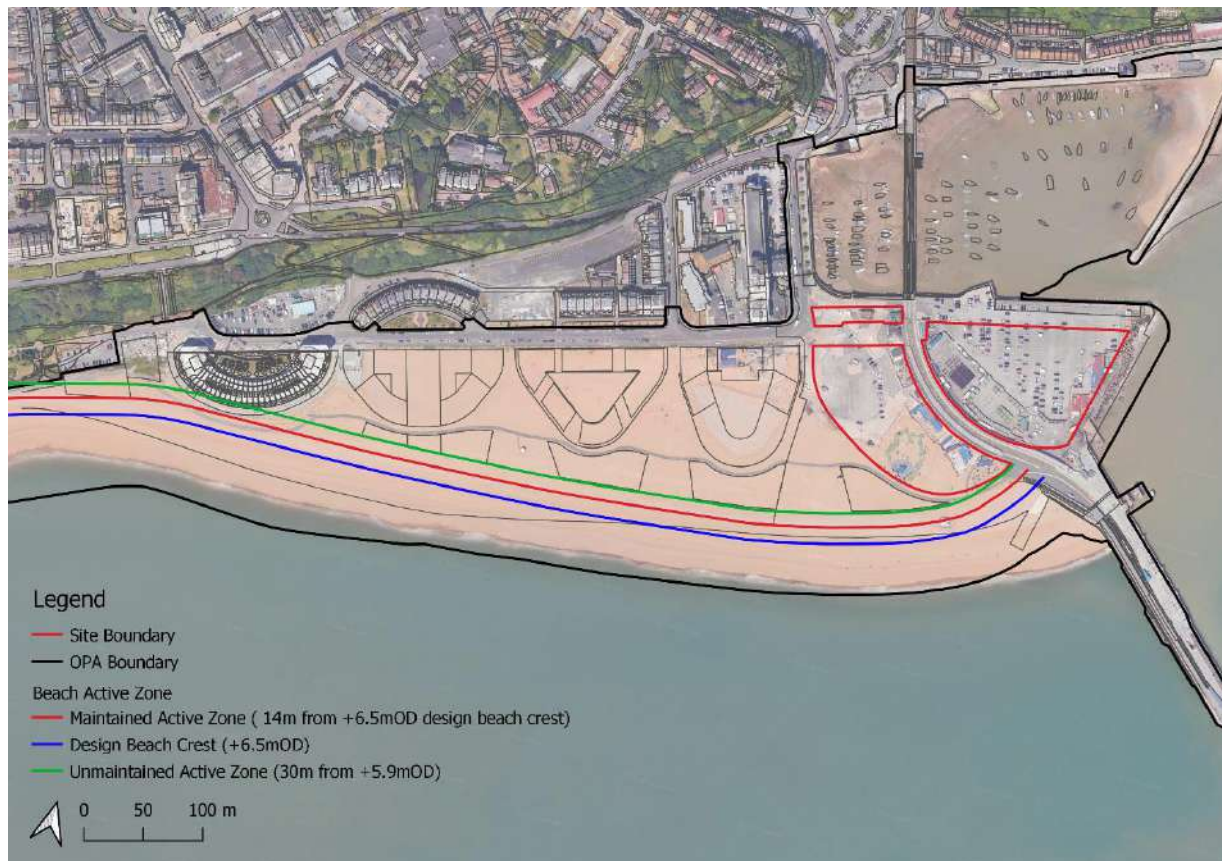


**Figure 5-1 Beach active zone lines relative to development masterplan**

To manage the residual risk of larger storm events impacting the beach or the beach not being maintained to the required levels, all buildings are to be located behind the unmaintained active zone.

### 5.2.2 Harbour Plots (including Plots G1 and H)

Wave modelling undertaken along the South Quay as part of the OPA FRA indicated that the harbour area is most vulnerable from waves approaching from an easterly direction (Figure 5-2). A sloping rock revetment with a crest wall was found to reduce overtopping rates to a rate that could allow pedestrian movement during storms with a 1 in 200 year return period including the effects of climate change. The results indicate that a safe access/egress to and from the proposed development site would be achievable and acceptable.

As part of the development of the Harbour Plots; F1, G1 and H, the design of the South Quay Sea Defence is being developed to ensure the latest available data is considered in ensuring a 1 in 200 year return period including the effects of climate change to 2115 and to re-confirm the design. This will limit wave overtopping to tolerable levels up to and including the design event. This design is summarised in Section 7.1.2.



**Figure 5-2 Location of Plot G1 Sea Defence with a wave rose showing the significant wave height for the UK MetOffice hindcast point offshore (extracted from Folkestone Seafront Harbour Masterplan Development – Coastal/ Wave Modelling Report (document no. PC4284-RHD-XX-ZZ-RP-0103-S3-P01-2) (RHDHV, 12/05/2023))**

### 5.3 Finished Floor Levels

The dominant source of flooding to the site is from the coastal environment. Section 4.4.2 stated that the extreme water level in the year 2115 is +5.77mOD for the higher central sea level rise projection, increasing to +6.10mOD for the upper end sea level rise projection. In the context of sea level rise projections, the higher central represents the 70<sup>th</sup> percentile of the UKCP18 projection with the upper end representing the 95<sup>th</sup> percentile.

To provide a safety factor to the extreme water level, a freeboard allowance of 600mm is applied in line with the OPA FRA. This freeboard is applied to the higher central projection only on the basis that the upper end is considered to be a sensitivity test should sea levels rise by more than expected.

|                                                                                                                                             | Higher Central  | Upper End       |
|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------|
| 1 in 200 year 2115 Future Epoch                                                                                                             | +5.77mOD        | +6.10mOD        |
| Freeboard (for development level)                                                                                                           | 600mm           | N/A*            |
| <b>Total</b>                                                                                                                                | <b>+6.37mOD</b> | <b>+6.10mOD</b> |
| <ul style="list-style-type: none"> <li>*no freeboard applied as "upper end" projection is considered for a sensitivity test only</li> </ul> |                 |                 |

The OPA FRA recommended a minimum level of +6.5mOD for all residential property and entrance thresholds into basement car park areas. Working back from this level the freeboard for the higher central and upper end sea level rise projections would be 730mm and 400mm respectively. There is therefore no basis to increase the minimum level of +6.5mOD to account for changes in sea level rise projections and extreme water levels.

The mobile nature of the beach presents an enhanced risk to built assets that are close to the foreshore. Where built assets are proposed to be located immediately behind the unmaintained active zone line, they shall have piled foundations and residential buildings should have their threshold levels set at +8.0mOD. This is to enhance the level of protection in this potentially volatile area and to manage the risks of scour undermining building foundations if the beach is unmaintained or a larger event than the 1 in 200yr storm impacts the beach. All other residential buildings set away from the unmaintained active zone shall have a minimum threshold level of +6.5mOD.

## 5.4 Beach Management Plan

To facilitate the regeneration of Folkestone Harbour into a mixed use residential and commercial development, it is the intention that the existing shingle beach provides the primary flood defence on the site's southern boundary. In order to raise the standard of protection offered by the beach a capital recharge of the shingle beach was required to improve flood defence against future storms within the English Channel. The primary mechanism of mitigating the flood risk is through reducing the degree of wave overtopping.

Beaches are highly mobile environments that quickly respond to the wave climate. The result is that material is constantly shifting across the beach in the longshore direction, and on and off the beach in the cross-shore direction. At Folkestone the prevailing movement of shingle is from west to east with only small volumes of material being lost from the beach system to offshore areas. This is shown by the morphological assessment of historic data contained within Appendix B. It is this migration of shingle that alters the beaches ability to provide the required protection to the development.

To assess, manage and control the risk of the mobile nature of the beach, a Beach Management Plan (BMP) was produced. Its purpose was:

1. to facilitate and support the initial recharging of the beach in 2017 as part of the Enabling Works for the development; and,
2. the subsequent maintenance of the beach in order to maintain the required degree of flood protection.

The latest version of this document was updated in November 2023 (*ref. 231127 TG Folkestone Seafront – Beach Management Plan P06*).

The Folkestone Seafront BMP covers the area of shingle beach between the rock groynes in the west to the Harbour Arm in the east. Both structures effectively act as terminal groynes. As the majority land owner between these structures, the Folkestone Harbour Company has taken responsibility to manage, monitor and maintain the beach to date. The extent of land ownership and the management responsibilities are outlined within Figure 5-3.

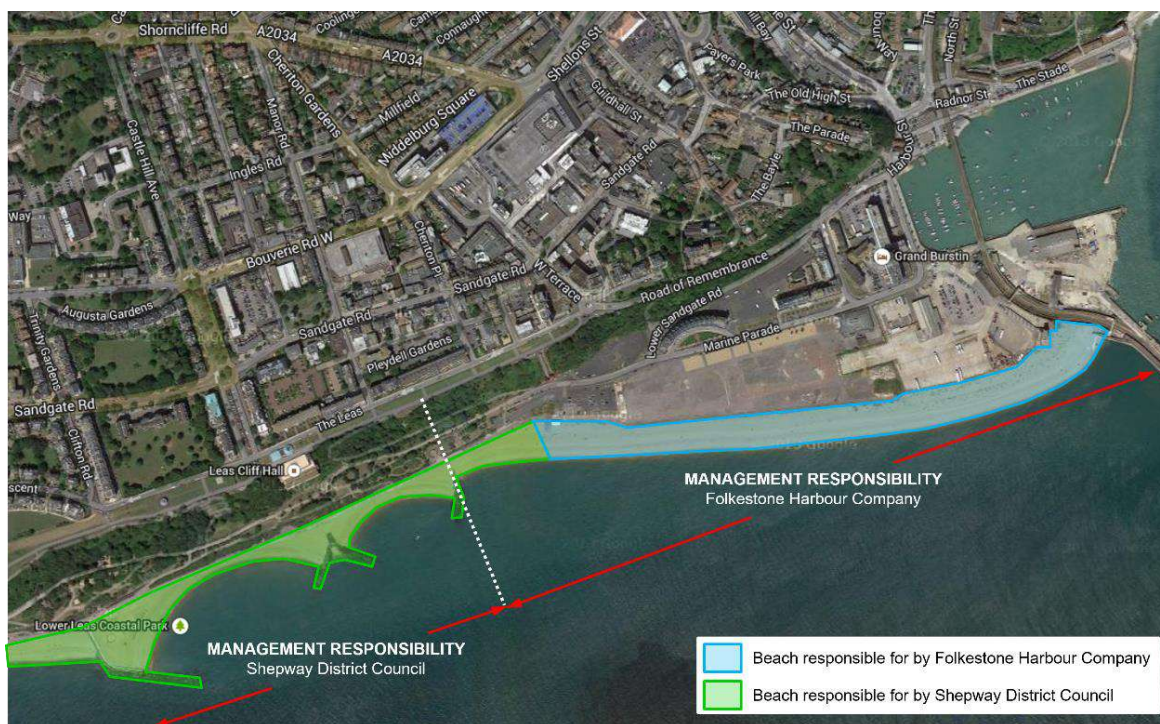


**Figure 5-3 Limits of Management Responsibility (extract Figure 2-1 of the BMP)**

The design profile of the beach, trigger levels and the maintenance regime outlined within the BMP are summarised in the following sections.

#### 5.4.1 Design Beach Profile

The required standard of protection for the beach is to defend against a 1 in 200yr storm event with an allowance for climate change in the form of sea level rise and increased storminess to the year 2115. This data is defined based upon a 100 year design life from the planning application date of 2015.

To provide the standard of protection, numerical modelling undertaken by Herrington Consulting in the Outline Planning Application Flood Risk Assessment (OPA FRA) identified the following criteria for the beach:

|                                          |                                                                                                                 |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Crest Level</b>                       | +6.5mOD                                                                                                         |
| <b>Minimum Crest Width</b>               | 14m                                                                                                             |
| <b>Slope Angle</b>                       | Nominal 1 in 7                                                                                                  |
| <b>Setback of Development Properties</b> | 30m from +5.9mOD beach contour<br>(taking the 1 in 7 profile this equates to 25.8m from the +6.5mOD crest line) |

The design profile is to be applied along the entire length of the beach fronting the proposed development only, and represents the required defence in the year 2115.

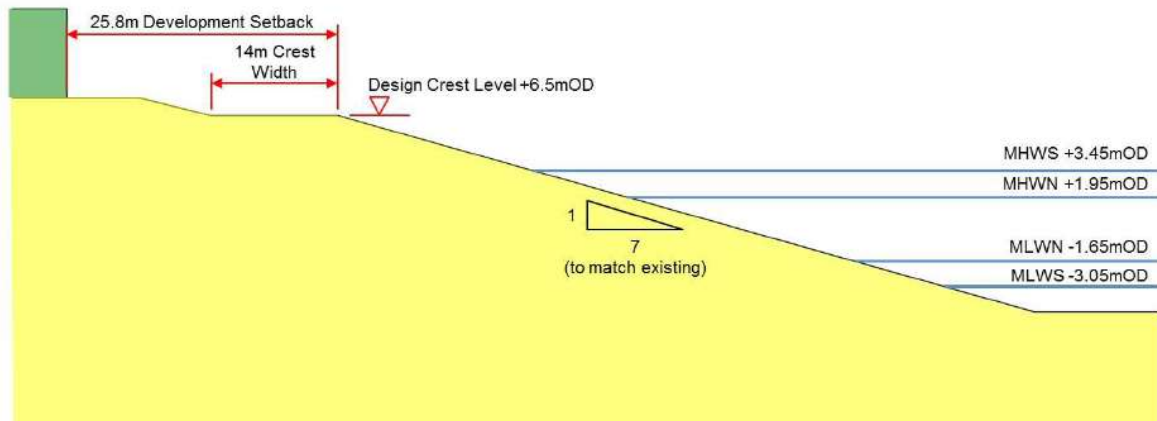
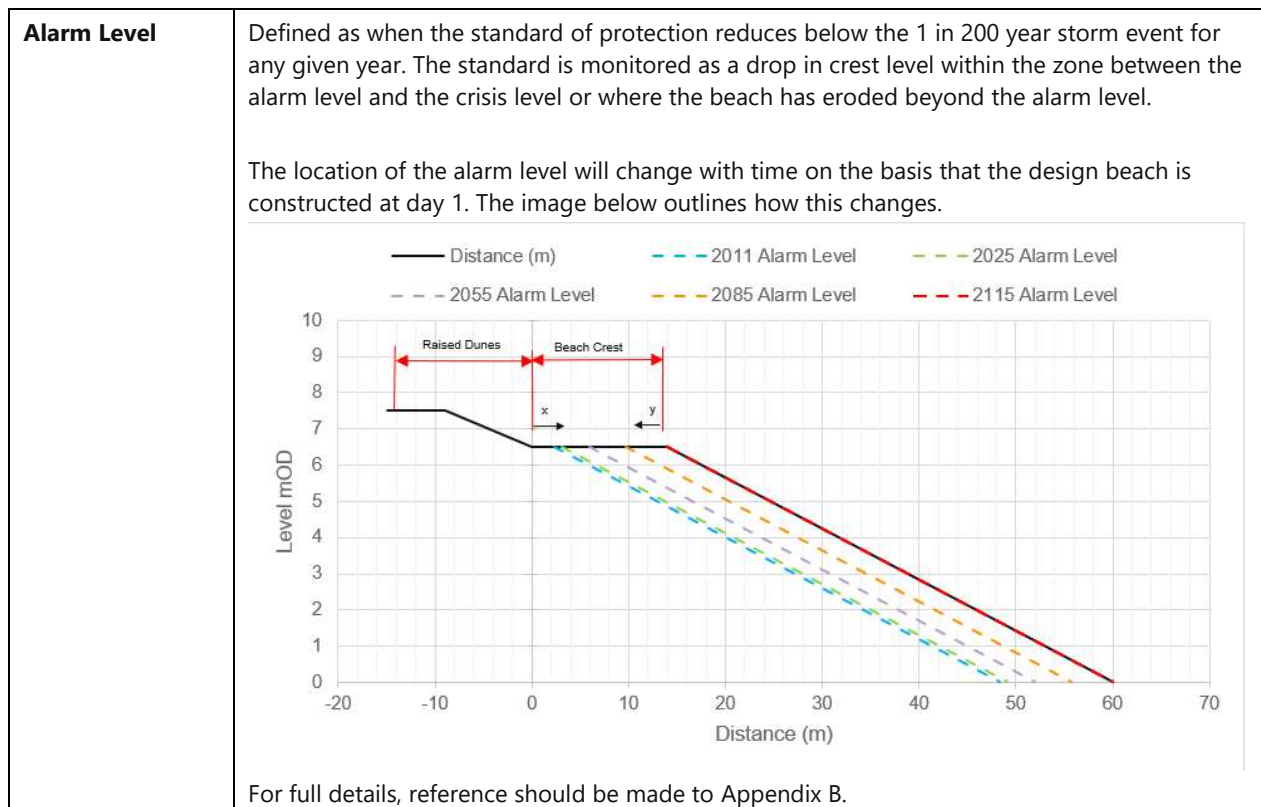


**Figure 5-4 Scheme design beach profile to provide flood defence to the development**

Between the back of the 14m wide crest and the 25.8m development setback, beach levels are to be set to increase to a level of +7.5mOD as mentioned in Section 5.2.1 to manage any overtopped water, encouraging it to flow back towards the sea instead of towards the development.

#### 5.4.2 Trigger Levels

The performance of the beach is managed through trigger levels broken down into an alarm level and a crisis level.



**Crisis Level** Defined as a consistent lowering of the beach at the back of the raised dunes (i.e. the back of the 1m wide crest) below +6.5mOD and/or damage occurring to the raised dunes. For the purpose of determining when to undertake work for the crisis level, this is defined as a consistent lowering below +6.5mOD for a distance of 100m

### 5.4.3 Beach Maintenance and Monitoring

The programme of maintenance recommended within the BMP is outlined below:

- The beach will require regular maintenance and is intended to follow the methodology current employed by Folkestone and Hythe District Council (formally Shepway District Council) on the beach to the west of the development.
- Periodic maintenance after and before the winter storm season to reform the design beach crest and crest width.
- Material will be recycled from areas of accretion (typically from the beach adjacent to the Harbour Arm) to areas of erosion to the west, counteracting the natural longshore drift.

Monitoring of the beach in the form of topographic surveying has been undertaken by the Channel Coastal Observatory twice yearly since 2003. This has been supplemented with annual surveys by the Folkestone Harbour Company since 2017. This data was used to prepare the initial BMP and to inform the annual reporting of the beach's health status. These are used to inform decisions on when maintenance should take place.

## 5.5 Flood Warning

The EA operate a flood forecasting and warning service in areas at risk of flooding from rivers or the sea which relies on direct measurements, in-house predictive models and information from the Met Office. This service is operational at all times and is in place to warn the public of emergencies.

The EA has general supervisory and other statutory duties for flood defence and flood warnings in South East Kent, with flood warning procedures being in place for various locations within the Shepway District, including Coastal areas from Folkestone to St Mary's Bay, as noted in the SFRA.

As part of the Site Wide Flood Risk Management Strategy it is recommended that the development is linked to the EA Flood Warnings Direct service to ensure they receive flood alerts, flood warnings and severe flood warnings to allow the development to be informed, prepared and act where required.

## 5.6 Safe Access and Egress

The numerical modelling of the potential overland flow routes undertaken as part of the SFRA has shown that there are safe access and egress routes available to the residents and visitors to the proposed Folkestone seafront development in the 1 in 200 design events including the effects of climate change. Access and egress from the entire development will, therefore, be possible from any part of the site.

It is recommended that appropriate signage be provided which provides clear directions for evacuation in the unlikely event of a flood.

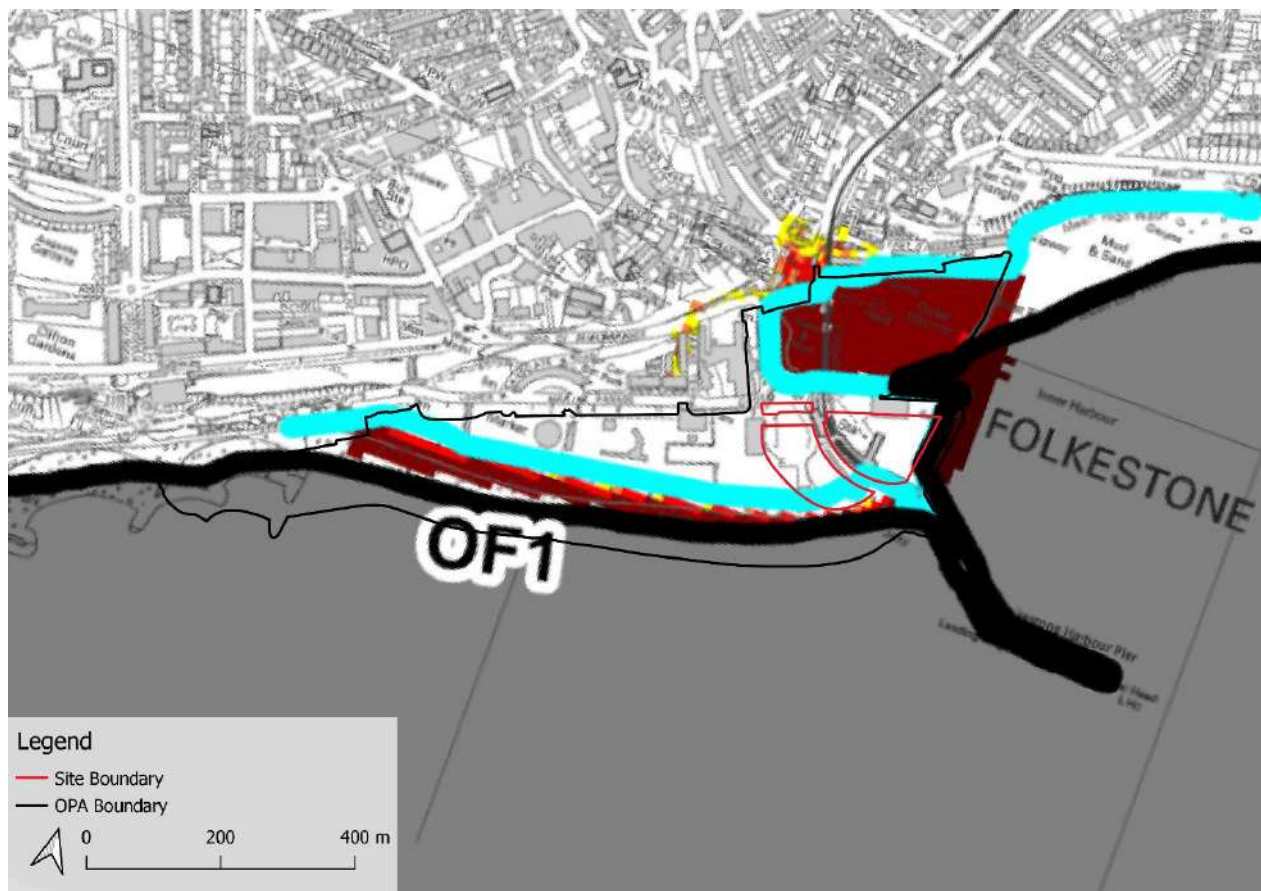


**Figure 5-5 Extract from SFRA showing future day hazard map (2115) with site boundary shown**

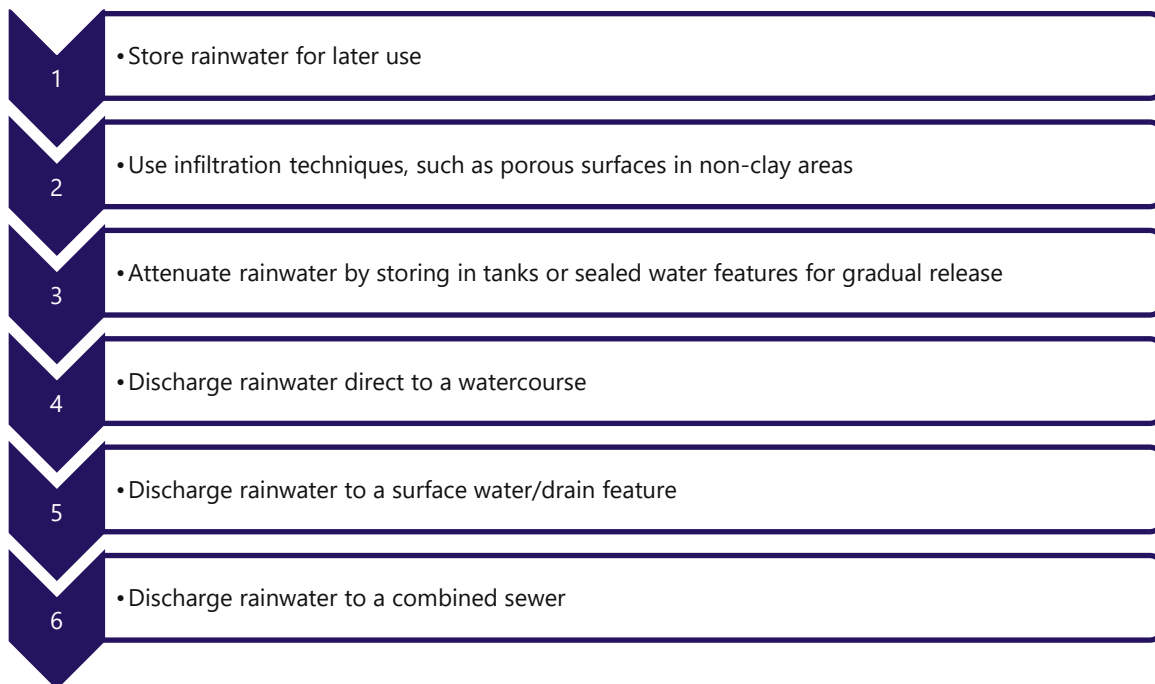
## 5.7 Site Drainage Strategy

The ground that underlies the site is formed of beach deposits, predominantly shingle (gravel) with deposits of sand. Based upon this the underlying soil is highly permeable with infiltration rates of between 90-250mm/hour being predicted from ground investigation information. Given the permeable nature of the underlying soil, instead of discharging direct to source, the site wide drainage strategy is to implement Sustainable Drainage Systems (SuDS) with a focus upon infiltration and attenuation. Infiltration rates will need to be verified during the design of the stormwater network.

SuDS features are to be provided to accommodate and manage surface water runoff to ensure that the rate of rate discharging from the site is not in excess of permissible runoff rates by controlling both the quantity and quality of the discharged water. The Site Drainage Strategy shall be designed:

1. Such that no surcharging of the underground network occurs for 1 in 2 year storm event;
2. That no flooding occurs at ground level for a 1 in 30 year storm event;
3. Storm events in excess of 1 in 30 year and up to a 1 in 100 year event shall be contained above ground in between kerb lines but shall not flood adjacent properties. Attenuation systems shall be increased in size as required to ensure this.
4. Climate change allowances shall be taken in line with the latest National Planning Policy Framework (NPPF) guidance at the time of designing the storm water network.

The SuDS hierarchy that is outlined within the OPA FRA is given below:



Specific considerations for individual SuDS features are given below:

- **Store rainwater for use** – The use of rainwater harvesting is to be decided upon on a plot-by-plot basis. Use of rainwater by the building during the peak storm will be minimal and therefore should not be considered during design of the stormwater network. They do however provide other sustainable benefits e.g. reducing water demand.
- **Infiltration systems** –External hardstanding path areas can utilise permeable paving to allow water to infiltrate into the ground below with roof areas infiltrating to soakaways. Any soakaways will need to be approved by the local planning authority as per condition 34 of the planning permission (Y12/0897/SH). The height of the groundwater table may limit the depth of infiltration structures. Where this occurs, shallow geocell units should be specified.
- **Green roofs** – Provide complementary drainage capacity by providing retention and reducing discharge and peak rates of runoff by elongating the time over which runoff occurs. Green roofs should be deployed on podium deck areas throughout the masterplan.
- **Attenuation via tanks** – Below ground attenuation is an option to serve individual plots with discharge rates aligned to the capacity of the existing Southern Water sewer in Marine Parade. Attenuation within the development can be provided in a number of ways either within podium decking areas or within landscaped area:
  - Below ground attenuation tanks
  - Podium attenuation cells
  - Blue roofs

All hardstanding is to have permeable paving with roof and podium areas utilising source control techniques e.g. green podium decks, infiltration cells and swales, to control surface water flow. To reduce the size of infiltration cells, it is recommended that spare capacity in the existing Southern Water network is utilised, subject to the water authority's approval.

## 6 Proposed Development

This section summarises the key components of the proposed development that are relevant to the assessment of flood risk in the following section.

A basement level is proposed within the development as shown in Figure 6-1 which accommodates car parking, bike storage, back of house infrastructure (e.g. bin stores, plant rooms and water storage) and F&B kitchens for Plots G1-B6 and G1-B9 (Figure 2-5).

There is one entrance to the basement level on the ground floor, as shown in Figure 6-2. This entrance is located to the west of the overall site, to the north-west of Plot F1.

The general arrangements for the ground floor across Plots F1, G1 and H are shown in Figure 6-2 and cross sections through the site in Figure 6-3.

Relevant full-scale plans are included within Appendix C.

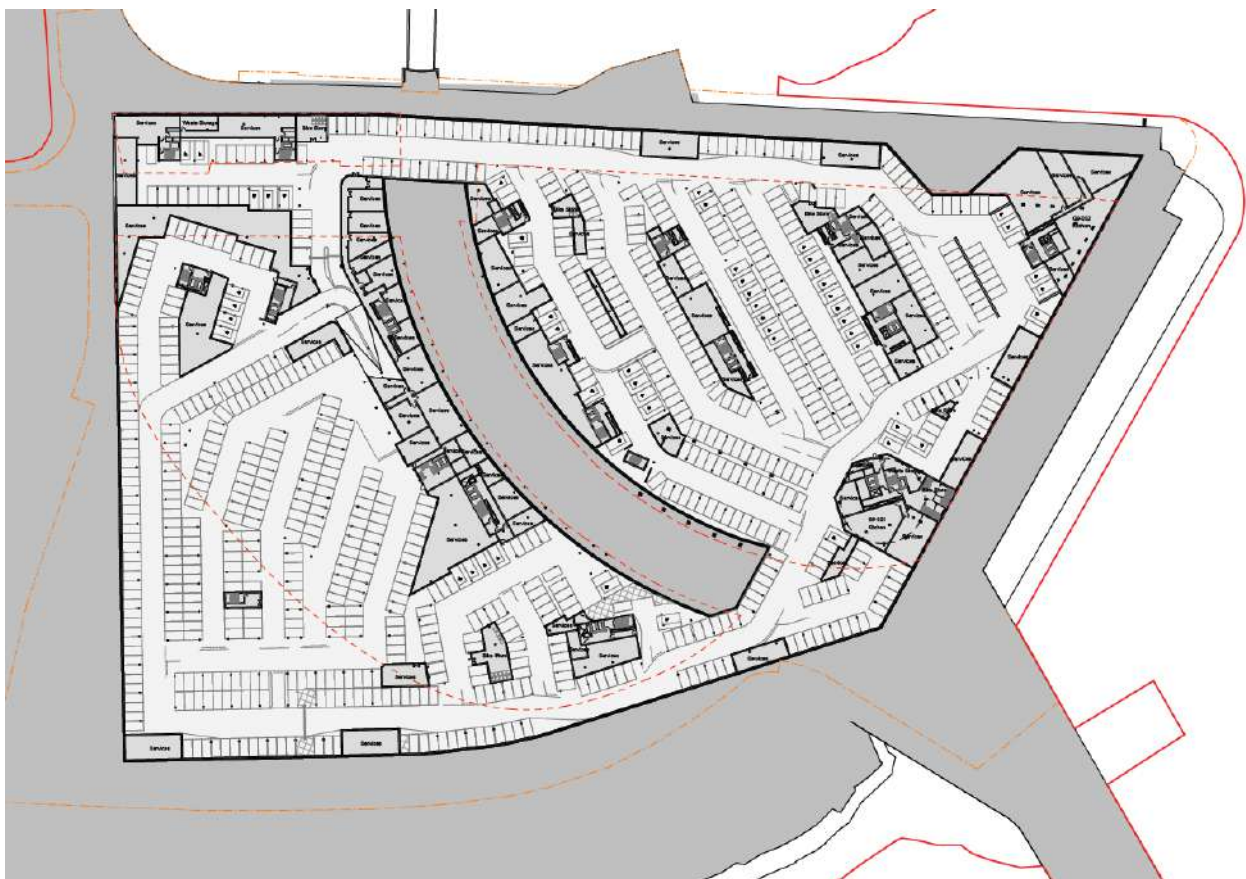


Figure 6-1 Proposed Site Plan Basement (drawing no: 008-AISF-PL-60-0120) (A is For, February 2024)



Figure 6-2 Proposed Site Plan Ground Floor (drawing no: 008-AISF-PL-60-0101) (A is For, February 2024)

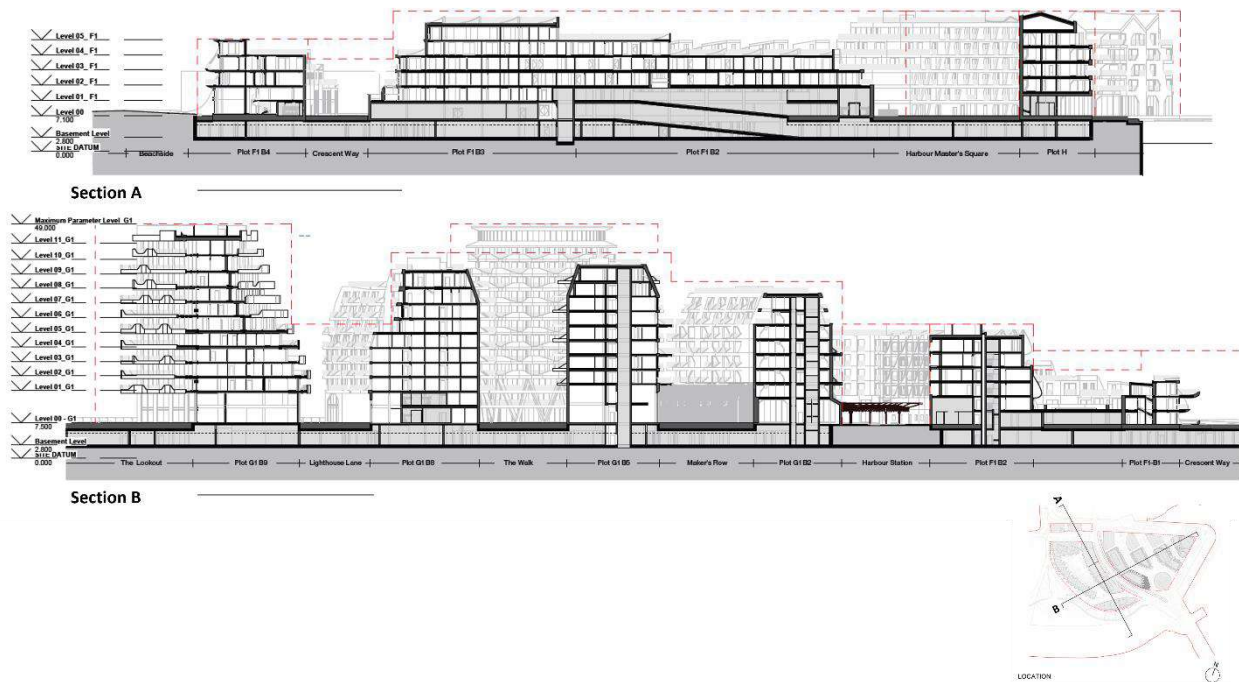


Figure 6-3 Proposed Site Cross Sections (drawing no: 008-AISF-PL-60-0301) (A is For, February 2024)

## 7 Proposed Development Flood Risk

This section outlines the flood risk to the proposed development and any mitigation measures required to remove flood risk to the development.

From Section 4, we have established that coastal flood risk is the primary source of flood risk and that fluvial flood risk, flooding from sewers and water mains, and flooding from reservoirs to not pose a flood risk to the development. These are therefore not considered in this section.

Owing to the proximity to the sea and presence of basements, groundwater flood risk will also be considered in terms of proposed development flood risk. The surface water flood risk strategy for the proposed development is also outlined in the section below.

### 7.1 Coastal Flood Risk

#### 7.1.1 Finished Floor Levels

As outlined in Section 5.3, the OPA FRA recommended a minimum threshold level of +6.5mOD for all residential property and entrance thresholds into basement car park areas unless the residential properties are proposed to be located immediately behind the unmaintained active zone line, where their minimum threshold levels should be set at +8.0mOD.

Across Plots G1, F1 and H, all thresholds into the buildings and basement levels have been set at or above a level of +6.5mOD to manage the risk. Ground floor levels across the 3 plots vary from +6.5mOD to +7.5mOD.

Plot F1, Building 4 is located behind the beach active zone with a threshold level of +7.5mOD. The ground and first floors have commercial uses only, with residential uses located from the second floor upwards (shown in Figure 7-1), this is therefore considered appropriate.

Within Plot G1, all buildings have a minimum threshold level of +7.5mOD. This raised level is a function of the proposed ground levels and the geometry of the South Quay Sea Defence.

Collectively the thresholds for Plots F1, G1 and H prevent the ingress of water from a coastal flood event into the building and basement during the design 1 in 200yr 2115 coastal flood event.

The ingress of flood water via surface flow is prevented from the +6.5mOD threshold of the basement entrance. There remains a residual risk that events larger than the design event may breach the basement threshold and result in flooding within the basement due to the basement finished floor level being at +2.8mOD. This is considered a residual risk and is covered in Section 8.2.3.

The basement structure shown in Figure 6-1 accommodates various different uses ranging from plant rooms and back of house services to car parking and bike storage. The categorisation of all uses in line with the NPPF are outlined in Table 7-1.

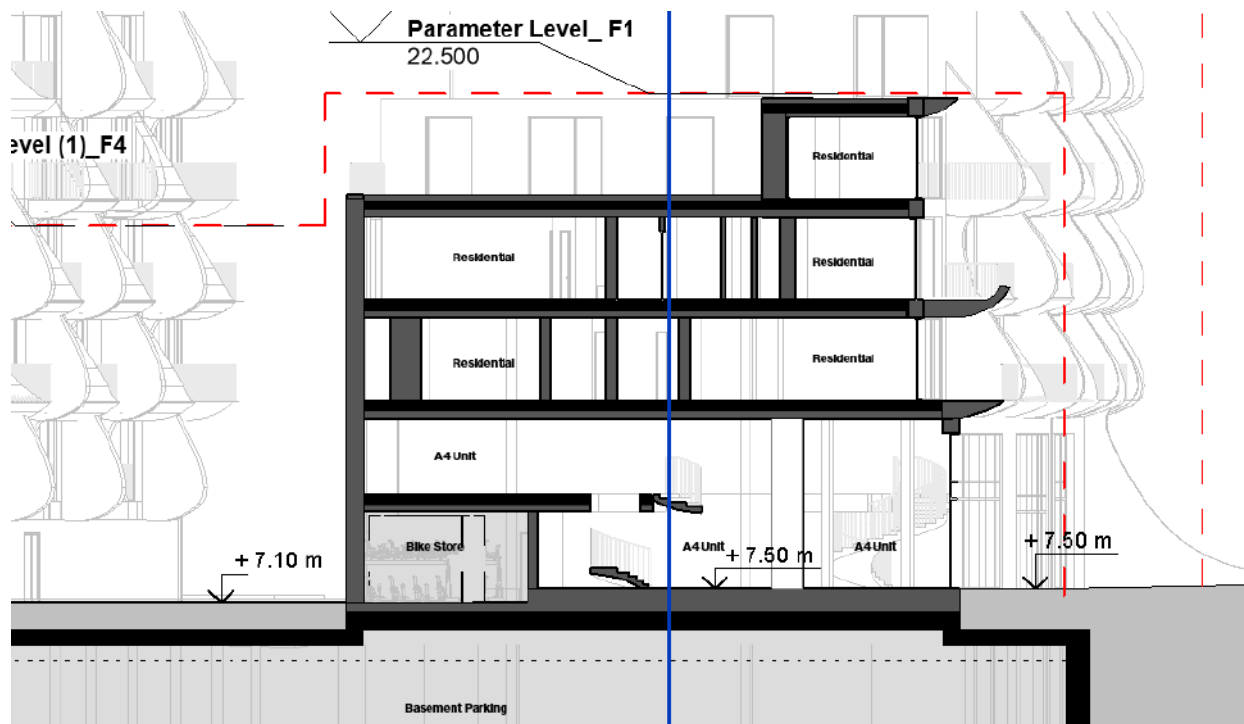


Figure 7-1 Cross-section through Plot F1 Building 4 showing threshold levels and level of residential units drawing no: 008-AISF-PL-60-0301) (A is For, February 2024)

Table 7-1 Basement land uses vulnerability classification

| Basement Use                                          | NPPF Vulnerability Classification |
|-------------------------------------------------------|-----------------------------------|
| Water Storage                                         | Water compatible                  |
| Services (generator rooms, switch rooms, ventilation) | Less vulnerable                   |
| Waste Storage                                         | Less vulnerable                   |
| Residential back of house storage                     | Less vulnerable                   |
| F&B kitchens for Plots G1-B6 and G1-B9                | Less vulnerable                   |
| Bicycle parking                                       | Less vulnerable                   |
| Car parking                                           | Less vulnerable                   |

All land uses within the basement structure are therefore classed as being lower than the overall *More Vulnerable* classification of the wider residential development that is Plots F1, G1 and H. The sequential approach has therefore been applied to locate all more vulnerable land uses (i.e. habitable residential spaces) to the upper floors of the development and less vulnerable land uses to the lower floors.

This approach is reflected in the placement of the MEP Rooms, Cycle Storage, F&B Kitchens and residential back of house storage. A residential dwelling would be classified as *More Vulnerable* under the NPPF on the basis that it is habitable. In accordance with Building Regulations Part F a “habitable room” is defined as:

*“A room used for dwelling purpose, but which is not solely a kitchen, utility room, bathroom, cellar or sanitary accommodation.”*

This definition allows the MEP Rooms, Cycle Storage, F&B Kitchens and back of house storage to be separated from the More Vulnerable classification of the wider residential building. It is also noted that the kitchens located in the basement are part of the commercial assets and are therefore classified as Less Vulnerable.

The sequential approach outlined above is therefore considered appropriate for locating these assets below the +6.5mOD threshold level.

### 7.1.2 Plot G1 Sea Defence

Plot G1 is at risk from wave overtopping from its eastern flank. Storm events in the southern North Sea can penetrate through the Dover Strait and result in significant wave attack from the southeastern sector. Some wave overtopping occurs onto the existing car park, although this is at a lower level than the finished scheme. To counteract this risk, a new sea defence is proposed – a sloped armoured rock revetment with a wave crest wall. The outline elements of this scheme were both approved in the Outline Planning Permission (2015) and are permitted works under a Harbour Revision Order (2017). The Sea Defence has been progressed to a RIBA Stage 2 Design, which is summarised here.

Figure 7-2 and Figure 7-3 shows the schematic cross section and plan respectively for the structure for the preferred option – ‘Configuration 1’. This will be further refined in the Stage 3 Design, with the levels and dimensions confirmed. The rock structure has been designed to require only minimal maintenance during its design life to 2115, through the assumption of only ‘initiation of damage’ during the 1 in 200yr design event, and a 12 hour storm duration, both conservative assumptions. The wave wall will be able to withstand the horizontal wave forces due to overtopping. The slope stability of the structure has been assessed using Eurocode 7 (BS EN 1997-1:2004 and the UK National Annex).

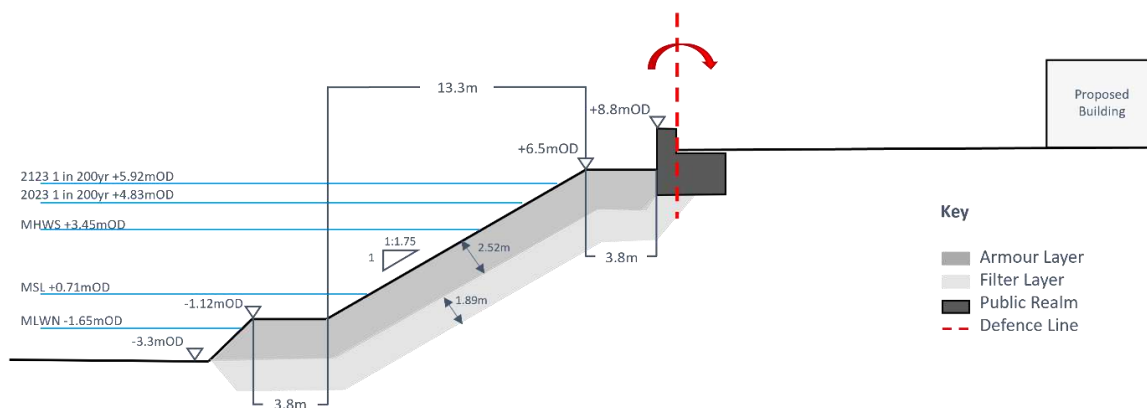


Figure 7-2 Proposed cross-section of Configuration 1

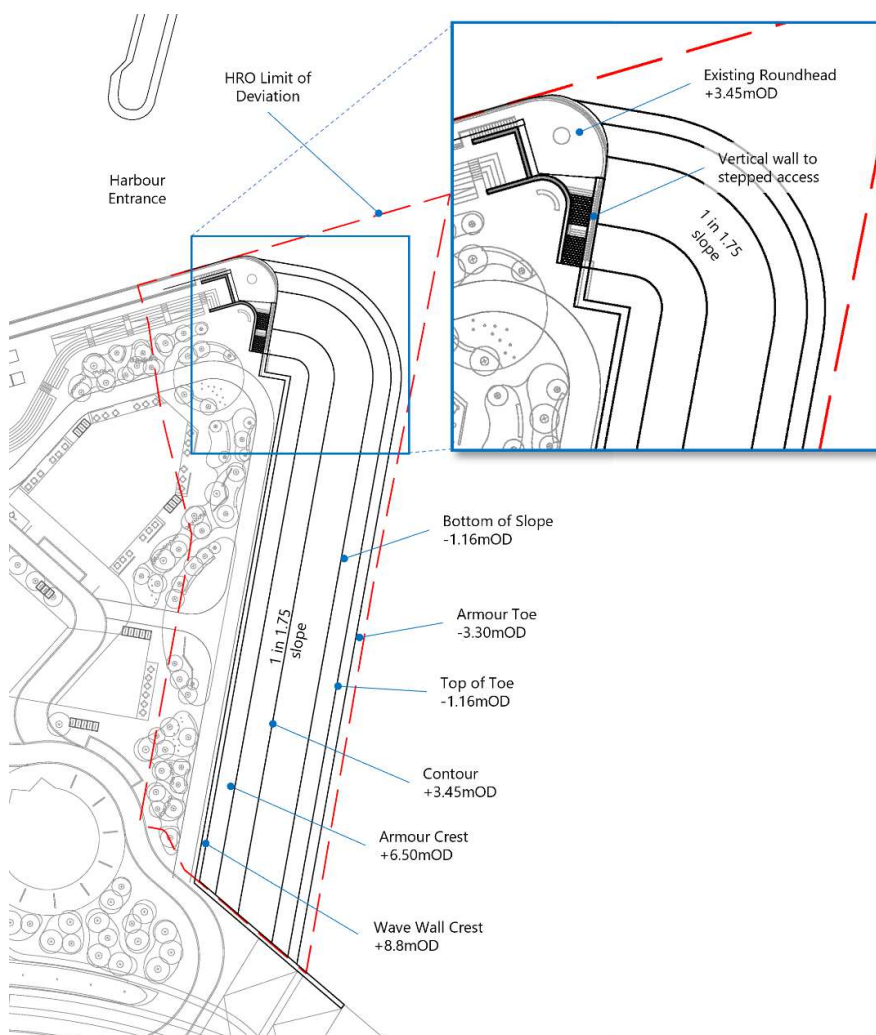


**Figure 7-3 Proposed plan of Configuration 1**

Functionally, the sea defence will restrict wave overtopping into Plot G1 to tolerable levels according to the latest international guidance. The safe overtopping limits considered appropriate for the design of the Plot G1 Sea Defence are provided in Table 7.2.

**Table 7.2 Overtopping limits for people, property, landscaping for the Plot G1 Sea Defence**

|                                                                                   | Mean discharge, q (l/s/m) |                         |                      |                   | Max volume, Vmax (l/m) |
|-----------------------------------------------------------------------------------|---------------------------|-------------------------|----------------------|-------------------|------------------------|
| People                                                                            | 20<br>(Hm0 ≤ 0.5m)        | 10<br>(Hm0 = 0.5 to 1m) | 1<br>(Hm0 = 1 to 2m) | 0.3<br>(Hm0 > 2m) | 600                    |
| Property <sup>(1)</sup>                                                           | 1                         |                         |                      |                   | 1000                   |
| Landscaping <sup>(2)</sup>                                                        | 5                         |                         |                      |                   | 2000                   |
| Sea Defence <sup>(3)</sup>                                                        | 50                        |                         |                      |                   | N/A                    |
| (1) Damage to equipment set back 5-10m or damage to building structure elements   |                           |                         |                      |                   |                        |
| (2) grass covered crest and landward slope. Chosen to represent public realm      |                           |                         |                      |                   |                        |
| (3) informed by EurOtop I for a coastal structure that has a well protected crest |                           |                         |                      |                   |                        |

The overtopping limits presented within Table 7.2 are assigned to different return period events to reflect a serviceability and ultimate limit state design assessment.

- **Serviceability Limit State**

Defined by the 1 in 1 year return period event. This limit is used to assess the safety of the public/people walking behind the sea defence.

- **Ultimate Limit State**

Defined by the 1 in 200 year return period event. This limit is used to assess the extreme events that have the potential to lead to damage or failure of the sea defence or built assets.

Table 7.3 provides the matrix of how the safe overtopping limits are applied to different return period events.

**Table 7.3 Protection vs. storm return period matrix for design of the sea defence (including for sea level rise to 2115)**

|             | <b>Serviceability Limit State<br/>(1 in 1 year storm)</b> | <b>Ultimate Limit State<br/>(1 in 200yr storm)</b> |
|-------------|-----------------------------------------------------------|----------------------------------------------------|
| People      | X                                                         |                                                    |
| Property    |                                                           | X                                                  |
| Landscaping |                                                           | X                                                  |
| Sea Defence |                                                           | X                                                  |

EurOtop II, the industry standard guidance for calculating wave overtopping volumes of sea defence structures, has been utilised to calculate the crest heights and subsequent overtopping rates required to meet the defined limits. Table 7.4 shows the overtopping performance of the structure according to the worst-case joint-probability event tested. This joint probability event is for the 1 in 200yr 2123 JP2 event for the harbour, which considers a wave height of 2.34m (Table 4-5).

**Table 7.4 Overtopping rates and volumes and required crest levels for Configuration 1**

| <b>Configuration</b> | <b>Overtopping Rate</b> | <b>Overtopping Volume</b> |
|----------------------|-------------------------|---------------------------|
| 1                    | 0.92 l/s/m              | 124.4 l/m                 |

## 7.2 Surface Water Flood Risk

The Proposed Surface Water Drainage Strategy for the site has been designed and written by Eckersley O'Callaghan (EOC). Their document presents the existing and proposed drainage strategy that will manage drainage from the new development. The key strategies are outlined below which demonstrate how surface water flood risk on site is to be managed and consequent flood risk to the development assessed to be low. More detail can be sought in the full Drainage Strategy document (Appendix D).

Given the site location being immediately adjacent to the harbour and sea wall the available infiltration area will be minimised compared to the plots adjacent to the beach. Therefore there will be a hybrid discharge arrangement with:

- Infiltration where available at the SW corner of the plot (Px2 in Figure 7-4);
- Discharge to public storm sewer at the NW corner of the plot to match existing connected catchment areas (Px1 in Figure 7-4); and,
- New stormwater outfalls to sea at the East of the site (Px3, Px4 and Px5 in Figure 7-4). Outfalls are to be minimised in number to reduce the inconvenience and nuisance on harbour and sea defence wall infrastructure.

The post-development surface water flood risk will be managed through the proposed surface water drainage network with a design return period of 1:100years + 45% climate change. Figure 7-4 shows the proposed catchment plan, further detail on the strategy can be found in Appendix D.

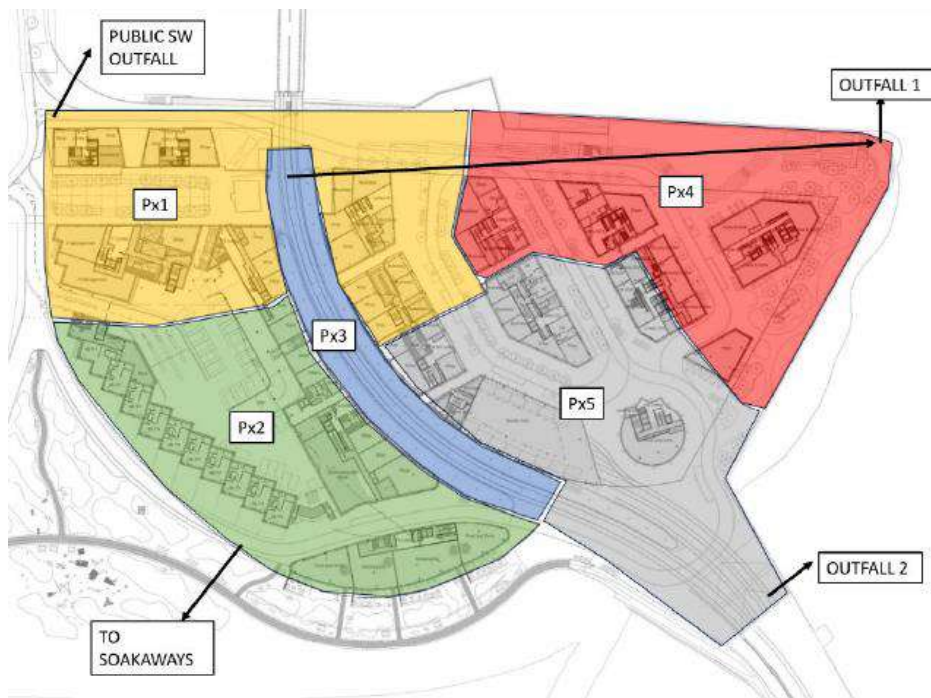


**Figure 7-4 Proposed Surface Water Drainage Catchment extracted from Folkestone Harbour Seafront Plot F1, G1 and H Drainage Strategy (EOC, 31/01/24)**

### 7.3 Groundwater Flood Risk

As mentioned in Section 7.1, the basement structure has a finished floor level of +2.8mOD. Whilst Section 4.7 outlined that the risk from groundwater flooding is negligible, this is on the basis that groundwater does not breach the surface. The highest recorded present day groundwater level from that investigation was +3.44mOD. This level is above the base of the basement. Including the 0.97m of sea level rise under the higher central projection, this increases to +4.41mOD. This is therefore above the bottom of the basement floor slab and therefore groundwater flood risk during normal conditions represents a source of flood risk if unmitigated.

The material onto which Plot F1 is to be built is predominantly shingle. As a highly permeable material it could be expected that high coastal water levels could percolate through the shingle and into the basement. The extreme 1 in 200yr water level is expected to be +5.77mOD under the higher central and +6.10mOD under the upper end sea level rise projections. Both of these are below the basement floor level of +2.8mOD.

To mitigate any ground water flood risk to the basement, it is recommended that the basement is tanked to a minimum level of +6.10mOD to prevent percolation into the basement during future extreme coastal flood events. This is also above the potential future groundwater level of +4.41mOD.

It may also be possible to deal with any percolation through the basement wall using the car park drainage system covered in Section 7.2. The design will be developed and confirmed by the drainage/building designers through following design stages, ensuring the basement will be waterproof to a minimum level of +6.10mOD.

## 8 Residual Risks and Proposed Mitigation

### 8.1 Overview

Masterplanning and design activities to support the planning application have followed a sequential risk to flood risk management, avoiding areas of higher baseline flood risk. Section 7 contains an assessment of flood risk for each type of flooding that poses a risk to the proposed development, referencing measures taken within the design to eliminate or minimise this risk. Section 7 also refers to residual risks, i.e. the risks that remain once all flood risk management infrastructure and design measures are taken into account.

These residual risks are summarised as follows:

- Coastal flood risk as a result of overtopping of the shingle beach to the south of the development plot;
- Coastal flood risk as a result of overtopping of the new sea defence on the eastern flank of Plot G1;
- Flooding of the basement structure as a result of groundwater flooding or through an extreme coastal flood event larger than the DFE overwhelming the entrance threshold level.

The following sections consider these residual risks further, proposing further mitigation measures where necessary as well as describing the flood warning and evacuation plan to be considered in the event of an exceedance event.

### 8.2 Coastal Flood Risk

#### 8.2.1 Scenarios

Whilst the development is safe from expected extreme still seawater events, there remains the small possibility of wave energy propelling sea water toward the development. This can occur via one of two routes:

1. Overtopping of the shingle beach to the south of the development plot, due to a south-westerly storm event, possibly propagating toward Plot F1;
2. Overtopping of the Harbour walls, due to a south-easterly storm event, most notably the exposed eastern facing quay edge of Plot G1; and,
3. Wave overtopping of the new Plot G1 Sea Defence.

#### 8.2.2 Beach Drawdown and Overtopping Risk to Plot F1

Waves breaking on the beach crest could, theoretically, run up the beach slope and overtop the crest, with the discharged water saturating the beach and resulting in water pooling and flowing toward the building. This could conceivably have the potential to increase wave run-up and overtopping to a point at which the F1 buildings are threatened. If the beach in front of F1 is at or less than that required by the Beach Management Manual (Appendix B) then there is no risk of this occurring. The risk would only become significant if there was significant beach drawdown here through successive storm events with no maintenance carried out, as was examined for the Plot E1 FRA.

However, it is concluded that such a scenario is not credible for Plot F1. In reality, the westerly storm events that result in significant beach change only result in significant beach accretion in front of Plot F1, due to shingle moving longshore from west to east and being trapped by the effective terminal groyne, the Harbour Arm. The beach has been shown to continually grow here far beyond the design profile, unless shingle is recycled back to the western plots. Anecdotally, this accretion causes operational issues for the Harbour as following storm events shingle banks up

against the Arm and spills into the public realm areas. Southeasterly events are shown to cause minimal to no change in the beach here due to the sheltering effect of the Arm.

### 8.2.3 Wave overtopping risk to Plot G1

Although the new sea defence is designed to restrict wave overtopping to tolerable levels established by best practice guidance, overtopping will still occur at low levels. Due to the very low anticipated volumes of overtopping there is not believed to be any risk to property with Plot G1. Spray will be relatively small even under the Design Event and will all be within the area of Public Realm. The stormwater drainage network is designed to accommodate such flows.

There is a small residual risk to people. Although the average and maximum discharges are within tolerable limits for the design event, large waves within a wave spectrum still could surprise pedestrians. There are two mitigating factors to this:

- The wave overtopping discharges include for sea level rise for the full design life. This effectively means that discharges will be significantly lower than shown for most of the intervening period, even for a 1 in 200-yr event.
- The Harbour Arm is notorious for large wave overtopping events, even for storms less severe than the annual event. The Arm, a very popular area of public realm is closed to the public when a storm is anticipated. The Harbour Company has demonstrated over a long period that they are very capable at managing these risks on their estate.

## 8.3 Flooding of the Basement Structure

In this FRA, potential flooding of the basement has been assessed to occur from two sources:

1. The percolation of groundwater through the basement structure; and,
2. An extreme coastal flood event larger than the design 2115 1 in 200yr flood event overwhelming the +6.5mOD entrance threshold.

With the recommended measures for the basement (see Section 7.3) and the low likelihood of a larger than a 1 in 200yr 2115 storm event occurring, the residual risk is considered low. However, if it does occur, the basement could quickly fill up with water. Any persons within the basement during this would be exposed to unacceptably high risks. In this eventuality, rapid evacuation of the basement will be needed.

Figure 8-1 shows the location of all access points out of the basement. Based on there being 20 access and egress routes across the basement structure, the residual risk is considered mitigated.



**Figure 8-1 Access and Egress routes from the basement structure**

#### 8.4 Flood Warning and Evacuation Plan

Flood Warning and Evacuation Plans (FWEPs) have been written for Plot F1 (240221-0058918-Folkestone Harbour-Plot F1-Flood Warning and Evacuation Plan-01.pdf), Plot G1 (240221-0058918-Folkestone Harbour-Plot G1-Flood Warning and Evacuation Plan-01.pdf) and Plot H (240221-0058918-Folkestone Harbour-Plot H-Flood Warning and Evacuation Plan-01.pdf). These documents have been written to provide details of how flood warnings will be issued to residents and detail the actions that users will need to take before and during a flood event to ensure safety, including identification of safe refuge areas.

These FWEPs have been prepared to support the discharge of Paragraph 167 of the National Planning Policy Framework (NPPF) relating to "e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan."

As noted in Sections 7 and 8, Plots F1, G1, and H are at no risk of flooding from all events up to and including the DFE. On this basis, there are no emergency measures, such as evacuation or evacuation, that are required to be taken for flood events up to and including the DFE.

It is recommended that the Development Management Team signs up to the EA flood warning service, Flood Warnings Direct, to receive flood warnings provided by phone, text or email. It is further recommended that a designated Flood Marshall is appointed within the facilities management organisation, with responsibility for receiving flood warnings from the EA and passing these and the associated actions on to the staff and users of the

development. The FWEP outlines the different levels of flood warning that may be issued by the EA and the recommended actions for both the Flood Marshall and the Development site users.

It should be noted that the Development Management Team does not need to wait for a specific Flood Warning from the EA before implementing actions to manage a flood risk. The Development Management Team should be aware of potential risk factors (forecasted bad weather, tide times), which may result in a change in flood warning. The Development Management Team shall pay particular attention to weather conditions and flood warnings during these times of bad weather and forecasted astronomical high tides.

Should it be predicted that the DFE could be exceeded, then there is safe access and egress from all exits of the development. Should an evacuation be considered necessary, it is recommended that residents are encouraged to evacuate via Marine Parade. Although the majority of the flood hazard to the north of the site is classified as 'Very Low', there two areas to the west of Marine Terrace classified as 'Danger to Some'. It is therefore recommended that residents and visitors evacuate along Marine Parade (from north-western corner of site boundary). It is predicted that during the Design Flood Event, this evacuation route is to remain free from flooding.



**Figure 8-2 Safe access and egress from Plot E1 (red line boundary) to areas outside maximum flood extent. Evacuation route identified in Green. Hazard Rating: <0.75 – very low hazard, 1.25 – Danger for some, 2.5 – Danger for Most, >2.5 – Danger for all**

Once the flood event has passed, the Development Management Team should undertake a site walk-over if the development site has been closed to ensure that all floodwater has receded to a safe condition. Key infrastructure, such as surface water drainage, should be inspected for debris and blockages and cleared as appropriate. Access should be restricted and controlled until the site has been deemed safe for all users to return. Residents and users should contact the Development Management Team to ensure that the site is safe before returning. If further information is sought, contact The Environment Agency Floodline (24-hour service) on 0345 988 1188.

Key contact details that can be easily referred to by the Development Management Team member must be completed at practical completion or as soon thereafter as possible. This information should be periodically reviewed and kept up to date for the lifetime of the development to ensure accurate information can be readily accessed by the Development Management Team.

It is important to understand that, whilst climate change allowances have been included within the flood risk management strategy, predictions of extreme events are likely to change in the future. It is therefore recommended that the Plot F1, G1, and H FWEPS are reviewed on a five yearly basis and updated in accordance with the latest advice and data from the EA. It is the responsibility of the representative of the Development Management Team for Folkestone Harbour Company to maintain and ensure that this FWEPS is kept up to date.

## 9 Conclusion

Plots F1, F2, G1, G2 and H are part of the wider Folkestone Seafront Development proposed as part of the OPA ref: Y12/0897/SH which was obtained for the wider 23 hectares development. This FRA will focus on Plots F1, G1 and H as this is where the residential development is proposed. Plots F2 and G2 are proposed to be landscaping only, therefore Plots F1, G1 and H are referred to as the 'proposed development'.

As noted within this document, flooding from the sources of fluvial, surface water, sewers and water mains and artificial sources are considered to be low in both the existing and the proposed. Flooding from the coastal environment represents the primary source of flood risk to the site and proposed development. Flooding from groundwater is considered to be low in the existing however requires mitigation to ensure the proposed development is not at groundwater flood risk.

As part of the sitewide flood risk strategy, a number of mitigation measures were put in place or proposed which act to protect the site to a design flood event of 1 in 200yr with an allowance of climate change up until 2115. The primary flood defence to Plot F1 is the shingle beach which consists of a design beach crest of +6.5mOD, a minimum crest width of 14m and shingle dunes rising to +7.5mOD prior to the back of the unmaintained active zone. In combination to this, recommended minimum threshold levels of +6.5mOD for residential buildings across the entire site in line with the OPA FRA, unless immediately behind the 30m unmaintained active zone where minimum threshold levels of +8.0mOD for residential buildings are recommended and with all buildings founded on piles to mitigate scour wave run-up and wave overtopping risks from the highly mobile beach environment.

All entrances and thresholds into the Plot F1 building and the basement are at or above +6.5mOD. The sequential approach has been applied to site all vulnerable development/land uses above this level. This is particularly important within the basement where only water compatible and less vulnerable land uses are located. Plot F1, Building 4 is located behind the beach active zone and correspondingly its threshold level has been raised to +7.5mOD. The ground and first floors have commercial uses only, with residential uses located from the second floor upwards, this is therefore considered appropriate.

Plot G1 and H are located on the South Quay. In line with the OPA FRA a sloping rock revetment with a crest wall is required to achieve an appropriate standard of protection. As part of the development of the Harbour Plots, the design of the South Quay Sea Defence is being developed to ensure the latest available data is considered in ensuring a 1 in 200 year return period including the effects of climate change to 2115 and to re-confirm the design. This will limit wave overtopping to tolerable levels up to and including the design event.

Even with the above flood risk management infrastructure and design measures put in place, residual risks may remain. It has been concluded that the overtopping of the shingle beach to the south of the development plot due to a south-westerly storm event and subsequent beach drawdown is not a credible scenario for Plot F1 and therefore not a residual risk. In reality, the westerly storm events that result in significant beach change only result in significant beach accretion in front of Plot F1, due to shingle moving longshore from west to east and being trapped by the effective terminal groyne, the Harbour Arm.

Although the new sea defence in front of Plot G1 is designed to restrict wave overtopping to tolerable levels established by best practice guidance, overtopping will still occur at low levels. Due to the very low anticipated volumes of overtopping there is not believed to be any risk to property with Plot G1, however there is a small residual risk to people as a result of wave overtopping risk to Plot G1. It should be noted that these volumes include sea level

rise for the full design life and so the discharges will be significantly lower than shown for most of the intervening period, even for a 1 in 200yr event.

Flooding of the basement structure as a result of an extreme coastal flood event larger than the DFE overwhelming the entrance threshold level exists as the secondary residual risk. Risks have been controlled by the provision of multiple access and egress routes out of the basement. Through this provision, the rapid of evacuation of the basement in a flood event mitigates the residual risk.

With these mitigation measures in place, the overall flood risk to the proposed development is assessed to be Low for all sources of flooding.

# Appendix A NPPF Flood Risk tables

- A.1 Table 1 – Flood Zones
- A.2 Annex 3 – Flood risk vulnerability classification
- A.3 Table 2 – Flood risk vulnerability and flood zone ‘incompatibility’

# National Planning Policy Framework – Flood Risk

**Table 1: Flood Zones**

<https://www.gov.uk/guidance/flood-risk-and-coastal-change#table1> (accessed 20/02/2024)

| Flood Zone                        | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Zone 1 Low Probability            | Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Zone 2 Medium Probability         | Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Zone 3a High Probability          | Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Zone 3b The functional Floodplain | <p>This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise:</p> <ul style="list-style-type: none"><li>• land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or</li><li>• land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding).</li></ul> <p>Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)</p> |

Note: The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding. Reference should therefore also be made to the Strategic Flood Risk Assessment when considering location and potential future flood risks to developments and land uses.

### **Annex 3: Flood risk vulnerability classification**

<https://www.gov.uk/guidance/national-planning-policy-framework/annex-3-flood-risk-vulnerability-classification>

(accessed 20/02/2024)

#### **Essential Infrastructure**

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood.
- Wind turbines.
- Solar farms.

#### **Highly Vulnerable**

- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use.
- Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.)

#### **More Vulnerable**

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non-residential uses for health services, nurseries and educational establishments.
- Landfill\* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

#### **Less Vulnerable**

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill\* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
- Car parks.

**Water-compatible development**

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

\*Landfill is as defined in Schedule 10 of the Environmental Permitting (England and Wales) Regulations 2010.

**Table 2: Flood risk vulnerability and flood zone ‘incompatibility’**

<https://www.gov.uk/guidance/flood-risk-and-coastal-change#table2> (accessed 20/02/2024)

| Flood Zones | Flood Risk Vulnerability Classification |                         |                         |                 |                  |
|-------------|-----------------------------------------|-------------------------|-------------------------|-----------------|------------------|
|             | Essential infrastructure                | Highly vulnerable       | More vulnerable         | Less vulnerable | Water compatible |
| Zone 1      | ✓                                       | ✓                       | ✓                       | ✓               | ✓                |
| Zone 2      | ✓                                       | Exception Test required | ✓                       | ✓               | ✓                |
| Zone 3a     | Exception Test required †               | <b>X</b>                | Exception Test required | ✓               | ✓                |
| Zone 3b     | Exception Test required *               | <b>X</b>                | <b>X</b>                | <b>X</b>        | ✓ *              |

Key:

✓ Exception test is not required

**X** Development should not be permitted

Notes to table 2:

- This table does not show the application of the Sequential Test which should be applied first to guide development to the lowest flood risk areas; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to those developments set out in National Planning Policy Framework footnote 56. The Sequential and Exception Tests should be applied to ‘major’ and ‘non major’ development;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.
- “†” In flood zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood
- “\*” In flood zone 3b (functional floodplain) essential infrastructure that has been passed the Exception Test, and water-compatible uses, should be designed and constructed to:
  - Remain operational and safe for users in times of flood;
  - Result in no net loss of floodplain storage
  - Not impede water flows and not increase flood risk elsewhere

# Appendix B Beach Management Plan

# **Folkestone Seafront**

## **Beach Management Plan**

**0058918-BHE-XX-XX-XX-X-001**

**0046983**

16 October 2023

Revision P06

| Revision | Description                                                                           | Issued by | Date       | Checked |
|----------|---------------------------------------------------------------------------------------|-----------|------------|---------|
| P00      | Draft for Comment                                                                     | SDSM      | 02/06/2014 |         |
| P01      | Issue for MMO Approval                                                                | SDSM      | 13/06/2014 | PNB     |
| P02      | Issue for MMO Approval – Incorporating CEFAS Comments                                 | SDSM      | 29/10/2014 | PNB     |
| P03      | Issue for MMO Approval – Incorporating Folkestone and Hythe District Council Comments | SDSM      | 25/04/2016 | PNB     |
| P04      | Issue for MMO Approval – Variation to Initial Nourishment Source                      | SDSM      | 18/11/2016 | PNB     |
| P05      | Issue for Approval – Incorporating Folkestone and Hythe District Council Comments     | SDSM      | 30/01/2017 | PNB     |
| P06      | Update to cross sections, volume analysis and sea level rise                          | TG        | 27/11/2023 | SDSM    |

<https://burohappold.sharepoint.com/sites/058918/Shared Documents/Water/03 Reports/Updated BMP/231127 TG Folkestone Seafront - Beach Management Plan P06.docx>

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## Glossary

| Term | Definition                                 |
|------|--------------------------------------------|
| BMP  | Beach management Plan                      |
| CCO  | Channel Coastal Observatory                |
| CEMP | Construction Environmental Management Plan |
| CMTF | Construction Management Travel Plan        |
| HAT  | High Astronomical Tide                     |
| LAT  | Lowest Astronomical Tide                   |
| mCD  | Metres Chart Datum                         |
| mOD  | Meters Ordnance Datum                      |
| MHWN | Mean High Water Neaps                      |
| MHWS | Mean High Water Springs                    |
| MLWN | Mean Low Water Neaps                       |
| MLWS | Mean Low Water Springs                     |
| MMO  | Marine Management Organisation             |
| NPPF | National Planning Policy Framework         |
| OS   | Ordnance Survey                            |
| SAC  | Special Areas of Conservation              |
| SMP  | Shoreline management Plan                  |
| SSSI | Special Site of Scientific Interest        |
| rMCZ | Recommended Marine Conservation Zone       |



This document has been prepared using the guidance presented within CIRIA C685 – The Beach Management Manual (2<sup>nd</sup> Edition) published in 2010.

Revision 04 of this document includes updates made to enable shingle from within the planning application boundary, located below the existing hardstanding and superficial deposits to be used as the source material for the initial nourishment of the beach.

The following sections have been updated as part of Revision 05:

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The following sections have been updated in Revision 06:

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# 1 Introduction

## 1.1 Overview

To facilitate the regeneration of Folkestone Harbour into a mixed residential and commercial development a capital recharge of the shingle beach fronting the development is required to improve flood defence against storms within the English Channel. The primary mechanism of mitigating the flood risk is through reducing the degree of wave overtopping discharge.

This Beach Management Plan (BMP) has been produced to facilitate and support the initial recharging of the beach and the subsequent maintenance of the beach in order to maintain the required degree of flood protection.

## 1.2 Location

The redevelopment site of approximately 23 hectares is located within the town of Folkestone, Kent in the south-east of England to the south and south west of the existing harbour. The site is bounded by Folkestone Harbour and Marine Parade to the north, the English Channel to the south and east and Leas Cliff to the west. The overall site has an approximate centre at OS Grid Reference 623218, 135714 (ST 23218 35714).

The shingle beach is located along the southern boundary of the development site between the eastern most rock groyne in the west and the harbour arm in the east (see Figure 1-1). The application site falls entirely under the jurisdiction of Folkestone and Hythe District Council.



**Figure 1-1 - Development Site Location Plan**

The site formerly comprised commercial and leisure buildings, including the Rotunda Funfair and formerly two outdoor swimming pools, and is now in a state of disrepair. Much of the site's former activities to the west of the development has been cleared and left as hard standing.

### 1.3 Objectives

The primary function of the beach is to provide defence against flooding and erosion from storm events.

A secondary function of the beach is to retain and improve the beach's amenity value to support the regeneration of the development site.

### 1.4 Issues

The wave climate incident on the beach causes the material on the beach to migrate over time, particularly during storm events. The movement of beach material alters the profile of the beach ultimately affecting the protective performance of the beach.

By assessing beach survey data over a number of years it was identified that the process of longshore drift causes the accretion of material in the lee of the Harbour Arm (Zone 4) and minor accretion of material in the lee of the rock groyne at the western end of the beach (Zone 1). This results in erosion of the central section of the beach which consequently reduces the beaches flood defence capability. Figure 1-2 shows a general plan of how material moves around on the beach.



Figure 1-2 - General Beach Characteristics

*NOTE: Due to the presence rock groyne field at the western end of the beach (within the development boundary as shown in Figure 1-1) the beach beyond the eastern most groyne has not be considered to be part of Zone 1 as it is believed to be stable and does not influence the beach in front of the development.*

As the movement of beach material affects the primary function of the beach to provide flood defence for the proposed development site it has been identified that the beach will need to be proactively maintained.

## **1.5 Links to other Appropriate Documents and Strategies**

### **1.5.1 Shoreline Management Plan**

The development site lies within Policy Unit “4c08 Folkestone and Sandgate” of the South Foreland to Beach Head Shoreline Management Plan produced by Folkestone and Hythe District Council (2006). The present day, medium term and long term policy plan for this section of the coastline is to “Hold the Line”.

For the present day, the policy is to maintain existing sea seawall, harbour arms and groyne structures as well as managing the shingle beach to the west of Folkestone Harbour and the sandy beach to the east of Folkestone Harbour.

The policy for the medium and long term is to upgrade existing defences to combat the consequences of sea level rise and subsequent inter-tidal squeeze. The policy notes that maintenance and the possibility of future beach nourishment will be required to avoid the character of the frontage changing from one that offers foreshore amenities to one that is purely defensive.

### **1.5.2 Existing Strategies**

Folkestone and Hythe District Council currently undertakes maintenance of the beach along the Hythe to Folkestone shoreline. This maintenance regime encompasses the rock groynes to the west of the development site but does not extend further east than the eastern most groyne. The beach to the east of the groynes is maintained by the Folkestone Harbour Company. From reference to Figure 2-1, part of the beach immediately east of the eastern most rock groyne is not owned by the Folkestone Harbour Company, instead being owned by Folkestone and Hythe District Council. There is an agreement that the area of beach situated between the rock groynes and Folkestone Harbour Company’s land (as shown in Figure 2-1) is not covered by Folkestone and Hythe District Council’s regular maintenance and that this beach sediment will not be taken as part of their beach maintenance works to the west.

The maintenance regime recycles material from the eastern end of each beach cell, i.e. areas where material has been accreting, and transports it via dumper trucks to the areas where erosion has occurred. The beach is then graded using a bulldozer to reinstate the profile necessary to provide the flood defence capability, as far as the available material allows. Maintenance is undertaken on a bi-annual basis normally in the months of February/March and September/October and when emergency work is required following a severe storm.

### **1.5.3 Environmental Plans and Designations**

An Environmental Statement has been prepared for the development that describes the risks posed by the development onto the environment both during and after construction. Of particular reference to the beach maintenance works is the Addendum to the Environmental Statement (refer to Section 3.3). The Contractor should make reference to this document when planning maintenance activities.

Within the vicinity of the development are three key environmental designations. The Lower Leas Coastal Park, Folkestone SSSI and the Folkestone to Etchinghill Escarpment SAC. As part of the Environmental Statement it was established that these designated sites are not at risk from beach maintenance works.

## 2 Consents and Responsibilities

### 2.1 Consents

All beach nourishment and maintenance activities within the marine environment, defined as the area below the Mean High Water Springs (MHWS), and in any tidal river to the extent of the tidal influence, are subject to a Marine Licence under the Marine and Coastal Access Act 2009. This process is managed and regulated by the Marine Management Organisation (MMO).

Prior to any works commencing a MMO Licence must be in place. The responsibility of applying for and maintaining the MMO Licence shall lie with Folkestone Harbour Company or until such time where negotiations are made to discuss future responsibility with Folkestone and Hythe District Council and other stakeholders.

It is intended that this document can be used to support the licencing process.

### 2.2 Responsibilities for Management

Management of the beach is to take place between the rock groynes at the western end of the development and the Harbour Arm to the eastern end of the development. Current land ownership highlights that the Folkestone Harbour Company owns the beach with the exception of an approximate 120m stretch immediately east of the rock groynes which is owned by Folkestone and Hythe District Council. As the beach acts as a sediment cell between rock groynes and the Harbour Arm it is recommended that it is managed by a single organisation. As the majority land owner naturally this shall fall to the Folkestone Harbour Company or until such time where negotiations are made to discuss future responsibility with Folkestone and Hythe District Council and other stakeholders.

The limits of responsibility with regard to management of the beach are defined graphically within Figure 2-1.

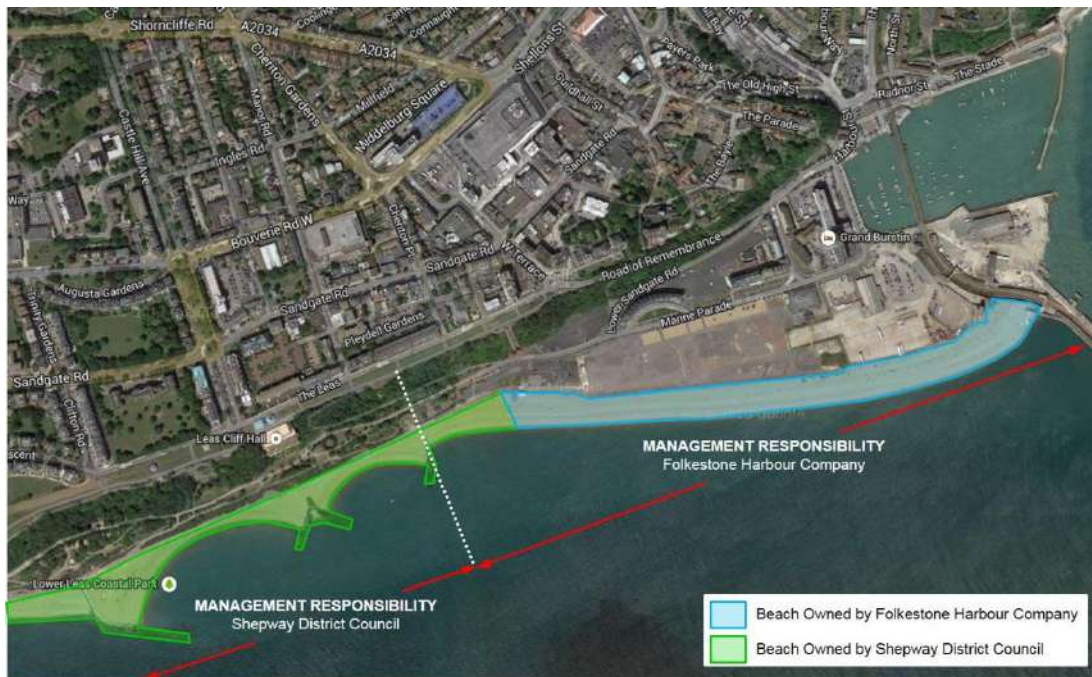


**Figure 2-1 - Limits of Management Responsibility**

### 2.2.1 Responsibility for Monitoring

Surveying of the beach is currently undertaken by the Channel Coastal Observatory (CCO) which is managed by the Southern Coastal Group and the South East Coastal Group and funded by DEFRA in partnership with Local Authorities and the Environment Agency.

Monitoring and interpretation of the survey data (including those obtained from other sources) will be the responsibility of the Folkestone Harbour Company.

Following storm events it will be the responsibility of the Folkestone Harbour Company to mobilise a team to survey the beach and assess the results against the trigger values defined in Section 4.6.

The responsibility and source of funding for future monitoring has not yet been agreed. This will be the subject of future discussion and negotiation between Folkestone Harbour Company, SDC and other stakeholders.

### 2.2.2 Responsibility for Maintenance

Maintenance of the beach will be the responsibility of the Folkestone Harbour Company with works being undertaken by a competent contractor.

The responsibility and source of funding for future maintenance has not yet been agreed. This will be the subject of future discussion and negotiation between Folkestone Harbour Company, SDC and other stakeholders.

### 2.2.3 Responsibility for Flood Warnings

The issuing of flood warnings will be the responsibility of the Environment Agency.

As an additional measure it is recommended that the Folkestone Harbour Company signs the development up to the Environment Agency's free flood warning service to assist in alerting occupants of the oncoming flood. This will enable the timely evacuation of any vulnerable people to a safe location.

## 3 Supporting Information

### 3.1 Physical Environment and Beach Performance

The information detailed below is intended to provide background information on the physical environment in the vicinity of the beach alongside any performance requirements that the beach is required to achieve.

#### 3.1.1 Tide Information

The tide information presented with Table 3.1 is derived from Admiralty Tide Tables Volume 1 for Folkestone using Dover as the Primary Port as follows:

**Table 3.1 - Folkestone Tide Level Information**

| Tide Reference                                                                              | Level (mCD) | Level (mOD) |
|---------------------------------------------------------------------------------------------|-------------|-------------|
| Highest Astronomical Tide (HAT)*                                                            | +7.8        | +4.05       |
| Mean High Water Springs (MHWS)                                                              | +7.2        | +3.45       |
| Mean High Water Neaps (MHWN)                                                                | +5.7        | +1.95       |
| Mean Low water Neaps (MLWN)                                                                 | +2.1        | -1.65       |
| Mean Low Water Springs (MLWS)                                                               | +0.7        | -3.05       |
| Lowest Astronomical Tide (LAT)                                                              | +0.1        | -3.65       |
| *LAT is estimated using the assumption that LAT at Folkestone is -0.1mCD above Dover levels |             |             |

#### 3.1.2 Wave Information

The wave information presented within Table 3.2 and Figure 3-1 are derived from the Folkestone Directional Waverider Buoy – Annual Wave Report 2022.

**Table 3.2 - Folkestone Wave Height Information**

| Return Period (years) | Significant Wave Height (m) |
|-----------------------|-----------------------------|
| 1                     | 2.49                        |
| 2                     | 2.97                        |
| 5                     | 3.18                        |
| 10                    | 3.43                        |
| 20                    | 3.60                        |
| 50                    | 3.75                        |
| 100                   | 4.06                        |

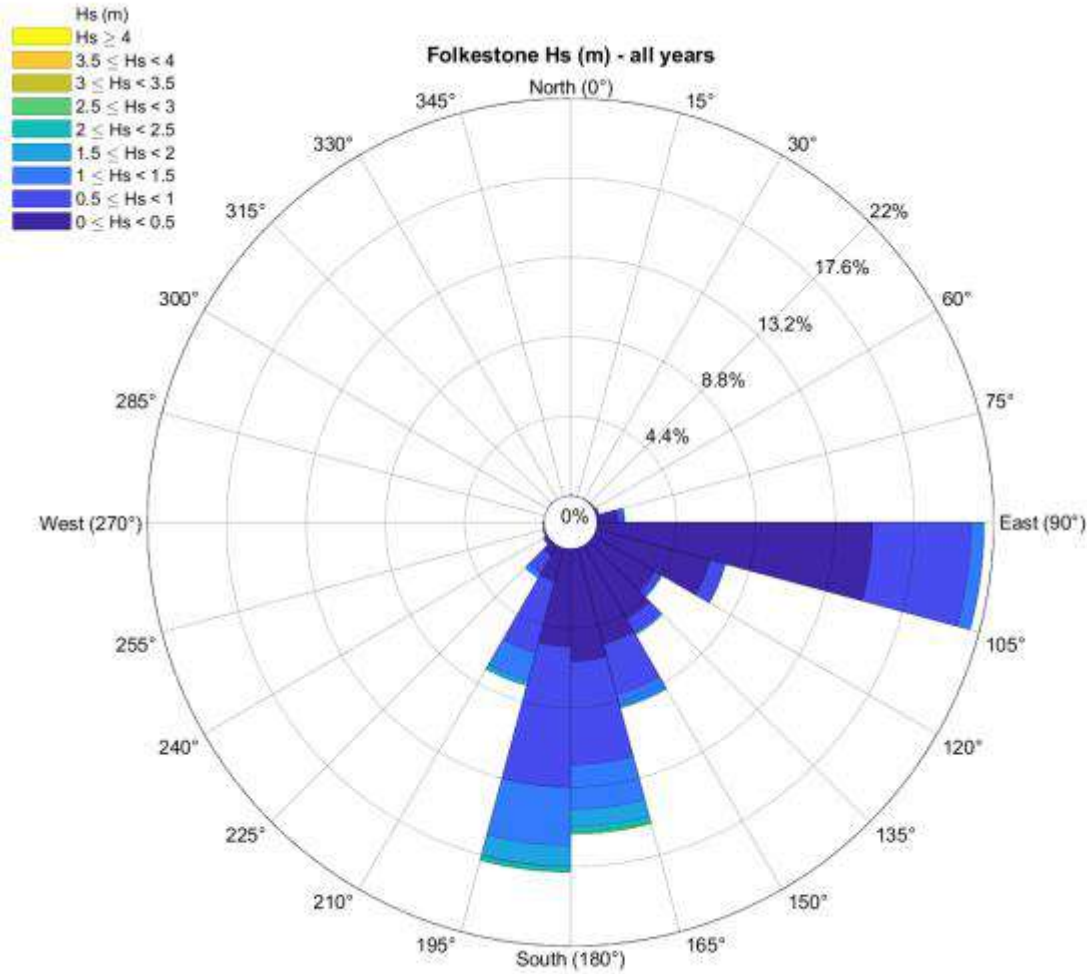


Figure 3-1 - Folkestone Offshore Wave Rose (2003 to 2022)

3.1.3 Extreme Water Levels

The extreme water level information presented within Table 3.3 is derived from the Environment Agency’s “Coastal Design Sea Levels (2018) Database”

Table 3.3 - Folkestone Extreme Water Level Information

| Return Period (years) | Extreme Water Level (mOD) |
|-----------------------|---------------------------|
| 2                     | +4.16                     |
| 10                    | +4.39                     |
| 20                    | +4.49                     |
| 50                    | +4.61                     |
| 100                   | +4.70                     |
| 200                   | +4.80                     |
| 1000                  | +5.01                     |

### 3.1.4 Sea Level Rise

Utilising the guidance that accompanies the National Planning Policy Framework (NPPF) (May 2022), it recommends that the Upper End values are generally used for sensitivity testing. For this Beach Management Plan, the Higher Central Values have been adopted and are presented within Table 3.4 for sea level rise within South-east England:

**Table 3.4 - Sea Level Rise allowances for each epoch in mm for each year (1981 to 2000 baseline) for the South East river basin district**

| Allowance      | 2000 to 2035 | 2036 to 2065 | 2066 to 2095 | 2096 to 2125 |
|----------------|--------------|--------------|--------------|--------------|
| Higher central | 5.7 mm/year  | 8.7mm/year   | 11.6mm/year  | 13.1mm/year  |
| Upper end      | 6.9mm/year   | 11.3mm/year  | 15.8mm/year  | 18.2mm/year  |

### 3.1.5 Beach Material

Beach material is typically described as being a dense, fine to coarse, slightly sandy gravel with some cobbles. Cobbles are approximately 150mm in size with a small number of boulders up to 500mm observed at the surface.

Beach material was noted to become slightly larger in size towards the rear of the beach once the material lied outside of the intertidal and splash zone.

### 3.1.6 Beach Profile

Numerical modelling undertaken by Herrington Consulting (see Section 3.3) on the current typical beach profile identified that, under a design 1 in 200 year storm with a still water level equivalent to MHWS, with sea level rise up to 2115, resulted in the beach reshaping over a zone 30m landward of the present day beach crest. This amount of reshaping would adversely affect the development proposals through potential undermining of properties and flooding due to overtopping of the beach.

To mitigate these risks, the crest of the beach was required to be raised to a level of +6.5mOD along the entire length of the beach to reduce the beach reshaping zone to 14m landward of the crest, and facilitate the development masterplan.

### 3.1.7 Existing Beach

As mentioned within Section 2.2.1 the Channel Coastal Observatory (CCO) undertakes regular surveying of the beach along standard beach profiles. Appendix C contains time series plots of the surveying undertaken by the CCO from 2004 until 2023. It should be noted that post 2017, the Folkestone Harbour Company have undertaken their own topographic and bathymetric surveys as part of implementing this Beach Management Plan. This has been used to ascertain the status and health of the beach. Data from these surveys is incorporated in favour of data from the CCO.

This data formed the start point for understanding the morphology of the beach.

## 3.2 Environmental Characteristics

The Folkestone Seafront site includes part of Folkestone Harbour, with the site extending westwards towards the Lower Leas Coastal Park and north from the shingle beach towards Marine Parade. The Leas cliff, behind the site, provides an elevated position from which to view the Seafront site and coastline. The site has had a number of former uses associated with the harbour, railway, and tourism; these were generally in the areas nearest to Marine Parade and

around the harbour itself. The shingle beach has accumulated since the 19<sup>th</sup> century, behind the harbour and subsequently the harbour arm. As such, there is little archaeological potential within the shingle beach area, and any contamination associated with former uses is likely to be found around the northern and eastern parts of the site, although a full ground investigation and detailed risk assessment have not yet been carried out.

Little of the shingle beach is vegetated, and habitats and species present on the site are common and of relatively low ecological value. The beach nourishment works will modify the current littoral habitat, but this will not affect any notable habitats in proximity to the site, such as the littoral chalk and clay communities found on the foreshore of Folkestone Warren Site of Special Scientific Interest (east of the site), or the Blue Mussel beds found at Mill Point (west of the site). Although the marine environment immediately adjacent to the site does not contain any particularly sensitive habitats or species, the wider marine environment is an important habitat for a number of species, and includes the Dover to Folkestone recommended Marine Conservation Zone (rMCZ). Risks of accidental pollution, including sedimentation, will be controlled through the preparation and implementation of Construction Environmental Management Plans (CEMP) for all works. Construction management will also require disturbance from noise and construction traffic to be minimised which will be managed as part of the CEMP and the Construction Management Travel Plan (CMTP).

Further information on the environmental baseline, potential effects, and mitigation measures are provided in the Environmental Statement and addendums, which accompany the marine licence application.

### 3.3 Other Appropriate Information

For additional information on site the reader should make reference to the following reports:

- Folkestone – Extreme Sea Level Review (Buro Happold, October 2023)
- Folkestone Seafront – Environmental Statement (Buro Happold, August 2012)
- Folkestone Seafront – Environmental Statement Addendum (Buro Happold, April 2013)
- Folkestone Seafront – Environmental Statement Addendum (Buro Happold, June 2014)
- Folkestone Seafront – Flood Risk Assessment rev02 (Buro Happold, August 2012)
- Numerical Modelling Report for Folkestone Seafront. Folkestone, Kent Rev2 (May 2012)
- Folkestone Seafront – Post Maintenance Beach Status Report rev01 (Buro Happold, Jan 2023)

## 4 Beach Scheme Design

### 4.1 Scheme Description

Through the process of longshore drift material on the beach has gradually been moved across the beach in response to the prevailing storm direction. This has resulted in a general reduction in the width of the beach within the central western section (Zone 2) of the beach, reducing the beach's ability to provide flood defence. Although this has not been a problem in the past for the derelict site, continued erosion of the beach will affect the proposed redevelopment of the Harbour.

To combat the effects of longshore drift the design proposal is to recycle material from areas of accretion to areas of erosion to restore the beach's flood defence capability as shown in Figure 4-1. The source of the recycle material will be dependent upon the prevailing wave direction. Where necessary this will be supplemented with recharging.

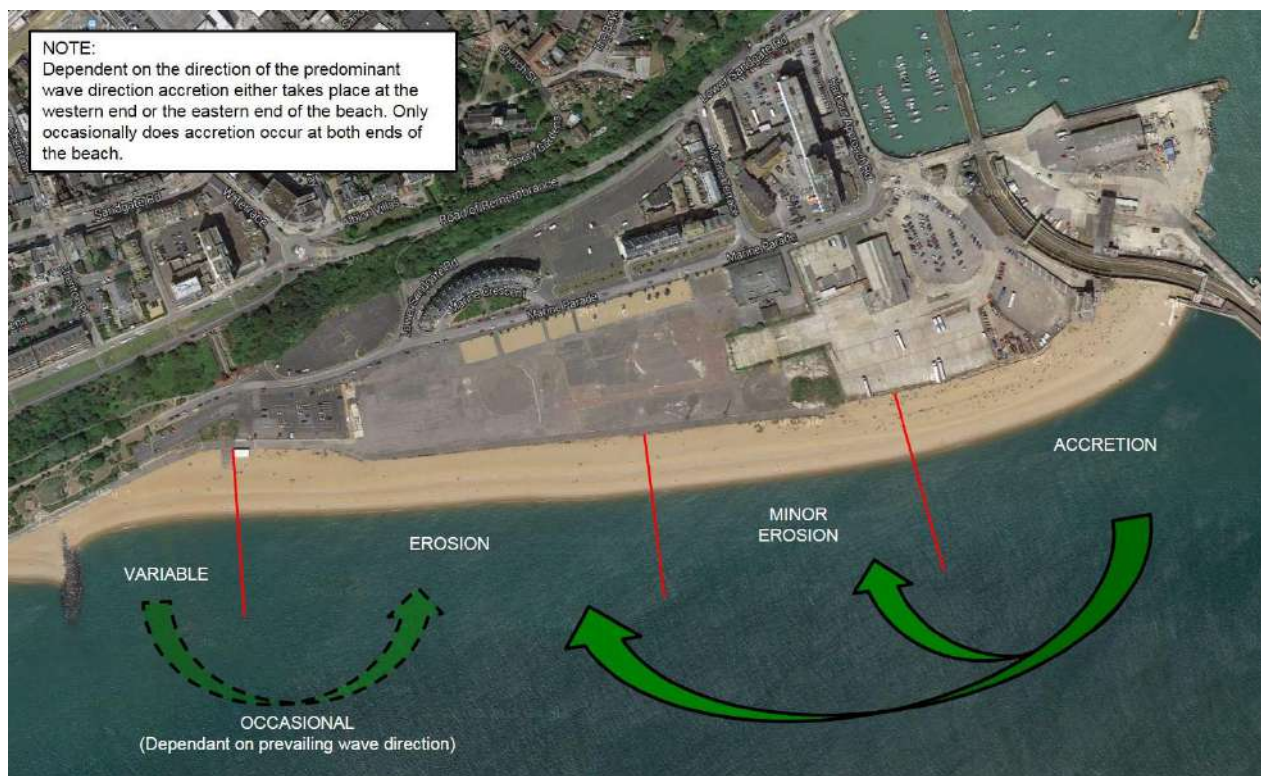


Figure 4-1 - Scheme Design of the Beach to Provide Flood Defence

### 4.2 Standard of Protection

The required standard of protection for the beach is to provide defence against a 1 in 200 year storm event with an allowance for climate change in the form of sea level rise and increased storminess. Given the design life of the development, climate change has been assessed until 2115.

### 4.3 Design Profile

To provide the required standard of protection stated within Section 4.2 the numerical modelling undertaken by Herrington Consulting identified the following performance criteria of the design beach.

|                                           |                                                                                                               |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <b>Crest Level</b>                        | +6.5mOD                                                                                                       |
| <b>Minimum Crest Width</b>                | 14m                                                                                                           |
| <b>Slope Angle</b>                        | Nominal 1 in 7                                                                                                |
| <b>Set back of development properties</b> | 30m from +5.9mOD beach contour<br>Taking the 1 in 7 profile this equates to 25.8m from the +6.5mOD crest line |

The design profile is to be applied along the length of the beach fronting the proposed development only, and represents the required defence in the year 2115 should a sea level rise of 1.01m from current levels be realised.

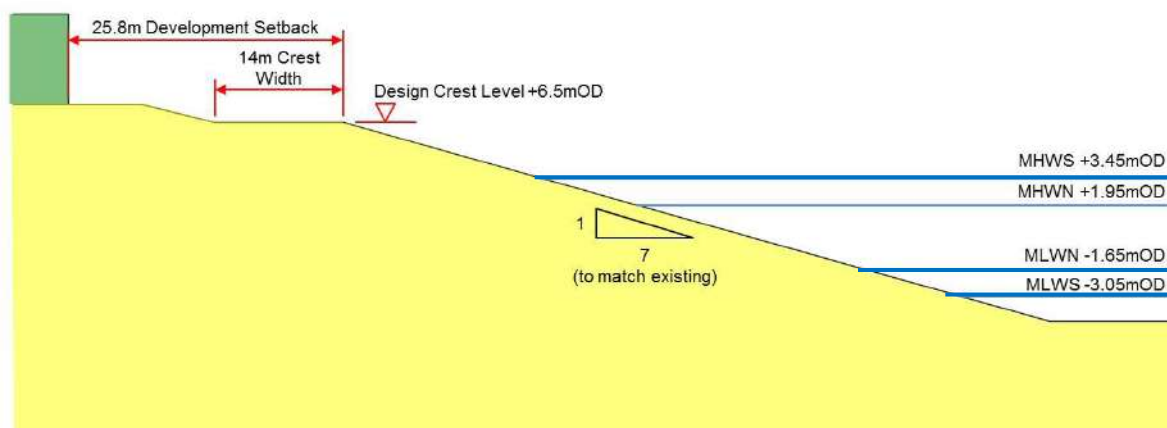


**Figure 4-2 - Scheme Design Beach Profile to Provide Flood Defence**

It is noted that the 1:7 slope angle used by Herrington Consulting is a nominal angle which is typically found within the central to western portion of the beach. In reality the beach slope varies in a cross-shore and long-shore direction with a gradual steepening slope from west to east (refer Appendix B). Beach maintenance works should aim to maintain the existing 'natural' beach slopes, as far as it is practical, to minimise material import and the re-distribution of material post works. This strategy minimises the impacts of the beach nourishment on the marine environment whilst also ensuring that the beach meets the intended sea defence function.

For the design profile a beach slope which varies between 1 in 7 (at the western end) to 1 in 5 (at the eastern end) is proposed in order to approximately match existing. Proposed beach levels adjacent to the rock groyne at the western end of the beach may have to be locally adjusted to tie into the existing structure.

In order to provide the required standard of protection the beach will need to be nourished with additional shingle material. Further information regarding the amount of material required is given in Section 4.4. Drawings of the proposed works can be found in Appendix E.

#### 4.4 Design Volume

In order to determine the volume of material required as part of the initial beach nourishment, survey data was obtained from the Channel Coastal Observatory (CCO) who has regularly monitored the beach bi-annually from 2003 until October 2013. By comparing the latest survey data at the time against the design beach profile it was established that a recharge volume of up to 28,500m<sup>3</sup> is required.

As part of the 2017 Earthworks Contract to prepare the site for redevelopment, placement of the 28,500m<sup>3</sup> recharge volume was focussed at the western end of the beach where the most significant fill was required to bring the beach crest and width up to that required by the design, combined with recycling works as described below. To allow for reshaping, and the loss of finer material than the shingle from the beach face, the volume needed to be increased, giving a design recharge volume of up to 35,000m<sup>3</sup>.

Since placement of this material in 2017, no further beach recharge works have occurred with none being planned in the near future.

#### 4.5 Sediments

When sourcing the nourishment material, the following principles should be followed to minimise the initial degree of erosion, reduce the regularity of future nourishment activities and the regularity of maintenance should it be observed:

1. Nourishment material shall either be similar or coarser in size than existing. This shall be determined prior to sourcing material via a sampling regime of the beach to establish the nominal diameter,  $D_{50}$  and the range and distribution of size or the shingle.
2. The amount of fines material, defined as particle diameter,  $d < 0.06\text{mm}$ , should be minimised.
3. Material should be sourced from a marine source where possible. Should a land based source be used the material should be washed prior to placing in on the beach to minimise sediment plumes. Angular quarried material should also be avoided due to amenity considerations.
4. The mineralogy of the nourishment material should match the existing beach material as closely as possible to maintain the durability of the individual particles.

#### 4.6 Trigger Levels

To maintain the standard of protection for the beach trigger levels are required to define when maintenance needs to occur. These trigger levels are broken down into an "alarm" level and a "crisis" level. These are defined in the sections that follow:

##### 4.6.1 Alarm Level

CIRIA C685 defines the alarm level as;

*"The level below crisis level. This is usually a predetermined value where the monitored beach parameter falls to within range of the crisis level, but has not resulted in systematic failure of the function being monitored."*

For the situation at Folkestone, the alarm level is defined as when the standard of protection reduces below the 1 in 200 year storm event for any given year. This standard is monitored as a drop in crest level within the zone between the alarm level and the crisis level or where the beach has eroded to or beyond the alarm level.

As the beach will be constructed to provide defence against the future design case, rising sea levels throughout the design life of the project will result in the alarm level changing with time. Figure 4-3 and Table 4.1 detail the location of the trigger level relative to the design crest level of the beach. For years and/or levels of Mean High Water Springs (MHWS) between the quoted values, the location of the alarm level for that given year should be interpolated.

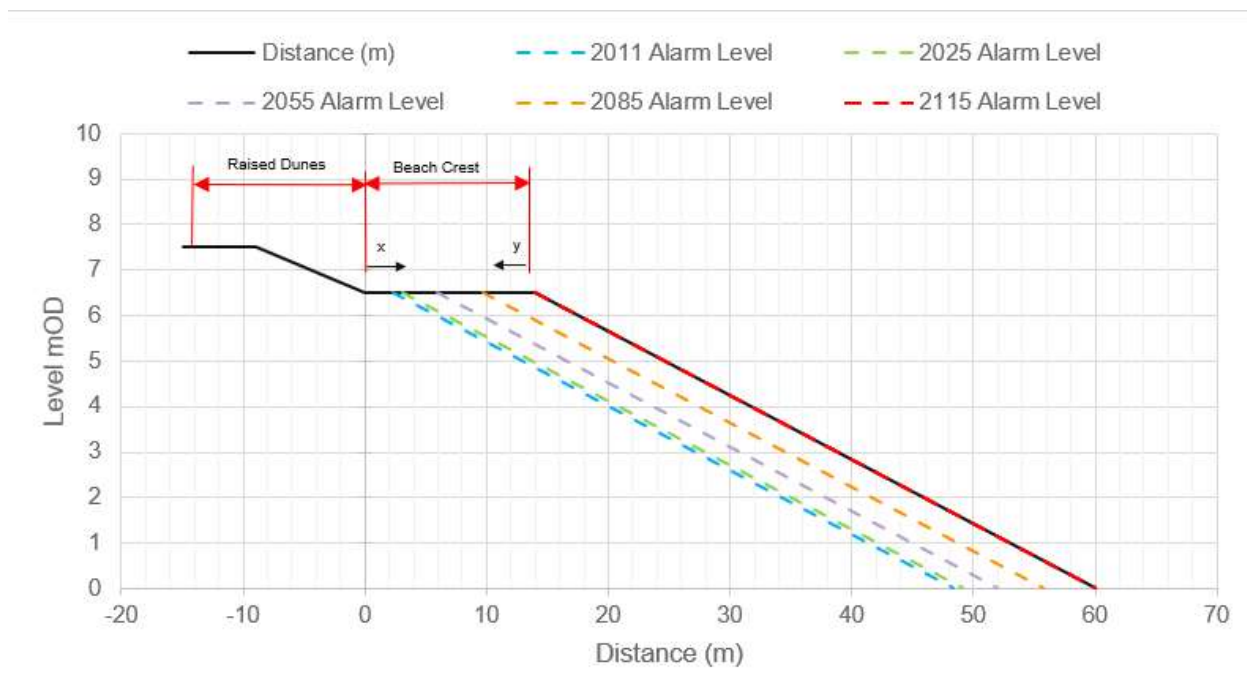


Figure 4-3 - Scheme Design Beach Profile Alarm Levels

Table 4.1 - Alarm Level Locations

| Year (MHWS Reading)                                                                                                                                                                                                                                                                            | 2011 Baseline (+3.45mOD) | 2025 (+3.51mOD) | 2055 (+3.77mOD) | 2085 (+4.13mOD) | 2115 (+4.58mOD) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-----------------|-----------------|-----------------|-----------------|
| Distance from Base of the Raised Dunes, x (m)                                                                                                                                                                                                                                                  | 2.3                      | 3.05            | 5.90            | 9.70            | 14              |
| Distance from Design Beach Crest, y (m)                                                                                                                                                                                                                                                        | 11.7                     | 10.95           | 8.10            | 4.30            | 0               |
| NOTE: Years are indicative only and may be subject to change if sea level rise accelerates or decelerate from current predictions. The location of the alarm level should therefore be determined using the MHWS reference level. This can be readily obtained from the UK Hydrographic Office |                          |                 |                 |                 |                 |

For further information on how the different alarm levels were established refer to Appendix A.

#### 4.6.2 Crisis Level

CIRIA C685 defines the crisis level as;

*"The level at which the function being monitored, such as the stability of the beach and / or any backing structures (seawalls / promenade), could be compromised and emergency remedial action becomes necessary."*

For the situation at Folkestone, the crisis level is defined as a consistent lowering of the beach at the base of the raised dunes below +6.5mOD and / or damage occurring to the raised dunes.

For the purpose of determining when to undertake work as a result of the crisis level being reached consistent lowering is defined as the beach level being below +6.5mOD for a distance of 100m. It should be noted that should damage to the raised dunes occur from a smaller distance, then this will take precedence.

#### 4.7 Zone 1 Erosion Risk

Through correspondence with Folkestone and Hythe District Council, they have identified that Zone 1 is susceptible to erosion in the lea of the structure for approximately 100m extending eastwards along the beach (see Appendix D; comments dated 23<sup>rd</sup> January 2017). Folkestone and Hythe District Council state that:

*"SDC has placed material in zone 1 in the past and scour around the Groyne has caused material to wash out within a week", and "...that the area up to 100m east of the groyne is highly susceptible to change and a weak spot that causes some concern."*

As part of efforts to reduce the overall quantity needed for nourishment alongside the risk of erosion in Zone 1 the beach design has been refined in this area as follows:

1. The full design profile required for defence shall only be applied where the development is present i.e. up to the land ownership boundary defined in Figure 2-1, separating Folkestone Harbour Company land from Folkestone and Hythe District Council land
2. West of this point the crest level shall be reduced from +6.5mOD to the crest level of the rock groyne at approximately +5.0mOD
3. Similarly, west of this point the crest line shall be pulled landward reducing the crest width from 25.8m to 17.3m over a distance of 115m to tie into the rock groyne
4. The alarm and crisis level defined in Section 4.6 shall continue to be applied to the design beach crest line

Whilst this refinement will not fully mitigate the risk of erosion in the lea of the groyne it goes some way to managing it and its effects of the development.

## 5 Monitoring Programme and Objectives

### 5.1 Beach Monitoring

The purpose of monitoring the beach is to establish the ongoing performance of the beach, and specifically whether the alarm and/or crisis level described within Section 4.6 have been reached to inform what form of maintenance is required. For details on the maintenance regime refer to Section 6.

#### 5.1.1 Routine Monitoring

Routine beach monitoring and surveying is currently undertaken by the Channel Coastal Observatory (CCO) on a bi-annual basis during typical pre-winter storms during September and October and post-winter storms during March and April. This monitoring covers the following:

- Surveying of 17No. pre-determined primary and secondary beach cross sections between 807B (Reg\_ID 4c00174) in the west to 802C (Reg\_ID 4c00157) in the east. The 5No. primary cross sections are designated 807 (Reg\_ID 4c00172), 806 (Reg\_ID 4c00169), 805 (Reg\_ID 4c00166), 804 (Reg\_ID 4c00163) and 803 (Reg\_ID 4c00159). Primary cross sections are surveyed bi-annually with secondary cross sections being surveyed once a year, although recently the regularity of secondary cross section surveys has reduced.
- Topographic surveying of the beach on a yearly basis. Although information is not available on the CCO online portal for 2012 and 2013.
- Bathymetric surveying of the sea floor below mean low water to a distance of approximately 1.5km offshore although this has not taken place since 2006.

This information is freely available from the CCO's online portal under an Open Government Licence, and should be sufficient to assess the performance of the beach. Where this in-survey data is deemed not to be sufficient additional surveying should be undertaken.

Since 2017, Folkestone Harbour Company has undertaken yearly topographical surveys of the beach to ascertain its status and health. This was supported by a bathymetric survey in 2022. It is intended that topographical surveys continue to be taken every year with the bathymetry survey being updated every 2 to 5 years.

Survey data obtained from the CCO or by other means should be used to establish whether a stretch of beach has triggered the alarm of crisis level (see Section 4.6) alongside any trends in the following criteria:

1. The crest level of the beach and the change from the previous survey data
2. The crest width of the beach and the change from the previous survey data
3. The slope of the beach and the change from the previous survey data
4. The change in material volume within defined beach zones in the inter-survey period
5. The general direction of material movement across the beach in the inter-survey period

In addition to physical surveying techniques a visual inspection of the beach should be undertaken to establish the following points:

1. Inspection of the base of the raised dunes for damage and movement
2. Visual identification of low spots along the crest of the beach
3. Changes in the composition and grading of the beach material

### 5.1.2 Pre and Post Storm Monitoring

The CCO defines a storm event as having wave heights above that which would be expected, on average, once a year i.e. wave heights that exceed the 1 in 1 year return period wave height. To assist in defining when a storm event has occurred, reference should be made to CCO who produce and maintain a real time wave database for the Folkestone area from July 2003 until the present day. The 1 in 1 year wave height is represented graphically as a red line.

Following a storm event, the following monitoring should be implemented:

1. Undertake a visual survey of the beach to establish qualitatively whether the defence capability of the beach has reduced.
2. Where the visual survey identifies a reduction, measurements of crest width, crest level and beach slope should be taken. If these measurements establish that the beach is sufficiently far away from the alarm level continue to monitor the situation.
3. If these measurements establish that the beach is close to or beyond the alarm level a detailed cross section and a topographic survey (where appropriate) should be undertaken to determine how wide spread the reduction in defence capability is. This should be followed up with the appropriate maintenance operation (see Section 6).

## 5.2 Physical Conditions

At the time of surveying sea conditions, including offshore wave data and tide level, should be recorded with a summary of the wave conditions in the intervening period between surveys being documented.

For post storm events the sea conditions during the storm should be documented.

Data on the sea conditions at Folkestone can be readily obtained from the CCO.

## 5.3 Environmental Monitoring

As discussed in Section 3.2, the shingle beach itself is of low ecological value, with limited flora due to the mobile nature of the beach material; and no significant littoral, sub-littoral or marine habitats or designated sites are considered at risk from the beach maintenance works. However, as best practice, a Construction Environmental Management Plan will be prepared. The preparation and monitoring of the CEMP will be the responsibility of the contractor carrying out the works and shall include measures to minimise the risk of accidental harm and emissions to the environment including noise, air pollution, spills, and run-off. As part of this, some form of monitoring may be required to ensure that the plan is appropriately implemented which may need to be undertaken by a third party.

## 6 Maintenance Regime

### 6.1 Maintenance Programme

#### 6.1.1 Existing Maintenance Programme

Folkestone and Hythe District Council currently operates an annual maintenance programme to the west of the proposed development along a 6km stretch of beach between Hythe and the rock groynes adjacent to the development site. The maintenance of the beach involves the recycling of shingle which has moved along the beach due to longshore drift. The operation involves moving shingle from areas of accretion to areas of erosion to reform beach crests and crest widths.

Folkestone and Hythe District Council undertakes maintenance twice a year after and before the winter storm season in February/March and September/October respectively. Each period of maintenance lasts between 2 and 4 weeks and are programmed to continue indefinitely. Folkestone and Hythe District Council also undertakes emergency maintenance works following major storm events.

#### 6.1.2 Proposed Maintenance Programme

Analysis of the current beach performance indicates that although stable with regard to material gain / loss the material on the beach is highly mobile. The average yearly net movement of material from the beach into the marine environment across the whole data set is  $-450\text{m}^3$  but has been seen to range between  $-12,240\text{m}^3$  and  $+13,540\text{m}^3$  for specific year. Across the beach the amount of material moved via process of longshore drift in any given year is on average  $19,100\text{m}^3$  but can be as little as  $2650\text{m}^3$  or as much as  $44,305\text{m}^3$ . These volumes therefore demonstrate the highly mobile nature of the beach material even given the long term stability.

The beach will require regular maintenance, which is intended to follow the methodology currently employed by Folkestone and Hythe District Council on the beach to the west of the development i.e. twice yearly maintenance after and before the winter storm season to reform the design beach crest and crest width.

Material for the maintenance of the beach will be recycled from areas of accretion on the existing beach, principally the beach adjacent to the Harbour Arm but occasionally from the beach adjacent to the rock groynes, to the areas of erosion in the centre of the beach.

Based on the database only being for the past 20 years it is entirely possible that from time to time the beach may need to be nourished with additional beach material. However, at the present time this is not anticipated to be in the near future provided the beach is regularly maintained. The responsibility and source of funding for future monitoring and nourishment has not yet been agreed. This will be the subject of future discussion and negotiation between Folkestone Harbour Company, SDC and other stakeholders.

It should be recognised that this maintenance programme may need to be amended in light of changes to the behaviour of the beach.

### 6.2 Trigger / Threshold Level (Alarm) Works

Works in response to the alarm level defined in Section 4.6 being reached or exceeded will initiate the recycling of material from areas of accretion to the areas where the alarm level has been triggered. Unless considered necessary works in response to the alarm level being triggered will not involve the nourishment of the beach. Such instances

where nourishment would be considered are when the design beach crest and crest width cannot be reformed over a sizeable portion of the beach e.g. a 100m length of beach crest. Due to the cost of mobilising a dredger and undertaking nourishment works the decision to nourish as opposed to recycling material should be based upon the balance between the cost of the works and the flood risk posed to the development.

### 6.3 Trigger / Threshold Level (Crisis) Works

Works in response to the crisis level defined in Section 4.6 being reached or exceeded will constitute the recycling of material from areas of accretion to the area where the crisis level has been triggered to enable reinstatement of the minimum required flood defence. If sufficient material cannot be sourced from the beach and no new shingle can be found quickly from another source rock protection may also be considered to provide temporary defence. Such examples where the use of rock would be allowed include when a storm has triggered the crisis level but there is insufficient material on the beach to “plug the hole” and a following storm a few days out has the potential to degrade the beach further.

If the raised dunes have been damaged they shall be repaired.

### 6.4 Implementation

#### 6.4.1 Source of Nourishment Material

For any future nourishment that may be anticipated the material will be sourced from a licenced offshore dredging area. Shingle cannot be sourced from within the site boundary, as set out in the Marine License - L/2015/00174/3. Whereby any subsequent nourishment will be from a designated offshore site.

#### 6.4.2 Required Plant

##### Regular Beach Maintenance

For regular beach maintenance works involving the recycling of material on the beach material will be redistributed using land based plant in the form of tracked excavators and dump trucks similar to the plant currently used by Folkestone and Hythe District Council.

##### Beach Nourishment

For any subsequent nourishment where material will be sourced from an licenced offshore dredging area there are three likely delivery mechanisms described below in descending likelihood:

- **Small Dredger:** Given the relative modest quantity of material and the shallow depth of water close to the beach it is most likely that the small dredger will rainbow shingle onto the beach at low tide. Land based plant would then redistribute the shingle to form the design profile. With a small dredger this work will take several months.
- **Large Dredger:** A faster alternative would be to use a dredger with a larger capacity. The shallow water depth near the beach would require the shingle to be pumped to the beach through a pipeline either floating or sun to the seabed. This pipeline would discharge material straight onto the upper beach where it would be distributed using land based plant. Given the greater capacity of the dredger, and the fact that it is not so tidally limited, the works would be undertaken in a short intense period of the order of 1-2 weeks.

- **Barges:** A third option, often used when dredged material requires re-handling and screening, is to load the material onto a flat bottomed barge and float these onto the beach at high tide. The material is then deposited onto the beach and redistributed by land based plant.

The choice of which methodology to use will be determined upon selection of the source of the nourishment material, any environmental constraints imposed by governing bodies and the local authority and the window within which nourishment activities need to be completed within.

### 6.4.3 Access Routes

The principle access routes to the site for HGV's and all development site traffic are via the A260 in the form of Tram Road, Tontine Street and Dover Road as shown in Figure 6-1.

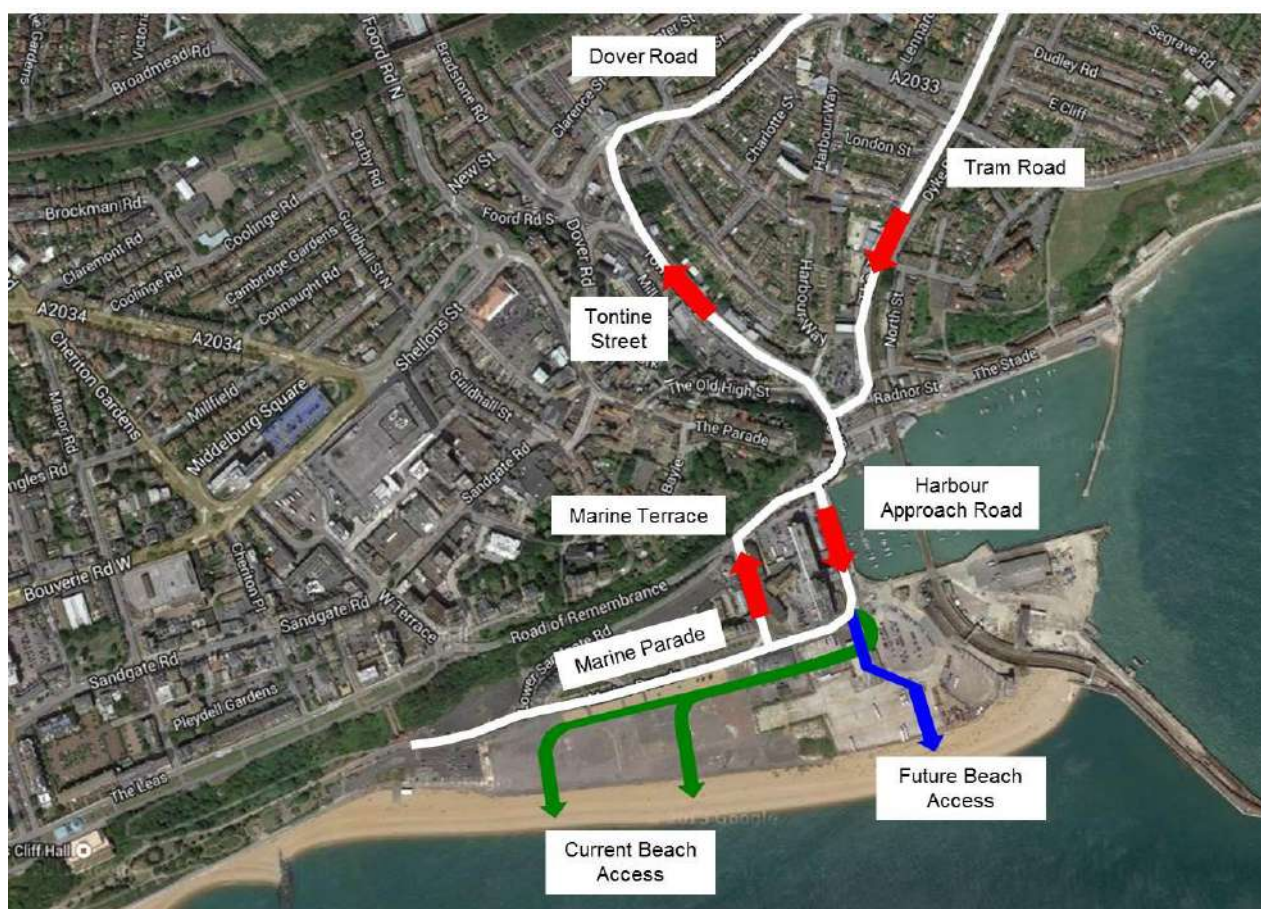


**Figure 6-1 - Access Routes to the Development Site**

Tram Road, recently converted from a one-way system to a two-way road, Tontine Street and Dover Road form the access and egress routes to the harbour. Harbour Approach Road and Marine Terrace then provide a one-way system that enables access to Marine Parade and the development site. To reduce the effects of construction traffic to Folkestone town centre the contractor will be encouraged to adopt the traffic routing plan shown in Figure 6-1.

At present access to the beach is at the western end of the development due to the presence of existing harbour buildings. Once the development is completed access to the beach will be at the eastern end of the development

along a designated access road. The provision for the parking of plant undertaking the beach maintenance works remains to be identified through discussions with all relevant stakeholders at a later date.

## 7 Reporting and Review

### 7.1 Beach Status Report

Following each period of maintenance, whether this is part of the regular maintenance programme or emergency maintenance to the beach, a brief summary report should be prepared to cover the following items:

- Works undertaken during maintenance
- Plant used
- Volume of material moved during recycling and which part of the beach the material was sourced from
- Volume of material brought onto the beach and where this material was sourced from
- The condition of the beach and the raised dunes to the rear of the beach
- Photographs of the beach before and after maintenance works
- General comments on the status of the beach
- Whether any alarm or crisis levels have been triggered

The responsibility and source of funding for preparation of the Beach Status Report has not yet been agreed. This will be the subject of future discussion and negotiation between Folkestone Harbour Company, SDC and other stakeholders.

### 7.2 Annual Reporting

At the end of every yearly maintenance period, this is suggested to be post the winter storm season. An annual report shall be produced to cover the following points which are in addition to the point detailed under Section 7.1:

- Comparison between previous years
- Identification of general trends in the crest level, crest width, beach slope and changes in material volume
- Description of the works carried out within the maintenance period
- The total volume of material moved during recycling
- The total volume of material brought onto the beach
- Information on the number of storms along with typical storm wave heights and the direction of the storm and their impact i.e. did they trigger any alarm or crisis levels

The responsibility and source of funding for preparation of Annual Reporting has not yet been agreed. This will be the subject of future discussion and negotiation between Folkestone Harbour Company, SDC and other stakeholders.

### 7.3 Review and Feedback

As a supplement to the Beach Status and Annual Report a review should be undertaken to identify whether the type and level of beach management described within this document needs to be altered in order to maintain the flood defence capabilities of the beach and defend the development against the design 1 in 200 year return period event as sea levels rise.

This BMP is intended to be a live document and should be reviewed periodically once a pattern of work has been established. For transparency and consistency, it would be beneficial if this plan is incorporated within SDC's BMP.

## 8 References

CCO Annual Wave Report 2022 – Folkestone Directional Waverider Buoy

CIRIA C685 – The Beach Management Manual (second edition), published by CIRIA (2010)

Environment Agency - Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018)

South Foreland to Beachy Head Shoreline Management Plan, published by the South East Coastal Group (April 2006)

NP201 Admiralty Tide Tables, Volume 1, 2014, United Kingdom and Ireland including European Channel Ports, published by the United Kingdom Hydrographic Office (2013)

Numerical Modelling Report for Folkestone Seafront, Folkestone, Kent rev02, produced by Herrington Consulting (May 2012)

National Planning Policy Framework available from (<http://planningguidance.planningportal.gov.uk/>) published by the UK Government Department for Communities & Local Government (May 2022)

Folkestone Seafront, Environmental Statement rev00, produced by Buro Happold (August 2012)

Folkestone Seafront, Environmental Statement Addendum 00 rev00 (Buro Happold, April 2013)

Folkestone Seafront, Environmental Statement Addendum 01 rev01 (Buro Happold, June 2014)

Folkestone Seafront, Flood Risk Assessment rev02 (Buro Happold, August 2012)

SR01, Review of south coast beach response to wave conditions in the winter of 2013-2014, published by the Channel Coastal Observatory (April 2014)

Regional Shingle Sediment Budget Report – Rye Harbour to Folkestone, published by Canterbury City Council (June 2013)

## Appendix A Determination of Trigger Levels

# Technical Note

Project Folkestone Seafront  
Subject Determination of Beach Trigger Levels  
Project no 0058918  
Date 15 November 2023

| Revision | Description                                          | Issued by | Date       | Approved (signature) |
|----------|------------------------------------------------------|-----------|------------|----------------------|
| 00       | Summary on the determination of beach trigger levels | SDSM      | 13/06/2014 | PNB                  |
| 01       | Updated as part of BMP rev06                         | TG        | 15/11/2023 | SDSM                 |

## 1 Introduction

The purpose of this technical note is to support the Folkestone Seafront Beach Management Plan and aims to document how the alarm and crisis levels were determined for the beach to act a trigger levels for maintenance works. This has been prepared using the guidance presented within CIRIA C685 – The Beach Management Manual (2<sup>nd</sup> Edition) published in 2010.

## 2 Definitions

To maintain the standard of protection that the beach provides, trigger levels are required to define when maintenance needs to take place. These trigger levels are broken down into an “alarm” level and a “crisis” level. These are defined in CIRIA C685 and in the sections that follow.

### 2.1 Alarm Level

CIRIA C685 defines the alarm levels as;

*“The level below crisis level. This is usually a predetermined value where the monitored beach parameter falls to within range of the crisis level, but has not resulted in systematic failure of the function being monitored.”*

For the situation at Folkestone, the alarm level is defined as when the standard of protection reduces below the 1 in 200 year storm event for any given year. A reduction in the standard of protection is defined by a drop in crest level within the zone between the alarm level and the crisis level or where the beach has eroded to or beyond the alarm level.

For the calculations defining the location of the alarm level for any given year refer to Section 3.

### 2.2 Crisis Level

CIRIA C685 defines the crisis level as:

*“The level at which the function being monitored, such as the stability of the beach and / or any backing structures (seawalls / promenade), could be compromised and emergency remedial action becomes necessary.”*

For the situation at Folkestone, the crisis level is defined as a consistent lowering of the beach at the base of the raised dunes below +6.5mOD and / or damage occurring to the raised dunes. A consistent lowering is defined as the beach level at the base of the beach being below +6.5mOD for a distance of 100m. It should be noted that should damage to the raised dunes occur from a smaller distance then this will take precedence.

### 3 Calculation of Alarm Level

As the beach will be constructed to provide defence against the future design case, rising sea levels throughout the design life of the project will result in the alarm level changing with time. The rate at which the alarm levels changes and its location along the beach crest can be determined by considering how the beach performs under the design storm in the present day and future conditions and an appreciation for the rate of change of sea level rise.

#### 3.1 Beach Performance

Herrington Consulting were appointed to undertake numerical modelling of the existing beach to establish its performance under current day and future events, whether this meets the required flood defence and propose measures to improve the flood defence of the beach to facilitate the development. The following results have been extracted from the Herrington Report<sup>1</sup>:

##### Existing Beach – Typical Crest Level +5.9mOD

Crest response to 1 in 200 year event in 2011 = reshaping of material up to 5m behind the beach crest (A)

Crest response to 1 in 200 year event in 2115 = reshaping of material up to 30m behind the beach crest (B)

*NOTE 1: Leaving the beach crest at +5.9mOD resulted in too much of the development being vulnerable to the sea. The beach crest was therefore raised.*

*NOTE 2: 30m distance behind the beach crest sets the seaward limit of properties within the development*

##### Proposed Beach – Design Crest Level +6.5mOD

Crest response to 1 in 200 year event in 2115 = reshaping of material up to 14m behind the beach crest (C)

*NOTE 1: 14m distance behind the beach crest sets the seaward limit of the raised dunes*

By assuming that a beach with a crest level of +6.5mOD will perform in a similar manor to a beach with a crest of +5.9mOD the +6.5mOD crest response to a 1 in 200 year event in 2011 can be approximated as follows:

$$+6.5\text{mOD Crest response to 1 in 200 year event in 2011} = (A) \times \frac{(C)}{(B)} = 5 \times \frac{14}{30} = 2.3\text{m}$$

#### 3.2 Rate of Change of Sea Level Rise

The rate of sea level rise for Folkestone can be established using the planning practice guidance that accompanies the National Planning Policy Framework (NPPF). The guidance was last updated in May 2022 and it recommends that for Southeast England the Higher Central estimates are the rates presented in Table 3.1: The Higher Central allowance has been adopted over the Upper End allowance on the basis that the Upper End represents the 95<sup>th</sup> percentile i.e. and extreme condition where as the Higher Central represents the 70<sup>th</sup> percentile. An allowance closely related to the mean and therefore more likely protected sea level rise.

**Table 3.1 - Recommended Rates of Sea Level Rise for Folkestone (Higher Central)**

|                                                            | 1990 to 2025 | 2025 to 2055 | 2055 to 2085 | 2085 to 2115 |
|------------------------------------------------------------|--------------|--------------|--------------|--------------|
| Sea level rise (mm/year) relative to 1981 to 2000 baseline | 5.7          | 8.7          | 11.6         | 13.1         |

Taking 2011 as the baseline reading for the project to tie up the numerical modelling, the amount of sea level rise in each period to the development's design year of 2115 is shown in Table 3.2:

**Table 3.2 - Degree of Sea Level Rise over the Design Life of the Development**

| Year | No. of Years | Rate of Sea Level Rise (mm/year) | Sea Level Rise within Period (m) | Cumulative Sea Level Rise (m) | Cumulative % of the Total |
|------|--------------|----------------------------------|----------------------------------|-------------------------------|---------------------------|
| 2011 | -            | -                                | 0                                | 0                             | 0%                        |
| 2025 | 24           | 5.70                             | 0.14                             | 0.14                          | 13.6%                     |
| 2055 | 30           | 8.70                             | 0.26                             | 0.40                          | 39.5%                     |
| 2085 | 30           | 11.60                            | 0.35                             | 0.75                          | 74.0%                     |
| 2115 | 20           | 13.10                            | 0.26                             | 1.01                          | 100.0%                    |

<sup>1</sup> Numerical Modelling Report for Folkestone Seafront, Folkestone, Kent Revision 2 (May 2012) by Herrington Consulting Limited

### 3.3 Setting Alarm Levels

Using the knowledge that in 2011 the crest response to the 1 in 200 year event with no sea level rise is 2.3m, that in 2115 the crest response to the 1 in 200 year event with 100% of the sea level rise is 14m, and assuming that the degree of crest reshaping changes at the same rate as the rate of sea level rise the location of the alarm levels at discrete years can be established. The location of the alarm level relevant to the design beach crest and the base of the raised dunes is shown in Table 3.3.

Table 3.3 - Alarm Level Locations

| Year (MHWS Reading)                           | 2011 Baseline<br>(+3.45mOD) | 2035<br>(+3.59mOD) | 2065<br>(+3.85mOD) | 2095<br>(+4.20mOD) | 2115<br>(+4.46mOD) |
|-----------------------------------------------|-----------------------------|--------------------|--------------------|--------------------|--------------------|
| Distance from Base of the Raised Dunes, x (m) | 2.30                        | 3.05               | 5.90               | 9.70               | 14.00              |
| Distance from Design Beach Crest, y (m)       | 11.70                       | 10.11              | 7.08               | 3.04               | 0.00               |

NOTE: Years are indicative only and may be subject to change if sea level rise accelerates or decelerates from current predictions. The location of the alarm level should therefore be determined using the MHWS reference level. This can be readily obtained from the UK Hydrographic Office

This information is represented graphically within Figure 3.1.

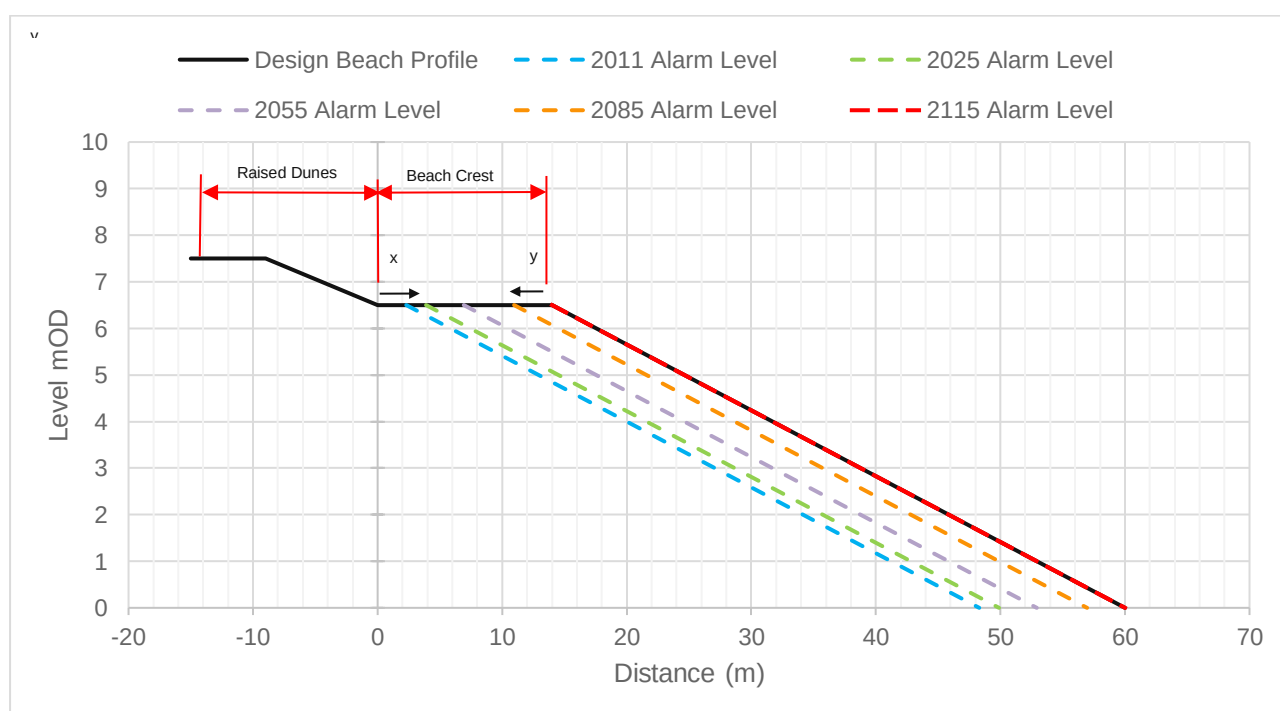


Figure 3.1 - Location of Alarm Levels on Design Beach Profile

For years and/or levels of Mean High Water Springs (MHWS) between the quoted values, the location of the alarm level for that given year should be interpolated e.g. for 2040,  $x = 3.53$ ,  $y = 9.61$ .

## Appendix B Summary of Beach Morphology Analysis

## Technical Note

|            |                                      |
|------------|--------------------------------------|
| Project    | Folkestone Seafront                  |
| Subject    | Summary of Beach Morphology Analysis |
| Project no | 0058918                              |
| Date       | 16 November 2023                     |

| Revision | Description                                     | Issued by | Date       | Approved (signature) |
|----------|-------------------------------------------------|-----------|------------|----------------------|
| 00       | Summary of Beach Morphology Analysis            | SDSM      | 12/06/2014 | PNB                  |
| 01       | Update to incorporate 2014 and 2015 survey data | SDSM      | 22/03/2016 | PNB                  |
| 02       | Update for BMP rev05                            | SDSM      | 30/01/2017 | PNB                  |
| 03       | Updated as part of BMP rev06                    | TG        | 15/11/2023 | SDSM                 |

## 1 Introduction

The purpose of this technical note is to support the Folkestone Seafront Beach Management Plan and aims to summarise the analysis undertaken to understand the beaches morphology and how it has changed over time. This analysis has been undertaken using the general guidance presented within CIRIA C685 – The Beach Management Manual (2<sup>nd</sup> Edition) published in 2010.

Since Revision 05 of the Beach Management Plan produced in January 2017, the Folkestone Harbour Company has undertaken an Earthworks Contract to prepare the site for redevelopment. This Earthworks Contract added material to the beach in 2017 to improve the standard of protection offered by the beach. Since its conclusion Folkestone Harbour Company has undertaken regular monitoring of the beach, included detailed topographical survey to ascertain the status and health of the beach. The information gathered by the Folkestone Harbour Company has been added to this document as part of updating the Folkestone Seafront beach Management Plan.

It should be noted that a maintenance campaign was undertaken in February 2023 that moved shingle material from the eastern end of the beach to the western end. Comments on where this activity has affected the results are mentioned throughout this document as required.

## 2 Source Data

Investigations into the morphology of the beach will be based upon data gathered from regular monitoring and survey data of the beach by the Channel Coastal Observatory (CCO). The CCO began collecting data on at least a twice yearly basis in 2003, all of which can be easily obtained through an open government licence. The monitoring and survey data covers the following:

- Surveying of 17No. pre-determined primary and secondary beach cross sections. Primary cross sections are surveyed at least twice a year with secondary cross sections being surveyed once a year.
- Topographic survey of the beach on a yearly basis.
- Bathymetric survey of the sea floor below mean low water to a distance of approximately 1.5km offshore.

Post 2017, all survey data has been sourced from topographical and bathymetric surveys undertaken by the Folkestone Harbour Company who now actively managed and maintain the beach.

### Table 2.1 and

Table 2.2 provide a summary of what information is available from the CCO and Folkestone Harbour Company with Figure 2.1 showing a plan location of the 17No. cross sections that are regularly recorded by the CCO. For consistency all cross section surveys undertaken post 2017 have been aligned to those taken by the CCO.

## Technical Note

Table 2.1 - Available Cross Section Survey Data (CCO data in white, Folkestone Harbour Company data in yellow)

| Reg_ID  | Profile      | Type      | 2003            | 2004      | 2005                              | 2006            | 2007            | 2008            | 2009      | 2010      | 2011            | 2012      | 2013      | 2014            | 2015            | 2019 | 2020 | 2021 | 2022 | 2023 |
|---------|--------------|-----------|-----------------|-----------|-----------------------------------|-----------------|-----------------|-----------------|-----------|-----------|-----------------|-----------|-----------|-----------------|-----------------|------|------|------|------|------|
| 4c00174 | 2043A / 807B | Secondary | May             | Oct       | Jun                               | Jun / Dec       | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00173 | 2043B / 807A | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00172 | 2044 / 807   | Primary   | Feb / May / Oct | Feb / Oct | Jan / Mar / Jun / Oct / Nov / Dec | Mar / Jun / Nov | Feb / Aug / Nov | Mar / Aug / Nov | Feb / Oct | Apr / Jul | Mar / Jun / Oct | Mar / Oct | Apr / Oct | Apr / Jul / Nov | Apr / Aug / Dec | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00171 | 2044A / 806B | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00170 | 2044B / 806A | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00169 | 2045 / 806   | Primary   | Feb / May / Oct | Feb / Oct | Jan / Mar / Jun / Oct             | Mar / Jun / Nov | Feb / Aug / Nov | Mar / Aug / Nov | Feb / Oct | Apr / Jul | Mar / Jun / Oct | Mar / Oct | Apr / Oct | Apr / Jul / Nov | Apr / Aug / Dec | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00168 | 2045A / 805B | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00167 | 2045B / 805A | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00166 | 2046 / 805   | Primary   | Feb / May / Oct | Feb / Oct | Jan / Mar / Jun / Oct             | Mar / Jun / Nov | Feb / Aug / Nov | Mar / Aug / Nov | Feb / Oct | Apr / Jul | Mar / Jun / Oct | Mar / Oct | Apr / Oct | Apr / Jul / Nov | Apr / Aug / Dec | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00165 | 2046A / 804B | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00164 | 2046B / 804A | Secondary | May             | Oct       | Jun                               | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |

| Reg_ID  | Profile      | Type      | 2003            | 2004      | 2005                  | 2006            | 2007            | 2008            | 2009      | 2010      | 2011            | 2012      | 2013      | 2014            | 2015            | 2019 | 2020 | 2021 | 2022 | 2023 |
|---------|--------------|-----------|-----------------|-----------|-----------------------|-----------------|-----------------|-----------------|-----------|-----------|-----------------|-----------|-----------|-----------------|-----------------|------|------|------|------|------|
| 4c00163 | 2047 / 804   | Primary   | Feb / May / Oct | Feb / Oct | Jan / Mar / Jun / Oct | Mar / Jun / Nov | Feb / Aug / Nov | Mar / Aug / Nov | Feb / Oct | Apr / Jul | Mar / Jun / Oct | Mar / Oct | Apr / Oct | Apr / Jul / Nov | Apr / Aug / Dec | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00161 | 2047A / 803B | Secondary | May             | Oct       | Jun                   | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00160 | 2047B / 803A | Secondary | May             | Oct       | Jun                   | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             | Aug             | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00159 | 2048 / 803   | Primary   | Feb / May / Oct | Feb / Oct | Jan / Mar / Jun / Oct | Mar / Jun / Nov | Feb / Aug / Nov | Mar / Aug / Nov | Feb / Oct | Apr / Jul | Mar / Jun / Oct | Mar / Oct | Apr / Oct | Apr / Jul / Nov | Apr / Aug / Dec | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00158 | 2048A / 802D | Secondary | May             | Oct       | Jun                   | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             |                 | May  | Mar  | Mar  | Mar  | Feb  |
| 4c00157 | 2048B / 802C | Secondary | May             | Oct       | Jun                   | Jun             | Aug             | Aug             | -         | Jul       | Jun             | -         | -         | Jul             |                 | May  | Mar  | Mar  | Mar  | Feb  |

Table 2.2 - Available Topographic and Bathymetric Survey Data (CCO data in white, Folkestone Harbour Company data in yellow)

| Data Type          | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Topographic Survey | x    | x    | x    | x    | x    | x    |      | x    | x    |      |      | x    | x    |      |      |      | x    | x    | x    | x    | x    |
| Bathymetric Survey | x    |      |      | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |      |

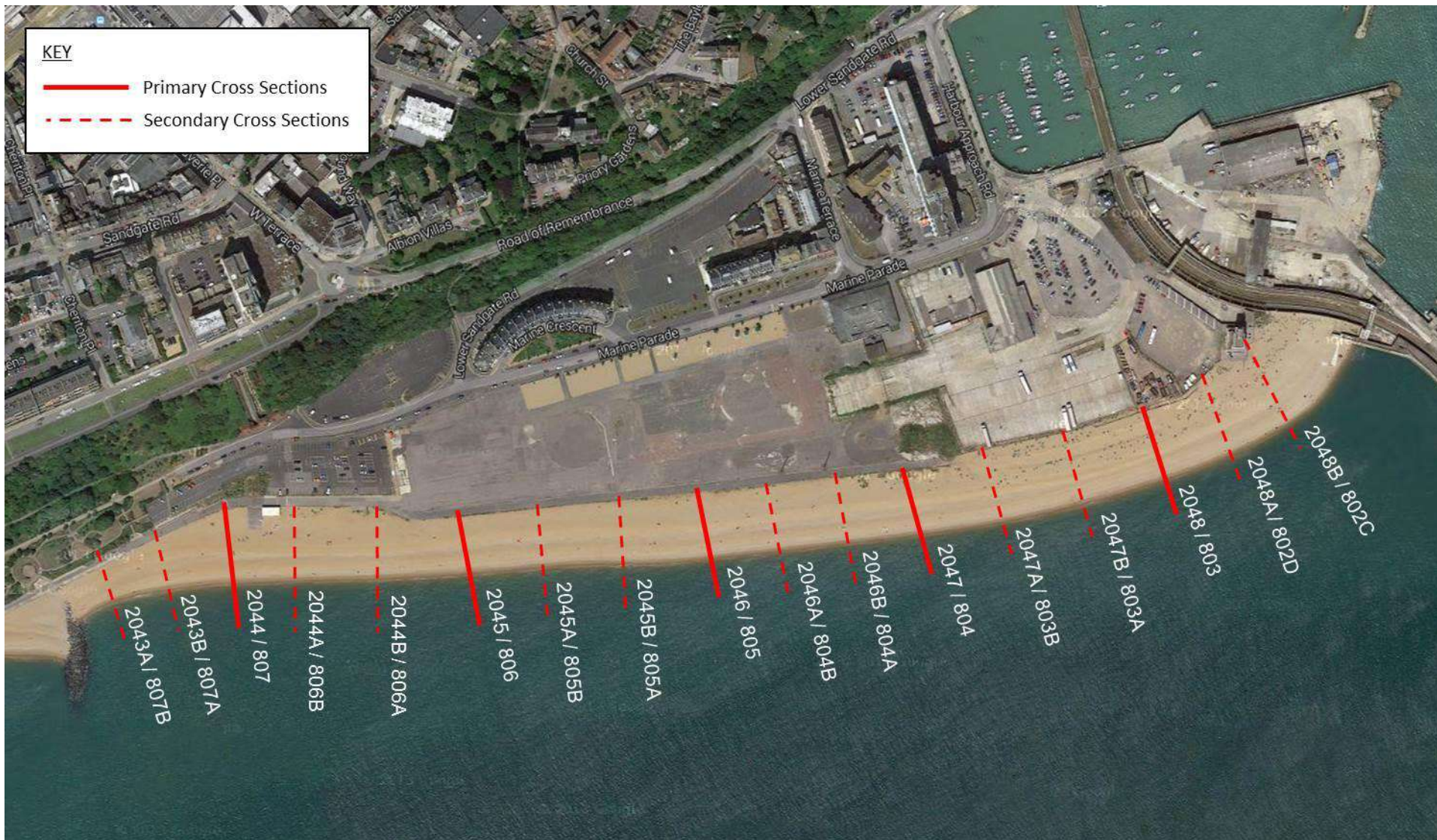


Figure 2.1 - Cross Section Location Plan

## Technical Note

### 3 Analysis

Analysis of the beach will be undertaken in two key stages:

1. **Cross Section Analysis:** Used to determine changes in crest level, crest width, slope angle and a preliminary assessment of where accretion and erosion are taking place to identify discreet beach zones for use in the volume analysis.
2. **Volume Analysis:** Used to determine the degree of accretion and erosion, the volumes of material being moved, where this goes to and whether material is being lost or gained from the system.

The methodology and results of this analysis are detailed in the sections that follow.

It should be noted that data pre 2004 has been ignored due the construction of the rock groynes at the western end of the beach during 2003.

#### 3.1 Cross Section Analysis

##### 3.1.1 Crest Level

###### Definition

As the focus of the analysis is to determine how the beach responds to storms the crest level of the beach is defined as the highest level on the beach that is exposed to storm conditions which may not necessarily be the highest level encountered on the beach. Figure 3.1 provides examples of the point used to define the extreme storm crest level.

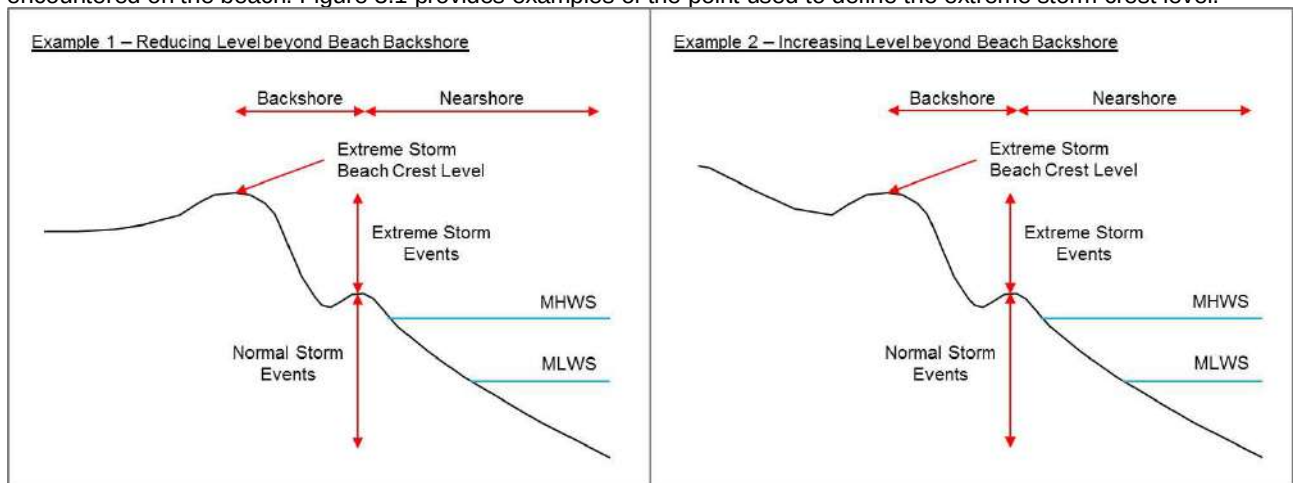


Figure 3.1 - Definition of Extreme Storm Beach Crest

###### Results

Across all years, where there is data to analyse, Figure 3.2 and Figure 3.3 summarise the general trend in the crest level along the beach.

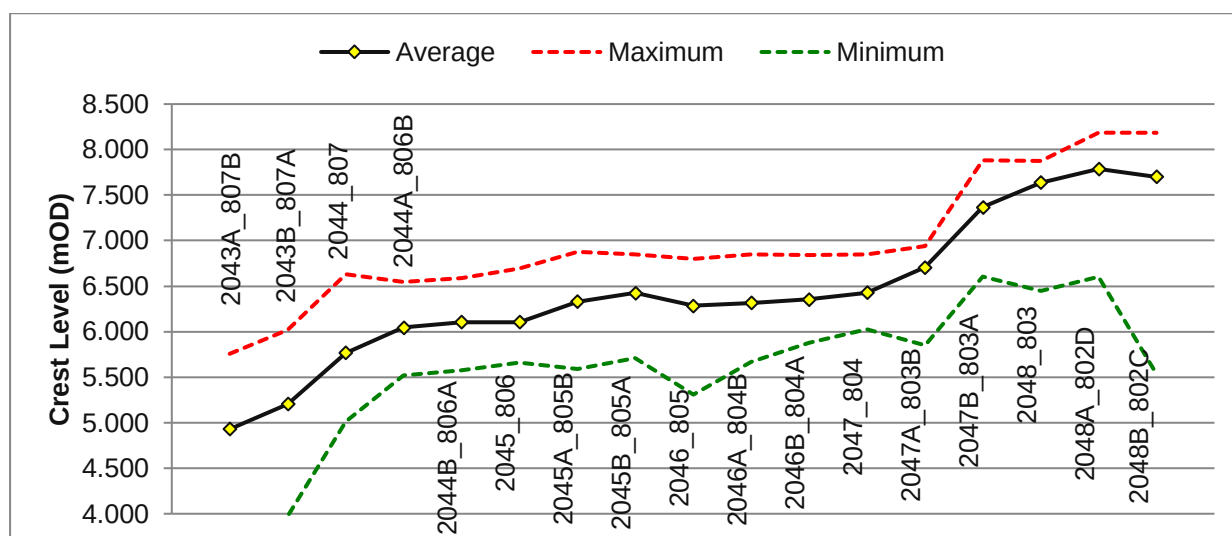


Figure 3.2 - Variation in Crest Level from 2004 to 2023

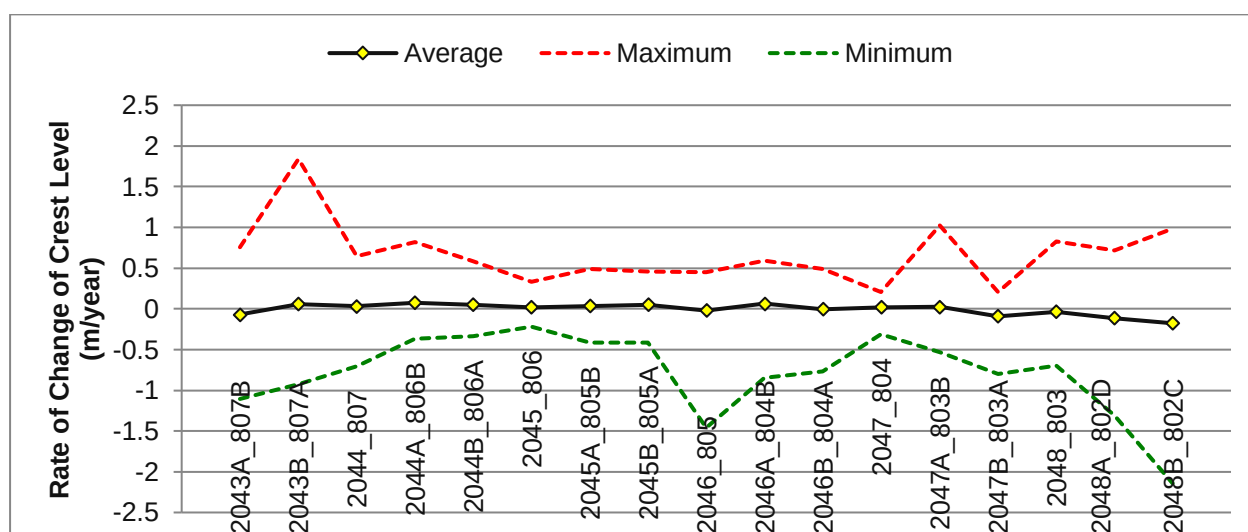


Figure 3.3 - Variation in Rate of Change of Crest Level from 2004 to 2023

Within Figure 3.2 and Figure 3.3 the following trends were identified:

1. The extreme storm crest level consistently rises from a level of +5.0mOD at the western end of the beach to +7.75mOD at the eastern end.
2. Variation in the level of the extreme storm crest level stays relatively the same from west to east, however at the far eastern side the variation is much larger with the minimum crest level much lower. This is a result of the beach maintenance works undertaken early in 2023, resulting in 2023 being the lowest crest level in the east.
3. In line with the variation in crest level the average rate of change of crest level is generally static as you move from the west to east with the average rate of change in crest level for the last 4 cross sections being slightly negative i.e. the crest level is gradually reducing with time.

### 3.1.2 Crest Width

#### Definition

The key function of the area behind the crest of the beach is to facilitate the lateral movement of beach and provide a buffer between the area of the beach exposed to wave attack and the area of undisturbed material at the rear of the beach. The width of the crest is therefore a key factor in providing flood protection.

In this analysis the width of the beach crest is defined as the distance between the extreme beach crest level and the point where beach material remains undisturbed. In the case of Folkestone Harbour this is either the edge of the concrete hardstanding or a sea wall.

#### Results

Across all years, where there is data to analyse, Figure 3.4 summaries the general trend in the crest width of the beach. It should be noted that as the back of the beach is not at an equal distance from the crest of the beach along the whole of the beach frontage; the variation in crest width has therefore been omitted as this would present erroneous results. Comments are however provided for the broad observations in crest width.

Within Figure 3.4 the following trends were identified:

1. In general, the yearly rate of change of crest width at the ends of the beach west of profile 2044 / 807 and east of profile 2047 / 804 cause a gradual increase in the crest width the remaining central section of the beach reducing in width. This behaviour is indicative of accretion at the western and eastern ends of the beach and erosion in towards its centre.
2. Variation in the rate of change of crest width is more pronounced at the western end of the beach to the west of profile 2044A / 806B with variations to the east of this profile i.e. the central and eastern section of the beach being much less.
3. Variation in the rate of change of crest width is generally more pronounced for primary cross sections. This is likely due to these sections being surveyed more regularly and after storm events. It is believed that although the variation for the secondary cross sections (which are surveyed once a year during the summer months), is less the actual variation is likely to be closer to the variations observed at the primary cross sections.

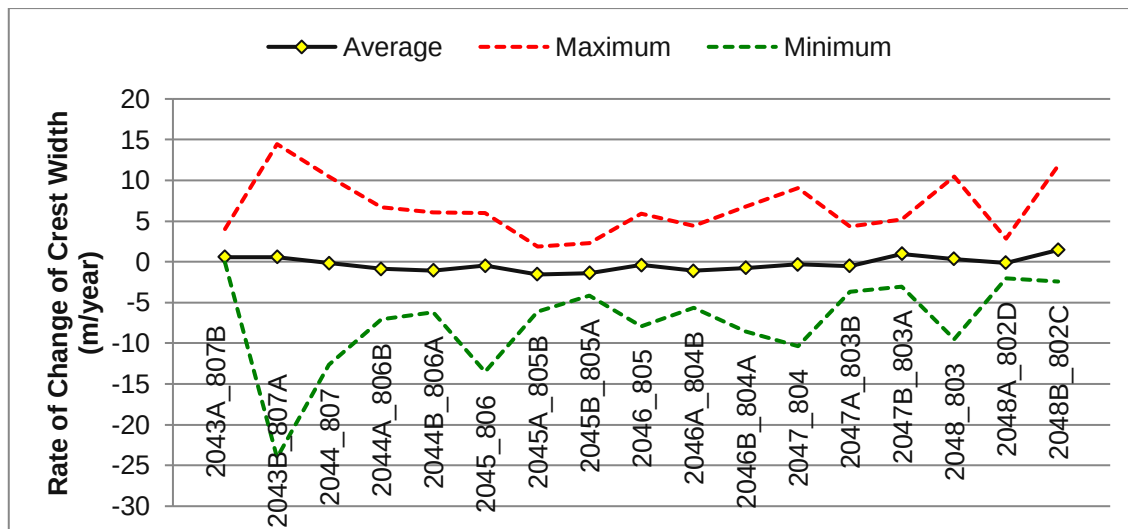


Figure 3.4 - Variation in Rate of Change of Crest Width from 2004 to 2023

The general trends in the width of the beach crest were identified as follows:

1. The width of the crest at the western end of the beach beyond profile 2044 / 807 rapidly reduces from approximately 25m to 0m as the beach rolls into the adjacent rock groyne and sea wall.
2. The width of the crest east of profile 2044 / 807 until profile 2047A / 803B remains approximately parallel to the rear of the beach.
3. The width of the crest east of profile 2047A / 803B reduces as the beach crest retreats landward. Although this behaviour could be attributed to erosion this is not the case based upon the results in Figure 3.4. This reduction is more likely to be due to the rapid increase in crest level seen in Figure 3.2.

### 3.1.3 Slope Angle

#### Definition

Whilst not as important as crest level and crest width from the point of view of flood defence the slope of the beach can help give detail on whether erosion or accretion are causing steepening or slackening of the beach. Within the analysis the beach slope is defined as the slope of the beach between MHWS and MLWS i.e. the area where the beach experiences the most wave energy, with any storm beach that has formed being ignored. An example of this is given in Figure 3.5.

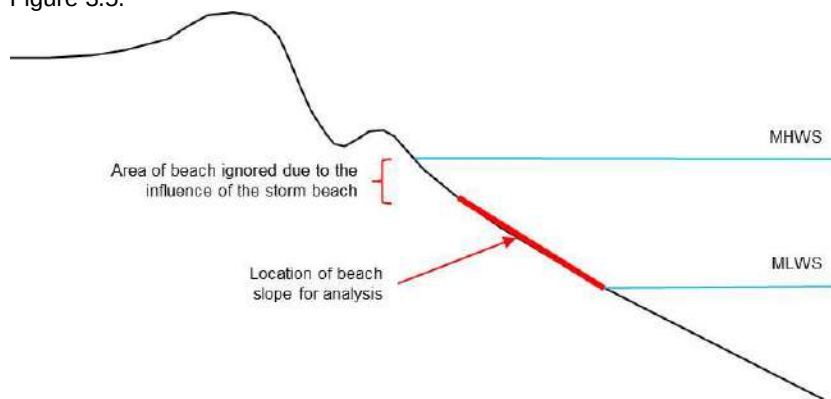


Figure 3.5 - Definition and Location of Beach Slope

#### Results

Across all years, where there is data to analyse, Figure 3.6 summarises the general trend in the slope of the beach.

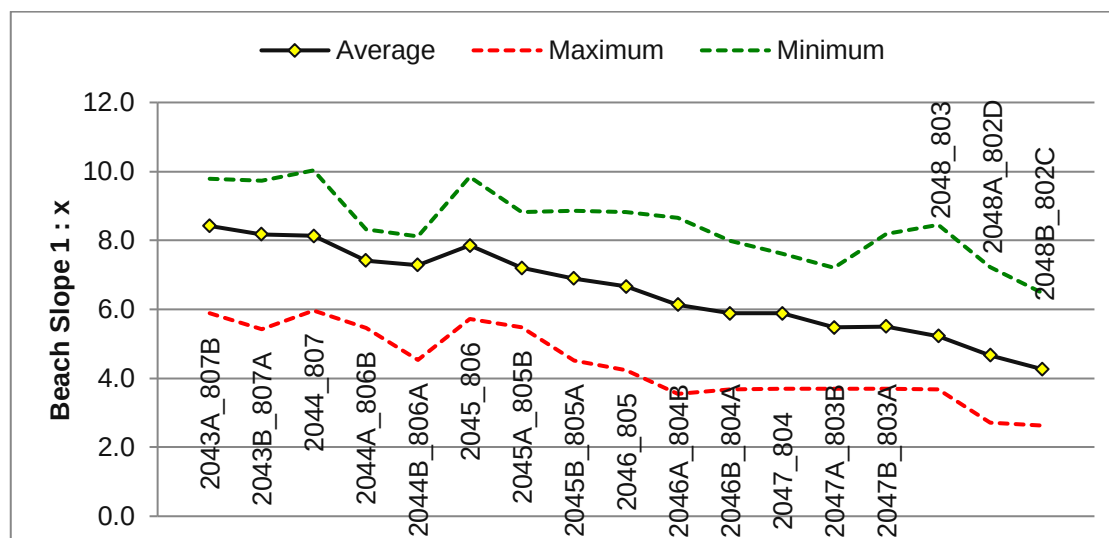


Figure 3.6 - Variation in Beach Slope from 2004 to 2023

### 3.1.4 Preliminary Assessment of Accretion and Erosion

#### Definition

A general picture of whether a beach is accreting or eroding can be determined from analysing how a defined level moves in plan. Of particularly use are the plan locations of defined tide levels. Given that the cross sections only extend to approx. -2.5mOD three tide levels were chosen; MHWS (+3.45mOD), MHWN (+1.95mOD) and MLWN (-1.65mOD). All movements were referenced to a baseline survey in 2004.

#### Results

Across all years, where there is data to analyse, Figure 3.7 summarises the general trend in accretion and erosion across the beach for the defined tide levels of MHWS, MHWN and MLWN.

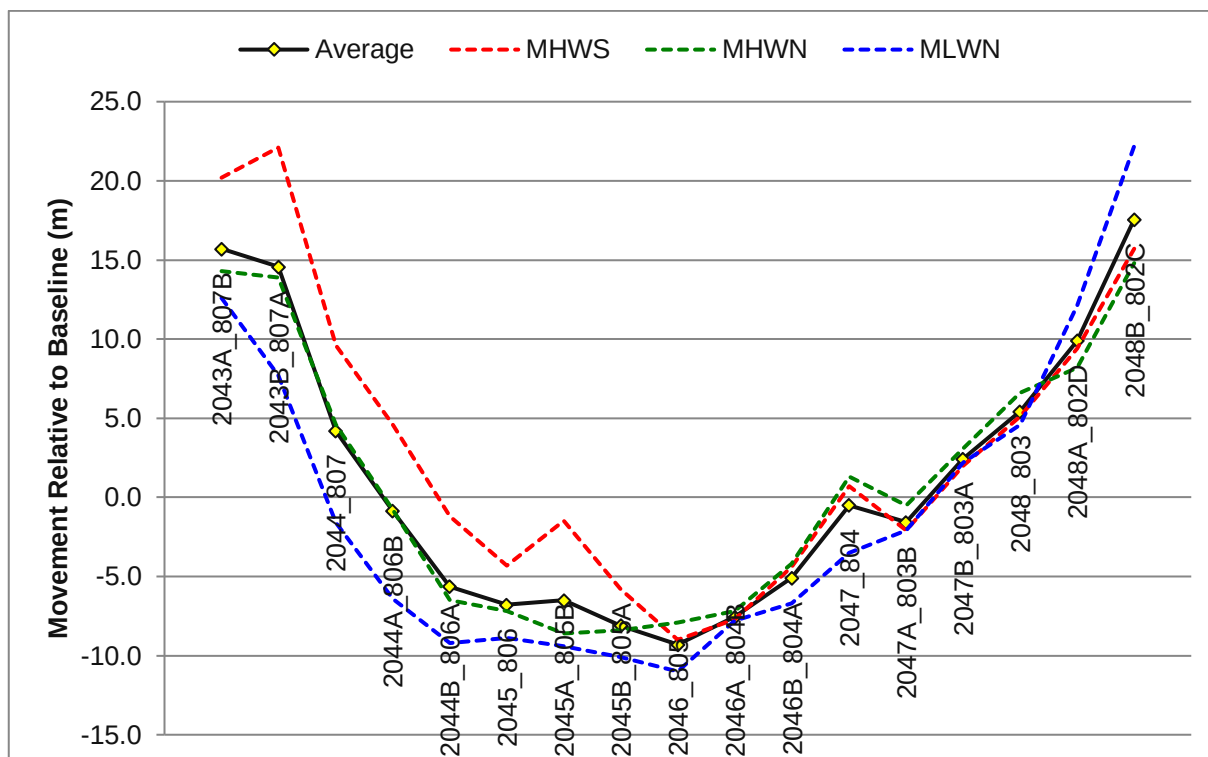


Figure 3.7 - Plan Movement to Tide Levels Relative to 2004 Baseline

Within Figure 3.7 the following trends were identified:

1. Overall, the beach has accreted in zone 1 and zone 4 but has remained relatively stable between zones 2 and 3.
2. MHWS and MLWS have both accreted material for all zones, however, the MHWN level has moved inshore. This is a result of the beach slope increasing in steepness.
3. To the east in cross sections 802D and 802C, this has witnessed an build out in the cross sections, this is a result to long shore drift shifting sediment predominantly from west to east.
4. In the west, there is also a build out, this is primarily due to beach works at the beginning of 2023 moving sediment westwards away from the significant build up that was witnessed in 2022 at the eastern side of the beach.

### 3.1.5 Summary and Conclusions

From Sections 3.1.1 to 3.1.4 it is possible to define areas of the beach that behave in a similar manner. Table 3.1 provides a simplified summary of the trends identified for each cross section.

Table 3.1 - Summary of Cross Section Analysis

| Profile ID   | Crest Level | Crest Width | Beach Slope | Accretion and Erosion Assessment | Beach Zone |
|--------------|-------------|-------------|-------------|----------------------------------|------------|
| 2043A / 807B | Falling     | Increasing  | Slackening  | Accretion                        | 1          |
| 2043B / 807A | Rising      | Increasing  | Slackening  | Accretion                        | 1          |
| 2044 / 807   | Rising      | Reducing    | Slackening  | Accretion                        | 1          |
| 2044A / 806B | Rising      | Reducing    | Slackening  | Retreating                       | 2          |
| 2044B / 806A | Rising      | Reducing    | Slackening  | Retreating                       | 2          |
| 2045 / 806   | Rising      | Increasing  | Slackening  | Retreating                       | 2          |
| 2045A / 805B | Rising      | Increasing  | Slackening  | Retreating                       | 2          |
| 2045B / 805A | Rising      | Reducing    | Slackening  | Retreating                       | 2          |
| 2046 / 805   | Falling     | Reducing    | Slackening  | Retreating                       | 2          |
| 2046A / 804B | Rising      | Reducing    | Slackening  | Accretion                        | 3          |
| 2046B / 804A | Falling     | Reducing    | Slackening  | Accretion                        | 3          |
| 2047 / 804   | Rising      | Reducing    | Slackening  | Accreting                        | 3          |
| 2047A / 803B | Rising      | Reducing    | Slackening  | Accreting                        | 3          |
| 2047B / 803A | Falling     | Increasing  | Slackening  | Accreting                        | 4          |
| 2048 / 803   | Falling     | Increasing  | Slackening  | Accreting                        | 4          |
| 2048A / 802D | Falling     | Reducing    | Steepening  | Accreting                        | 4          |
| 2048B / 802C | Falling     | Increasing  | Slackening  | Accreting                        | 4          |

From Table 3.1, four zones have been identified across the length of the beach. The locations of these zones are displayed within Figure .



**Figure 3.8 - Location of Beach Zones and Zone Characteristics from Cross Section Analysis**

What this analysis shows is that in general, beach material is accreting in zones 1, 3 and 4 with erosion occurring within zone 2. Based on the predominant wave direction being from the south west accretion within Zone 1 is likely to be due to the sheltering effect of the rock groynes at the far western end of the beach whilst accretion within Zones 3 and 4 is likely to be due to material from zone 2 migrating along the beach through the process of longshore drift.

The zones identified within the cross section analysis will be used to inform the volume analysis within Section 3.2.

## 3.2 Volume Analysis

All volume analysis was undertaken using the topographic and bathymetric information listed within

Table 2.2 with survey information from 2004 being used as a baseline. As the topography information extends to low water material below this point is less likely to be moved as this area receives less wave energy than the intertidal zone. For this reason the bathymetry from 2006 was used for all volume analyses undertaken up to the year 2022 when a new bathymetry survey became available. All years post and including 2022 tied into the 2022 bathymetry survey.

It should be noted that for 2012 and 2013 the beach topography was interpolated from the cross section data. The volumes derived from these were treated with care as they will not be an exact representation of the whole beach.

Volume assessments were undertaken using the discreet zones identified within the cross section analysis in Section 3.1.

### 3.2.1 Volume Change

#### Aim

The key goal of the volume change analysis is to understand how each beach zone varies from year to year i.e. is the beach accreting or eroding and how much material is being lost or gained from the zone.

#### Results

Across all years, where there is data to analyse, Figure 3.7 summaries the general trend in how much material is moved within each beach zone varies year on year with Figure 3.9 presenting the cumulative volume change from 2004 to 2023.

It should be noted that general trends in material movement within Figure 3.8 should be determined from the average line. The average gain line is calculated from is calculated from all the years that showed gain in each beach zone, similarly the average loss line is calculated from all the years that showed loss in each zone i.e. if material gains occurs in 2006, 2007 and 2010 then the average gain would be the average of the volumes from these years.

For example, beach zone 1 in the left hand graph experiences an average material gain of approximately 195m<sup>3</sup>/year across the data set indicating that although negligible, accretion dominates in this zone. However, in a year where beach zone 1 loses material this is on average 5200m<sup>3</sup> and in a year where beach zone 1 gains material this is on average 6400m<sup>3</sup>. The error bars represent the range of material gain and loss that has historically occurred in any given year.

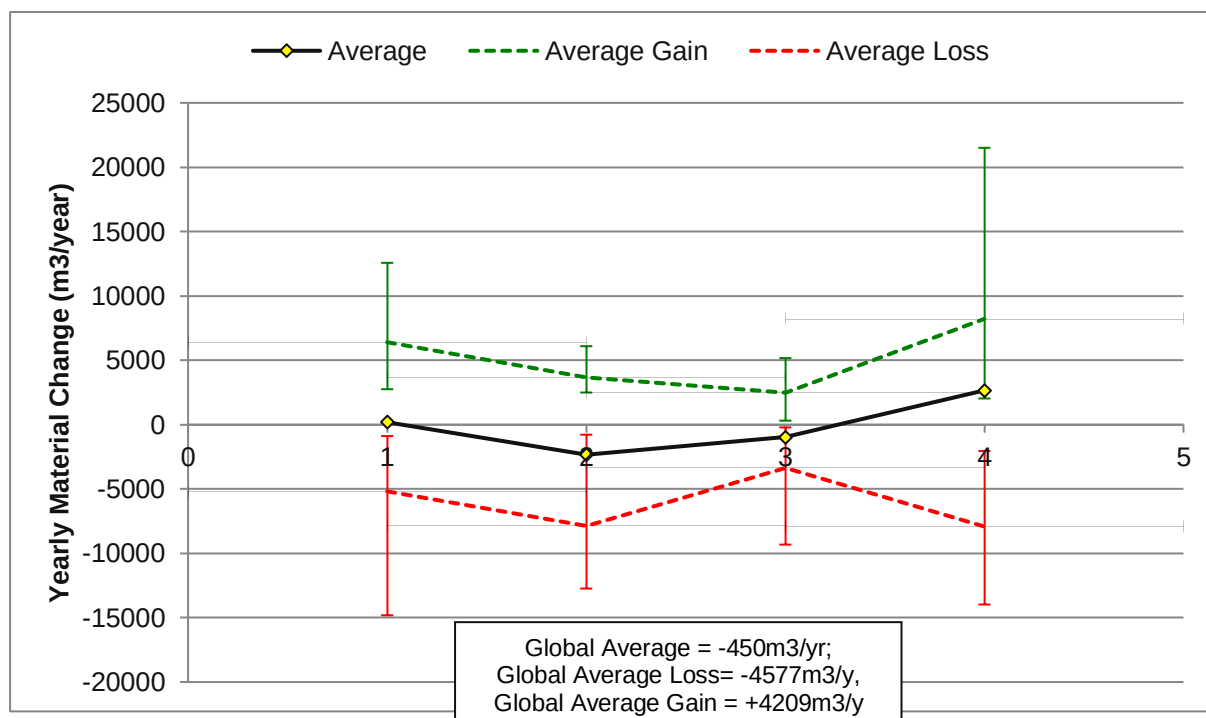


Figure 3.8 - Yearly Volume Change for each Beach Zone from 2004 to 2023

Within Figure 3.8 the following trends were identified:

1. Up until the end of 2023 beach zones 1 and 4 experience a general accretion of material with beach zones 2 and 3 experiencing a general loss of material. Whilst in zone 3 stayed primarily stable.
2. The variations in the volume of material within beach zones 2 and 4 are approximately twice that within beach zone 3 (near zero for zone 1). It is therefore reasonable to assume that beach zones 1 and 3 are relatively stable in comparison to the others.
3. Beach zones 1 and 4 experience the greatest degree of material movement for both material gain and material loss.
4. Although the beach is highly mobile the modest net yearly loss in the material indicates a relatively stable beach with minimal material being lost from the system to the sea.

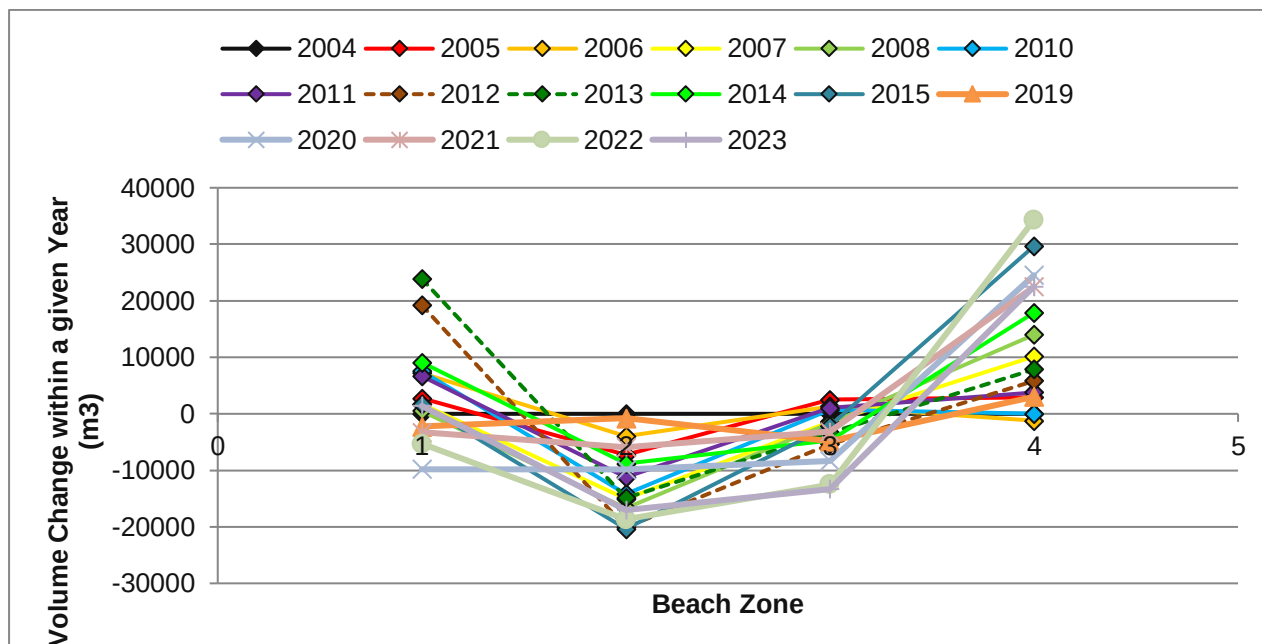


Figure 3.9 - Cumulative Volume for each Beach Zone

Within Figure 3.9 the following trends were identified:

1. Significant storms during 2005, 2007, 2012, 2013 and 2015 caused large amounts of material to be lost from beach zone 2. This appears to have been redistributed into the other beach zones.
2. Although beach zone 4 clearly shows a gain in material a significant storm during 2010 caused a loss of approximately 15,000m<sup>3</sup> of material from the zone. As with point 1 it would appear that this material was redistributed into the other beach zones.
3. As shown in Figure 3.8 beach zone 3 remains relatively stable in comparison with the other beach zones. It would also appear that another stable section of beach exists between beach zones 1 and 2. This would imply that the beach has two null points about which the beach orientates.
4. Within this latest assessment, zone 4 has witnessed a significant accumulation between 2020 and 2023, particularly in 2022, however, this has decreased in 2023. The reduction in 2023 from 2022 is due to beach management works that took place in early 2023.

### 3.2.2 Material Movement

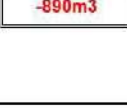
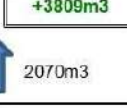
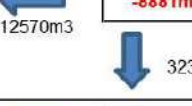
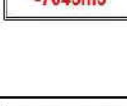
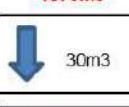
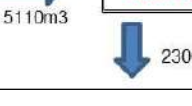
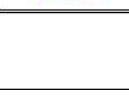
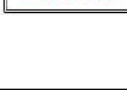
#### Aim

The key goals of the material movement analysis are to understand how much material moves across the beach, whether material is being lost or gained by the system and further investigate whether the beach is stable or unstable.

#### Results

Across all years, where there is data to analyse, Figure 3.10 summaries the movement of material across the beach and the amount of material gained or lost from the beach for each year where information exist. The results presented within Figure 3.10 have been calculated using the following assumptions:

1. Material can only move from one cell to another i.e. to the cell(s) that is(are) adjacent to it
2. The rock groynes at the western end of the beach and the Harbour Arm at the eastern end of the beach act to isolate the system therefore any material loss or gain is a result of the seas effect on the beach
3. Any gain in material from the sea is shared equally over the beach zones that gain material
4. Any loss in material into the sea is shared equally over the beach zones that lose material.

|      | BEACH ZONE 1                                                                        | BEACH ZONE 2                                                                        | BEACH ZONE 3                                                                        | BEACH ZONE 4                                                                          | VOLUMES                                                             |
|------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| 2005 |    |    |    |    | Volume of Material Moved = 9884m3<br>Net Material Change = +894m3   |
| 2006 |    |    |    |    | Volume of Material Moved = 12676m3<br>Net Material Change = +2446m3 |
| 2007 |    |    |    |    | Volume of Material Moved = 25486m3<br>Net Material Change = -7944m3 |
| 2008 |    |    |    |    | Volume of Material Moved = 7145m3<br>Net Material Change = +767m3   |
| 2010 |    |    |    |    | Volume of Material Moved = 28483m3<br>Net Material Change = -2093m3 |
| 2011 |    |    |    |    | Volume of Material Moved = 2654m3<br>Net Material Change = +6210m3  |
| 2012 |  |  |  |  | Volume of Material Moved = 18614m3<br>Net Material Change = -640m3  |
| 2013 |  |  |  |  | Volume of Material Moved = 17949m3<br>Net Material Change = +4215m3 |
| 2014 |  |  |  |  | Volume of Material Moved = 33505m3<br>Net Material Change = -60m3   |
| 2015 |  |  |  |  | Volume of Material Moved = 31270m3<br>Net Material Change = -4600m3 |