Christchurch Bay & Harbour FCERM Strategy

Marine Conservation Zone Screening and Stage 1 Assessment

Bournemouth, Christchurch, and Poole Council

Project number: 60656006

March 2024

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Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
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1. Introduction

1.1 Project Background

AECOM has been commissioned by Bournemouth, Christchurch, and Poole (BCP) Council to develop a Flood and Coastal Erosion Risk Management (FCERM) Strategy for the coastal frontage at Christchurch Bay and Harbour (herein referred to as 'the Strategy'). The Strategy will be developed collaboratively by AECOM and the Project Board consisting of officers of BCP Council, New Forest District Council (NFDC) and the Environment Agency (EA).

The aim of the Strategy is to provide an integrated plan for the Christchurch Bay and Harbour frontage, delivering sustainable and long-term management for coastal flood and erosion risks over the next 100 years. The Strategy extent is the coastal frontage between Hengistbury Head (immediately to the east of Hengistbury Head Long Groyne) and the landward (western) end of Hurst Spit. Within Christchurch Harbour, the Strategy extent is to Tuckton Bridge on the River Stour and Knapp Mill on the River Avon (Figure 1).

The Strategy is being undertaken across a spatial framework comprised of six Strategy Management Zones (SMZ) (Figure 2) and 18 smaller Option Development Units (ODU) (Figure 3 - Figure 8), each with different proposed management options. The Leading Options are summarised in Table 1 and are further defined within **The Strategy Leading Options Report (AECOM, 2024)**.

Figure 1. Map of Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy area

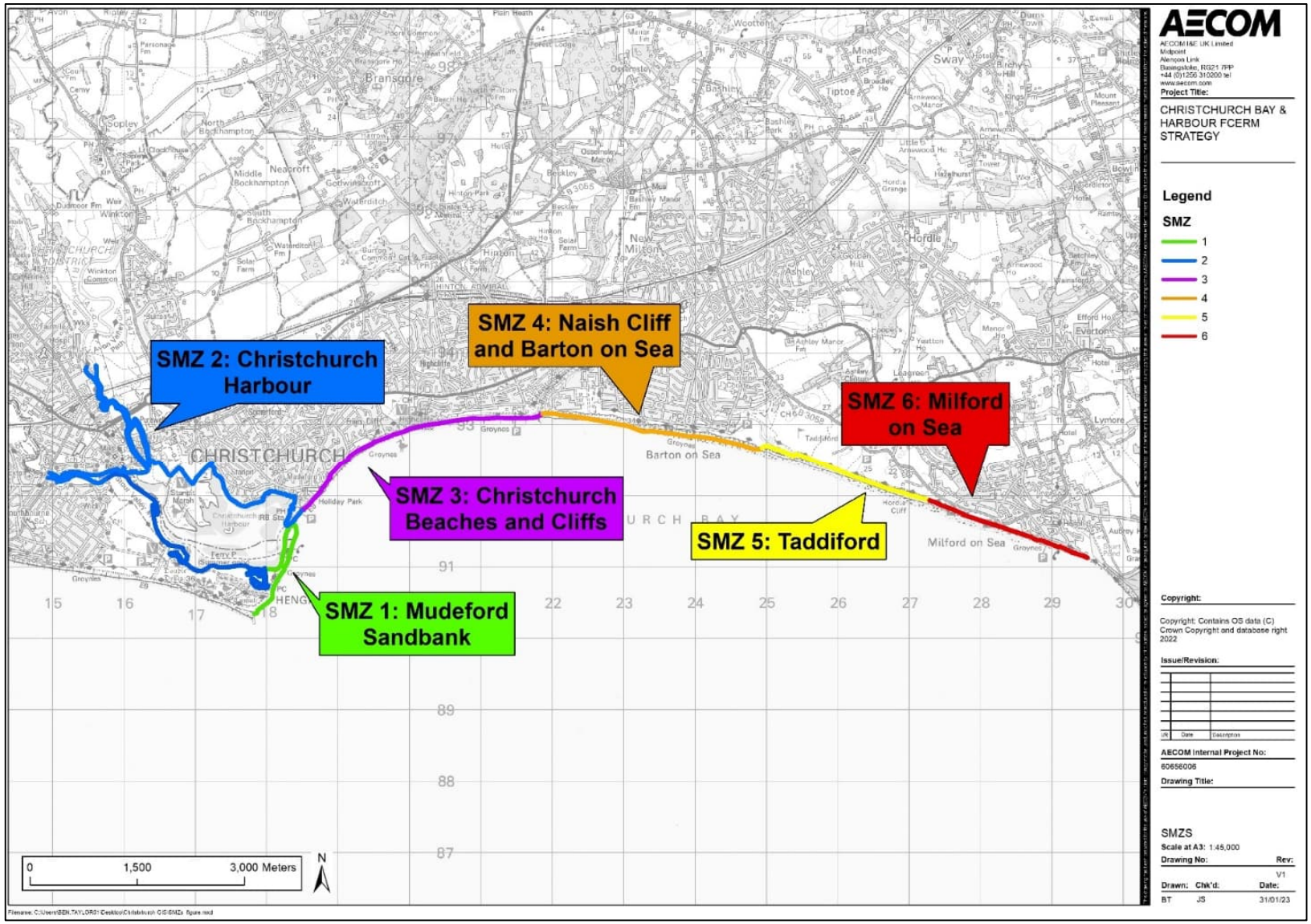

Figure 2. Map of Flood and Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy Management Zones (SMZ)

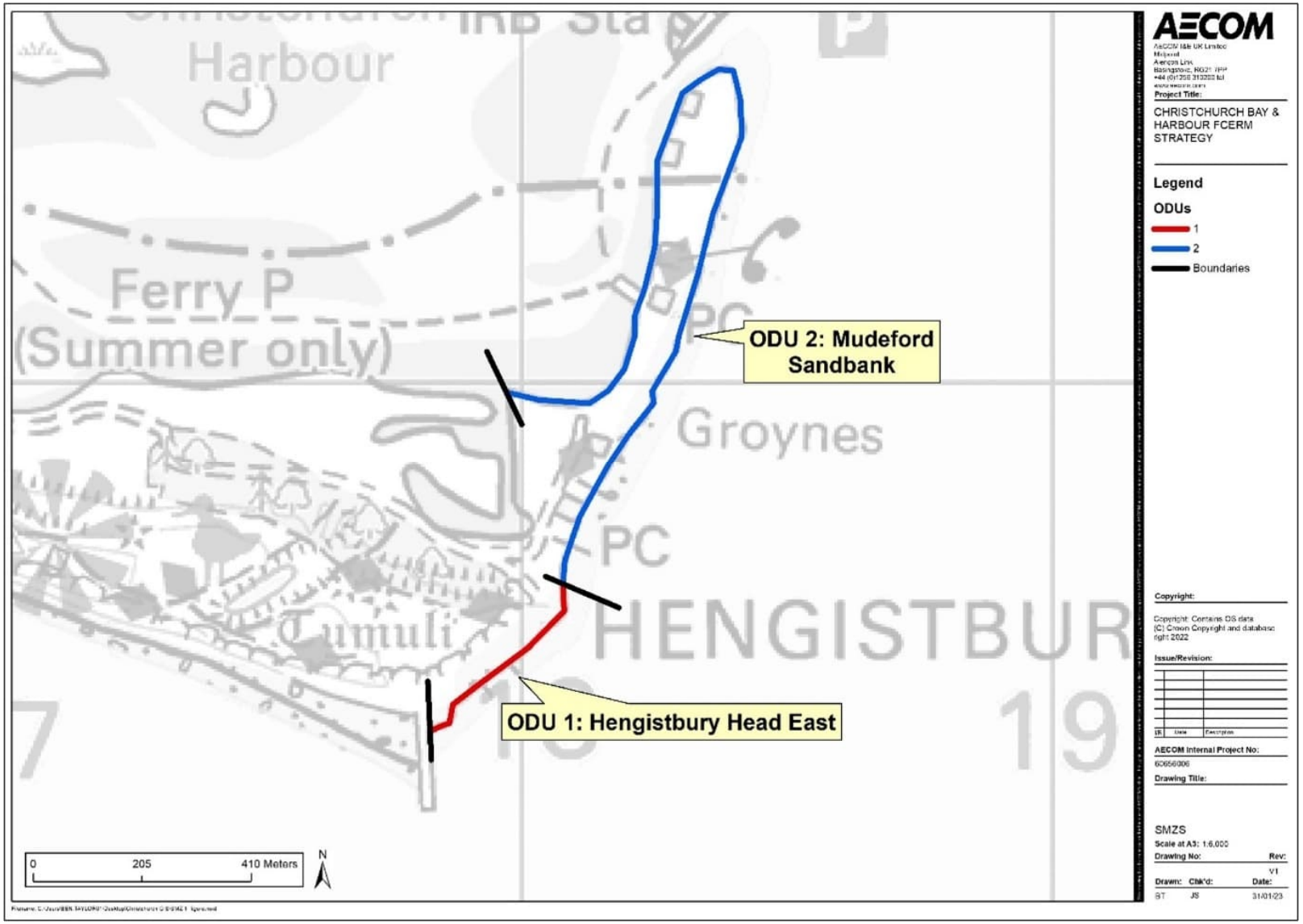

Figure 3. Location of Option Development Units (ODU) 1 and 2 within Shoreline Management Zone (SMZ) 1

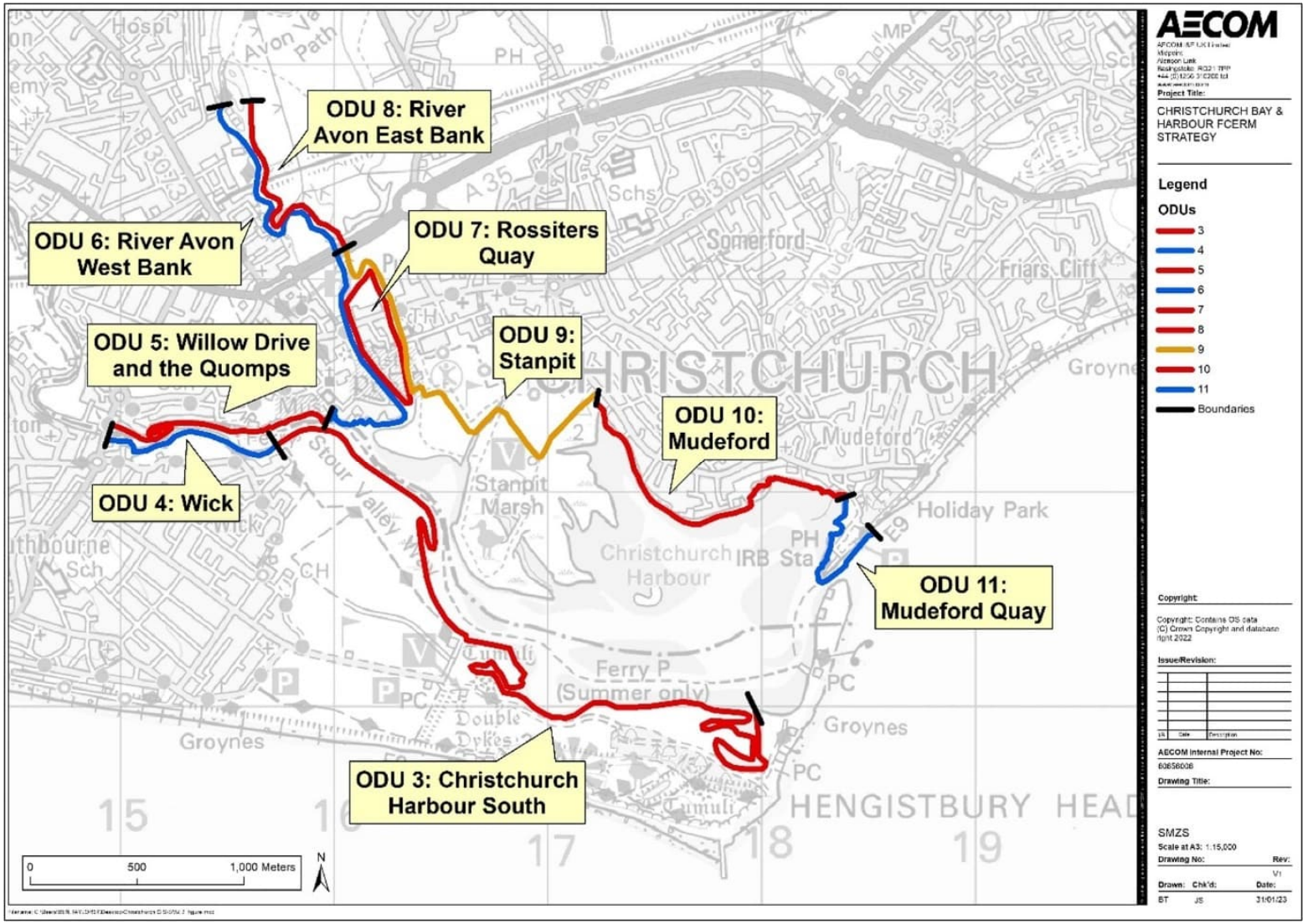

Figure 4. Location of Option Development Units (ODU) 3 to 11 within Shoreline Management Zone (SMZ) 2

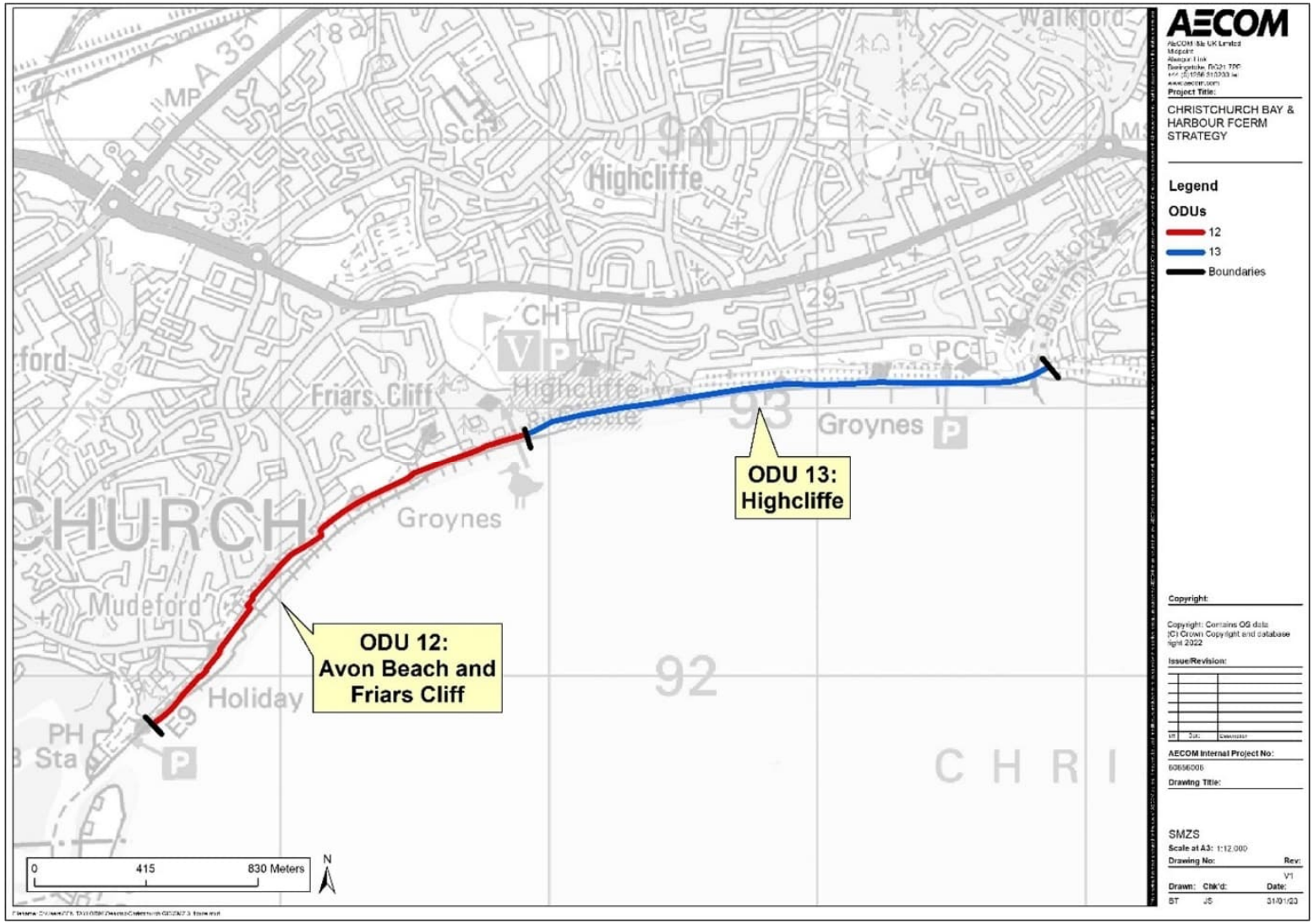

Figure 5. Location of Option Development Units (ODU) 12 and 13 within Shoreline Management Zone (SMZ) 3

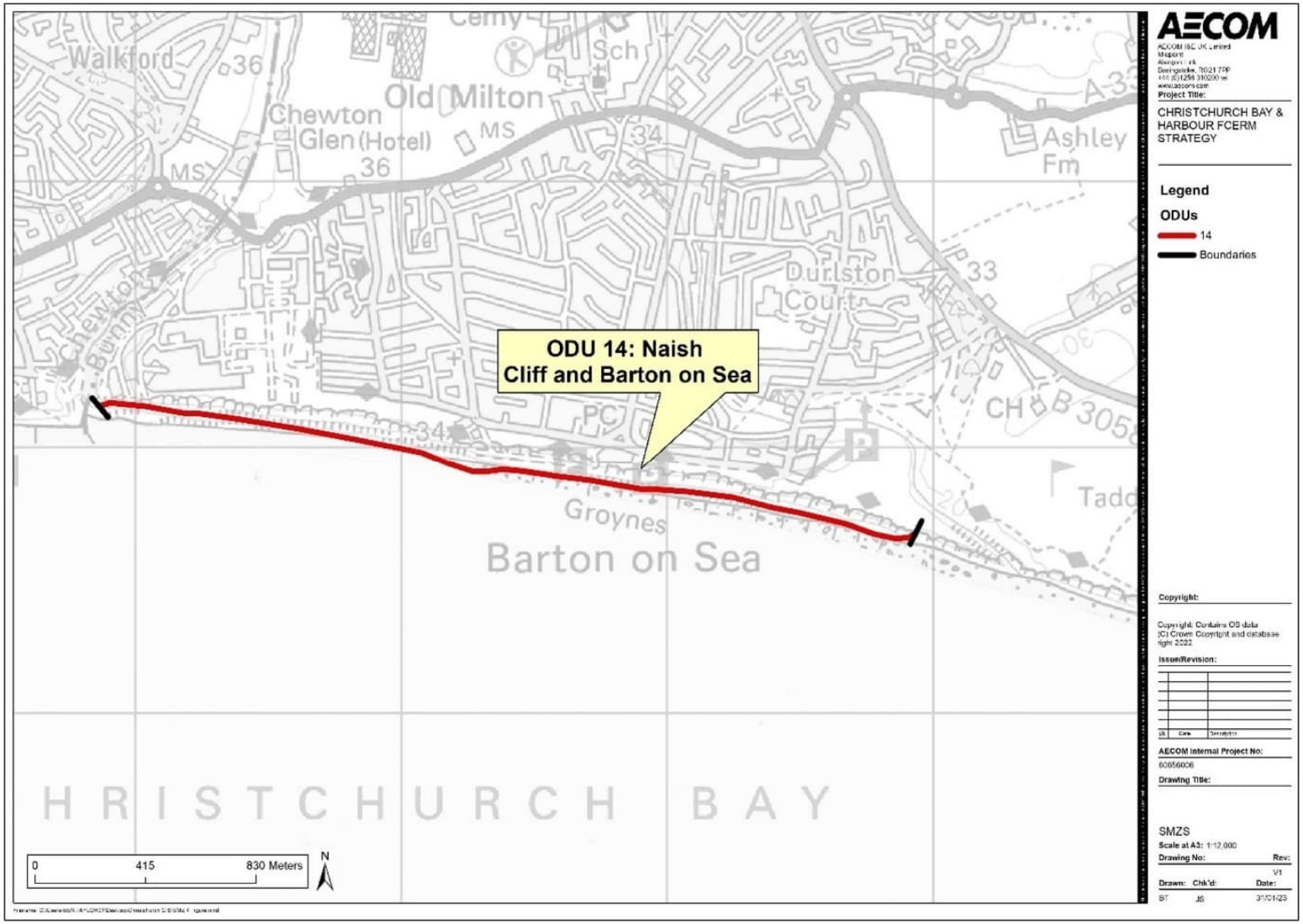

Figure 6. Location of Option Development Units (ODU) 14 within Shoreline Management Zone (SMZ) 4

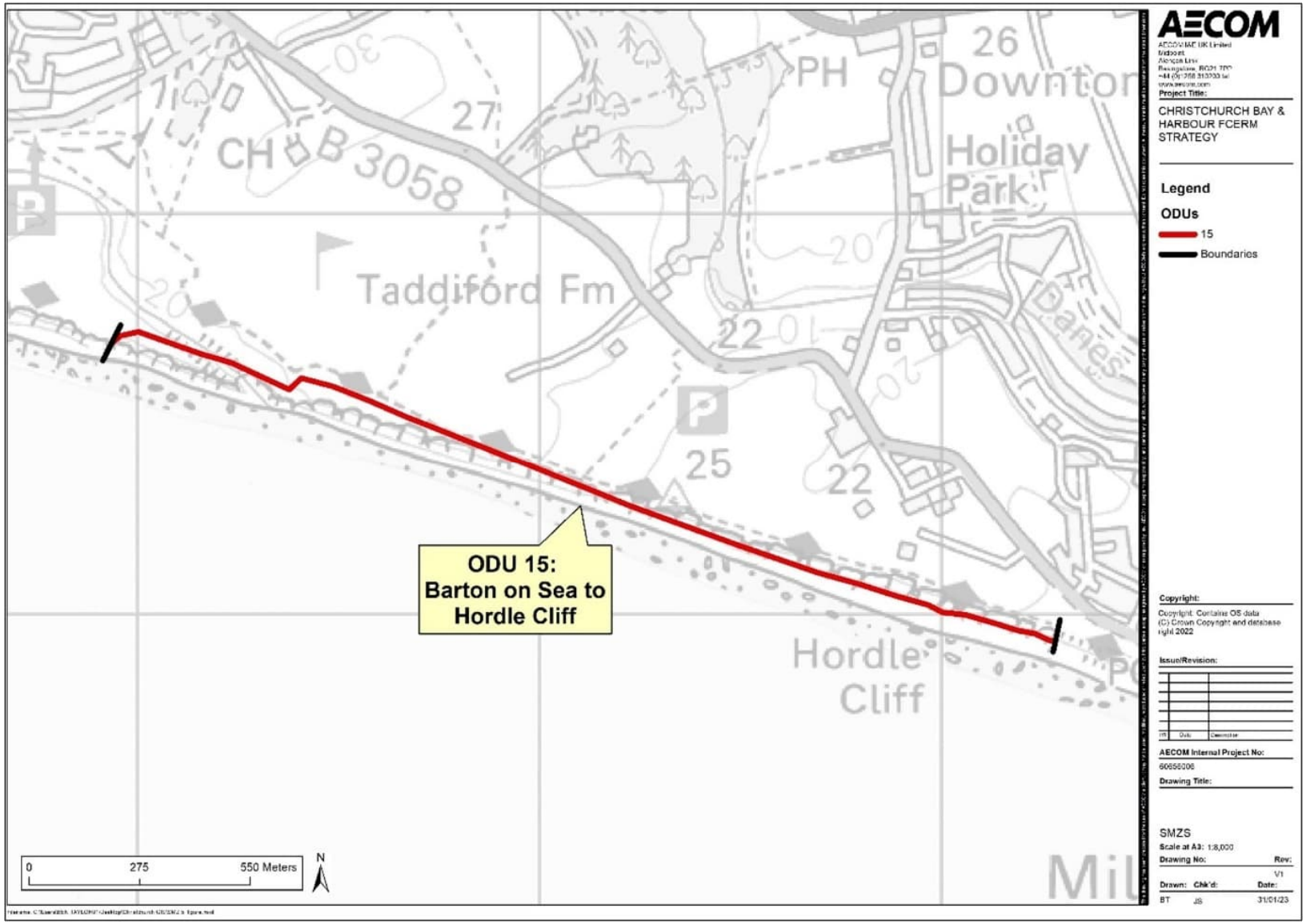

Figure 7. Location of Option Development Units (ODU) 15 within Shoreline Management Zone (SMZ) 5

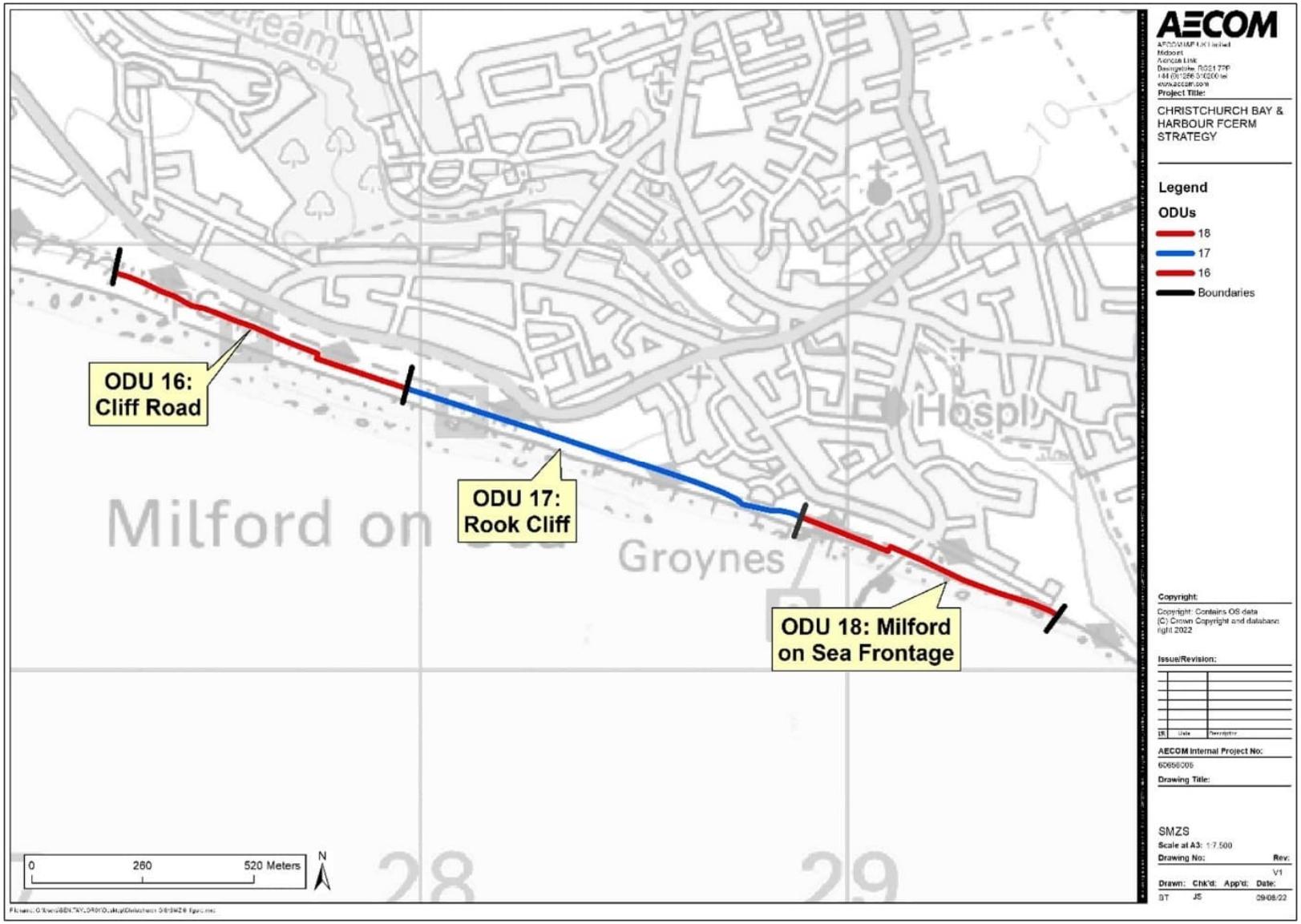

Figure 8. Location of Option Development Units (ODU) 16, 17, and 18 within Shoreline Management Zone (SMZ) 6

1.2 Purpose of this Report

Specific consideration of the potential for impacts on Marine Conservation Zones (MCZs) is required for any marine licence application in English waters. The need for the consideration of MCZs is set out Section 126 of the Marine and Coastal Access Act (2009) (MCAA). This assessment follows guidance outlined by the Marine Management Organisation (MMO), identifying potential impacts to MCZs that could arise from planned activities.

The purpose of this report is to inform the MCZ assessment process in determining whether the Strategy is capable of significantly affecting (other than insignificantly):

- Protected features of an MCZ; and / or
- Any ecological or geomorphological process on which the conservation of any protected features of an MCZ is (wholly or in part) dependant.

This report includes:

1. Section 1: Introduction
2. Section 2: a background to the legislative framework
3. Section 3: a project description
4. Section 4: an overview of the assessment methodology
5. Section 5: An MCZ Screening Assessment, including;
   - Identification of the potential impacts that could arise from the planned activities
   - Identification of the MCZ sites that could be affected
6. Section 6: An MCZ Stage 1 Assessment, including;
   - assessment of the likelihood and magnitude of any impacts on the conservation objectives of the MCZs screened in during the MCZ Screening Assessment.
7. Section 7: Summary and conclusions

The assessment process considered for MCZs during the licensing process is outlined by the MMO in the guidance document ‘Marine conservation zones and marine licensing’ (MMO, 2013).

2. Legislative Framework

MCZs are designated under the MCAA (2009) to protect a range of important marine habitats, species and geological formations in English and UK offshore waters. In conjunction with other existing international and national designations, these sites contribute to an ecologically coherent network of MPAs in the North East Atlantic.

MCZs have been identified through the MCZ Project, set up in 2008 and led by the Joint Nature Conservation Committee (JNCC) and Natural England (NE). The purpose of the MCZ Project was to identify and recommend MCZs to Government for designation. To date a total of 91 sites have been designated.

Under Section 126 of the MCAA (2009), the MMO has a duty to consider MCZs during marine licence decision making. To meet the requirements of Section 126, the MMO has implemented an MCZ assessment process which is integrated into the marine licence decision making procedures. The process comprises three main stages, i) screening, ii) Stage 1 Assessment, and iii) Stage 2 (this is further explained in Section 4).

Section 126 of the MCAA (2009) places specific duties on the MMO relating to MCZs and marine licence decision making. Section 126 applies where:

- A public authority has the function of determining an application (whenever made) for authorisation of the doing of an act; and
- The act is capable of affecting (other than insignificantly):
  - The protected features of an MCZ;
  - Any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or part) dependent.

3. Project Description

As described in Section 1, the frontage is split into six SMZs (Figure 2) and 18 smaller ODUs (Figure 3 - Figure 8), each with different management options.

The **Leading Options Report** (AECOM, 2024) has identified National Economic Leading Options determined by following the Environment Agency's Flood and Coastal Erosion Risk Management Appraisal Guidance (EA, 2020). In some circumstances, the National Economic Leading Option may not be preferable for local decision makers and stakeholders and in these situations a Local Aspirational Leading Option has also been identified, taking into account the local opportunities. These options are summarised in Table 1.

For the majority of the ODUs, these two options are similar; and therefore, the MCZ assessment has been completed based on the National Economic Option. However, for ODUs 3, 4, 11 and 12, there is a significant difference between the options, and therefore, both options are considered.

Further detail regarding the options can be found in the **Leading Options Report**.

Table 1. Summary of Leading Options for the Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy

Shoreline Management Zone (SMZ)	Option Development Units (ODU)	National Economic Leading Option	Local Aspirational Leading Option
1 **Figure 3**	**1**	**Do Minimum** This approach would involve small scale repairs to existing defences (i.e. patch-repairs). Over time the defences would fail, and erosion would be expected to occur.	**Managed Realignment** This approach would involve maintaining the existing defences at the toe of the cliff and beach through proactive maintenance and refurbishments. Beach recycling would also be undertaken to help sustain beach levels in this location, providing support to the linear defences to help reduce the amount of maintenance required.
	2	**Do Minimum** This approach would involve small scale repairs to existing defences (i.e. patch-repairs). Over time the defences would fail, and erosion of the Mudeford Sandbank would be expected to occur.	**Maintain with Adaptation** Sustain the FCERM service of the Mudeford Sandbank by holding its form over time and aiming to keep it broadly in its current position. Achieved through beach nourishment and defence maintenance to the existing seawall, rock groynes and rock revetment. In addition, property level protection to the existing permanent properties on the Mudeford Sandbank to reduce the risk of flooding.
2 **Figure 4**	**3**	**Adaptation / Resilience A** The option is to provide property level protection defence measures. The option does not include any erosion defences. As part of this option, it is also recommended that opportunities for saltmarsh restoration / creation are explored. Potential areas where this could occur could be to the north of the Hengistbury Head access road.	**Adaptation / Resilience C** This option includes the same Property Level Protection measures as Adaptation / Resilience A, but also includes localised erosion defences and defence maintenance. As part of this option, it is also recommended that opportunities for saltmarsh restoration / creation are explored.
	4	**Sustain C** In the east part of the unit this option is raising and lengthening the existing flood defence embankment over time to keep pace with sea level rise. However, in the west part of the unit there would be no capital refurbishments or upgrades to the existing quay wall.	**Sustain B** This option would involve undertaking repeat capital refurbishments of the existing quay wall in the west part of the unit. However, this would not involve raising the crest level of the quay wall and therefore over time there would be increased flood risk to the historic landfill site, with a potential for leaching to occur. In the east part of the unit the approach would be to lengthen the existing flood defence embankment.

Shoreline Management Zone (SMZ)	Option Development Units (ODU)	National Economic Leading Option	Local Aspirational Leading Option
	5	**Improve D-F (alignment to be decided)** **<u>Improve D</u>** Improve D follows the same approach as Improve A, except the initial upgrade to the defences would occur at a later date. **<u>Improve E</u>** Improve E follows the same approach as Improve B, except the initial upgrade to the defences would occur at a later date. **<u>Improve F</u>** Improve F follows the same approach as Improve C, except the initial upgrade to the defences would occur at a later date.	**Improve A-C (alignment to be decided)** **<u>Improve A</u>** This option includes upgrading defences to manage the flood risk. In the west part of the unit the existing frontline quay wall would be upgraded, and in the east part of the unit the existing setback floodwall would be raised. It would result in a high up-front investment but would mean that repeat interventions over time to raise and lengthen the defences would not be required. **<u>Improve B</u>** This option includes upgrading defences the manage the flood risk. In the west part of the unit the existing frontline quay wall would be upgraded and in the east part of the unit, rather than raising the setback floodwall. **<u>Improve C</u>** This option includes no new defences along the frontline alignment in the west of the unit. In the east part of the unit, the option involves upgrading the defences, raising the setback floodwall, and refurbishing the existing frontline wall.
	6	**Adaptation / Resilience** This option would involve implementing property level protection to the properties at risk of flooding in this unit. In addition, this option would also involve maintenance of the existing quay walls.	
	7	**Improve A** This option includes constructing new flood defences, resulting in a higher up-front investment, but would mean that repeat interventions over time to raise and lengthen the defences would not be required.	
	8	**N/A*** **This area is within the original Strategy boundaries. However, flood management options are now being developed through future projects on the Lower River Avon (Environment Agency), rather than the Christchurch Bay and Harbour FCERM Strategy*	
	9	**Sustain A** This option would involve constructing new flood defences and then lengthening / raising them over time to keep pace with sea level rise. The alignment of the defences will need to be determined during outline design / business case development but for the purposes of the Strategy appraisal it has been assumed that the new defences would follow the existing defence alignment in the north part of the unit adjacent to the River Avon. At Stanpit Marsh in the south, it has been assumed that the new defence will follow the existing shoreline position around the historic landfill site. It would be the intention to build the new defence within the footprint of the existing bank / verge to minimise footprint encroachment into the harbour / saltmarsh habitat. Due to sea level rise, the existing saltmarsh habitat in front of Stanpit Marsh historic landfill site could be threatened in the future. Therefore, work should be undertaken as part of this option to investigate opportunities to enhance / restore the saltmarsh habitat. This could involve placing dredged material in the saltmarsh area to encourage accretion, allowing the saltmarsh to recolonise higher areas as sea levels rise. Other options for saltmarsh restoration such as seeding / planting / fencing could also be explored.	
	10	**Improve A** This option would involve constructing new flood defences (likely in the form of a quay wall with a raised floodwall). For the purposes of costing / Strategy development the defence alignment has been assumed to be along the same alignment of the existing frontline quay wall along the length of the unit. This would ensure minimal encroachment into the harbour to minimise impact on biodiversity / ecology. At either end of the frontage the new defences would be extended to tie-in with adjacent areas. New defences may also be required along the lower sections of the River Mude and Bure Brook.	

Shoreline Management Zone (SMZ)	Option Development Units (ODU)	National Economic Leading Option	Local Aspirational Leading Option
		Access is a key consideration along the frontage in this location and therefore it is likely that deployable flood defences such as flood gates will need to be incorporated into the defence alignment in some locations. Due to sea level rise, the existing saltmarsh habitat in the harbour could be threatened in the future. Therefore, work should be undertaken as part of this option to investigate opportunities to enhance / restore the saltmarsh habitat. This could involve placing dredged material in the saltmarsh area to encourage accretion, allowing the saltmarsh to recolonise higher areas as sea levels rise. Other options for saltmarsh restoration such as seeding / planting / fencing could also be explored.	
	11	**Do Minimum** This approach would involve small scale repairs to existing defences (i.e. patch-repairs). Over time the defences would fail, and erosion would be expected to occur.	**Adaptation / Resilience** This option would involve maintaining the existing quay walls through to the end of the Strategy period. This would be achieved through a series of capital refurbishments to the existing defences over time, as required based on the condition and deterioration of the defences. However, it would also involve providing property level protection to the properties at risk of flooding in the unit throughout the appraisal period.
3 **Figure 5**	**12**	**Improve A** This option is focussed on increasing the beach levels and providing upgraded linear defences and beach control structures. This would minimise the probability of any land / cliff erosion from occurring in the future. This option would be achieved by initially refurbishing the existing linear defences (seawall and rock revetment), and then a large-scale beach nourishment scheme would then be undertaken alongside the construction of new rock groynes to help retain the beach material. At the same time the seawall at Avon beach would be raised so that it could accommodate the additional beach volume in front of the wall. For the purposes of costing, it has been assumed that the beach nourishment would need to be repeated in the future, but with a lower volume of material relative to the initial scheme. The dominant longshore drift direction is from west to east and therefore the beach nourishment scheme here would also provide a strategic benefit to the adjacent unit (ODU 13) over time. Through ongoing beach management this option would provide protection to minimise the chance of erosion to the land / cliffs behind the beach and would also provide an amenity benefit to the area by retaining / increasing beach volumes in the future.	**Improve C** This option is similar to Improve A but would involve additional investment into raising the seawall and promenade area at the back of the beach along its full length.
	13	**Improve C** This option is the same approach as Improve A with the only difference being in the timing of the major beach nourishment intervention.	**Improve A** The objective of this option is to minimise the amount of cliff erosion in the future by refurbishing the existing defences and using soft engineering solutions such as Beach Nourishment to defend the toe of the cliff. This option would involve constructing a new rock armour defence at the eastern end of the unit to prevent outflanking of the existing defences. Initially, this would largely be a continuation of the existing management approach, with small scale patch-repair of the existing defences as well as beach recycling to top-up any areas prone to erosion. Then beach nourishment would be undertaken to help mitigate the potential impacts of sea level rise. At a later date, new rock groynes may be constructed. At this point in time new groynes

Shoreline Management Zone (SMZ)	Option Development Units (ODU)	National Economic Leading Option	Local Aspirational Leading Option
			may be required to help retain beach material due to sea level rise. The design of the beach nourishment scheme in this location would need to consider the beach nourishment scheme in ODU 12 and the potential feed of material from this location. By defending the toe of the cliff throughout the next century, it has been assumed that the existing cliff drainage system that is working well would continue to operate and would not require large scale replacement / refurbishment as part of this option.
4 **Figure 6**	**14**	**Managed realignment A** This option involves providing new toe defences and cliff drainage / stabilisation from Marine Drive West to the eastern end of Barton on Sea.. The initial capital interventions as part of this option would be most likely between years 5-10. This would involve the following initial interventions: • Construction of a rock revetment at the toe of the cliff beneath Marine Drive West. • Refurbishment / upgrade of the existing rock revetment at the toe of the cliff between the Cliff House Hotel and the eastern end of Marine Drive East. • Installation of new cliff stabilisation / drainage between the western end of Marine Drive West and Barton Court Avenue. The option would aim to significantly slow the rate of cliff top erosion between the western end of Marine Drive West and the eastern end of Barton on Sea.	
5 **Figure 7**	**15**	**Do Nothing** The Do Nothing scenario is a scenario whereby any maintenance of FCERM assets or defences and/or beach management is not undertaken. With the Do Nothing scenario, the cliffs would continue to erode over time. As the cliffs erode this option may involve ensuring health and safety compliance – e.g. restricting access to unsafe zones / clearance of debris etc.	
6 **Figure 8**	**16**	**Managed Realignment C** This option is the same overall approach as Managed Realignment A and B, except the initial interventions would be delayed. This would lead to more erosion of the cliff in the interim period. With this approach it has been assumed that an even longer length of defence would be required for the strong point (250-300 m).	**Managed Realignment A or B** **<u>Managed Realignment A</u>** The Managed Realignment approach would seek to control the rate of cliff erosion and transition the coastline position into a more sustainable position over time, creating a wider space for the beach to adjust to sea level rise. This would result in some erosion to the cliff top, but this would be controlled through the use of toe defences in strategic locations and beach nourishment. This option would allow some erosion of the open space between the cliff top and the Cliff Road but would aim to prevent the erosion progressing to the main road and beyond. Initially, this option would involve undertaking beach nourishment along the full frontage to provide the primary defence to the cliff toe. It has been assumed that the volume of material added to the beach would be approximately 100,000 m^3. In addition, at the base of the cliff beneath the junction between Cliff Road and Whitby Road, a local strong point would be constructed (likely rock armour). It is envisaged that it would be a rock structure approximately 50-100 m in length. It would act to hold the position of the coastline in this location, providing a local anchor point for the cliff line to the west and east. **<u>Managed Realignment B</u>** This option is the same overall approach as Managed Realignment A, except the initial interventions would be delayed. This may lead to more erosion of the cliff in the interim period. With this approach it has been assumed that a

Shoreline Management Zone (SMZ)	Option Development Units (ODU)	National Economic Leading Option	Local Aspirational Leading Option
			longer length of defence would be required for the strong point (150-200 m).
	17	**Improve C** This option is the same overall approach as Improve A and B, however the initial capital intervention to upgrade the toe defences and add cliff drainage / stabilisation would be delayed even further. It is unlikely that the existing toe defences could be maintained until this time with just small-scale maintenance, and therefore this option also includes an initial refurbishment of the existing toe defences.	**Improve A or B** **<u>Improve A</u>** This option would aim to minimise the amount of erosion to Rook Cliff and would achieve this by upgrading the defences at the cliff toe and installing cliff stabilisation / drainage measures to the cliff. In addition, beach control structures such as groynes would be constructed to help retain beach material. Should the leading options be implemented in ODU 16 to the west there could be an increased feed of material from the west due to the beach nourishment scheme and therefore the groynes in ODU 17 would be used to capture this material. The initial intervention would be undertaken between the years 5-10. This would involve constructing an upgraded rock revetment along the majority of the frontage that would be designed to accommodate variable beach levels and sea level rise. It has been assumed that the rock revetment would not be required in the section of frontage that was recently stabilised with rock given the long existing residual life of this part of the defence system. In addition, rock or timber groynes would also be constructed to help capture beach material (from ODU 16) and Rook Cliff would be stabilised with a cliff stabilisation / drainage scheme. At a later date, the new defences (rock revetment and cliff drainage) will be refurbished given the exposed nature of this frontage and higher potential for damage to occur. **<u>Improve B</u>** This option follows the same approach as Improve A, but the initial capital interventions would be delayed until a later date.
	18	**Improve A** The aim of this approach would be to improve beach levels in this location to improve the protection provided to the toe of the defences and to reduce flood risk by constructing setback defences. Initially, this would involve a large-scale capital beach nourishment scheme to add significant quantities of material to the beach in this location. At the same time as undertaking the beach nourishment, the seawall in this unit would be upgraded. New groynes would also be constructed to help to retain the material placed in this location. In the future, the beach nourishment would need to be repeated to ensure the beach volume stayed as desired. To reduce the risk of tidal flood risk from the Sturt Pond direction this option would involve constructing a setback defence at the eastern end of Milford on Sea.	

4. Assessment Methodology

Guidance published by the MMO describes how MCZ Assessments could be undertaken during the process of marine licence decision making (MMO, 2013). These MMO guidelines recommend a staged approach to assessment, involving three sequential stages: screening, stage 1 assessment, and stage 2 assessment. Full details of these stages have been provided below and presented in Figure 9.

- **Screening** – Determine whether the licensable activity is taking place within of near an area being put forward or already designated as an MCZ and whether the activity is capable of affecting (other than insignificantly) either (i) the protected features on an MCZ; or (ii) any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant. If the answer is yes, then proceed to Stage 1. MCZ Screening for the Christchurch Bay and Harbour FCERM Strategy was completed in April 2023 and is presented in Section 5 of this report.
- **Stage 1 Assessment** – Is the authority satisfied that there is no significant risk of the activity hindering the conservation objectives stated for the MCZ and can the authority exercise its functions to further the conservation objectives of the site. If the answer is no to either of these questions, then the authority must consider whether there are other means of proceeding with the act which would create a substantially lower risk of hindering the achieving objectives. If the answer is still no, then proceed to Stage 2.
- **Stage 2 Assessment** – This stage looks at whether the benefit to the public clearly outweighs the risk of damage to the environment and seeks to satisfy the authority that the applicant can make arrangements to undertake measure of equivalent environmental benefit to the damage which the act will have of the MCZ.

To determine whether section 126 applies, it is necessary to consider the geographical proximity of the Proposed Project to the MCZ, and the potential for proposed activities to affect the designated features of an MCZ or the ecological/geomorphological processes upon which designated features are reliant.

A risk-based approach is recommended by the MMO when determining the proximity of an activity to an MCZ. The application of appropriate buffer zones to the protected features of an MCZ under consideration, as well as consideration of the potential risk of impacts from activities at greater distances from the MCZ is necessary.

If the screening stage determines that section 126 does apply, it is necessary for the MMO to assess which elements of section 126 should apply to a marine licence application.

The leading options for the FCERM Strategy include National Economic and Local Aspirational Options. For the majority of the ODUs, these two option types are similar; and therefore, the MCZ assessment has been completed based on the National Economic Option. However, for ODUs 3, 4, 11 and 12, there is a significant difference between the options, and therefore, both options are considered during this assessment.

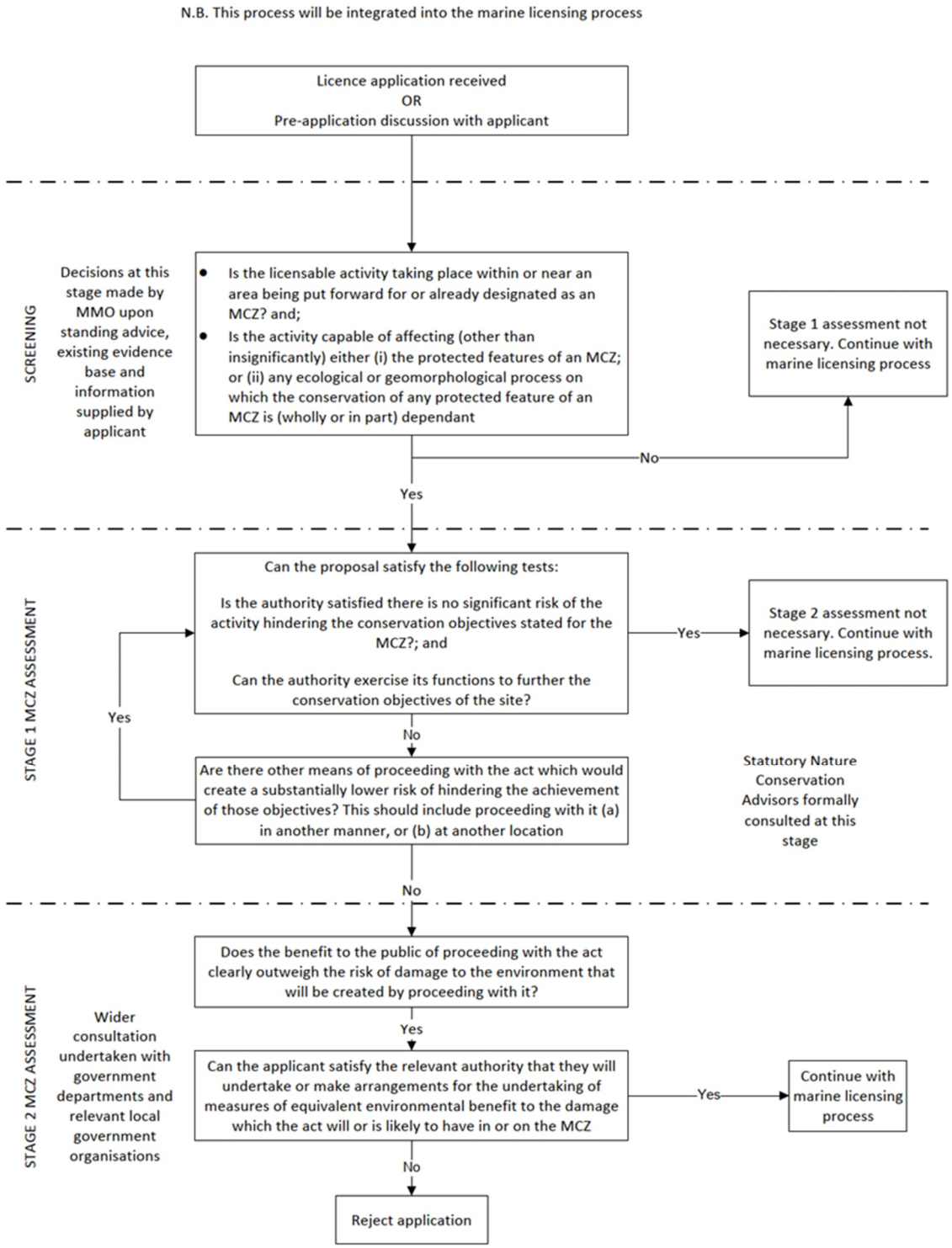

Figure 9. Summary of the Marine Conservation Zone (MCZ) assessment process used by the Marine Management Organisation (MMO) in marine licence decision making (MMO, 2013)

5. MCZ Screening Assessment

5.1 Potential Impacts, Effects and Zones of Influence

The OSPAR Intersessional Correspondence Group on Cumulative Effects pressure list and the Marine Life Information Network (MarLIN) (Tyler-Walters, et al., 2023) marine evidence-based sensitivity assessments (MarESA) (Tyler-Walters, Tillin, d'Avack, Perry, & Stamp, 2018) have been used to describe the potential impacts expected from the Offshore Scheme.

The impact pathways and associated Zones of Influence (ZoIs) (the extent of the potential impact from the activity) considered within this assessment are those that specifically relate to benthic habitats, benthic species, and fish receptors. A summary of impact pathways and associated ZOIs are presented in Table 2.

Table 2: Potential impact pathways from the Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy and their associated Zones of Influence (ZoI) that could affect habitats and species

Potential impact pathway	Rationale	ZoI
Direct loss and physical disturbance to habitats and species	Activities associated with the Strategy may include the refurbishment, extension and/or construction of defences. Generally, it is expected that new hard defences would be constructed within the footprint of existing defences and would therefore not be expected to lead to habitat loss although there are some exceptions (the Habitat Regulations Assessment assesses this in more detail). These activities can result in temporary and/or permanent physical disturbance to and/or loss of intertidal and subtidal benthic habitats and species within the footprint and immediate vicinity of the works. There is also potential for the loss of seabed areas that could be important for fish habitat, including spawning grounds. In options where construction would introduce artificial hard substrata (including options for Option Development Units (ODU) 1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14, 16, 17, and 18) which could have the capacity to function as an artificial rocky reef allowing species dependant on hard substrates to colonise areas that might have previously been unsuitable. This is effectively replacing one habitat type for another, which may (or may not) be beneficial for the area. The impact of this resultant loss is expected to be limited to the Strategy footprint. Sensitivity to physical disturbance varies between receptors. For mobile receptors displacement would be likely, whilst sedentary or less mobile receptors may experience physiological/morphological damage and/or mortality. The impact of impact pathway is expected to be limited to the proposed Project footprint, therefore, a precautionary ZoI of 25 m has been identified.	Localised to the Strategy frontage (25 m)
Temporary increase in Suspended Sediment Concentration (SSC) and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects	Activities such as beach nourishment, have the potential to increase SSCs within the water column. Beach nourishment has been identified as an option for ODUs 2, 12, 13, 16, and 18. Increased SSC may reduce the feeding efficiency and subsequent growth rates of filter feeders if clogging of feeding structures occurs. Any contaminants, such as heavy metals and toxins, within the sediments, can also be released into the water column and may alter marine water quality with subsequent indirect effects on benthic species. Moreover, an increase in SSC can elevate turbidity, which can reduce photosynthesis and result in reduced primary production in marine seaweed and algae. Furthermore, increased deposition can smother the seabed, potentially resulting in changes to seabed geomorphology, sediment structure and habitats. This would have an impact on species that currently rely on these habitats for food, refuge, and reproduction, leading to potential indirect effects on survival, growth, reproduction, and displacement of individuals. As exact details regarding construction methodology are yet to be confirmed, a precautionary ZoI has been identified. This ZoI has been identified based on professional judgement and experience with projects in highly dynamic environments. Therefore, the effect of increased sediment concentrations is expected to be limited to within 5000 m. This should be considered in relation to coastal processes (**Coastal Processes Report, AECOM 2022**) and knowledge on local sediment transport (**Figure 10**).	5000 m

Potential impact pathway	Rationale	ZoI
Underwater noise and vibration	During construction, underwater noise may be generated by a range of construction activities. Construction within the marine environment is only anticipated to occur within Christchurch Harbour (Shoreline Management Zone 2; ODUs 3 to 11) where new piling may be required. Manmade sound sources, particularly if of high intensity or long duration have the potential to result in permanent and temporary injury and auditory effects and can result in masking and behavioural disturbance in a range of species. There has been very little research into the impact of underwater noise on marine invertebrates. At present there are no published sensitivity thresholds for this receptor group. However, effects to invertebrates have been recorded in some studies such as Solan et al. (2016) where a number of species tested, including the crustacean *Nephrops norvegicus* and the bivalve *Ruditapes philippinarum*, demonstrated behavioural responses to impact pile driving sound source levels in a controlled laboratory environment. In other laboratory experiments, Wade et al. (2016) found some evidence for a stress response in green shore crab, *Carcinus maenas,* subject to ship playback sound, particularly in larger individuals. However, repeated exposure responses indicated that the crabs habituated or become tolerant to it. Therefore, there is currently very limited evidence to suggest that the type and duration of underwater noise that will be generated by the proposed Project will have any effect on benthic communities. However, there is also potential for underwater noise to impact fish behaviour The ZOI for potential underwater noise impacts varies depending on the species (Popper, et al., 2014)	Varies depending on the species, considered on a site-by-site basis.
Introduction and spread of Invasive Non-native Species (INNS)	In options where construction would introduce artificial hard substrata, there is the potential for impacts on localised biodiversity. These structures could provide different environmental conditions suitable for marine organisms. There is potential for colonisation by INNS which could displace local fauna. INNS are capable of spreading rapidly, and the introduction of structures to the seabed could facilitate the localised spread of any existing INNS populations. Given the number of vessels that visit the site, which can act as vectors for the transport of INNS, Christchurch Bay may be susceptible to new introductions. Currently, slipper limpet, *Crepidula fornicata*, are known to be present within Christchurch Bay (Colenutt & Evans, 2014) and nearby areas (Mylroie, Evans, & Colenutt, 2015). Wire weed, *Sargassum muticum*, and Pacific oyster, *Magallana gigas*, have also been identified within the area (Dale, 2012). These species are already well established in waters along the south coast of England. It is assumed that with appropriate mitigation, and adherence to best practice measures, employed by vessels and during construction, the impact of introduction and spread of INNS will be minimal, and considered on a sit-by-site basis.	Considered on a site-by-site basis

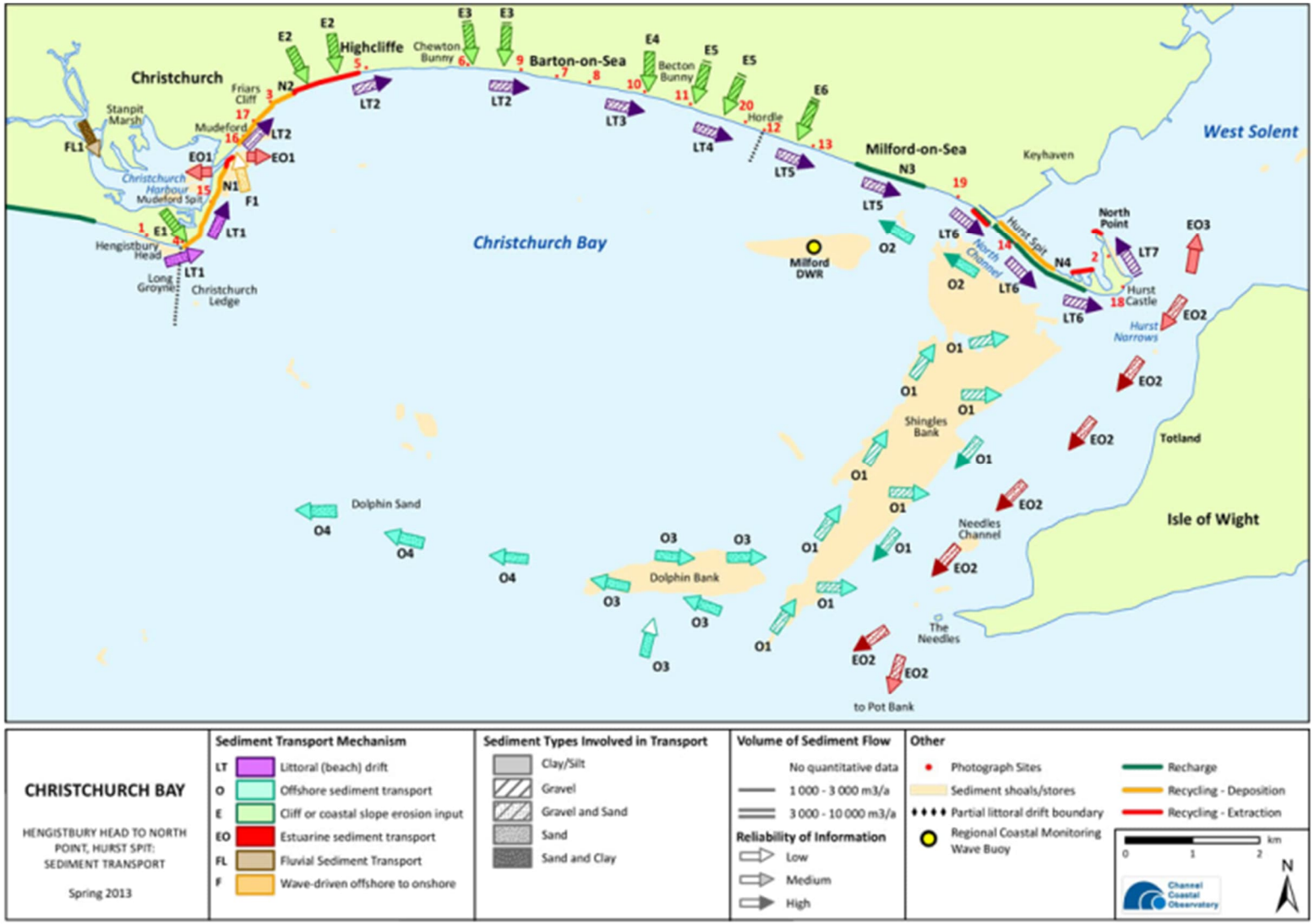

Figure 10: Schematic diagram of sediment transport pathways in Christchurch Bay (obtained directly from SCOPAC, 2012)

5.1.1 Summary of Potential Impact Pathways

The potential impact pathways for the proposed Project are outlined in Table 2**.**

The following potential impact pathways could be associated with the construction phase of the proposed Project and will be included in the following MCZ Assessment:

- Direct loss and physical disturbance to habitats and species;
- Temporary increase in Suspended Sediment Concentration (SSC) and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects;
- Underwater noise and vibration; and
- Introduction and spread of Invasive Non-native Species (INNS).

5.2 Screening

The assessment approach applied during the MCZ screening is based on MMO guidance document (2013) and presented in Figure 11.

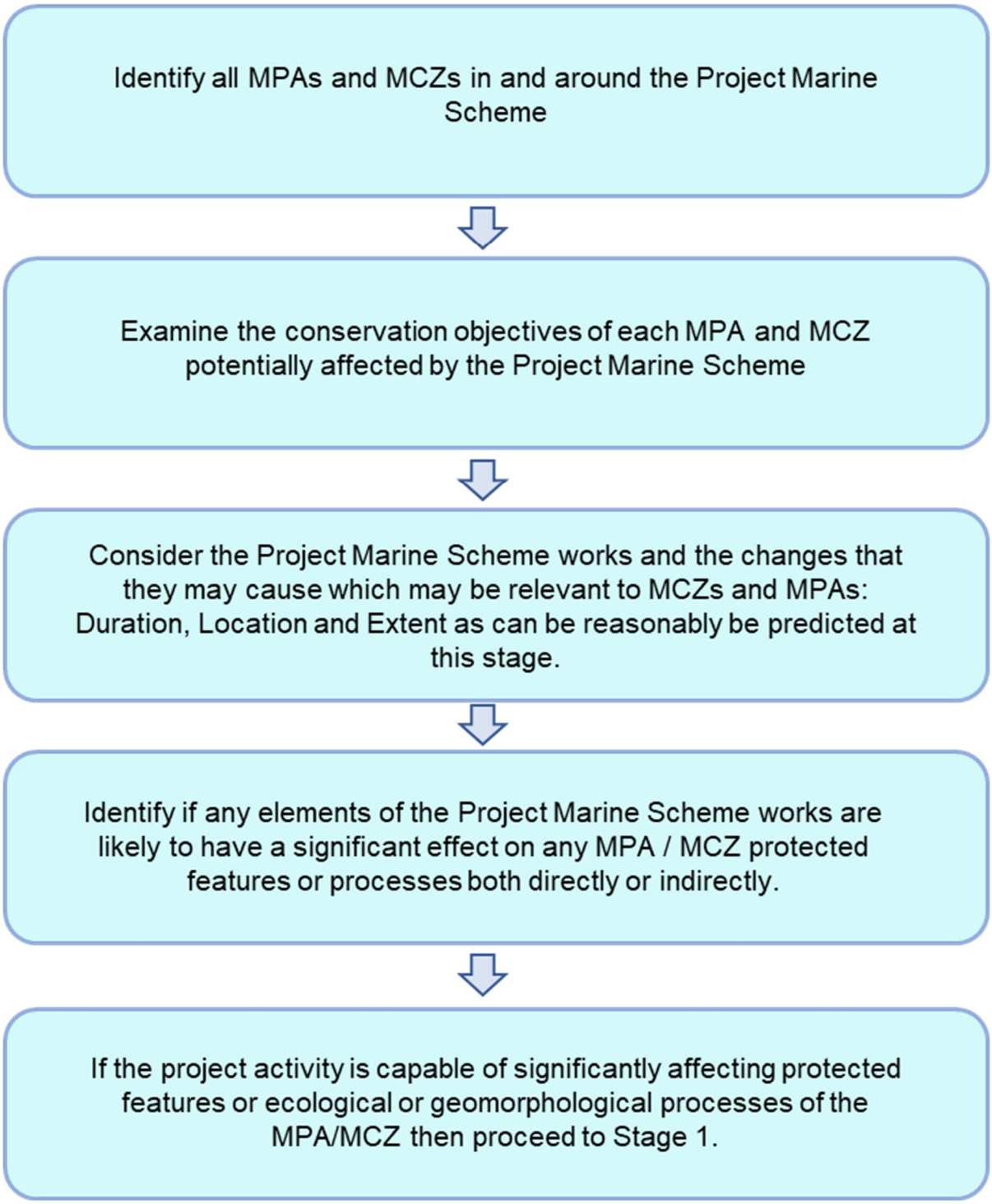

Figure 11: Marine Conservation Zone (MCZ) assessment screening process

In line with the precautionary approach encouraged by the MMO and CIEEM Guidance for assessment (CIEEM, 2018), the screening process has considered any MCZ site within 10 km of the FCERM frontage. This is considered to be a sufficiently precautionary buffer around the proposed Project, that exceeds the maximum ZoI of project related activities that are likely to impact MCZ designated features in this instance.

Therefore, any MCZ within 10 km of the proposed Project has been assessed within the screening stage (Figure 12, Table 3).

Figure 12: Marine Conservation Zones (MCZ) in the vicinity of the Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy frontage

Table 3: Marine Conservation Zones (MCZs) screened into the next stage of the assessment for Christchurch Bay & Harbour Flood and Coastal Erosion Risk Management (FCERM) Strategy

Site name	Protected Features	Distance to FCERM frontage (km)	Screening decision	Reason for screening decision
The Needles MCZ (UKMCZ0040)	• Moderate energy infralittoral rock; • High energy infralittoral rock; • Moderate energy circalittoral rock; • Subtidal chalk; • Subtidal coarse sediment; • Subtidal mixed sediments; • Subtidal sand; • Subtidal mud; • Sheltered muddy gravels; • Seagrass Beds; • Stalked jellyfish *Lucernariopsis campanulata*; • Peacock's tail *Padina pavonica*; and • Native oyster *Ostrea edulis*.	2.9 km	In	Sessile features and habitats such as seagrass are very sensitive to SSC and increased deposition. Based on SCOPAC (2012), littoral sediment moves towards this MCZ and there are therefore, potential impacts from activities such as the beach nourishment anticipated to occur in ODUs 16 and 18. There are potential impact pathways associated with the proposed Project that may adversely impact the features of the MCZ. As the impacts are uncertain at this stage, The Needles MCZ has been screened in for further consideration.
Southbourne Rough MCZ (UKMCZ0071)	• Black seabream *Spondyliosoma cantharus* (nesting).	3.0 km	In	Black sea bream exhibit inshore spawning aggregations over the nesting sites, including male nest creation and guarding behaviours lasting several weeks (Pinder, Velterop, Cooke, Britton, & Michel, 2017) between April and July (Collins & Mallinson, 2012). Bream are demersal spawners and depend on particular substrates in which to excavate their nests. Nests are created by adult males clearing sediment to expose underlying hard substrate for eggs to adhere to, with the males remaining at the nest site until eggs hatch. As the nests are constructed of relatively mobile gravel

Site name	Protected Features	Distance to FCERM frontage (km)	Screening decision	Reason for screening decision
				and sediment, they require constant maintenance during occupation by bream. Therefore, an increase in SSC and settlement of sediment may result in nesting bream expending higher levels of energy ensuring that eggs within the nest remain clear from silt. This may impact the success of the bream guarding nests. There are potential impact pathways associated with the proposed Project that may impact the features of the MCZ, specifically the effects of underwater noise and vibration, as well as temporary increase in Suspended Sediment Concentration (SSC) and sediment deposition. It is considered that any impacts are unlikely based on the precautionary Zone of Influence (ZoI) identified in Table 2. However, as the impacts are uncertain at this stage, Southbourne Rough MCZ has been screened in for further consideration.
Yarmouth to Cowes MCZ (UKMCZ0075)	• Bouldnor Cliff geological feature; • Estuarine rocky habitats; • Intertidal coarse sediment; • Intertidal under boulder communities; • Littoral chalk communities; • Low energy intertidal rock; • Moderate energy intertidal rock; • Subtidal coarse sediment; • High energy circalittoral rock; • High energy infralittoral rock; • Moderate energy circalittoral rock;	6.0 km	Out	Yarmouth to Cowes MCZ is beyond the ZoI of potential impact pathways associated with the proposed Project that may adversely impact the habitats and sessile features of the MCZ. **No LSR is determined.**

Site name	Protected Features	Distance to FCERM frontage (km)	Screening decision	Reason for screening decision
	• Moderate energy infralittoral rock; • Native oyster *Ostrea edulis*; • Peat and clay exposures; • Sheltered muddy gravels; • Subtidal chalk; • Subtidal mixed sediments; and • Subtidal mud.			
Poole Rocks MCZ (UKMCZ0014)	• Moderate energy circalittoral rock; • Subtidal mixed sediments; • Black seabream *Spondyliosoma cantharus*; • Couch's goby *Gobius couchi*; and • Native oyster *Ostrea edulis*.	9.0 km	Out	Poole Rocks MCZ is beyond the ZoI of potential impact pathways associated with the proposed Project that may adversely impact the habitats and species of the MCZ. **No LSR is determined.**

5.3 Summary and Conclusions

The first stage of the assessment process was screening to identify if the MCZs should be taken through the full assessment in the stage 1 assessment process. During this process Poole Rocks MCZ and Yarmouth to Cowes MCZ were screened out for the subsequent assessment.

The screening concluded that there is an **LSR of the Strategy affecting the designated features and/or conservation objectives of The Needles MCZ and Southbourne Rough MCZ**, due to their site falling within the ZoIs of the following impact pathways:

- Temporary increase in SSC and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects.

It is, therefore, recommended that **The Needles MCZ and Southbourne Rough MCZ are screened into further Stage 1 Assessment** (see Figure 13).

Figure 13. Marine Conservation Zones (MCZ) screened into Stage 1 Assessment

6. Stage 1 Assessment

This Stage 1 Assessment will assess the likelihood of a temporary increase of SSC as a result of the Christchurch Bay and Harbour FCERM Strategy, and the magnitude of impact, on the features and conservation objectives of The Needles MCZ and Southbourne Rough MCZ**.**

The impact of temporary increase in SSC and sediment deposition is associated with the beach nourishment management options of the FCERM Strategy. Beach nourishment has been identified as part of the Leading Options in ODUs 2, 12, 13, 16, and 18 (Figure 14; Table 1).

When mobilised, fine sediments have the potential to be suspended in the water column for significant periods of time due to their associated low settling velocities. The suspension of such fine-grained material can therefore lead to the formation of a plume that has the potential to travel significant distances carried by currents. In contrast, bedload transport occurs relatively near the seabed, and thus does not affect turbidity levels within the higher water column, settling quickly. For each of the ODUs identified, it is assumed that the beach nourishment material will be carefully selected to ensure it contains a negligible proportion of fines (i.e. sediment with a grain size of less than 63 µm). Therefore, any sediment that is mobilised will therefore be transported as bedload (sand, gravels, and boulders), rather than as a suspended load (suspended silts and clays).

6.1 The Needles MCZ

The Christchurch Bay and Harbour FCERM Strategy is approximately 2.9 km from The Needles MCZ. This site is designated for the protection of the following features (Defra, 2016):

Features to maintain in favourable condition:

- Moderate energy infralittoral rock;
- High energy infralittoral rock;
- Moderate energy circalittoral rock; and
- Stalked jellyfish *Lucernariopsis campanulata*.

Features to recover to favourable condition:

- Subtidal chalk;
- Subtidal coarse sediment;
- Subtidal mixed sediments;
- Subtidal sand;
- Subtidal mud;
- Sheltered muddy gravels;
- Seagrass Beds;
- Peacock's tail *Padina pavonica*; and
- Native oyster *Ostrea edulis*.

6.1.1 Temporary increase in SSC and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects

Temporary increase in SSC and sediment deposition associated with the beach nourishment activities occurring in ODUs 12, 13, 16 and 18 (Figure 6 andFigure 8) may have an impact on the sessile features and habitats of The Needles MCZ.

Increased SSC may reduce the feeding efficiency and subsequent growth rates of filter feeders if clogging of feeding structures occurs, and the elevated turbidity can reduce photosynthesis and result in reduced primary

production. Furthermore, increased deposition can smother the seabed, potentially resulting in changes to seabed geomorphology, sediment structure and habitats. Moreover, any contaminants, such as heavy metals and toxins, within the sediments, can also be released into the water column and may alter marine water quality with subsequent indirect effects on benthic species. This would have an impact on species that rely on these habitats for food, refuge, and reproduction, leading to potential indirect effects on survival, growth, reproduction, and displacement of individuals.

Sediment habitats such as 'subtidal coarse sediment' and 'subtidal sand' are dynamic as they are frequently subjected to varying levels of turbidity, thus are considered to have high capacity to tolerate increased SSC. Although it is noted that other benthic receptors are able to withstand small changes in SSC over a short period of time, species such as oysters and peacock's tail algae are sensitive to high levels of deposition (Roche & Tillin, 2017; Perry, Jackson, Garrard, Williams, & Tyler-Walters, 2023). However, other habitats such as seagrass beds may be particularly sensitive to elevated SSC and have a very low tolerance to high levels of smothering (Tyler-Walters, 2008; d'Avack, Tillin, Jackson, & Tyler-Walters, 2014).

ODU 12 and 13 consist of Avon Beach and Highcliffe (Figure 5). Within these ODUs, the recycling of beach material is currently practiced. Beach nourishment at this location is expected to include both shingle and sand-sized material, consistent with the composition of the existing beach material. The sand will be more mobile than the shingle, however the existing groynes in ODU 13 can be expected to retain a significant proportion of this material. A small proportion of sand will be transported offshore and dispersed by tidal currents before depositing within the deeper waters of Christchurch Bay. It is therefore reasonable to conclude that beach nourishment within ODU 12 and 13 will not lead to any detectable change in turbidity levels or deposition within The Needles MCZ.

Beach nourishment within ODU 16 and 18 (Figure 8) is expected to require predominantly shingle type material in an area where the direction of net transport along the coast is from west to east (SCOPAC, 2012). The Leading Option for ODU 18 includes the construction of new beach control structures (Table 1), such as groynes, to help retain beach nourishment material. When the groynes in ODU 18 eventually reach full capacity, there is potential for shingle to be transported further along this coast towards Hurst Spit, Shingles Bank and potentially the Needles Channel. With the existing defences at Milford on Sea providing an effective barrier to much of the natural supply of material to Hurst Spit, any residual impacts on the Needles MCZ resulting from beach nourishments will be managed by making minor adjustments to recharge volumes, thereby eliminating the risk affecting baseline conditions within the Needles MCZ. Therefore, there is no anticipated change in baseline conditions within The Needles MCZ

Therefore, sediment transport within the ODUs is not anticipated to impact the conditions within The Needles MCZ. Moreover, as previously stated, at the scheme design stage it is assumed that the beach nourishment material will be carefully selected to ensure it contains a negligible proportion of fine sediments. As fine particulate material remains in suspension longest and settles to the seabed more slowly, by minimising the proportion of these finer fractions, the impact of increased SSC is limited and the subsequent effects of contaminant mobilisation, turbidity, and smothering are avoided. Therefore, it is concluded that there is **no significant risk to the conservation objectives of The Needles MCZ**.

6.2 Southbourne Rough MCZ

The Christchurch Bay and Harbour FCERM Strategy is approximately 3.0 km from Southbourne Rough MCZ. This site is designated to recover the black seabream, *Spondyliosoma cantharus* (nesting), to favourable condition (Defra, 2019).

Based on the precautionary assessment within the **MCZ Screening Assessment Report**, it was noted that any impacts were considered unlikely. However, as the effects were uncertain, the impact of temporary increase in SSC and sediment deposition on Southbourne Rough MCZ was screened in for consideration within the Stage 1 assessment.

6.2.1 Temporary increase in SSC and sediment deposition leading to contaminant mobilisation, turbidity, and smothering effects

Temporary increase in SSC and sediment deposition associated with the beach nourishment activities occurring in ODUs 2, 12 and 13 (Figure 3 and Figure 5) may have an impact on the black seabream feature of Southbourne Rough MCZ.

Black seabream exhibit inshore spawning aggregations over their nesting sites, including male nest creation and guarding behaviours lasting several weeks (Pinder, Velterop, Cooke, Britton, & Michel, 2017) between April and July (Collins & Mallinson, 2012). Bream are demersal spawners and depend on particular substrates in which to excavate their nests. Nests are created by adult males clearing sediment to expose underlying hard substrate for eggs to adhere to, with the males remaining at the nest site until eggs hatch. As the nests are constructed of relatively mobile gravel and sediment, they require constant maintenance during occupation by bream. Therefore, an increase in SSC and settlement of sediment may result in nesting bream expending higher levels of energy to ensure that eggs within the nest remain clear from silt. This may impact the success of the black seabream guarding nests.

Beach nourishment material on the beach within ODU 2 (Figure 3) will be relatively mobile with net transport towards the north-east (SCOPAC, 2012). Sediment placed at this location will not therefore affect the offshore Southbourne Rough MCZ area and the majority of this material can be expected to accumulate near the sand bar at the entrance to the harbour. Moreover, nourishment of beaches along the Mudeford Sandbank within ODU 2 has been undertaken previously and forms part of the ongoing maintenance regime for this feature.

As previously mentioned in Section 6.1.1, beach nourishment at ODU 12 and ODU 13 (Figure 5) is expected to include both shingle and sand-sized material, consistent with the composition of the existing beach material. It is anticipated that the existing groynes in ODU 13 will retain a significant proportion of material, with some of the finer sediment being transported offshore and dispersed. It is therefore reasonable to conclude that beach nourishment within ODU 12 and 13 will not lead to any detectable change in turbidity levels or deposition within Southbourne Rough MCZ.

Therefore, sediment transport within the ODUs is not anticipated to impact the conditions within Southbourne Rough MCZ. Moreover, as previously stated, at the scheme design stage it is assumed that the beach nourishment material will be carefully selected to ensure it contains a negligible proportion of fine sediments. As fine particulate material remains in suspension longest and settles to the seabed more slowly, by minimising the proportion of these finer fractions, the impact of increased SSC is limited and the subsequent effects of contaminant mobilisation, turbidity, and smothering are avoided. Therefore, it is concluded that there is **no significant risk to the conservation objectives of Southbourne Rough MCZ**.

Figure 14. Option Development Units (ODU) of the Christchurch Bay & Harbour Flood and Coastal Erosion Risk Management Strategy identified for beach nourishment in relation to the Marine Conservation Zones (MCZ)

7. Summary and Conclusions

The Stage 1 Assessment, undertaken in Section 6, assessed the likelihood and magnitude of a temporary increase of SSC as a result of the Christchurch Bay and Harbour FCERM Strategy on the features and conservation objectives of The Needles MCZ and Southbourne Rough MCZ.

With beach nourishment identified in the Leading Options for ODUs 2, 12, 13, 16, and 18, it has been concluded that sediment transport within these ODUs is not anticipated to impact the conditions within either MCZ.

Moreover, at the scheme design stage with the careful consideration of recharge volumes and beach nourishment material to ensure minimal proportions of fine sediments (i.e. diameter less than 63 µm), the SSC should be minimised to avoid significant quantities of suspended sediment in the water column. Therefore, there will not be any persistent plumes of suspended sediment reaching the MCZs and raising turbidity above background levels. Consequently, it is concluded that there is **no significant risk to the conservation objectives of The Needles MCZ and Southbourne Rough MCZ, and no further assessment is required.**

8. References

APEM. (2012). *Marine Ecology Survey to Support Proposed RNLI Site Redevelopment in Poole Harbour: Ramboll UK Ltd.*

CIEEM. (2018). *Guidelines for Eoclogical Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine.* Winchester: Chartered Institute of Ecology and Environmental Management.

Colenutt, A., & Evans, J. (2014). *oole Rocks MCZ Post-survey Site Report v3. A report to the Department for Environment, Food and Rural Affairs (Defra) by the Channel Coastal Observatory: Channel Coastal Observatory.*

Collins, K. J., & Mallinson, J. J. (2012). Surveying black bream, Spondyliosoma cantharus (L.), nesting sites using sidescan sonar. *Underwater Technology, 30*, 183-188.

Dale, A. (2012). *Hampshire & Isle of Wight Seasearch Summary Report 2011.* Seasearch.

d'Avack, E. A., Tillin, H., Jackson, E. L., & Tyler-Walters, H. (2014). *Assessing the sensitivity of seagrass bed biotopes to pressures associated with marine activities. JNCC Report No: 505.* Peterborough: JNCC.

Defra. (2016). *The Needles Marine Conservation Zone.* Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492458/mcz-the-needles-factsheet.pdf

Defra. (2019). *Southbourne Rough Marine Conservation Zone.* Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915224/mcz-southbourne-rough-2019.pdf

EA. (2020). *Flood and Coastal Erosion Risk Management Appraisal Guidance*. Retrieved from https://www.gov.uk/guidance/flood-and-coastal-erosion-risk-management-appraisal-guidance

Marine and Coastal Access Act. (2009). Retrieved from https://www.legislation.gov.uk/ukpga/2009/23/contents.

MMO. (2013). *Marine conservation zones and marine licensing.* Marine Management Organisation.

Mylroie, P., Evans, J., & Colenutt, A. (2015). *The Needles rMCZ Post Survey Site Report.* DEFRA.

Perry, F., Jackson, A., Garrard, S. L., Williams, E., & Tyler-Walters, H. (2023). Retrieved from Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom: https://www.marlin.ac.uk/species/detail/1146

Pinder, A. C., Velterop, R., Cooke, S. J., Britton, J. R., & Michel, K. (2017). Consequences of catch-and-release angling for black bream Spondyliosoma cantharus, during the parental care period: implications for management. *ICES Journal of Marine Science, 74*, 254-262.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, T., . . . Tavolga, W. N. (2014). *ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. .* Cham, Switzerland: Springer and ASA Press.

Roche, C., & Tillin, H. M. (2017). *Padina pavonica Peacocks tail*. Retrieved from Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom.: https://www.marlin.ac.uk/species/detail/1423

SCOPAC. (2012). *Christchurch Bay*. Retrieved from https://www.scopac.org.uk/scopac_sedimentdb/chrst/chrst.htm

Solan, M., Hauton, C., Godbold, J. A., Wood , C. L., Leighton, G. E., & White, P. (2016). Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. *Scientific Reports, 6*(1), 1-9.

Tyler-Walters, H. (2008). *Zostera subg. Zostera marina Common eelgrass. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews.* Marine Biological Association of the United Kingdom.

Tyler-Walters, H., Hiscock, K., Tillin, H. M., Stamp, T., Readman, J. A., Perry, F., . . . Lear, D. B. (2023). *Marine Life Information Network: Biology and Sensitivity Key Information Review Database*. Retrieved from www.marlin.ac.uk

Tyler-Walters, H., Tillin, H. M., d'Avack, E. A., Perry, F., & Stamp, T. (2018). *Marine Evidence-based Sensitivity Assessment (MarESA) - A Guide. Marine Life Information Network (MarLIN).* Plymouth: Marine Biological Association of the UK.

Wade, H. M., Masden, E. A., Jackson, A. C., & Furness, R. W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. *Marine Policy, 70*, 108-113.