Land and Water Services Ltd

Beneficial Use of Dredged sediment at Chichester Harbour – West Itchenor

Disposal Site Characterisation Assessment for a new beneficial use disposal site (incorporating HRA and WFD)

November 2022

Innovative Thinking - Sustainable Solutions

ABP mer

Page intentionally left blank

Beneficial Use of Dredged sediment at Chichester Harbour – West Itchenor

Disposal Site Characterisation Assessment for a new beneficial use disposal site (incorporating HRA and WFD)

November 2022

Document Information

Document History and Authorisation		
Title	Beneficial Use of Dredged sediment at Chichester Harbour – West Itchenor	
	Disposal Site Characterisation Assessment for a new beneficial use disposal site (incorporating HRA and WFD)	
Commissioned by	Land and Water Services Ltd	
Issue date	November 2022	
Document ref	R.3943	
Project no	5140	
Date	**Version**	**Revision Details**
26/09/2022	1	Issue for client review
21/11/2022	2	Issue for client use

Prepared (PM)	Approved (QM)	Authorised (PD)
Susanne Rupp-Armstrong	Stephen Hull	Colin Scott
		

Suggested Citation

ABPmer (2022). Beneficial Use of Dredged sediment at Chichester Harbour – West Itchenor, Disposal Site Characterisation Assessment for a new beneficial use disposal site (incorporating HRA and WFD), ABPmer Report No. R.3943.
A report produced by ABPmer for Land and Water Services Ltd, November 2022.

Notice

ABPmer
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: http://www.abpmer.co.uk/

Contents

Appendices

Tables

Images

Figures

1 Introduction

1.1 Project background

This report has been prepared to inform a marine licence application to the Marine Management Organisation (MMO) for consenting a proposed alternative/beneficial use dredge disposal site and saltmarsh restoration site west of Itchenor in Chichester Harbour (West Sussex) (Figure 1).

To inform this licence application, this report provides the required Disposal Site Characterisation Assessment for the site. This assessment includes details about the proposed project, as well as the consultation and survey work that has underpinned their development. It also includes other supporting assessments, including a Water Framework Directive (WFD) Regulations Compliance Assessment, and a shadow Habitats Regulations Assessment (HRA).

The project will involve the trialling of a novel Saltmarsh Restoration Drag Box (SRDB), to restore saltmarsh with bottom placed materials, in a location where saltmarshes have eroded dramatically over the past few decades. Should the trials in the first winter prove successful, then the licence is to also include further bottom placement and saltmarsh restoration campaigns in subsequent winters, with a licence period of 5 years being applied for. Further details about the project can be found in Section 2.

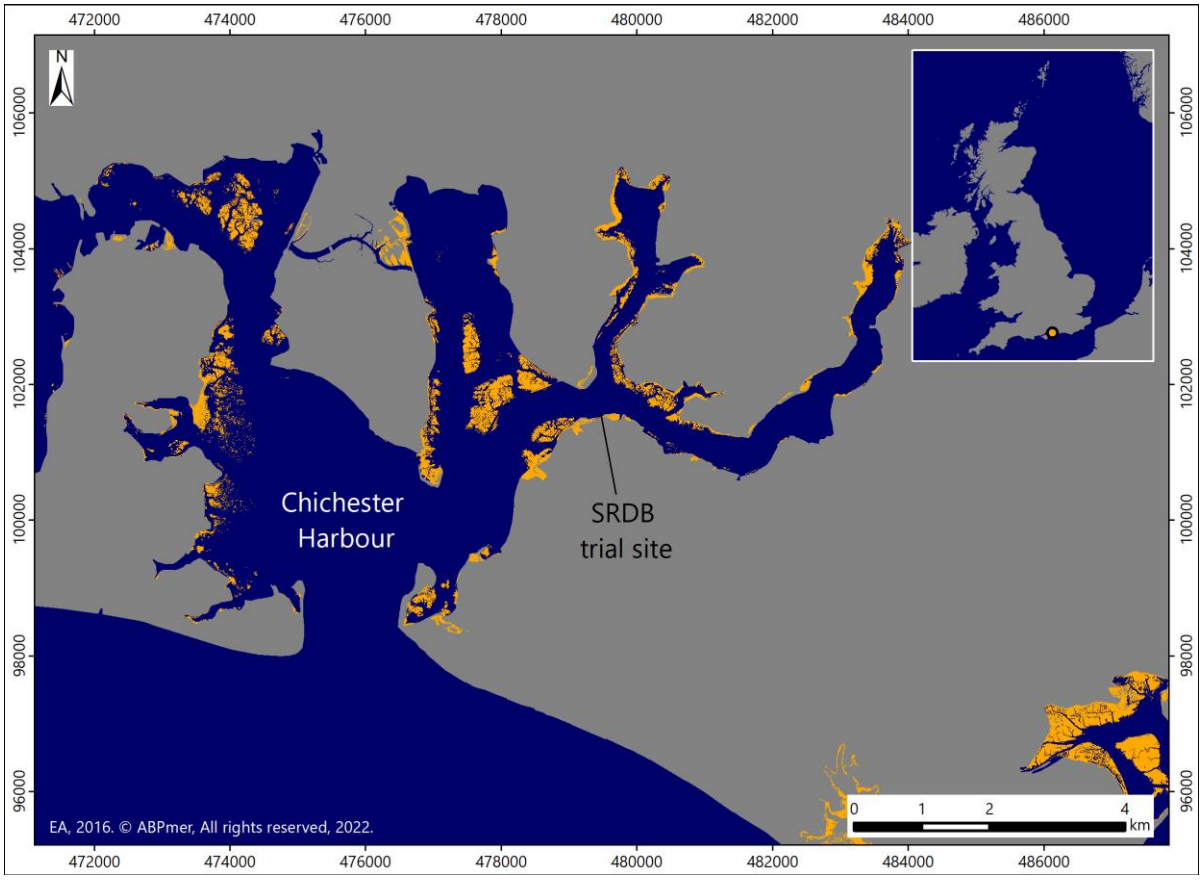


Figure 1. Location (orange areas = saltmarsh extent (in 2016))

Marine licences and other consents will be required to pursue this project and, to inform these future consents, this review also describes the physical and ecological conditions of the disposal and

restoration site. This includes the results of sampling work that was undertaken as the first stages in the process of designating the site as a licensed sediment disposal ground.

1.2 Report structure

This report is structured as follows:

Section 1: Introduction;
Section 2: Project context and approach – describes the proposed approach and rationale, as well as the consultation undertaken to date, and also alternatives considered;
Section 3: Regulatory framework – outlines the information requirements associated with key legislation and policy of relevance to the proposed project;
Section 4: Assessment scope and methodology – describes the scope of the assessment, as well as the methodology applied to assess the potential impact pathways;
Section 5: Assessment of potential impacts – considers the potential impacts of the proposed project to key receptors (and presents baseline information for each);
Section 6: Mitigation and monitoring – outlines the currently envisaged mitigation measures and monitoring programme; and
Section 7: Conclusion – summarises the findings of the report.

In addition, the following appendices are included to support the application for a marine licence:

Appendix A Shadow HRA;
Appendix B WFD Regulations Compliance Assessment;
Appendix C Lessons learned at similar sites.

2 Project Context and Approach

2.1 Introduction

This section outlines the approach that is envisaged for this project (Section 2.2), and the consultations that have to date been pursued to progress the project (Section 2.3). Section 2.2 incorporates a sub-section providing general background to the location and the proposed trial, as well as one on site details (including historic saltmarsh losses) and another presenting a construction method statement. Potential sediment sources are also discussed, and the dredged materials characterised. Section 2.4 discusses alternatives to the project.

2.2 Project background

2.2.1 Background

This project will involve beneficially using dredged sediment from Chichester Harbour to enhance and protect the harbour's eroding saltmarsh habitats at West Itchenor. The application is for a five-year licence, with the potential for restoring up to around 3.5 ha of saltmarsh at the site, using materials sourced from various marinas within the Harbour. However, in the first winter of 2022/23, a trial of the technique is to be undertaken, whereby up to 0.7 ha are to be restored with circa 4,500 m^3 of materials. A restoration and deposit zone has been drawn up; this is displayed in Figure 2, together with the trial saltmarsh restoration area. This is the maximum area within which sediment will be deposited, then dragged up the shore and reshaped to restore saltmarsh (more detail on this is provided below).

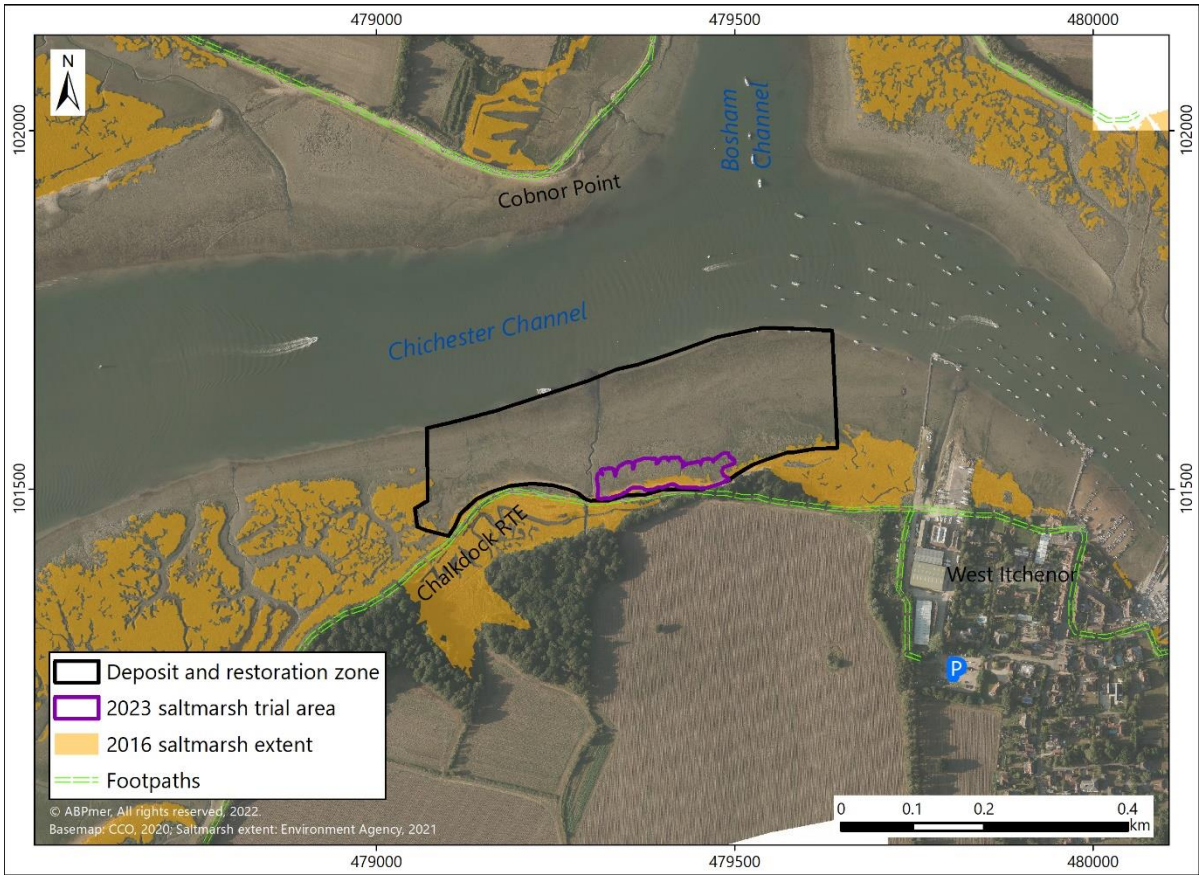


Figure 2. Annotated aerial image of the SRDB site at West Itchenor

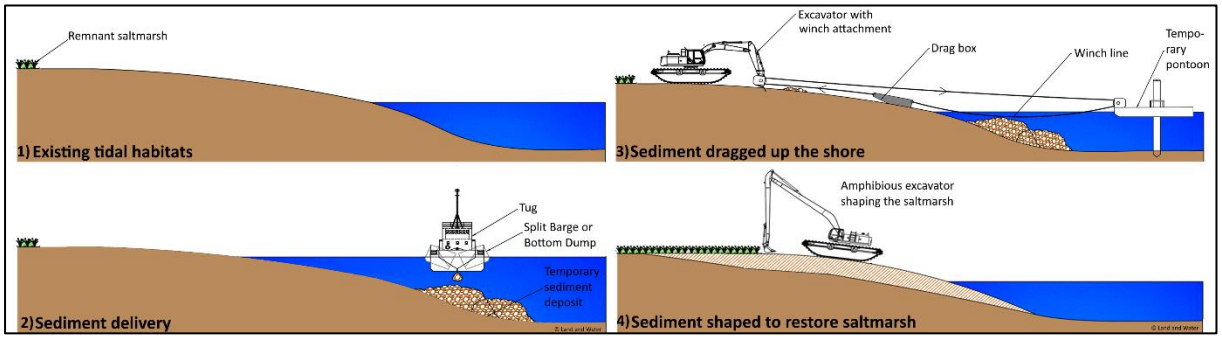
Subsequent beneficial use and restoration campaigns would only take place if the trials during the first winter proved to be successful. Should the trials be successful, then annual campaigns are envisaged until around 3.5 ha have been restored within the site area. Inclusive of the initial trial volumes, up to 25,0000 m^3 of materials may be required to achieve this level of restoration, with exact volumes to be confirmed once/if the initial trial has been successful (as, at present, a detailed Digital Terrain Model (DTM) has only been produced for the trial area – see below / Image 2 for further detail).

However, for the purpose of the five year licence, it is proposed that 25,0000 m^3 be taken as the maximum volume to be deposited over the licence term, with a maximum of 5,000 m^3 to be reused at Itchenor in any given year. It is envisaged that the licence will be for a new disposal site and saltmarsh restoration works. The dredged materials will be derived from maintenance dredge activities from nearby marinas, whereby these marinas hold separate dredging licences (including a provision which enables them to take material to the new beneficial use site) (see Section 2.2.4 for more detail). The licence will need to identify the operators of Northney Marina (Marina projects) as a 'source site' for the first winter, as well as future winters. Future other source sites will be confirmed in due course and licence variations sought as necessary.

This winter's trials are to test Land and Water's innovative Saltmarsh Restoration Drag Box (SRDB); this technique is explained further below.

There have been substantial losses of saltmarsh habitat in Chichester Harbour historically, and the habitat is continuing to decline (see Sections 2.2.2 and 5.4.1 for further detail). At the same time, the marinas within the harbour are regularly dredged, and the materials mostly taken offshore, instead of being used to rebuild the marshes. There are many financial, technical, regulatory and environmental reasons why dredged sediment has not been used to 'recharge' saltmarshes in the past. However, there is now a growing impetus to find ways of resolving these challenges.

This proof of concept trial seeks to resolve these issues. The scope and aims of this project have been developed collaboratively between Land and Water, Earth Change, and ABPmer. It has also been discussed with the Chichester Harbour Conservancy (CHC), Natural England, the Environment Agency and the MMO over the course of several meetings, and during a site visit to West Itchenor on 29 March 2022 (see Section 2.3 for more detail on consultation to date). This novel approach is illustrated in Image 1, and a construction method statement is provided in Section 2.2.3.



Source: Land and Water

Image 1. Illustrative graphics of the SRDB restoration process

Firstly, dredged materials will be deposited by spilt hopper barges on low shore (low mudflat) areas during high tide. The sediment for this trial is likely to originate from the nearby Northney Marina that already carry out maintenance dredge operations (and hold a licence for this, though Itchenor would need to be added to this as a disposal ground). However, for future winters, other sources are also being sought to maximise the amount of sediment that is beneficially reused. Without the new deposit

site west of Itchenor, dredged sediment would instead be disposed offshore at the Nab Tower or, alternatively, at the subtidal Treloar Hole, where it will not directly benefit intertidal saltmarshes.

Once the sediment has been deposited, the SRDB will drag the recently deposited sediment from the low shore areas to higher elevation surfaces. The SRDB sits on skis, with several sets of skis (of different widths) available to facilitate adaptation to local conditions, and minimise sinking/compaction. Using the SRDB approach will mean that dredged sediment can be placed on the upper intertidal areas (i.e. fronting eroding saltmarshes), in a much firmer consistency than could be achieved by pumping and without requiring the use of pipes[1] and costly retainment bunds.

Use of this novel SRDB approach could open opportunities for beneficially using a lot more of the sediment that is dredged from UK ports and harbours every year for habitat restoration. That is because it creates a way of ensuring that the efficiency or 'productivity' of dredging and disposal operations is not hampered, while also ensuring that dredged sediment is placed at these higher elevations that need it most.

2.2.2 The site

Elevations and zones

The deposit and restoration site itself measures 9.3 ha (see Figure 2), and is located wholly within the intertidal zone, between around -2 m Ordnance Datum (OD) (0.1 m above the level of Mean Low Water Springs (MLWS)) and 2.1 mOD (Mean High Water Springs (MWHS)). Elevations at the site, as derived from a 2020 Light Detection and Ranging (LiDAR) dataset, are shown in Figure 3.

The deposit and restoration zone covers the low shore, where the temporary deposit grounds would be located, as well as the upper shore habitat restoration areas, and the sediment drag areas in-between. However, it is proposed that materials will only be permanently deposited in the restoration/enhancement areas at the top of the shore. That has a maximum extent of around 3.5 ha. Beyond the 2023 saltmarsh trial area, the further saltmarsh restoration areas have not yet been mapped, as it is envisaged that future phases will be undertaken in close cooperation with nature conservation bodies (notably Natural England and the CHC). However, these would be located along the upper shore, to the west and east of the 2023 trial area; some modest (further) seaward expansion north of the trial area is also conceivable. It is worth noting that the mudflat areas over which saltmarsh is to be restored would have all been saltmarsh at some point in the not too distant past, and old saltmarsh platforms and creek shapes are frequently still evident on the mudflats (see below for more detail).

The temporary deposit zone is located over low mudflat elevations (i.e. between around -2 and 0 mOD), whereas the drag area would be over some of the mid shore areas (between around 0 m OD and 0.8 mOD). The permanent (restoration) areas will generally be between around 0.8 mOD (just below MHWN) and 1.8 mOD (around 0.4 m below MHWS), where the restoration would tie into either existing high saltmarsh strips, or the unvegetated upper shore.

[1] To date, it has always proven difficult to get materials up the shore to saltmarsh elevations, as bottom opening dredgers can typically only reach low to mid mudflat elevations on an intertidal shore. Alternatively, materials can be piped from an appropriately equipped vessel to the receiving ground. With this approach, the material is mixed with water, either through the dredging process itself (e.g. by the cutter suction dredger), or in the hopper of a trailer suction dredger. Because materials would come out quite liquid, retainment structures would need to be constructed. Undertaking beneficial use with this piping technique is typically very costly (see Manning *et al.*, 2021 for more detail).

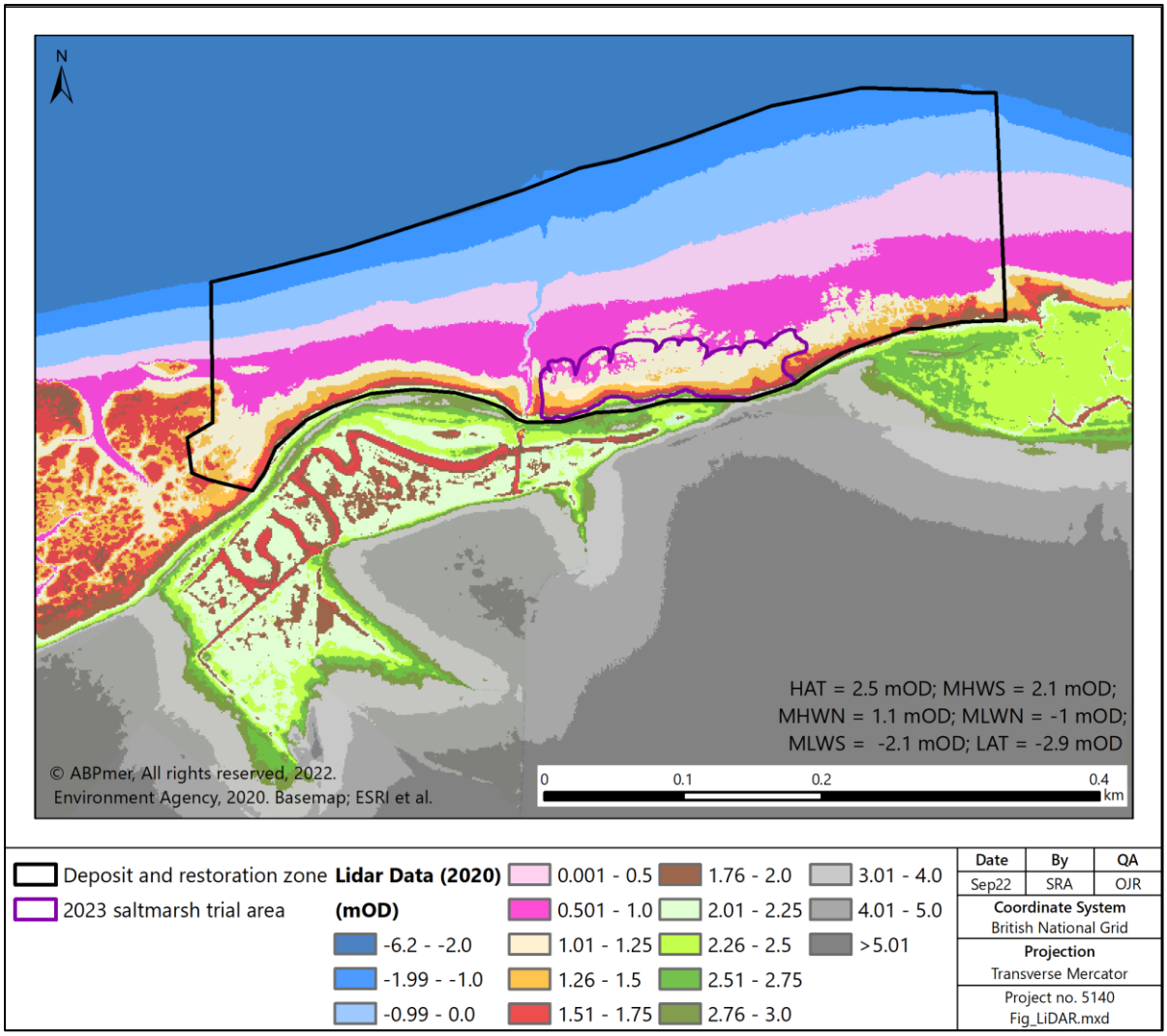


Figure 3. Elevations at the SRDB site

In the first year, the trial year, the proposal is to restore a maximum of 0.7 ha within this elevation band. If the trial is successful, then up to another 2.8 ha will be restored in subsequent winters. A DTM has been developed for the Year 1 trial; this is shown in Image 2; should the trial be successful and subsequent placement and shaping campaigns take place, then DTMs would be created for those future phases. For the initial trial phase, based on the DTM shown below, it has been estimated that 4,500 m^3 of material will be required. Please note that sinuous upper saltmarsh creeks would also be cut into the upper areas of the new saltmarsh platform during the final phase of the shaping; these are not shown in Image 2. Furthermore, the DTM has been designed in such a fashion that future restoration areas can be tied in east and north of it. Please note that a very small section of low saltmarsh (measuring less than 0.008 ha or 80 m^2) will be buried in sediment; this is in a small isolated protrusion which cannot be incorporated (as otherwise a lower dip would result at the back of the new saltmarsh); however, new, high, saltmarsh will establish in its stead in due course.

The trial will be the first stage in an adaptive process whereby the concept is upscaled and developed so that stakeholder concerns are managed and addressed. This will be accompanied by a thorough monitoring programme that will include analysis of bed level changes, mapping of vegetation growth and sampling of the benthic invertebrates. The proposed monitoring programme is presented in Section 6.

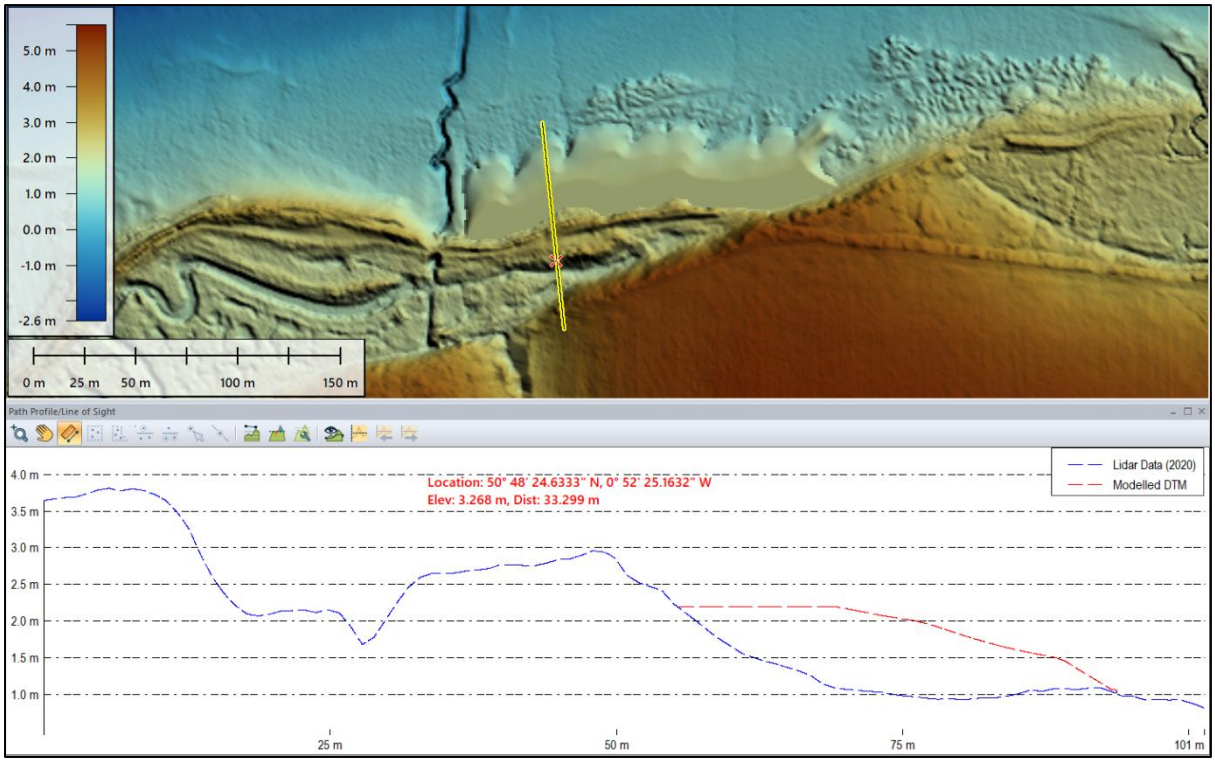


Image 2. The DTM for the initial Year 1 trial

Saltmarsh extent and evolution

In addition to trialling a new technique, the aim of the SRDB project is to restore saltmarsh which has been lost over the past decades.

Research undertaken by various authors shows that the intertidal habitats of Chichester Harbour have been subject to progressive change for well over a century. *Spartina anglica* started colonising the upper mudflats of Chichester Harbour in late 1800s, and saltmarshes consequently expanded rapidly from then into the early 1900s. From the 1920s onwards, however, saltmarshes in this area have been progressively declining (Tubbs, 1999; Chatters, 2017).

Detailed analyses of the rate and pattern of marsh and mudflat decline in this area up until the early part of this current century were made by Solent Dynamic Coast Project (SDCP) (Cope *et al.*, 2008). Based on aerial imagery interpretation, this study estimated that saltmarsh extent had more than halved by 2002 when compared to 1946, from 717 ha (1946) to 335 ha (2002). A similar assessment was not possible for mudflat, as the seaward edge is often submerged.

A recent review for Natural England has updated the SDCP study, by using a combination of data sources, including aerial imagery data (collected by the Environment Agency; the saltmarsh zonation and extent data displayed in Figure 2 and Figure 4) (Parry and Hendy, 2022). This found that the rate of saltmarsh loss has dropped recently when compared with the 1960s and 70s, when rates were almost 3 % per annum. Over the last three decades, rates of decline have been below 1% yr^{-1}. There furthermore appeared to be no changes in saltmarsh extent occurring between 2016 and 2019. The authors estimate that there were 315.8 ha of saltmarsh remaining in Chichester Harbour in 2020.

The intertidal habitats of the Chichester Harbour Site of Special Scientific Interest (SSSI) are considered to be in 'unfavourable declining' condition due to these ongoing saltmarsh losses, as well as water quality issues (nutrient enrichment (macroalgae)). The condition assessment states that '*the synergistic*

impacts of climate change, coastal process disruption especially from flood defence structures, inappropriate coastal management and excessive nutrients mainly nitrogen are the primary causes' [for the unfavourable declining condition of the saltmarsh units] (Natural England, 2019).

These trends reported for Chichester Harbour are also reflected at the SRDB site. Dramatic losses have occurred here since the 1940s, and are ongoing, albeit at lower rates. In July 2022, the saltmarsh edge along the project area, and immediately adjacent, was surveyed using Real-time kinematic positioning (RTK). This was then mapped, and the results are displayed in Figure 4, together with historic saltmarsh edge lines (as digitised from Cope *et al.*, 2008), as well as the latest Environment Agency extent and zonation mapping (which, for the study area, was based on 2016 aerial imagery interpretation).

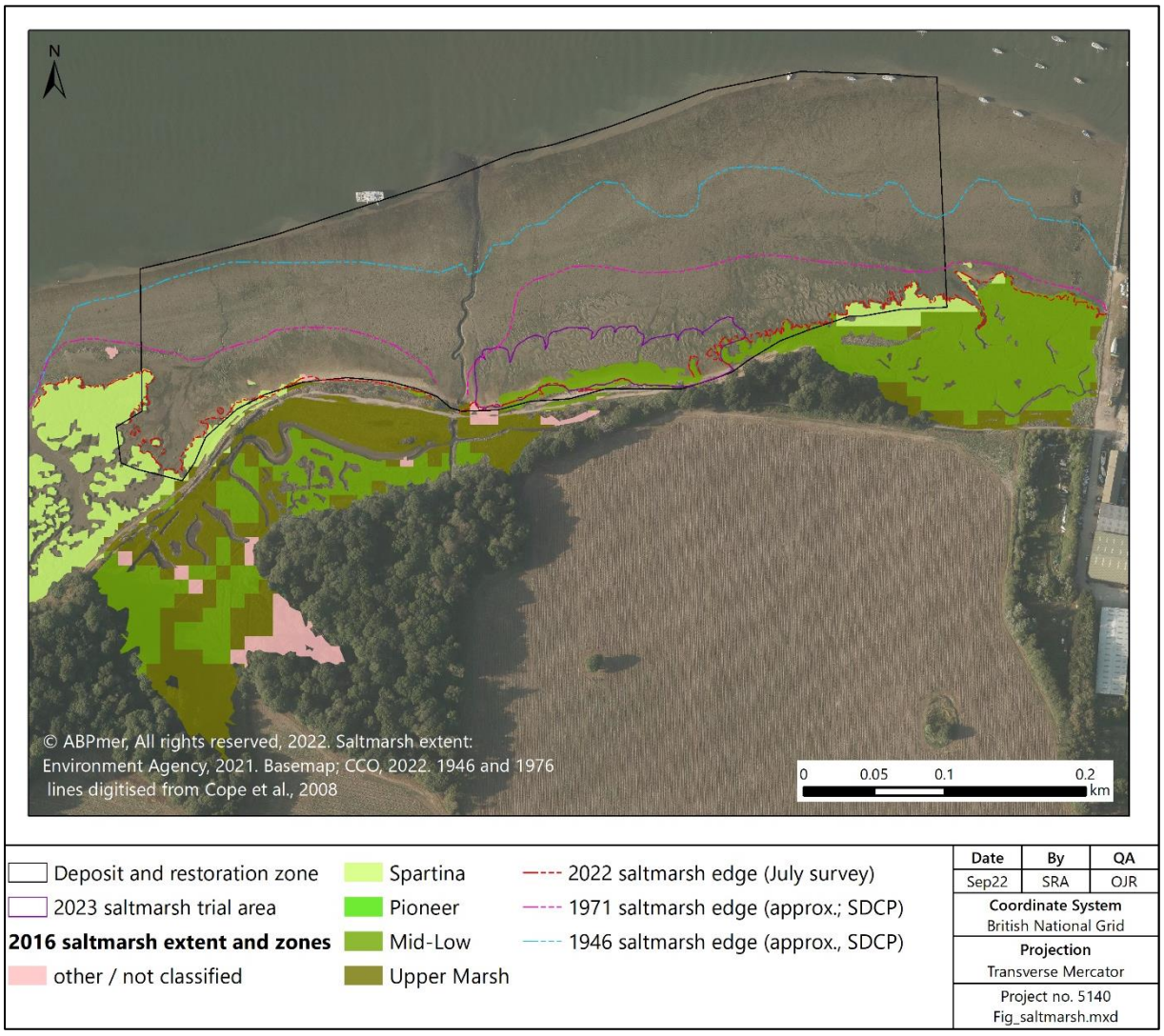


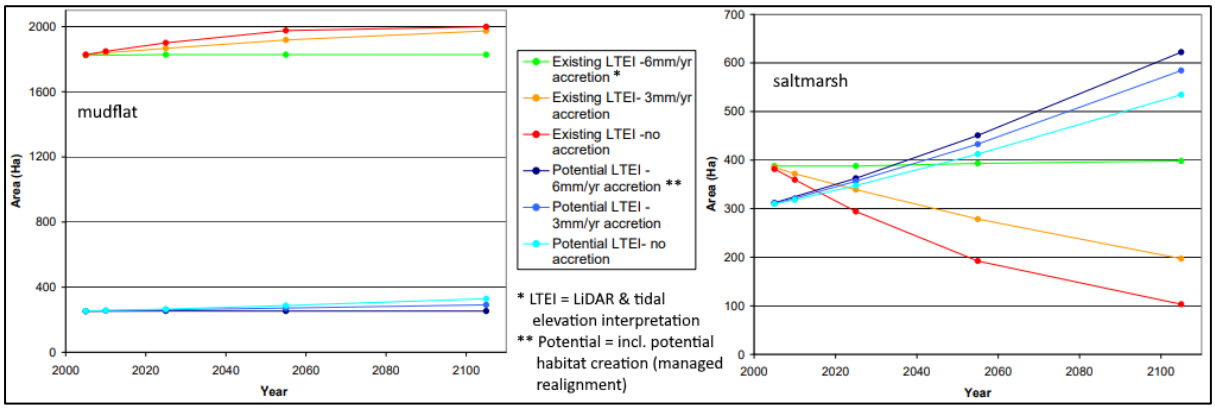
Figure 4. Saltmarsh extent and zonation at the SRDB site

The comparison of 2016 to 2022 mapping shows that the saltmarsh edge has retreated slightly along most of the frontage, and, at the 2023 trial site, much remaining strip of saltmarsh has been lost[2]. In

[2] Whilst there appears to have been some slight expansion along some short stretches (e.g. amongst the mid to low marshes east of the trial area), this is not considered to be believable, as this was generally over platforms which were clearly already present in 2016, and thus would have been expected to hold saltmarsh in 2016. This is likely due to mapping errors (the 2016 layer was created via automated aerial imagery interpretation); it would not be due to seasonal differences (the 2016 aerial image was taken in August, and the 2022 survey undertaken in July. A comparison

total, 2.37 ha of saltmarsh were mapped in 2016. Around 0.17 ha of this has been lost since then along the edges, this equates to a loss rate of 7% between 2016 and 2022, largely due to the loss of the saltmarsh strip along the trial frontage.

It is worth noting the SDCP also made predictions of future mudflat and saltmarsh extent, based on LiDAR and tide level analysis, as well as historic interpolation. For saltmarsh, a 'best case' prediction (based on historic trends and 3 mm year^{-1} accretion) assumed that around 210 ha of the existing saltmarshes would remain by 2100 (see Image 3; orange line). For mudflat, given an estimated 2002 baseline of around 1,830 ha, then gains of around 150 ha were predicted, for the low (3 mm year^{-1}) to no accretion scenarios. These loss / gain predictions imply that, whilst around 50 ha of mudflats are predicted to be lost / become subtidal at the seaward edge, 150 ha are still gained through saltmarsh loss. Parry and Hendy (2022) updated the SDCP saltmarsh predictions, and stated that '*the best-case for saltmarsh extent is still within the accuracy of the previous [SDCP] estimate. However, the worst-case scenario has been extended by 30 years [to 2054]*'.



Source: Cope *et al.*, 2008

Image 3. SDCP mudflat and saltmarsh extent predictions for Chichester Harbour

2.2.3 Construction Method Statement for February / March 2023

A high level method statement for this winter's works is provided below; future years would likely be very similar, although an adaptive management approach is suggested, and thus slight changes may be made to the method statements for future years, depending on the outcome of the trials and discussions with stakeholders.

Sediment delivery

Sediment delivery would be by split hopper barges with bottom opening doors; these will likely have a capacity of around 300 tonnes (some 200 m^3). They will arrive at high tide and will deposit the materials as high up the shore as possible. The target areas for the initial depositing of the sediment will be demarcated by buoys. It is likely that, at most, two deliveries per day will be achievable. Somewhere between 15 and 20 barge loads will likely be needed in total, with the number depending on how fully the barges will be loaded. Bottom discharge at the site will be fairly swift, taking around 10 to 15 minutes per barge.

SRDB

Generally on the same day, up-dragging of the material will commence as soon as possible after the barges have left. Using information obtained from a recent hydrographic survey of the channel, the

with 2013 and 2015 aerial imagery on Google Earth (NB: no 2016 data available) supports this conclusion, as these both show the saltmarsh extending slightly further in those locations than was mapped in 2016.

intended area for sediment deposition will be buoyed, allowing the deposition to be carried out accurately at any time of the day. As illustrated above, a spud barge/pontoon will be moored in the shallow subtidal just to seaward of the deposition area to operate the seaward pulley of the SRDB winch. A land-based excavator would hold the winch mechanism for the landward end of the drag box cable (see Image 4). The spud barge/pontoon would need to be moved aside prior to the hopper barges coming in for delivery (i.e. spud legs lifted and pontoon shifted), to avoid entanglement with the winch cable. Using the buoys as markers, the pontoon would then swiftly be moved back in position once the last barge delivery had been made. Assuming two barges had delivered up to around 300 m^3 on the day, then it would take somewhere between 5 and 8 hours to drag the material from the lower shore to the upper shore (with the SRDB being able to scoop somewhere between 6 and 10 m^3 per cycle). Every effort will be made to drag materials up the shore on the same day as the materials were delivered, to minimise the risk of materials slipping/being washed away.

Source: still from video taken by U. Dornbusch on 18 July 2022

Image 4. SRDB dragged upwards by excavator winch during July 2022 trials at Rainham

Shaping

In between deliveries, and during low tide periods, the material which has been dragged up the shore using the SRDB would then be moved and shaped using an amphibious excavator with GPS guidance; this will ensure that the DTM shown in Image 2 is followed faithfully and to within a tolerance of 0.1 m.

Mobilisation of plant and Equipment

The pontoon will be a modular type which allows it to be mobilised by land to a nearby facility where it can be crane lifted into the water and assembled. It is proposed that this will occur at the Northshore Shipyard. The marine plant will include the spudded pontoon with a hiyab crane and welfare cabin on board, plus an attendant tug and a personnel boat.

It is envisaged that the two pieces of land based machinery, the excavator operating the winch, and the amphibious excavator used for shaping the marsh, will be brought onto site along the edge of the arable field located immediately to the south of the restoration site. Should any bush trimming be required to facilitate access between the field and the restoration site, this would be undertaken prior to works commencing (see below for timelines).

Machinery storage

Discussions are currently ongoing as to where machinery will be stored when not required at the site. In order to reduce the number of times the plant has to cross the footpath, the shore based plant will largely be left within a locked fenced area on the top of the foreshore when not in use (the plant will be amphibious, so able to withstand some inundation, but would be moved off site, onto the adjacent arable field, prior to the highest tides). A site office and welfare will be situated in the nearby CHC car park, and fuelling the plant will be carried out from this secure location using best practice measures and relevant guidance for pollution prevention. A fuel bowser will likely be towed to the shore plant once a week via the adjacent arable field to refuel the plant.

Programme of works

Depending on tidal states and dredging schedules, it is estimated that the works will take between 3 and 4 weeks to complete. This includes 3 to 4 days of mobilisation and de-mobilisation. Actual days on site likely will be somewhere between 15 and 20. It is envisaged that the works will be undertaken in late February and March 2023, with the potential for some of the shaping taking place in April if unexpected delays are encountered (e.g. if works have to be halted during extremely cold weather periods, see Section 5.7.2 and 6 for more detail on this and other mitigation measures). Night/evening working may occasionally be required to fit in with tidal states, given the relatively limited day time hours during the winter months.

2.2.4 Potential sediment sources and characterisation

The sediment that is dredged, during maintenance campaigns, from the marinas in Chichester Harbour is fine silt and is expected to be suitable for deposition at Itchenor. Further details about the baseline sediment composition at Itchenor is presented in Section 5.2.1. Further information about the volumes and quality of the sediment from the potential sources is outlined below.

This information was derived from Northney Marina's extant marine licence (L/2014/00368/2), which was sourced from the MMO's Public Register / Marine Case Management System (MCMS). Such dredging licences are typically indicative of the maximum volumes of material that are licensed for removal and potentially available area. Actual dredge returns from each site are likely to differ from the values stated and will vary over time in response to specific dredging needs.

Northney Marina's owners, Marina Development Limited, hold a licence to undertake annual maintenance dredging at the marina to December 2024. The licence permits up to 75,000 m^3 of silt (31.25-62.5um) to be dredged every winter, from October to April ('*when disruption to other water users is minimised i.e. avoiding the busy boating summer season'*). The licence documents specifies that up to 700 m^3 of sediment would tend to be backhoe-dredged per day during typical campaigns. Disposal is currently permitted at the offshore Nab Tower disposal ground only. Disposal volumes are quoted at around 9,750 wet tonnes, which equates to around 7,500 m^3; it is thus considered that the 75,000 m^3 quoted in the licence for dredging is a typographical error. The licence notes that '*dredged material may include a small percentage of chalk (estimated at less than 5%)'*. Contamination analysis of sediments was undertaken in 2014 and 2021; results are shown in Section 5.2.1 below. Consultations with Northney Marina to date indicate they will be able to supply all of the required material volume (i.e. 4,500 m^3) this winter.

Several other marinas undertake maintenance dredging in the Harbour; with the exception of Northney and Sparkes (both Hayling Island), the other five marinas/quays do not require annual dredging. Instead, they undertake maintenance dredging as and when required, typically every 3 to 7 years. On average, it has been estimated at around 10,000 m^3 are dredged from Chichester Harbour every year, with actual values fluctuating depending on requirements. Not all of this would necessarily be available

for re-use at Itchenor; budgets, timings and priorities may not align, and the restricted tidal windows at Itchenor would mean that not all the materials from a given location/campaign can be deposited here.

Whilst this winter's materials will likely be sourced from Northney, other marinas would be expected to provide sediment for reuse at Itchenor in future years. As noted above, the licence for the Itchenor site will need to identify the operators of Northney Marina (Marina projects) as a 'source site' for the first winter, as well as future winters. Future other source sites will be confirmed in due course and licence variations sought as necessary. Relevant contamination survey data will be obtained as necessary to enable Cefas to make a decision on whether or not the materials can be disposed of at sea and at Itchenor.

2.3 Consultation to date

There have been extensive consultations on the proposed project to date, both by Land and Water and ABPmer; these have included, but are not restricted to:

- A site visit to West Itchenor on 29 March 2022, attended by representatives from Natural England, the Environment Agency and CHC (as well as ABPmer and Land and Water);
- A trial day (demonstrating the SRDB technique on terrestrial land) took place at Rainham Marshes near London on 18 July 2022, attended by representatives from Natural England, the Environment Agency, CHC, the RSPB, as well as various other interested parties;
- Two meetings between Natural England and ABPmer, to discuss HRA requirements and aspects such as site suitability, saltmarsh losses, the SRDB technique, etc. – these were on 22 June and 17 August 2022. Land and Water have also had separate conversations with Natural England on the potential of obtaining nutrient neutrality 'credits' through SRDB saltmarsh restoration. This is not being pursued for the Itchenor trial site at present;
- One meeting between the MMO and ABPmer, on 22 July 2022 (to discuss this application, as well as similar applications under way); also, other pre-application/sample plan communication has taken place via email (a sample plan was submitted to the MMO in April 2022, and a response schedule received in late September 2022);
- Several meetings / conversations between ABPmer and / or Land and Water and the CHC, to discuss aspects such as site bird use, seabed ownership, harbour works licence requirements and navigation concerns. Land and Water have also given a presentation to CHC's members, and the members have visited the site recently (CHC pers. comm.);
- Email communication with the local planning authority (Chichester District Council) and the Environment Agency to inquire regarding planning permission and environmental permitting respectively. These conversations are still ongoing;
- Many meetings / conversations between Land and Water and local marinas regarding the re-use of their dredged materials at Itchenor;
- Email communication (by ABPmer) with representatives of The Crown Estate;
- Several meetings / conversations between Land and Water and adjacent landowners (boatyard, sailing club, farmer, CHC) regarding construction access and machinery storage; and
- Pre-application reviews of a draft version of the Disposal Site Characterisation Assessment report by Natural England, the Environment Agency and CHC; this led to minor changes being made to this report.

2.4 Alternatives

With regard to alternatives, this has been given careful consideration throughout. The site at Itchenor was identified through consultation with the Environment Agency and CHC, with the former having previously (internally) identified the location as a preferred one for beneficial use. Whilst other sites in Chichester Harbour could benefit from beneficial use, the site west of Itchenor is particularly urgent, as the saltmarsh has eroded to the back of the foreshore here, as shown in Section 2.2. Furthermore, it is a very accessible site, both by sea and land, and it is in a popular location, close to a busy waterway and multiple moorings, as well adjacent to a well-used footpath and picturesque village, which is also the base of the CHC (see Sections 5.8.1 and 5.9.1 for more detail). Therefore this project offers an opportunity for boat owners, visitors and those that use this area frequently to see and understand the need for saltmarsh restoration (i.e. this site has added social and communications benefits).

Technique-wise, as noted above, utilising the SRDB is advantageous when compared to other forms of beneficial use, and would make the best use of the locally predominant dredging method, back hoe dredging. It is notoriously difficult to get materials from the lower shore (where boats can reach) to the upper saltmarsh shore; normally, this involves double handling and piping (and re-injection of water to make back-hoed materials liquid enough). The SRDB thus provides an exciting new opportunity. .

Two existing disposal sites are currently utilised by most of the marinas in Chichester Harbour; the subtidal Treloar Hole, which is within the Harbour near the mouth, and the Nab Tower, which lies 18 km from the mouth of the Harbour, east of the Isle of Wight. There are no other dredge disposal sites within the Harbour. Disposing at the Nab has no benefits to the habitats of the Harbour. Discharging at Treloar Hole meanwhile leads to uncertain benefits (it is also an unpopular site due to costly diver survey monitoring stipulations). The planned Itchenor beneficial use deposit site is therefore considered to be the best way of restoring declining habitats in the harbour using dredged sediment at this time.

3 Regulatory Framework

3.1 Introduction

The proposed beneficial use and disposal site will require a range of consents and approvals, supported by the necessary environmental assessment work. The principal consents and approvals that are required and studies that have been undertaken, as well as the key policy context, are summarised in the following sections.

The UK is no longer a member of the European Union (EU). EU legislation, as it applied to the UK on 31 December 2020, is now a part of UK domestic legislation, under the control of the UK's Parliaments and Assemblies, and is published on legislation.gov.uk. Some types of EU legislation such as Regulations and Decisions, are directly applicable as law in an EU Member State. This means that, as a Member State, these types of legislation applied automatically in the UK, under Section 2(1) of the European Communities Act 1972 (c.68), without any further action required by the UK. These types of legislation are published by the Publications Office of the EU on the EUR-Lex website. This legislation is now published on legislation.gov.uk as 'legislation originating from the EU'.

Other types of EU legislation, such as Directives, are indirectly applicable, which means they require a Member State to make domestic implementing legislation before becoming law in that State. In the UK, this was often achieved by making Statutory Instruments rather than passing primary legislation. This implementing legislation has always been published on legislation.gov.uk.

EU legislation which applied directly or indirectly to the UK before 11.00 p.m. on 31 December 2020 has been retained in UK law as a form of domestic legislation known as 'retained EU legislation'. This is set out in Sections 2 and 3 of the EU (Withdrawal) Act 2018 (c. 16). Section 4 of the 2018 Act ensures that any remaining EU rights and obligations, including directly effective rights within EU treaties, continue to be recognised and available in domestic law after exit.

References to applicable EU Directives as well as relevant UK legislation are provided in this report.

This section discusses the following in turn: required permissions and licences (Section 3.3); assessment requirements (Section 3.3) and policy context (Section 3.4).

3.2 Required permissions and licences

3.2.1 Marine licence (and disposal site characterisation)

The current process of marine licensing under the Marine and Coastal Access Act 2009 came into force on 6 April 2011 and covers the area from Mean High Water Springs (MHWS) out to 12 nautical miles. This process requires anybody wishing to undertake works below MHWS to obtain a marine licence from the MMO. The proposed beneficial use disposal sites, therefore, require a marine licence. The licence will cover those works that impact upon the marine environment, namely the placement (disposal) of dredged material at the proposed beneficial use site in West Itchenor.

To authorise the proposed disposal sites, a disposal site characterisation assessment is required (Manning *et al.*, 2021). A disposal site can be authorised solely for the objectives of the beneficial use (e.g. frequency and volume of disposal, as well as the physicochemical characteristics of the sediment that it can accept) and essentially represents the direct 'footprint' of the habitat restoration project.

Disposal sites are not themselves licensed, but a marine licence is required to dispose of dredged material within them (Manning *et al.*, 2021). Therefore, if a site is designated as a result of the characterisation report and licence application, that does not mean exclusive use of that site. A licence may be granted to other operators to use the same site (MMO, 2022)

In accordance with the guidance (Manning *et al.*, 2021), the disposal site characterisation assessment includes the following:

- An interpretation of the sediment quality sampling results (see Section 5.2);
- An assessment of any other relevant environmental and socio-economic impacts resulting from disposal according to the overall design of the project (see Section 5); and
- Any other specific assessments (see Appendices A and B).

This disposal site characterisation assessment has been submitted to the MMO in support of the marine licence application. On receiving an application, the MMO will assess the suitability of the dredged material for disposal at sea and make an evidence-based decision on whether it considers the proposed disposal sites are suitable to receive the material. Following this, the MMO will undertake a public consultation before making a decision on the acceptability of the proposed beneficial use disposal sites. If the sites are considered acceptable, the MMO will designate the sites as open.

The impacts associated with beneficial use disposal sites and the level of assessment required will be project and site specific and dependent on the nature, complexity, location and size of the project. For relatively smaller and simpler projects generally posing less risk, a comparatively reduced assessment may be carried out in comparison to more extensive assessments that may be required for higher risk projects. In accordance with the recently published handbook for restoring estuarine and coastal habitats with dredged sediment (Manning *et al.*, 2021), the impact assessment and regulatory decision-making processes should apply a pragmatic and risk based approach, to ensure that the evidence base, monitoring and associated costs of beneficial use projects are proportionate to their perceived risk. Applying the risk based in the handbook suggests overall level of risk associated with the proposed beneficial use disposal sites is likely to be low and, therefore, should only need expert assessment with level of detail tailored as detailed in Section 4.

3.2.2 Harbour works licence

The CHC are the Competent Harbour Authority for this area. They have a statutory conservancy duty to maintain safety of navigation in the harbour, and have thus also be consulted with regard to this aspect. The Chichester Harbour Conservancy Act 1971 (Sections 45, 47 and 48) makes it an offence for any person to construct, alter, renew or extend any works on, under or over tidal waters or tidal lands below the level of Mean High-Water Springs in Chichester Harbour unless licensed to do so by the Conservancy. Thus, a Harbour Works Licence will be required before the restoration works can be undertaken.

3.2.3 Seabed ownership

In Chichester Harbour, CHC hold the freehold for intertidal land between mean low water (MLW) and mean high water (MHW). Below MLW, the land is leased from The Crown Estate. MLW is at -1.6 mOD or 1.15 m Chart Datum (CD) at Itchenor; thus, parts of the deposit zone lie within ownership of The Crown Estate, with the remainder being under lease to CHC. Permission from both bodies will be required to undertake the works.

3.2.4 Planning permission

Under the Town and Country Planning Act 1990, which is implemented in England under the Town and Country Planning EIA Regulations, planning permission for the restoration element of the proposed works may be needed. Consultations with Chichester District Council have been initiated to determine whether planning permission is required, the outcome of this is not yet clear, but will be confirmed in due course.

3.2.5 Environmental permit / flood risk

For works taking place on or near a flood defence or sea defence structure, and also in a flood plain, an environmental permit (formerly flood defence consent), may be required. Consultations with the Environment Agency have been initiated to determine whether such a permit is required for the restoration works element, the outcome of this is not yet clear, but will be confirmed in due course.

3.2.6 Site of Special Scientific Interest (SSSI) notification

The proposed works overlap with a nationally designated site, the Chichester Harbour SSSI, which is notified for supporting extensive areas of saltmarsh and mudflats and the overwintering birds these .support, as well as various other habitats (see Section 5.3.1 for more detail). A SSSI notification will therefore be submitted to Natural England.

3.2.7 Protected habitats and species

Various species and habitats are protected from being killed, injured or disturbed under provisions of the Habitats Regulations and Section 9(4) and Schedule 5 of the Wildlife and Countryside Act 1981 (as amended)[3].

In particular, Regulation 43 of the Habitats Regulations makes it an offence to deliberately disturb wild animals of any 'European Protected Species' in such a way as to be of likely significance:

- To impair their ability:
  - To survive, to breed or reproduce, or to rear or nurture their young; or
  - In the case of animals of a hibernating or migratory species, to hibernate or migrate; or
- To affect significantly the local distribution or abundance of the species to which they belong.

European Protected Species include a range of terrestrial and marine species such as bats, otters, great crested newts and cetaceans (i.e. dolphins, porpoises and whales).

Section 9(4) of the Wildlife and Countryside Act 1981 (as amended) makes it an offence intentionally or recklessly to disturb dolphins, whales or basking sharks subject to a defence that the act was the incidental result of a lawful operation and could not reasonably have been avoided.

The Natural Environment and Rural Communities (NERC) Act came into force in October 2006. Section 41 (S41) of the Act requires the Secretary of State, in consultation with Natural England, to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The S41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under Section 40 of the NERC Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions.

[3] These have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (HMSO, 2019a).

There are 943 species of principal importance and 56 habitats of principal importance included on the S41 list.

There are no records of European Protected Species at the location of the proposed beneficial use disposal sites and, therefore, requirements for protected species licences are not considered further in this report.

Mudflats and coastal saltmarsh, both of which are S41 habitats, overlap the proposed site. Potential impacts to these habitats will need to be either avoided or mitigated satisfactorily. Further details are presented in Section 5.4.

3.3 Assessment requirements

As part of the various approval processes, the MMO will take account of environmental and project information. The following sections summarise the assessments and documentation that are considered to be required to support the marine licence application for the proposed disposal site.

3.3.1 Environmental Impact Assessment

The EIA Directive (2011/92/EU), amended by the 2014 Directive (2014/52/EU), requires plans, programmes or projects likely to have significant effects on the environment to undergo an environmental assessment, prior to their approval or authorisation. The EIA Directive is transposed into UK law, for development in the marine environment, by the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended).

These were amended by the Marine Works (Environmental Impact Assessment) (Amendment) (England and Wales) Regulations 2009, the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011, 2015, 2017, the Marine Works (Environmental Impact Assessment) and Marine Strategy (Amendment) Regulations 2018, and the Environment, Food and Rural Affairs (Environmental Impact Assessment) (Amendment) (EU Exit) Regulations 2019 (all of which are hereafter referred to as the Marine Works EIA Regulations).

The designation of a beneficial use disposal site does not require an EIA (Manning *et al.*, 2021); and the saltmarsh restoration is not considered to be of a scale which triggers an EIA. A combined disposal site characterisation assessment and environmental appraisal (this report) has been prepared to document all the relevant environmental assessment information in support of the marine licence application.

3.3.2 Marine Plan Conformance Assessment

The UK Marine Policy Statement (HM Government, 2011) contributes to the achievement of sustainable development in the UK marine area. Prepared under Section 44 of the Marine and Coastal Access Act 2009, it provides the framework for the preparation of marine plans and informing decisions affecting the marine environment. It ensures that marine resources are used in a sustainable way in line with marine objectives thereby:

1. Promoting sustainable economic development;
2. Enabling the UK's move towards a low-carbon economy, in order to mitigate the causes of climate change and ocean acidification and adapt to their effects;
3. Ensuring a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage assets; and

4. Contributing to the societal benefits of the marine area, including the sustainable use of marine resources to address local social and economic issues.

The proposed beneficial use disposal site is within the area covered by the South Inshore and South Offshore Marine Plan (South Marine Plans), published in July 2018 by the Department for Environment, Food and Rural Affairs (Defra, 2018). Policies are presented within an economic, social and environmental framework, helping to support the high-level objectives set out in the UK Marine Policy Statement, as well as sustainable development of the marine area (see Section 3.4.1 for more detail).

In considering an application for a marine licence, the MMO will take into account Government policy statements and guidance including the Marine Policy Statement (MPS) and South Marine Plans. In addition, consideration will be given to the principles of sustainable development.

As this report relates to a beneficial use project, and is of a relatively small scale, it is not considered that a full review of the vision, objectives and policies of the South Marine Plans is required.

However, this appraisal is considered to be in-keeping with the policies of the Plans, most notably policy S-DD-2 on beneficial use. Also, in undertaking this Environmental Appraisal, the mitigation hierarchy is adhered to, which is referred to for many of the receptors in the South Marine Plans, namely that proposal should (in order of preference) seek to: a) avoid, b) minimise, c) mitigate significant adverse impacts, d) if it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding. Lastly, in taking a proportionate approach to applying policies, it is highlighted that consideration should be given to the scale, complexity and impact of a proposal. Given the scale and nature of the proposed beneficial use project, it is considered that the application for a marine licence complies with the vision, objectives and policies of the South Marine Plans.

3.3.3 Habitats Regulations Assessment

Part 6 of the Habitats and Species Regulations 2017 (as amended) (commonly referred to as the Habitats Regulations)[4] apply and requires the competent authority, in this case the MMO, to determine whether the proposed beneficial use disposal and saltmarsh restoration site have the potential for a likely significant effect (LSE) on a European site and, if so, to undertake an Appropriate Assessment (AA) of the implications of the proposals in light of the site's conservation objectives. The AA takes account of the in-combination effects of the proposal on the protected areas in association with other relevant projects and plans.

The proposed beneficial use disposal and saltmarsh restoration site is within the following International/European/National sites:

- Chichester and Langstone Harbours Ramsar;
- Chichester and Langstone Harbours SPA; and
  Solent Maritime SAC.

A Habitats Regulations Assessment (HRA) has been undertaken in accordance with the latest available guidance for undertaking HRAs and is included in Appendix A. The legal process that needs to be followed for an HRA is very clearly laid out. In simple terms, it has been pursued in three key stages.

Following advice from Natural England, the first stage (Stage 1: Screening) concludes that the proposed beneficial use disposal site is neither directly connected with nor necessary to the management of a

[4] These have been modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (HMSO, 2019a).

European/Ramsar site. The second stage (Stage 2: Test of Likely Significant Effect (LSE)) confirms that the proposed disposal site has the potential to result in an LSE on a European/Ramsar site and, therefore, there is a need to progress to the next stage of the HRA. Stage 3 (Appropriate Assessment) provides the evidence required to confirm that the proposed disposal site does not have the potential to result in an adverse effect on integrity (AEOI) on any European/Ramsar site either alone or in-combination with other plans and projects.

The information contained in the HRA in Appendix A will enable the competent authority to undertake an AA, assessing the effects of the proposed beneficial use disposal and saltmarsh restoration site on designated features. Based on this information, it is considered that the proposed disposal site will not have AEOI either alone or in-combination with other plans and projects.

3.3.4 Marine Conservation Zone assessment

The Marine and Coastal Access Act 2009 facilitates the establishment of an ecologically coherent network of Marine Protected Areas (MPAs). The Act established a new type of MPA called a MCZ to protect nationally important marine wildlife, habitats, geology and geomorphology.

There are no MCZs that are located within 5 km of the proposed site, and an MCZ assessment is thus not considered to be required.

3.3.5 Water Framework Directive Compliance Assessment

The Water Framework Directive (WFD) (2000/60/EC) established a framework for the management and protection of Europe's water resources. It was implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017, known as the Water Framework Regulations. The overall objectives of the WFD as implemented by the Water Framework Regulations is to achieve "good ecological and good chemical status" in all inland and coastal waters by 2021 (now working towards revised objectives for 2027) unless alternative objectives are set or there are grounds for time limited derogation. For example, where pressures preclude the achievement of good status (e.g. navigation, coastal defence) in heavily modified water bodies (HMWBs), the WFD provides that an alternative objective of "good ecological potential" is set. Groundwater waterbodies are included in the WFD and are assessed on quantitative and chemical status. There is also a general "no deterioration" provision to prevent decline in status.

The proposed site at West Itchenor is in the Chichester Harbour transitional water body (ID: GB580705210000). The Chichester Harbour water body is a HMWB and is currently (2019) at moderate overall status, based on moderate ecological potential and failing chemical status (Environment Agency, 2022).

To support the marine licence application, a WFD compliance assessment has been undertaken to determine whether the proposed beneficial use disposal and saltmarsh restoration site complies with the objectives of the WFD. This assessment follows the format specified in the latest Environment Agency 'Clearing the Waters for All' guidance and is provided in Appendix B. It concludes that the proposed disposal and restoration activities are unlikely to result in non-temporary (i.e. permanent) effects on WFD parameters and that deterioration to the current status of the relevant water bodies is not predicted, nor would the proposed activities prevent these water bodies from achieving long-term future WFD status objectives.

3.3.6 Waste Hierarchy Assessment

Waste policy and, consequently, the Waste Hierarchy Assessment (WHA) are strongly governed by the waste hierarchy set out in the Waste (England and Wales) Regulations 2011[5]. Dredged material is classified as a 'waste', defined as "*any substance or object which the holder discards or intends or is required to discard*". Dredged material, therefore, falls under the remit of waste regulations, which requires consideration of the waste hierarchy and whether beneficial use options are available.

The waste hierarchy sets out the five tiers for managing all types of waste according to what is best for the environment and comprises the following in order of most to least favoured (top to bottom):

1. Prevention;
2. Re-use;
3. Recycle;
4. Other recovery; and
5. Disposal.

The waste hierarchy places emphasis on waste prevention or minimisation of waste, followed where possible by re-use of the material.

The 'prevention' of waste generation in the first instance is the primary aim (tier 1 of the waste hierarchy). This may mean not dredging, or, where dredging is required (e.g. in order to maintain safe navigation as is the case for the small harbours/marinas that are anticipated to be the main potential sediment sources for the proposed disposal site, see Section 2.2.4) or deemed viable (e.g. as part of a licensed development), using methods that are not considered to produce 'waste' (e.g. plough dredging or WID), establishing self-scouring conditions, or minimising the dredge volume as far as reasonably practical.

For all arising dredged material, 'preparing for re-use' is considered the most favoured management option (tier 2 of the waste hierarchy). This includes habitat restoration (i.e. direct disposal of dredged material to enhance or restore habitats), as is the case for the proposed beneficial use disposal options at West Itchenor, and is defined as using dredged material in a manner that will benefit society and the natural environment (Manning *et al.*, 2021).

The hierarchy strongly governs waste management policy in the UK and is considered by the relevant authorities when deciding whether or not to grant a dredging licence or authorise a disposal site (Manning *et al.*, 2021).

'Prevention; under tier 1 of the waste hierarchy is not feasible for the potential sediment sources that have been identified (see Section 2.2.4). The proposed beneficial use disposal site falls under tier 2 of the waste hierarchy 'preparing for re-use' and this is considered the Best Practical Environmental Option (BPEO).

3.4 Policy context

3.4.1 South Marine Plans

The South Marine Plans cover an area of around 12,000 km^2 of inshore and offshore waters across 1,000 km of coastline (Defra, 2018). This area includes one of the busiest shipping channels in the world,

[5] Following the departure of the UK from the EU, the main provisions of the Waste Framework Directive have been retained in English law through the Waste and Environmental Permitting etc. (Legislative Functions and Amendment etc.) (EU Exit) Regulations 2020 (HMSO, 2019c).

with significant numbers of freight and passenger transport, as well as military activity with almost two thirds of Royal Navy ships stationed at Portsmouth. This intense activity and shipping takes place alongside 60 marine protected areas, including nine MCZs and a UNESCO world heritage site. It is one of the most complex and used areas of the English coastline.

The South Inshore Marine Plan area stretches from Folkestone in Kent to the river Dart in Devon. It includes:

- The area from the MHWS tide to 12 nautical miles (nm);
- Any area submerged at MHWS tide;
- The waters of any estuary, river or channel, so far as the tide flows at MHWS tide;
- Waters in any area which is closed (permanently or intermittently) by a lock or other artificial means against the regular action of the tide, but into and from which seawater is caused or permitted to flow (continuously or occasionally).

The South Offshore Marine Plan area includes the area from 12 nm to the maritime borders with France and the Channel Islands, totalling approximately 10,000 km^2.

The proposed site is located below MHWS and within the area covered by the South Inshore Marine Plan area.

The vision for the South Marine Plans is included in Box 1.

Box 1. The Vision for the South Marine Plan areas by 2038

By 2038, the south marine plan areas' iconic and unique qualities, characteristics and culture will be conserved, promoted and where needed enhanced, through good management of its marine space. The natural beauty of the coastline and busy coastal and offshore waters are qualities that make the south marine plan areas distinctive. By 2038, the south marine plan areas will have maintained this distinctive natural beauty and diversity while sustainable economic growth, protection of the natural and historic environment, as well as the well-being of those who live, work and visit the south coast, will have been enhanced through balanced and sustainable use of its resources.

Source: South Inshore and South Offshore Marine Plan (Defra, 2018)

The vision for the South Marine Plans will be achieved through its objectives. The objectives are cross cutting rather than specific to individual topics and sectors. The order of the objectives is not a reflection of priorities. Economic, social and environmental objectives must be considered alongside one another. Objectives should be applied in an integrated way, though not every objective will apply to every situation and in every location.

As noted above, policy S-DD-2 relates specifically to beneficial use; it states that '*Proposals must identify, where possible, alternative opportunities to minimise the use of dredged waste disposal sites by pursuing reuse opportunities through matching of spoil to suitable sites*'. This policy recognises that re-use of dredged material can reduce the pressure on existing marine habitats with some materials being able to support beneficial re-use and ecosystem services. This policy also enables and reduces the need to dispose of excavated material at marine disposal sites.

3.4.2 Shoreline Management Plan

A Shoreline Management Plan (SMP) is a high-level, non-statutory, policy document setting out a framework for future management of the coastline and coastal defences. It promotes management

policies into the 22nd century that will achieve long-term objectives without committing future generations to unsustainable practices.

A SMP aims to define the coastal flooding and erosion risks to people and the developed, historic and natural environments, identify the preferred policies for managing those risks, identify the consequences of implementing the preferred policies, set out procedures for monitoring the effectiveness of the policies, inform others so future land use and coastal zone development can take account of the risks, the time frame of risks and the policies, and comply with environmental legislation and social obligations.

Shoreline management policies include:

- Hold the Line (HTL): Maintain or upgrade the level of protection provided by existing coastal defences.
- Advance the Line (ATL): Build new defences seaward of the existing defence line.
- Managed Realignment (MR): Allowing the shoreline to move backwards or forwards, with management to control or limit movement.
- No Active Intervention (NAI): a decision not to invest in providing or maintaining any defences.

Chichester Harbour is in Policy Unit 5a05 of the North Solent Shoreline Management Plan (2010), which has a Hold the Line (HTL) policy in place, for short (0 – 20 years), medium (20 – 50 years) and long-term (50 – 100 years) epochs. However, many of the defences are privately owned, and the policy has No Public Funding Available (NPFA). Therefore, building up the saltmarsh surrounding the harbour for natural coastal defence (as well as the multiple ecological values) is advantageous.

Many of the privately owned defences around Chichester Harbour are coming to the end of their design life at the end of the first epoch in 2025. There is a legal requirement to assess future strategies and schemes against protected site legislation. This provides an opportunity to manage the coastline to a more sustainable location and/or alignment, both in terms of managing flood risk and to create and restore habitat. The SMP's are currently undergoing a 'refresh'. Whilst this is not intended to be a complete review, the current study should feed into advice that Natural England will provide in future (Bardsley *et al.*, 2020).

3.4.3 CHaPRoN

The Chichester Harbour Protection and Recovery of Nature (CHaPRoN) partnership brings together organisations that are able to take practical steps to improve habitats around the Harbour both in the water and on the land. CHaPRoN will focus on priority habitats such as saltmarsh, seagrass, and oysters, as these are considered to be at the biggest risk of further loss, as well as have a high natural capital value. The ambition is wider though, and will seek to create wildlife recovery areas stretching from Langstone Harbour in the West to Pagham Harbour in the east and linking terrestrially to the South Downs National Park a mile to the north of Chichester Harbour (CHC, 2021).

3.4.4 The 2021 Environment Act

Several relevant policy changes are emerging from the Environment Act (2021), such as delivering Biodiversity Net Gain for terrestrial developments (inclusive of intertidal areas), or the development of Local Nature Recovery Strategies (LNRS). The latter are a new, England-wide system of spatial strategies that will establish priorities and map proposals for specific actions to drive nature's recovery and provide wider environmental benefits.

4 Assessment Scope and Methods

4.1 Level of assessment

In accordance with the recently published handbook for restoring estuarine and coastal habitats with dredged sediment (Manning *et al.*, 2021), this disposal site characterisation assessment and environmental appraisal report has applied a pragmatic and risk based approach. This is to ensure that the evidence base, monitoring and associated costs of beneficial use projects are proportionate to their perceived risk.

The intention of this risk based approach is to help guide a general understanding of the level of detail that may be required or expected for the characterisation of the disposal site (Manning *et al.*, 2021). It is not meant to be prescriptive and should be considered indicative, and involving an element of expert judgement.

Based on the generic risk based framework included in Table 3.9 of the handbook (Manning *et al.*, 2021), the scores that have been assigned to the risk criteria of relevance to the proposed beneficial use disposal site at West Itchenor are presented in Table 1.

Table 1. Risk based framework scores assigned to relevant risk criteria

Risk criterion	Score (risk)	Reasoning/justification
Volume (m^3) material disposed per annum	2 (medium)	This is based on a combined maximum total annual volume of up to 4500 m^3 that could initially be deposited at the proposed beneficial use site (Section 2.2.1), with similar annual maximum volumes possible in the future (maximum of 5,000 m^3 per annum, up to a maximum of 25,000 m^3 in total over five years).
Sediment quality	1 (low) to 2 (medium)	The maintenance dredge material from the potential sediment sources (i.e. nearby harbours and marinas) comprises silts with contaminants well below Cefas AL 2. For the most part, sediments at Northney Marina fell below Cefas Action Level (AL) 1, however, with some samples marginally exceeding AL1 (Section 5.2). The physical characteristics of the material that is present at the proposed beneficial use disposal site are presented in Section 5.2.1. Materials may be sourced from other marinas in future years.
Location of the disposal site	3 (high)	The proposed beneficial use site overlaps protected sites and, therefore, according to the handbook, this presents a potential high risk. It should be noted, however, that the proposed activity is to the benefit of the designated habitat features (saltmarsh habitats) in terms of their potential protection and restoration.
Nature of the disposal site	1 (low)	The proposed activities work with natural processes and are, therefore, considered more sustainable, provided that the level of uncertainty or potential negative effects associated with uncontrolled dispersal are considered acceptable. This disposal site characterisation assessment has only identified impacts that are insignificant or minor adverse significant (Section 5) and, therefore, the overall risk associated with this criterion is considered to be low.
Total risk score	**7 to 8 (medium)**	

The total risk score is 7 to 8 (medium) and, therefore, in accordance with the handbook (Manning *et al.*, 2021), a full characterisation and assessment has been carried out and is included in this report.

4.2 Topics scoped out of the assessment

The following topics have been 'scoped out' of the assessment as no direct or indirect pathways for impact are considered likely:

- **Terrestrial ecology** – the proposed beneficial use disposal and saltmarsh restoration site is wholly within the intertidal zone. Whilst machinery access will be via terrestrial areas (along the edge of the adjacent famer's field), and welfare units and bowser storage will be located in the terrestrial environment, this will not lead to habitat changes nor affect species, as it will be located on existing hard standing, and any shrub trimming, if required for machinery access, would be undertaken during the winter (to avoid impacts on breeding birds). There will, therefore, be no significant impact on terrestrial ecology features (including changes in air quality as noted below);
- **Traffic and transport** – the proposed activities will not result in a noticeable changes in landside traffic and transport. The few pieces of machinery and equipment needed will be brought on site at the start of the construction period, and will remain there for the duration. The potential impacts on commercial and recreational navigation are scoped into the assessment (Section 5.8);
- **Air quality** – any changes in local air quality associated with the operation of the dredging plant at the proposed site, and the machinery used in the shaping and SRDB winching, will be very short term/intermittent and negligible in scale;
- **Airborne noise and vibration** – the proposed site at West Itchenor is located more than 200 m from the nearest sensitive human receptors, namely the Northshore Shipyard and associated boat hire and café. The nearest residential receptors lie 250 m away, east of Northshore Shipyard. Furthermore, the area is already used regularly by a range of vessels transiting along the adjacent navigation channel into and out of Chichester Harbour. There is, therefore, considered to be no risk of the short term and intermittent placement of material at the proposed sites by small dredge plant, as well as the restoration works, to result in any significant disturbance to humans. The potential disturbance to marine species and waterbirds is considered in the relevant marine ecological topics scoped into the assessment (Sections 5.5 to 5.7); disturbance to footpath walkers is addressed in Section 5.9; and
- **Landscape, seascape and visual impact** – Construction at the proposed site will be intermittent and temporary; the newly created saltmarsh will be similar in character to the existing adjacent saltmarshes, once full plant coverage has been achieved. Given the level of existing activity and operations and the temporary and short-term nature of the proposed construction works, there will be no noticeable change to the landscape/seascape character or visual appearance.

4.3 Topics scoped into the assessment

The following topics are considered relevant and have been 'scoped in' to the assessment:

- Physical processes (Section 5.1);
- Water and sediment quality (Section 5.2);
- Nature conservation (Section 5.3);
- Benthic ecology (Section 5.4);
- Fish and shellfish (Section 5.5);
- Marine mammals (Section 5.6);
- Coastal ornithology (Section 5.7);
- Commercial and recreational navigation (Section 5.8);
- Other users and marine infrastructure (incorporating flood defences) (Section 5.9);

- Coastal archaeology (Section 5.10); and
- Cumulative and in-combination effects (Section 5.11).

For each of the above topics, a baseline characterisation description for the proposed beneficial use disposal sites is given, followed by an assessment of potential impacts following the methods set out below in Section 4.4 and, where necessary, mitigation requirements are identified (and summarised in Section 6).

4.4 Assessment methods

Although the proposed beneficial use disposal site and initial saltmarsh restoration do not require a statutory Environmental Impact Assessment (EIA), to facilitate and ensure a robust disposal site characterisation assessment is undertaken, a standardised methodology consistent with the requirements of EIA has been applied.

This framework, which is presented in the following sections, has been developed from a range of sources, including the Town and Country Planning (EIA) Regulations 2017 (as amended), Marine Works (EIA) Regulations 2007 (as amended), the new EIA Directive (2014/52/EU), statutory guidance, consultations and ABPmer's previous (extensive) EIA project experience. ABPmer has an IEMA Quality Mark, demonstrating a commitment to excellence in leading the co-ordination of statutory EIAs in the UK. In addition, the environmental appraisal has been undertaken following the principles of the Chartered Institute of Ecology and Environmental Management's (CIEEM) latest guidelines for ecological impact assessment in the UK and Ireland, which consolidate advice for terrestrial, freshwater and coastal environments (CIEEM, 2018).

The environmental issues are divided into distinct 'receiving environments' or 'receptors'. The effect of the proposed disposal sites on each of these is assessed by describing in turn: the baseline environmental conditions of each receiving environment; the 'impact pathways' by which the receptors could be affected; the significance of the impacts occurring; and the measures to mitigate for significant adverse impacts where these are predicted.

This Impact Assessment Framework, which is presented in the following sections, is designed to incorporate the key criteria and considerations without being overly prescriptive.

4.4.1 Stage 1 – Identify receptors and changes

The first stage identifies the potential environmental changes resulting from the proposed activity and the features of interest (receptors) that are likely to be affected (which are together referred to as the impact pathway). The potential impact pathways which are considered relevant to this disposal site characterisation assessment are set out at the beginning of the impact assessment section for each environmental receptor.

4.4.2 Stage 2 – Understand change, sensitivity and importance

The second stage involves understanding the nature of the environmental changes to provide a benchmark against which the changes and levels of exposure can be compared. The scale of the impacts via the impact pathways depends upon a range of factors, including the following:

- Magnitude (local/strategic):
  - Spatial extent (small/large scale);
  - Duration (temporary/short/intermediate/long-term);
  - Frequency (routine/intermittent/occasional/rare);
  - Reversibility;
- Probability of occurrence;
- The margins by which set values are exceeded (e.g. water quality standards);
- The sensitivity of the receptor (resistance/adaptability/recoverability);
- The importance of the receptor (e.g. designated habitats and protected species or local features);
- The baseline conditions of the system;
- Existing long-term trends and natural variability; and
- Confidence, or certainty, in the impact prediction.

4.4.3 Stage 3 – Impact assessment

The likelihood of a feature being vulnerable to an impact pathway is then evaluated as a basis for assessing the level or magnitude of the impact and its significance. The key impact levels are described in Table 2.

Minor impacts may be discernible but tolerable and are, therefore, not significant. Where moderate impacts are adverse, they may require mitigation. Major impacts are highest in magnitude and reflect the high vulnerability and importance of a receptor (e.g. to nature conservation). Where these changes are adverse, they will require mitigation.

Table 2. Assessment criteria

Type	Level or Magnitude of Impact	Indicative Criteria	Significance
Neutral	No change	There is no change from baseline conditions.	Not significant
Adverse or beneficial	Negligible	There is likely to be a change, but the level will not be discernible from baseline conditions.	Not significant
	Minor	Small spatial scale; Low intensity; Short-term; Low sensitivity/importance of receptors; and/or High tolerance/reversibility of receptors.	Not significant
	Moderate	Medium spatial scale; Moderate intensity; Medium-term; Moderate sensitivity/importance of receptors; and/or Moderate tolerance/reversibility of receptors.	Significant
	Major	Large spatial scale (size/number); Major intensity (level/magnitude); Long-term (duration/frequency); High sensitivity/importance of receptors; and/or Low tolerance/reversibility of receptors.	Significant

4.4.4 Stage 4 – Impact management

The final stage is to identify any impacts that are found to be moderate and/or major adverse significant and require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure, the use of mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e. with mitigation) identified.

4.4.5 Cumulative impact and in-combination assessment

Under Marine Works (EIA) Regulations 2007 (as amended) it is necessary to assess the potential cumulative impacts of a proposed activity on all environmental receptors together with other existing or consented developments in the area. Under the Habitats Regulations, it is also necessary to consider the in-combination effects of a development proposal specifically on the interest features of European sites.

The cumulative and in-combination effects assessment takes account of the total effects of all pressures from the proposed beneficial use disposal sites alone acting upon all relevant receptors in seeking to assess the overall significance of cumulative and in-combination effects. Additionally, consideration is given to any other plans, projects or activities, including any impacts that do not directly overlap spatially, but may indirectly result in a cumulative and/or in-combination impact.

The cumulative impact and in-combination assessment is presented in Section 5.11.

5 Assessment of Potential Impacts

5.1 Physical processes

5.1.1 Baseline description

Coastal Setting

Chichester Harbour is a meso-tidal estuary system located to the west of Chichester and north of Bracklesham Bay, with an entrance from the Solent between Selsey to the east and Hayling to the west. Chichester Harbour is part of a natural system of harbours formed from a series of drowned river valleys created during the last ice age, which include Langstone and Portsmouth Harbours.

The Harbour entrance has a narrow deep channel to the west and a wider intertidal section to the east, which are flanked by two mobile spit systems, Sandy Point and East Head. The Harbour opens out to provide a tidal area comprising saltmarsh, mudflat and some 70 km^2 of navigable water divided into three main channels, the Emsworth, Thorney and Chichester Channels. The latter channel is divided into the Itchenor Reach and Bosham Channel. The location for the proposed beneficial use site is on the south side of the Itchenor Reach, opposite Cobnor Point and just down estuary of confluence with the Bosham Channel.

Near Surface Geology

The main drainage system for the Harbour was established during the Pleistocene (ice age). Over the last 6,000 years, the Harbour has been infilling with fine grained sediments transported into the Harbour from marine sources by tidal currents (CBA, 2004). Today, the near surface geology is composed of Holocene alluvium deposits which comprise estuarine sands and muds (forming the mudflats and saltmarsh throughout the harbour), blown sand on East Head and beach gravels along the coastline. In places, the channels are cut into Eocene/Pleistocene strata below approximate mid tide level (ABP Research and Consultancy Ltd., 2001).

In recent times, the form of the harbour has been modified due to man-made land claim (and embankments), dredging, marina and quay developments, and managed realignment schemes.

Bathymetry

At the Harbour entrance, between the two spit systems, flow speeds in and out are high and maintain depths in excess of 12 m below Chart Datum (CD) (Treloar Hole). The channels within vary in the general range 2 – 6 m below CD, before drying at low water (LW) towards the inland extremities. For the most part, the channels are 'U' shaped in form with relatively steep sides below LW, before changing to relatively shallow sloping mudflats which merge to saltmarsh, often with a vertical edge.

The location of the proposed beneficial use site is a relatively narrow area of mudflat, adjacent to a previously claimed site (now a regulated tidal exchange (RTE), Chalkdock Marsh) and higher land. The 'thalweg' (line of deepest bathymetry) is moved to the south side of the channel at this location, creating a steeper subtidal slope and directing higher flows around the channel edge. Please note that a baseline bathymetry survey is planned for the trial area prior to works commencing (see Section 6 for detail).

Image 5 shows a comparison of four topographic (LiDAR) intertidal profiles at and in proximity of the proposed Beneficial Use site, and the change in the period 2007 – 2020.

Image 5. LiDAR (2007-2020) cross sections along the West Itchneor intertidal

Profile 1 crosses a wide area of saltmarsh with little mudflat. Here, vertical accretion (0.2 – 0.3 m) is evident on top of the marsh but the front edge has receded since 2007, by up to 12 m. Profile 2 is located in front of the remnant 'wall' at Chalkdock Marsh. Little change is evident on the upper intertidal, but erosion is evident in the middle around 0.5 mOD (low mudflat elevations). At Profile 3, which is at the trial area, a similar pattern is evident, except there is evidence of horizontal erosion at a level just below Mean High Water Neaps (MHWN), possibly suggesting this location may be more exposed to wave activity. Profile 4 is in a more sheltered location near the Quay, and shows near stability between 2007 and 2020, within the mudflat area, although marginal accretion has occurred at levels above Mean High water Spring (MHWS). Please note that the July 2022 saltmarsh edge survey (see Figure 4) indicated slight retreat of the saltmarsh edge here between 2016 and 2022 along the 70 m section immediately adjacent to the Quay, ranging between 0.5 and 2.5 m over 6 years.

These changes indicate that sedimentation is occurring from the water column and is being trapped by the saltmarsh, where it exists. In lower more exposed areas, including most of the saltmarsh edges, the erosional processes are tending to outweigh the sedimentation which occurs over the high water slack period. The greatest erosion occurs below approximate mid tide level, in areas that are not in the lee of higher saltmarsh areas (i.e. Profiles 2 and 3). These characteristics suggest the changes occurring are tidally dominated process which are augmented (erosional) by wave effects (both naturally and possibly vessel induced).

Physical Processes

The form a coastal/estuarine system takes is influenced by a range of physical processes that operate over varying temporal and spatial scales. In terms of the morphology of the system, the principal hydrodynamic forcing mechanisms are tidal flow, fluvial flow, waves and density driven circulation. Over the last *circa* 150 years, significant changes have occurred in these physical processes, decreasing the longshore supply of sediment within Bracklesham Bay. This is associated with a re-orientation of East Head spit into the Harbour and a widening of the Harbour mouth (CBA, 2004). Additionally, strong currents through the entrance have transported sand out of the Harbour, to deposit and form an ebb tide delta (East and West Pole Sand) and into the Harbour, forming Pilsey Sand (ABP Research & Consultancy Ltd., 2001). These changing processes give rise to the current form and evolution of Chichester Harbour.

Tidal Flow

The form of the tide in Chichester Harbour is controlled by the complex semi-diurnal tidal regime in the East Solent region. The tidal range at Chichester Harbour entrance is 4.0 m and 2.1 m for springs and neaps respectively (meso-tidal). The tidal curve retains a slight young flood stand, typical of Solent tidal curves, with an approximate two hour stand at high water. The flood phase lasts for approximately 7 hours with the ebb phase lasting for approximately 6 hours, indicating an ebb tidal dominance. Table 3 gives velocities inside the harbour based on the peak flood and ebb tidal streams measured by the Admiralty (Chart 3418). These figures clearly demonstrate the asymmetry in the tidal signal, as in many parts of the Harbour, the highest currents occur on the ebb; it also shows that currents decrease with increasing distance into the Harbour.

A recent spring tidal flow speed survey at Itchenor Pontoon observed maximum speeds of 0.9 m/s, at a depth of 0.5 m. This was recorded 3.5 hours after high water, on the ebb (ABPmer, 2022).

Table 3. Velocities from Admiralty Chart 3418 inside Chichester Harbour for peak flood and ebb flows

Tidal Diamond/ Position	Tide	Maximum Rate (m/s)	
		Spring	Neap
E - Emsworth Channel, confluence with Sweare Deep	Flood	0.8	0.4
	Ebb	1.1	0.5
F -Chichester Channel, confluence with Thorney Channel	Flood	1.6	0.8
	Ebb	1.7	0.8
G -Harbour Mouth	Flood	1.4	0.5
	Ebb	3.3	0.6
H -Mill Rithe, Emsworth Channel	Flood	1.0	0.3
	Ebb	0.6	0.4
J -Bosham Channel	Flood	0.5	-
	Ebb	0.8	-
K - Itchenor Sailing Club, Itchenor Reach	Flood	0.5	0.3
	Ebb	1.2	0.5
L - Longmore Point, Itchenor Reach	Flood	0.3	-
	Ebb	0.4	-

Source: Admiralty Chart

In the entrance, the strong ebb currents have often been described as an 'ebb tidal jet' and this has apparently scoured the region of the Harbour entrance to depths of 19 m (Webber, 1979; Harlow, 1980). Residual current speeds in the entrance to the harbour can reach 0.16 m/s on spring tides. These current speeds are 5 to 6 times greater than the residual currents over the remainder of the bay (Whitcombe, 1995).

There are no river freshwater discharges into the harbour of note, although there is the potential for overland flow at times of high rainfall.

The closest Admiralty Diamond to the proposed Beneficial Use site is Site K (Itchenor Sailing Club). This indicates that flood flows past the site are not likely to be greater than 0.5 m/s; however, ebb flows could be in excess of 1 m/s for periods of the ebb tide.

Winds

The prevailing winds for the south coast are from the southwestern sector, with the strongest winds occurring during the winter (JNCC, 1996). Estuaries and harbours on the south coast are relatively sheltered from the prevailing winds, but are exposed to gales from the south (JNCC, 1996). In the Chichester Harbour region, the mean hourly wind speed (exceeded for 75% of the time) between 1965 and 1973 was approximately 3 m/s. Wind data collected by the Meteorological Office at Thorney Island between 1958 – 1970 and 1970 – 1984 show that the wind climate is not as severe as would normally be expected, due to the shelter afforded by the Isle of Wight (Whitcombe, 1995). Overall the area is dominated for more than 90% of the time by winds of 8 m/s or less, from all directions, which result in a low wave energy environment.

Waves

Wave action in Bracklesham Bay is dependent upon the fetch and nearshore bathymetry. The area is also sheltered by the Isle of Wight from the prevailing south westerly winds In areas exposed to the south or south west, a 1.4 m significant wave height is predicted for 1:50 year storms (HR Wallingford, 1997). Whitcombe (1995) and Webber (1979) state that the longest period waves are refracted from the south west, and also that the greatest wave heights are associated with southerly and south easterly winds.

The narrow entrance configuration means the wave climate in the harbour is relatively low, however CBA, 2004 estimated maximum wave heights of 0.5 – 1 m could occur under storm conditions at Cobnor. Since Cobnor Point is opposite the proposed Beneficial Use site, similar waves can be expected here, although the area is marginally more sheltered.

Surges

Storm surges along the south coast are correlated with onshore wave action from either the south west or south east and the combination of surge, wave action and high tides can severely test coastal defences (HR, 1991). Surges up to 1.1m occur in the region of Chichester Harbour, and a number of surges have been recorded in recent years (e.g. Standing Conference on Problems Associated with the Coastline (SCOPAC), 2020).

Sediment Transport

In the East Solent, the main sediment sources are coastal erosion and offshore feed, whilst the main transport mechanisms are littoral drift and estuarine transport. However generally, the main supply of sediments is from the offshore regions and is wave driven (Hooke et al, 1995).

A mixture of shingle and sand is transported west from Selsey Bill as far as Chichester Harbour via littoral drift, whilst a transport pathway further offshore moves sand east and west from Bracklesham Bay (Hooke *et al.*,1995). Along the Hayling Island frontage, the drift is from west to east, although the current rate is very low.

The volume of littoral drift has declined over the past 100 years, and now there appears to be little input of materials to the Chichester Bar (HR Wallingford, 1991). Harlow (1980) and Webber (1979) suggest that drift has fallen from 70,000 - 75,000 m^3 in the second half of the 19th Century, to approximately 6,500 - 9000 m^3 in 1990. Whitcombe (1995) stated that there was little or no sediment transport occurring in Hayling , as illustrated by extensive marine growth in the area. This decline in littoral drift has been cited as the cause of rotation of East Head (HR Wallingford, 1995) and the formation of 'The Winner', a broad expanse of sand and gravel located in the entrance to the Harbour, to the west of East Head itself. Webber (1979) noted that The Winner was composed of coarse to medium gravels, much of which was encrusted with barnacles, signifying a stable substrate at that time.

In the Harbour entrance itself, there is an anticlockwise material circulation. Material moves out of the Harbour on the west side through the Emsworth Channel and into the estuary on the east side over The Winner. Within Chichester Harbour, the movement of fine-grained material is governed by the balance of the flood and ebb currents within the channels. Analysis of estuary regime relationships (ABP Research & Consultancy Ltd, 2001) indicate a longer duration of the slack around high water (HW) compared to that at LW. This means there is a longer period for settlement of sediment over the intertidal areas at HW, resulting in a net import of fine-grained sediments (muds) i.e. flood dominant for fine grained material. This has resulted in the build-up of mudflats and saltmarsh during the Holocene within the harbour, and the need for maintenance dredging to maintain navigation and marina facilities. HR Wallingford (2004) estimated that the annual sediment load transported into the harbour on flood tides was 490,000 tonnes (assuming a dry density of 500 kg/m^3).

The Harbour is also ebb dominant with respect to the tidal flows (see Table 3), i.e. stronger tidal flows. This implies a tendency for the export of coarser sediments (sand and gravel), particularly near to the entrance, which is considered the reason for the development of Pole Sands outside the Harbour entrance (ABP Research & Consultancy Ltd, 2001).

Estuary Form

The calculated hydraulic parameters for Chichester Harbour as whole are shown in Table 4. The overall tidal prism for the Harbour is 9.35 and 4.42 x 10^7 m^3 on spring and neap tides respectively. Given the area of the estuary, this creates an overall hydraulic depth ranging from 1.73 – 3.49 m.

Table 4. Hydraulic Parameters of Chichester Harbour

Parameter	Spring Tide	Neap Tide
Hydraulic depth at HW (m)	3.49	2.65
Hydraulic depth at LW (m)	1.73	2.23
Tidal prism (x$10^7$$m^3$)	9.35	4.51
Volume at LW (x$10^7$$m^3$)	1.55	2.35
Surface area at HW (x$10^7$$m^2$)	3.13	2.58
Surface area at LW (x$10^7$$m^2$)	0.89	1.05
CSA at mouth (x$10^3$$m^2$)	5.23	5.23
Inter-tidal storage(m^3)	6.62x10^7	1.90x10^7
Volume in channels at LW (m^3)	1.55x10^7	2.09x10^7
Entrance CSA at MSL (m^2)	5230	
M_2 (m)	1.49	
Av depth at MSL(m)	2.59	2.57
MSL at Harbour Mouth (m CD)	2.86	
MHWS at Harbour Mouth (m CD)	4.9	
MLWS at Harbour Mouth (m CD)	0.9	

Source: ABP Research & Consultancy, 2001

These data have been used to calculate a full range of geomorphological relationships for the Harbour as a whole and component parts. This work is detailed in ABP Research & Consultancy (2001).

These results showed that the tidal prism and channel cross section area decrease with distance from the Harbour mouth along the channels, as would be expected; however, increased area and prism values are found at the confluence of the channels. The O'Brien relationship, which relates the tidal prism and the cross-sectional area at the Harbour mouth, provided a value of 17,900 m on springs and 8,600 m on neaps.

This indicates that, on spring tides, the entrance area is smaller than the equilibrium area for the tidal prism of the Harbour. This shows that, on spring tides, there is a tendency for net erosion of the entrance, however on neap tides the area is too large, hence more deposition is likely. The average indicates that there is a net erosional stress to widen and deepen the entrance below mean sea level. Whether this can be achieved is dependent on the underlying geology and the material type. Other geomorphological relationships suggest the current Harbour mouth is constrained and more changes are likely in the future before stability is reached.

Taking sub-sections of the Harbour, the O'Brien relationship varies in the range 2,000 – 20,000, with values generally reducing with increasing up estuary distance from a confluence. The results tend to indicate that the upper reaches of the Harbour are closer to a stable state than the Middle and lower reaches. This was attributed to the greater rates of sedimentation, relative to the original channel size during the Holocene period.

The location of the proposed Beneficial Use site is close to the confluence of the Chichester Channel with the Bosham Channel. The O'Brien relationship for this section of the estuary (ABP Research & Consultancy, 2001) indicates values between 5,000 at the down estuary part of the reach and around 10,000 at Itchenor. This indicates for much of the area the cross-sectional area is too large for the tidal

volume, therefore likely to be an overall accretion tendency within the area, with stability up estuary. The LiDAR analysis in Image 5 however suggests there is a slight erosional tendency occurring with respect to the channel width/cross section, although sedimentation is evident particularly on the higher elevations, and near-stability is shown at Itchenor.

Dredging

Chichester Harbour is a natural tidal inlet which experiences a net deposition of typically fine silty material within its various marinas/boatyards and navigation channels. To maintain access for vessels and tidal windows, maintenance dredging is required. Siltation rates are low compared with other UK locations; therefore, annual maintenance dredging campaigns are not usually required. HR Wallingford (1999) estimated that the annual Harbour maintenance requirement was 10,000 – 13,000 m^3 (excluding Chichester Bar, outside the entrance). However, values can vary widely from year to year. Dredging records from the County Record Office in Chichester show that dredging has occurred in one form or another (inside and outside the Harbour) for at least the past 200 years.

Most dredging from the nine separate locations within the Harbour is undertaken by a backhoe dredger or traditional excavator loading barges for disposal at a licensed disposal site. A further estimated 500 m^3 of dredging by a plough is undertaken annually (HR Wallingford, 2011). Some of the clean uncontaminated sediments are placed at Treloar Hole within the Harbour, which is deemed a beneficial use site, with other material deposited at the Nab Tower deposit Ground to the east of the Isle of Wight.). The Treloar site is restricted to a maximum volume of 13,000 m^3 $year^{-1}$ (about 7,000 tonnes dry solid) deposited on the flood tide to re-enter the harbour. Assuming all material remains in the harbour this represents about 1.5% of the total load (HR Wallingford, 2011). In practice, not much material is being placed at Treloar Hole.

5.1.2 Impact assessment

The following impact pathways have been considered with respect to physical processes:

- Changes to the suspended sediment concentrations;
- Changes to the seabed bathymetry and morphology;
- Changes to the hydrodynamics; and
- Changes to the sediment transport regime.

Changes to the suspended sediment concentrations

It is estimated that a maximum total annual volume of up to around 5,000 m^3 of maintenance dredge material from the nearby marinas could be placed at the proposed beneficial disposal sites over a series of intermittent dredge campaigns, starting in late February/March 2023 with the trial, and a maximum of 4,500 m^3 (Section 2.2). Over the five-year licence period, as noted in Section 2.2, up to 25,0000 m^3 may be delivered and 3.5 ha of saltmarsh restored. Activities in any given year will very much depend on sediment availability, which is variable in Chichester Harbour, as noted in Section 2.2.4.

The dredged material will be consolidated back hoed silt which is to be deposited along the lower mudflat shores at the proposed beneficial use disposal site. It will then be dragged up the shore using the SRDB as soon as the barges have departed.

The bottom placement of material will take place on the highest tides and as high on the shore as possible, to minimise its dispersal by tidal currents and help maximise its retention. The maximum water depths at the site during the periods of bottom placement will be in the order of 3 to 4 m.

In terms of sediment suspension, the fine sediment comprising the potential dredged material sources (Section 2.2.4) will generally be contained within the bulk of the dredged material and will primarily

move as a cohesive mass from the hopper to the seabed. As the dredged material falls through the water column, there is likely to be a degree of stripping of material from the boundaries of the mass with subsequent entrainment into the water column. Further, as the mass reaches the seabed some material may rebound into the lower part of the water column, however, this then falls and settles back to the seabed. Increased suspended sediment concentrations (SSC) will be greatest at the immediate site of the disposal. Dispersion of material will be limited given the placement activities will take place as high up on the shore as possible, and as the materials will be dragged up the shore as soon as possible.

Overall, the increase in SSC and sediment plume will be discernible but highly localised and temporary at the beneficial use disposal site location. The spatial and temporal magnitude of changes in SSC is, therefore, assessed as small and the impact as **insignificant to minor adverse** at a local scale.

Changes to the seabed bathymetry and morphology

The material which is to be deposited will be dragged up the shore as soon as possible after the barges have departed (see Section 2.2). New saltmarsh platforms will then be shaped on the upper shore, in areas where saltmarsh would have existed in the not too distant past.

Bathymetric surveys will be undertaken immediately before and after the initial trial to ensure no noticeable volumes of material have slipped into the subtidal whilst the works were ongoing. This is considered unlikely, as the SRDB would be lowered a sufficient distance behind the deposits to ensure all of them are dragged up, and as the deposits will take place as high up the shore (and thus as far away from the subtidal edge) as possible. Should the post-trial bathymetry survey show that noticeable changes have occurred in the subtidal immediately adjacent to the trial area which can clearly be attributed to the trial, then Land and Water will rectify this and reinstate the pre-trial subtidal bathymetry.

The magnitude of the changes in seabed elevation at the proposed beneficial use disposal sites in the context of the existing elevations and water depths at these sites, are assessed as minor, but in-keeping with the local intertidal habitats. Thus, impacts are considered to be **insignificant.**

Changes to the hydrodynamics

The proposed project has the potential to result in changes to hydrodynamics (e.g. water levels and flow rates). The proposed beneficial use disposal and saltmarsh restoration site will cause a change in the local estuary geometry which in turn will marginally decrease the estuary tidal volume and tidal prism. The proposed site is within a relatively sheltered area of Chichester Harbour, and the amount of sediment which is to be disposed is relatively limited, leading to a maximum of around 3.5 ha of saltmarsh being restored, with up to 0.7 ha targeted during the first winter. The changes will all take place along the upper shore and will thus not affect dominant currents in the area.

The scale of any changes in tidal volume and tidal prism are considered to be negligible and will not modify the way the tide propagates through the harbour, in terms of the shape of the tidal curve, water levels and tidal range. Changes to flows following the proposed disposal activities will also be negligible in magnitude and extent, and confined to the immediate proximity of the proposed saltmarsh restoration. Considering the low existing flow speeds in the area and a minute decrease in overall estuary area during higher states of the tide, it is suggested that any decreases would be negligible in magnitude.

Overall, the proposed beneficial use disposal and saltmarsh restoration site at Itchenor is considered to result in a very localised and negligible change on hydrodynamics (e.g. water levels, flow rates, changes

to tidal prism). The extent and magnitude of the changes will remain negligible in response to climate change and sea level rise. Impacts are thus considered to be **insignificant**.

Changes to the sediment transport regime

The regular recharge placements and saltmarsh shaping at the proposed is expected to lead to medium to long-term changes along the upper shore. Whilst there is expected to be a small level of erosion along the edges of the newly shaped platforms, compaction and vegetation establishment is anticipated to soon help to stabilise them and provide additional protection from erosion[6].
The placement of material at the upper shore will help protect the shoreline behind, as well as provide some shelter to the saltmarshes to the east. In addition, placing material from Chichester Harbour at the site will help to add or retain more sediment within the local sedimentary system, rather than disposing of this material at more distant licensed sea disposal sites.

Overall, the changes to the sediment transport regime as a result of the proposed beneficial use disposal and saltmarsh restoration site are assessed as small in extent and magnitude, and impacts are considered to be **insignificant**.

5.2 Water and sediment quality

5.2.1 Baseline description

Water quality

Under the Water Framework Directive (WFD), a River Basin Management Plan (RBMP) has been developed for each river basin district in England and Wales. The proposed beneficial use disposal site is within the South-East river basin district (Environment Agency, 2015), and the Chichester Harbour transitional water body (ID: GB580705210000).

The Chichester Harbour transitional water body (ID: GB580705210000) is a heavily modified water body (HMWB) and is currently (2019) at moderate overall status, based on moderate ecological potential[7] and failing chemical status[8] (Environment Agency, 2022). There are 'good' levels of biological elements, invertebrates, and macroalgae; however, during all previous (RMBP cycle 2) reporting years, these two elements were set at 'moderate'. Phytoplankton has been assessed as being at 'high' status throughout the recent reporting period. Additionally, the levels of specific pollutants, arsenic, coper and zinc are considered to be at 'high' status. The moderate ecological potential is due to the physico-chemical quality element of dissolved inorganic nitrogen being classified as 'moderate'. Chemical status is failing to achieve good status due to priority hazardous substances, specifically, mercury and its compounds, and polybrominated diphenyl ethers (PBDE). However, levels of Benzo(a)pyrene, Cadmium and Its compounds, Dioxins and dioxin-like compounds, Hexabromocyclododecane (HBCDD), Hexachlorobenzene, Hexachlorobutadiene, and Perfluorooctane sulphonate (PFOS) are classified as 'good'. Priority substances, Fluoranthene, Lead and its Compounds, and Nickel and its compounds are also classified as 'good' (Environment Agency, 2022).

[6] It is well known that saltmarshes provide better wave protection than mudflats (e.g. Möller *et al.*, 2014). With regard to plant establishment, pioneer species typically colonise restoration sites during the first year, and similar local species pools and plant coverage to adjacent established marshes are typically attained within five years, provided suitable elevations are attained (Manning *et al.*, 2021; Hudson *et al.*, 2021).

[7] There are five classes of ecological status (high, good, moderate, poor or bad). Ecological status and chemical status together define the overall surface water status of a water body.

[8] Chemical status is recorded as good or fail. A status of good means that concentrations of priority substances and priority hazardous substances do not exceed environmental quality standards. The chemical status classification for the water body, and the confidence in this (high or low), is determined by the worst test result.

A 2019 masters thesis on the Chichester Harbour responses of saltmarshes to environmental factors (Rogers, 2019) found a relationship between the localised erosion of saltmarsh in years where there were higher nitrate values in Chichester Harbour. Rogers' work furthermore determined a statistically significant relationship between higher nitrogen (nitrate) rates resulting in greater annual saltmarsh losses at a local level, when combined with other factors likely to correlate with high nitrogen such as increased wave action (as they are related to increased wind and rainfall). Though all attributes correlated to saltmarsh, wave action and nitrate levels had the strongest correlation to losses of saltmarsh, with the correlation to winter nitrate stronger than summer nitrate (however both were statistically significant).

Chichester Harbour has been identified as a catchment which is subject to nutrient neutrality strategic solutions (Natural England, 2022)[9]. Such areas have recently been identified in several English catchments; including all the catchments into the Solent and Poole Harbour (Local Government, 2022). In such nutrient advice areas, new developments in some catchments cannot proceed if they increase levels of nutrients; mitigation actions are typically required before permission is granted.

The CHC regularly monitor water quality against bathing water standards at 11 sites around the Harbour (CHC, 2022). 'Deep End' is the closest sampling point to the project site at West Itchenor. Since January 2015, samples testing for Escherichia coli and Enterococci has been 99.01% and 99.02% excellent (respectively) by EU bathing water standards. Samples are collected and analysed every two weeks during April to the end of October and monthly in the winter. Most of the time, Harbour waters do not appear unduly impacted from high levels of bacteria from these sources. However, after heavy rain, bacteria levels can increase. These enter the Harbour from several sources:

- Wastewater Treatment Works (WWTW). There are three wastewater treatment plants that discharge directly into the Harbour; at Apuldram, Bosham and Thornham. In addition, storm discharges from Lavant WWTW can impact the Harbour via the River Lavant, as can Southern Water activity pumping from the surcharged pipes into the River Lavant to take pressure off the wastewater system in upstream villages such as East Dean. Storm discharges from Budds Farm WWTW in Langstone Harbour are also likely to impact to some degree.
- A number of streams flow into the Harbour, many of which will pass through fields grazed by cows, sheep and horses. There will also be run-off from land around the Harbour during heavy rain. Yachtsmen and other Harbour users will also have some impact.
- Private package treatment plants and outputs from septic tanks from older properties contribute further.

Sediment quality

There are no formal quantitative environmental quality standards (EQSs) for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority (hazardous) substances. Cefas has prepared a series of guideline Action Levels (ALs) to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Dredged material with contaminant levels between AL1 and AL2 requires further consideration before a decision can be made.

[9] i.e. it is an area where poor water quality due to nutrient enrichment from elevated nitrogen and phosphorus levels has been identified as a primary reasons for habitats in designated sites being in unfavourable condition.

The Cefas Guideline ALs should not be viewed as pass/fail thresholds. However, these guidelines provide an appropriate context for consideration of contaminant levels in sediments and are used as part of a 'weight of evidence' approach to assessing dredged material.

A sample plan request was submitted to the MMO in April 2022 which proposed that six surface samples are taken from the proposed beneficial use disposal site. As sampling requirements had not yet been confirmed by the MMO by the time the surveys were envisaged, sampling was nevertheless undertaken in July 2022. Sediment samples were taken from seven locations at the site, and analysed for particle size. The particle size analysis (PSA) results are shown in Table 5[10]. Across all the sampling sites (see Image 6 for locations), there was 60-80% fine sile (<63 µm) and the remainder was fine sediment in the range 2 mm to greater than 63 µm. All the sites were sandy muds with some additional coarser gravels also present at Sites 1, 2 and 7.

Table 5. Particle size analysis (PSA) results from Sample Plan survey on 1 July 2022

Sample	Classification	Particle Size Distribution (%)		
		Gravel (>2 mm)	Sand (2 mm - >63 µm)	Silt (≤63 µm)
1	Gravelly Mud	10.5%	25.4%	64.1%
2	Slightly Gravelly Sandy Mud	0.1%	20.1%	79.9%
3	Sandy Mud	0.0%	40.8%	59.2%
4	Sandy Mud	0.0%	33.9%	66.1%
5	Sandy Mud	0.0%	41.0%	59.0%
6	Sandy Mud	0.0%	23.3%	76.7%
7	Lightly Gravelly Sandy Mud	0.1%	34.0%	65.8%

Image 6. PSA (and benthic invertebrate) sampling locations

As noted in Section 2.2, the materials dredged at Northney consist of silt, and are thus considered suitable for deposit at West Itchenor. Contamination analysis undertaken on Northney Marina materials in 2011 and 2021 reveals that there was no exceedance of AL2 at the site, but some results were between AL1 and AL2 for some PAHs and heavy metals ; all exceedances were only slightly above AL1 levels. During both campaigns, the AL1s for the following heavy metals were exceeded; 2021 values are included in brackets:

[10] A response schedule was received from the MMO on 26 September 2022. This noted that three surface samples would be required and that Particle Size Analysis (PSA) needed to be undertaken on these. Thus the sampling campaign which was undertaken in July 2022, and subsequent PSA, fully conforms with those requirements.

- Arsenic (2021 result: 21.9 to 22 mg kg^{-1} across 3 sites (AL1: 20 mg kg^{-1}; AL2: 100 mg kg^{-1}));
- Chromium (2021 result: 73.1 to 75.8 mg kg^{-1} across 3 sites (AL1: 40 mg kg^{-1}; AL2: 400 mg kg^{-1}));
- Copper (2021 result: 49 to 64.5 mg kg^{-1} across 3 sites (AL1: 40 mg kg^{-1}; AL2: 400 mg kg^{-1})); and
- Nickel (2021 result: 26.6 to 27.5 mg kg^{-1} across 3 sites (AL1: 20 mg kg^{-1}; AL2: 200 mg kg^{-1})).

These ALs were deemed acceptable for disposal at sea, and the marina owners hold a licence to dispose at the Nab Tower until 2024. It is thus considered likely that the materials can be deposited at Itchenor as well, although the MMO and Cefas will need to confirm this in due course.

It is worth noting that maintenance dredging effectively dredges recently deposited materials only, and will thus generally reflect background concentrations of contaminants; i.e. surface level contamination is likely to be similar elsewhere in the Harbour. A review of sampling returns from other marinas, as well as the 2011 dredging protocol baseline document (HR Wallingford, 2011) confirms this, with the latter for example noting that elevated levels of copper and zinc have also previously been found in Sparkes Marina arisings. Similarly, at Emsworth Yacht Harbour, chromium and copper have previously been found to be above AL1 (though not in the latest samples reported on in the 2011 HR report). This is notwithstanding the fact that there will be local variations.

Shellfish Waters

The Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency to endeavour to observe a microbial standard in all 'Shellfish Water Protected Areas'.

There are currently no designated shellfish waters within 2 km of the proposed disposal site, however in previous years the Chichester Harbour (Thornham Channel) and Chichester Harbour (Chichester Channel) were previously designated within 2 km of the site. As these sites are no longer classified as shellfish production areas, they have not been considered further.

Nitrate Vulnerable Zones

The Nitrate Pollution Prevention Regulations 2015 (as amended), aim to reduce water pollution from agricultural sources and to prevent such pollution occurring in the future (nitrogen is one of the nutrients that can affect plant growth).

There are two designated Nitrate Vulnerable Zones (NVZs) within 2km of the proposed deposit site:

- Broad Rife to Chichester Harbour Surface Water NVZ; and
- Chichester, Langstone, and Portsmouth Harbours Eutrophic NVZ.

Eutrophic Sensitive Areas

The Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended) aim to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. It sets treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges. Sensitive areas under the Regulations are water bodies affected by eutrophication due to elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients.

Chichester Harbour is a Eutrophic Sensitive Area under these Regulations.

5.2.2 Impact assessment

The following impact pathways have been considered with respect to water and sediment quality:

- Potential changes to dissolved oxygen;
- Potential changes to levels of chemical contaminants (including accidental spillages) in water;
- Potential impacts from redistribution of sediment-bound chemical contaminants; and
- Potential long-term improvements in water quality of the Harbour due to nutrient cycling/burial service of saltmarsh habitats.

Potential changes to dissolved oxygen

The increase in chemical and biological oxygen demand associated with elevated suspended sediment concentrations (SSC) in the water column during the disposal activities may have the potential to reduce Dissolved Oxygen (DO) concentrations. The maintenance dredge material may contain an organic rich surface layer that has been recently deposited and not dispersed by existing vessel movements. There is, therefore, anticipated to be a proportion of organic rich material associated with the maintenance dredge material that could contribute to oxygen depletion.

As noted in Section 2.2, the innovative design idea for a Saltmarsh Restoration Drag Box (SRDB) transports sediment that has been deposited by the barge at low shore (consolidated backhoe material, silt), from the low shore / low intertidal areas to higher elevation marsh surfaces. This reduces the surface area of material exposed to the water column and transfers the material quickly up the shore, reducing its time in the water column and, therefore, minimising the potential resuspension and dispersion of sediment. The spatiotemporal changes in SSC are expected to be discernible but highly localised and temporary (Section 5.1.2).

Furthermore, DO is currently at 'high' status for the Chichester Harbour transitional water body (Environment Agency, 2022). It is, therefore, considered that there is a low probability that levels will fall below the standards set by the WFD.

Lastly, saltmarsh vegetation helps to oxygenate waters, though the scale of the restoration at Itchenor is unlikely to lead to noticeable effects. On warm, sunny summer days, oxygen enrichment occurs over saltmarshes during high water, as light penetrates the thin layer of water covering the saltmarsh and the plants release oxygen into the water column (Maris *et al.* 2008).

Overall, any changes in DO are expected to be localised and temporary, and are not considered to result in an effect at the WFD water body level. The potential changes to DO as a result of the placement of maintenance dredge material at the proposed beneficial disposal sites are, therefore, assessed as negligible, and impacts as **insignificant**.

Potential changes to levels of chemical contaminants (including accidental spillages) in water

As sediment is disturbed and re-distributed into the water column, any sediment-bound contaminants may be partitioned from the solid phase (i.e. bound to sediments or suspended matter), to the dissolved or aqueous phase (i.e. dissolved in pore water or overlying water) (Luoma, 1983). The levels of contaminants present in the potential dredged material sources are considered to be relatively low, mostly below, or marginally exceeding, Cefas AL1 (Section 2.2.4). It is, therefore, anticipated that Cefas and the MMO will consider the material to be suitable for disposal at the proposed beneficial disposal sites. Furthermore, the deposits are unlikely to cause a measurable change in the levels of chemical contamination in the water at or around the site given that the proposed bottom placement method of

disposal is aimed at retaining as much sediment as possible at the proposed beneficial use disposal site and minimising the potential resuspension and dispersion of sediment (Section 5.1.2).

With regards to the 2019 failing levels of 'mercury and its compounds' and 'polybrominated diphenyl ethers (PBDE) in the Chichester Harbour transitional water body (Section 5.2.1), the issue extends beyond the zone of influence for potential impacts associated with disposal activities. This supports the finding that the contaminants are from other sources and, therefore, it is highly likely that dredging and disposal activities are not contributing to these failures (Binnies UK Ltd, 2021).

Accidental spillages of oil and other substances have the potential to occur during the bottom placement activities at the proposed beneficial use disposal sites. Best practice pollution prevention guidelines (Defra and Environment Agency, 2016) will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal process to minimise the risk of accidental spillages and the risk of introduction of contaminants.

Overall, the potential changes to levels of chemical contaminants in the water as a result of the disposal of dredge arisings at the proposed beneficial use disposal sites are assessed as **negligible**.

Potential impacts from redistribution of sediment-bound chemical contaminants

The potential to impact the marine environment as a result of any sediment-bound contaminants arises primarily when the sediment that is released into the water column disperses and deposits elsewhere.

The potential sources of maintenance dredge material from nearby harbours and marinas and the physical and chemical characteristics of these sources are reviewed in Section 2.2.4 and Section 5.2.1. The majority of contaminants in the potential sediment sources are at relatively low concentrations, mostly below, or slightly exceeding, Cefas AL1. Maintenance dredge arisings will be used; these constitute recently deposited materials only, and will thus generally reflect background concentrations of contaminants in the Harbour. Furthermore, the proposed method of placing material at the proposed beneficial use disposal site is aimed at retaining as much sediment as possible at the site and minimising the potential resuspension and dispersion of sediment (Section 5.1.2). It is, therefore, unlikely that sediment quality criteria, as a result of a small proportion of material redistributed and deposited during the bottom placement of material at the proposed beneficial use disposal site, will be exceeded elsewhere. Furthermore, the disposal of dredged material is controlled by the MMO evaluation process for licensing disposals at sea.

Overall, the potential impacts from the redistribution of sediment-bound chemical contaminants are assessed as **insignificant**.

Potential long-term improvements in water quality of the Harbour due to nutrient cycling/burial service of saltmarsh habitats

One of the key environmental services associated with intertidal habitats (particularly saltmarsh) is that of nutrient (nitrogen and phosphorus) cycling/burial and trapping of carbon. This trapping arises through a combination of primary production, sedimentation and denitrification, predominantly in intertidal areas. It should be noted that the processes leading to nutrient and sediment storage in estuaries are highly non-linear, and are dependent on the concentrations in the water column (Nedwell *et al.*, 1999). Nevertheless, the loss or gain of intertidal areas directly impacts storage capacity. For example, Jickells *et al.* (2000) estimate that a modern Humber estuary without land claim would retain or denitrify 58% of the modern riverine nitrogen and 27% of the phosphorus input; whereas the current rate for both is below 4%. A recent study on water quality related benefits of marine habitats in the Solent calculated very high values for related saltmarsh services. Watson *et al.* (2020a) estimated the

value of saltmarshes on the basis of replacement costs, i.e. the difference in costs associated with reaching a nutrient reduction target by relying on the capacity of natural systems as opposed to utilising a manufactured alternative (e.g. wastewater treatment upgrades, use of alternative fertilisers). The total economic value provided by a hectare of saltmarsh was estimated to be £111,009 yr^{-1} for Nitrogen (N), and £13,807 yr^{-1} for Phosphorus (P). The differential between bare mudflat and saltmarsh was £71,709 ha^{-1} for N and £12,252 ha^{-1} for P. This was on the basis that '*saltmarsh communities are the most important habitat for N removal*', and also have higher benefits related to P when compared to bare littoral sediment areas (Watson *et al.*, 2020b). Saltmarshes were considered to remove almost 3 times more N and almost 8 times more P than bare mudflats (with the differentials to macroalgae-covered littoral sediments being lower).

Given the relatively small scale nature of the proposed saltmarsh restoration works at Itchenor, the magnitude of the cycling effects on a harbour scale would be considered to be negligible to small. The potential benefits are considered to be of an **insignificant to minor beneficial** nature.

5.3 Nature conservation

5.3.1 Baseline description

Designated sites

The proposed beneficial use disposal sites overlap the following International/European/National sites:

- Chichester and Langstone Harbours Ramsar (the proposed site directly overlaps with this Ramsar site);
- Chichester and Langstone Harbours SPA (the proposed sites directly overlaps with this SPA);
- Solent Maritime SAC (the proposed sites directly overlaps with this SAC); and
- Chichester Harbour SSSI (the proposed sites directly overlaps with this SSSI).

The location of these internationally and nationally designated sites in relation to the proposed beneficial use disposal site are shown in Figure 5. Chichester and Langstone Harbours are large, sheltered estuarine basins comprising extensive mud and sand flats exposed at low tide. Both Chichester and Langstone Harbours contain areas of seagrass beds, saltmarsh, shallow coastal waters, coastal lagoons, coastal grazing marsh and shingle ridges and islands. There are also eelgrass beds that are unique to this part of Sussex (HR Wallingford, 2011). As a major estuarine system, there is a wide variety of salinities, wave shelter, and intensity of tidal streams. These habitats support 15 nationally scarce plant species, and internationally and nationally important numbers of overwintering and breeding bird species. At low tide the mudflats are exposed, the water is drained by channels and creeks which meet to form narrow exits into the Solent. The sediments support rich populations of intertidal invertebrates, which provide an important food source for overwintering birds. Additionally, the harbour mouth is a nursery for bass (HR Wallingford, 2011).

The Chichester and Langstone Ramsar was designated to further protect the key features of the area, and to protect the assemblages of key species of international importance (see Table 7 for list of features). The Chichester and Langstone Harbours SPA was designated for supporting passage and wintering bird populations of international and pan-European importance (please see Table 6 for features and conservation objectives). Large populations of wildfowl either visit the harbour during migration or overwinter; many traveling from breeding grounds in Scandinavia, Greenland and Siberia. Additionally, bird species reside here in nationally important numbers. Both the SPA and Ramsar site include marine areas as well as land not subject to tidal influence. The Solent Maritime SAC (Table 8) was designated to protect the wide range of marine habitat features. The Chichester Harbour SSSI was designated for wintering wildfowl and waders and also breeding birds, both within the Harbour and in

the surrounding permanent pasture fields and woodlands. Furthermore, the SSSI is designated for nationally important species of flora and fauna (Table 9).

There are 43 live units within the SSSI, and, as noted previously, all the littoral/intertidal units in this SSSI are considered to be in an 'unfavourable declining' condition due to ongoing saltmarsh losses, as well as water quality issues (nutrient enrichment (macroalgae)).

Furthermore, the (2014) Site Improvement Plan for the Solent European sites (including Chichester Harbour SPA, Solent Maritime SAC) notes coastal squeeze as a threat to all the SPA bird features, as well as intertidal habitat features of the SAC. The proposed measures to address the issue were to '*investigate [various] options to create alternative habitat*'.

Aside from the overwintering birds, Chichester Harbour is also important for passage migrants such as osprey, which stop off to feed and rest on their way to and from their breeding grounds in northern England and Scotland

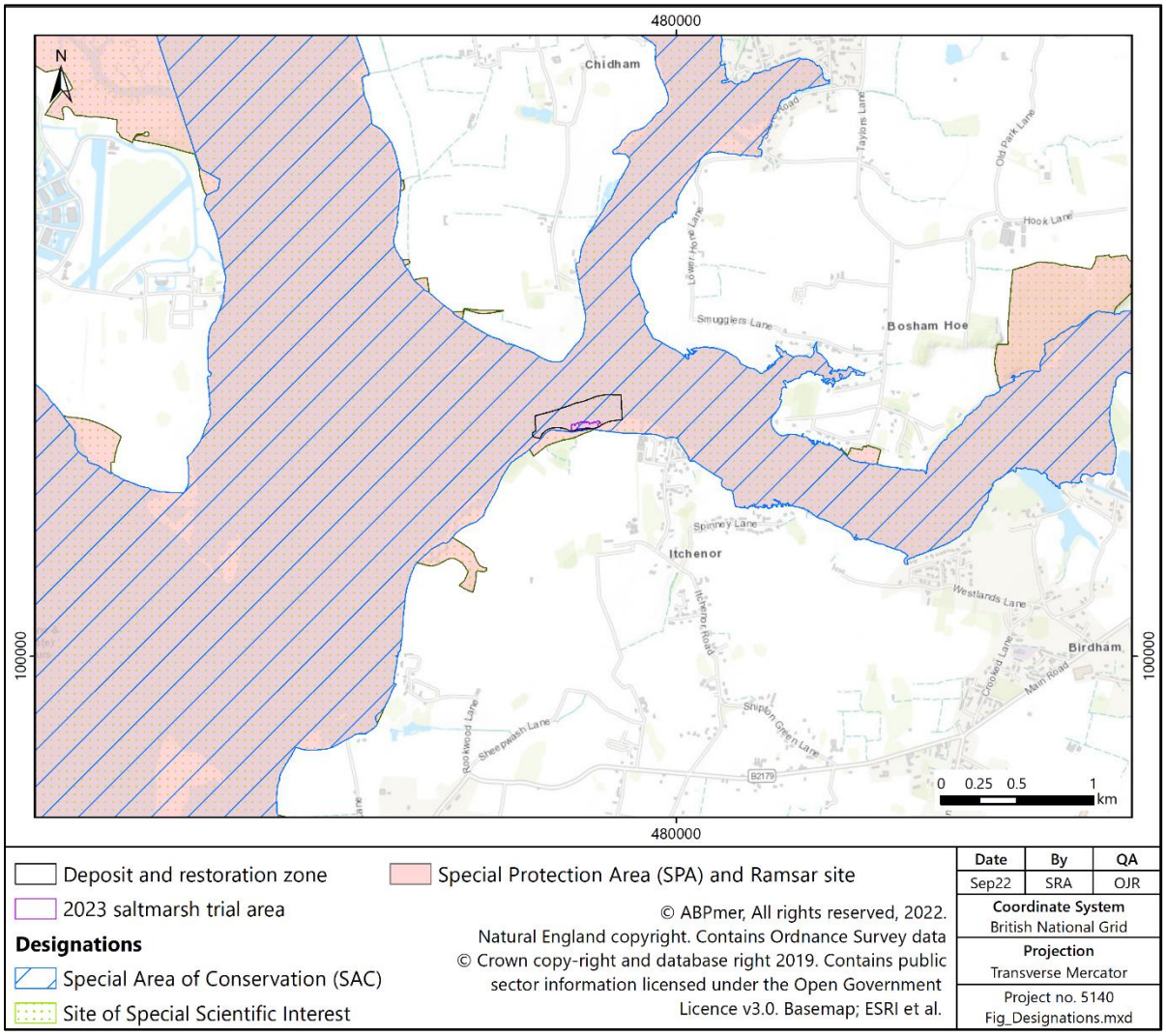


Figure 5. Nature conservation designations at Itchenor (international and national)

Currently the main protected area byelaw, issued and enforced by Sussex Inshore Fisheries and Conservation Authority (IFCA), is a prohibition against bottom towed fishing in historic eelgrass bed, and a prohibition of fishing method byelaw. There are also the following byelaws in more localised areas

within the harbour (west of the centre of Emsworth Channel); bottom towed fishing gear and prohibition of gathering (sea fisheries resources) in seagrass beds.

As noted previously, there are no Marine Conservation Zones (MCZ) within 5 km of the proposed site. The nearest is the Selsey Bill and the Hounds MCZ, which is over 7.5 km away (as the crow flies; almost 13 km via water).

Chichester Harbour is also an Area of Outstanding Natural Beauty (AONB); this was designated in 1964, in recognition of its beautiful land and seascape. As a tidal estuarine environment, framed by low-lying coastal plain against the backdrop of the South Downs National Park, is encompasses open water, intertidal mud, saltmarsh, shingle beach, sand dunes, farmland, woodland, meadows and grassland, ponds and streams, coastal grazing marsh, reedbeds, hedgerow, trees and ditches. Chichester Harbour is the smallest AONB in the South-East covering nearly 7,400 hectares. Of this, 41% is below MHWS.

Table 6. Qualifying features and conservation objectives of the Chichester and Langstone Harbours SPA

Features	Conservation Objectives
▪ Bar-tailed godwit, *Limosa lapponica* ▪ Common tern, *Sterna hirundo* ▪ Curlew, *Numenius arquata* ▪ Dark-bellied Brent goose, *Branta bernicla* ▪ Dunlin, Calidris *Alpina alpina* ▪ Grey plover, *Pluvialis squatarola* ▪ Little tern, *Sterna albifrons* ▪ Pintail, *Anas acuta* ▪ Red-breasted merganser, *Mergus serrator* ▪ Redshank, *Tringa totanus* ▪ Ringed plover, *Charadrius hiaticula* ▪ Sanderling, *Calidris alba* ▪ Sandwich tern, *Sterna sandvicensis* ▪ Shelduck, *Tadorna tadorna* ▪ Teal, *Anas crecca* ▪ Turnstone, *Arenaria interpres* ▪ Waterbird assemblage ▪ Wigeon, *Anas penelope*	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring; ▪ The extent and distribution of the habitats of the qualifying features, ▪ The structure and function of the habitats of the qualifying features, ▪ The supporting processes on which the habitats of the qualifying features rely, ▪ The population of each of the qualifying features, and ▪ The distribution of the qualifying features within the site.

Table 7. Qualifying features of the Chichester and Langstone Harbours Ramsar site (for conservation objectives, see SPA)

Features	Features (continued)
▪ Black-tailed godwit, *Limosa limosa* – Passage ▪ Dark-bellied brent goose, *Branta bernicla* – Wintering ▪ Dunlin, Calidris A*lpina alpina* – Wintering ▪ Grey plover, *Pluvialis squatarola* – Wintering	▪ Redshank, *Tringa totanus* – Passage ▪ Ringed plover, *Charadrius hiaticula* – Passage ▪ Shelduck, *Tadorna tadorna* – Wintering ▪ Waterbird assemblage - Wintering ▪ Estuary

Table 8. Qualifying features and conservation objectives of the Solent Maritime SAC

Features	Conservation Objectives
▪ Sandbanks which are slightly covered by sea water all the time ▪ Estuaries ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Coastal lagoons ▪ Annual vegetation of drift lines ▪ Perennial vegetation of stony banks ▪ Salicornia and other annuals colonising mud and sand ▪ Spartina swards *Spartinion maritimae* ▪ Atlantic salt meadows *Glauco-Puccinellietalia maritimae* ▪ Shifting dunes along the shoreline with Ammophila *arenaria* ('White dunes') ▪ Desmoulin's whorl snail, *Vertigo moulinsiana*	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring ▪ The extent and distribution of qualifying natural habitats and habitats of qualifying species, ▪ The structure and function (including typical species) of qualifying natural habitats, ▪ The structure and function of the habitats of qualifying species, ▪ The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely, ▪ The populations of qualifying species, and ▪ The distribution of qualifying species within the site.

Table 9. Qualifying features of the Chichester Harbour SSSI

Features	Features (continued)
Birds: ▪ Common Tern, *Sterna hirundo* ▪ Bar-tailed Godwit, *Limosa lapponica* ▪ Black-tailed Godwit, *Limosa limosa islandica* ▪ Brent Goose (Dark-bellied), *Branta bernicla bernicla* ▪ Curlew, *Numenius arquata* ▪ Dunlin, Calidris *Alpina alpina* ▪ Greenshank, *Tringa nebularia* ▪ Grey Plover, *Pluvialis squatarola* ▪ Redshank, *Tringa tetanus* ▪ Ringed Plover, *Charadrius hiaticula* ▪ Sanderling, *Calidris alba* ▪ Shelduck, *Tadorna tadorna* ▪ Teal, *Anas crecca*	▪ Little tern, *Sterna Albifrons* ▪ Sandwich tern, *Sterna sandvicensis* Habitats ▪ *Centaurea nigra* grassland ▪ *Phragmites australis* swamp and reed-beds ▪ *Rumex crispus - Glaucium flavum* shingle community ▪ *Honkenya peploides - Cakile maritima* strandline community ▪ *Elymus farctus* ssp. *Boreali-atlanticus* foredune community ▪ *Ammophila arenaria* mobile dune community ▪ Sheltered muddy shores (including estuarine muds) ▪ Zostera communities ▪ *Atriplex portulacoides* saltmarsh ▪ *Spartina anglica* saltmarsh ▪ *Quercus robur - Pteridium aquilinum - Rubus fruticosus* woodland ▪ *Quercus* spp.-*Betula* spp.- *Deschampsia flexuosa* woodland

5.3.2 Impact assessment

Information to inform an Appropriate Assessment (AA) under the Habitat Regulations is included in Appendix A, which provides an assessment of the potential impact of the proposed works on internationally designated sites and interest features.

The following sections review the potential impacts of the proposed works on other marine ecology receptors (including relevant protected habitats/species and interest features of nature conservation sites), specifically benthic ecology (Section 5.4), fish and shellfish (Section 5.5), marine mammals (Section 5.6) and coastal ornithology (Section 5.7).

5.4 Benthic ecology

5.4.1 Baseline description

Chichester Harbour context

Subtidal habitat and ecology

As noted previously, Chichester Harbour contains extensive intertidal areas interspersed by subtidal channels.

Sublittoral features were reviewed in a 2017 desk top study (Natural England, 2017). This report found that the subtidal habitats of the Harbour are dominated by mixed sediments with strong *Crepidula* communities with ascidians, anemones or *Mediomastus fragilis*. A 2020 study (Bardsley *et al.*, 2020) assigned the dominant subtidal community to *Aphelochaeta spp* and *Polydora* species in variable salinity infralittoral mixed sediment. Bardsley *et al.* (2020) stated that the harbour sediments had medium sensitivity to physical disturbance and that persistence of communities of this type indicated that the fisheries byelaws in the harbour (to limit physical disturbance to certain areas) were maintaining these features (Bardsley *et al.*, 2020)

The intertidal and subtidal sediments of estuaries support biological communities that vary according to the type of sediment and salinity gradients within the estuary, though geographic location and the strength of tidal streams also influence community structure. In the upper parts of the harbour arms of Chichester, the sediment-living animal communities are typically dominated by oligochaete worms, with few other invertebrates. The silt content of sediment usually decreases towards the mouth of the harbour, and the water gradually becomes more saline. In Chichester Harbour, the middle of the harbour contains the most extensive subtidal areas, dominated by marine mud and sandy areas. Here, the animal communities of the sediments are dominated by species such as ragworms, bivalves and sandhopper-like crustaceans. In the outer estuary, closer to the open sea, the substrate is often composed of fine sandy sediment, and supports more marine communities of bivalves, polychaete worms and amphipod crustaceans (Bardsley *et al.*, 2020)

Intertidal habitats and ecology

Sandy Point spit forms the western shore of the Harbour entrance channel. Sandy Point spit provides natural protection to the low lying, heavily developed land around the Harbour. To the north of the Harbour, revetments and embankments define the shoreline (HR Wallingford, 2011). Mudflats and saltmarshes are a critical part of the coastal ecosystem and provide a range of ecosystem services such as shoreline stabilisation, flood and storm surge protection, maintenance of coastal water quality and grazing for food production in addition to its inherent value for biodiversity (e.g., Costanza *et al.*, 2008;

Moeller et al., 2014; Watson et al., 2020a). The Solent saltmarshes are described as the second largest aggregation of saltmarshes in the south and south-west England, representing 33% of saltmarsh in this region and 3% of the national resource (Bardsley *et al.*, 2020). More specifically, Chichester Harbour has the largest area of saltmarsh in the South-East region and is the 7th largest area in Britain.

Between 1946 – 2016, 58% of saltmarsh habitat area was lost overall, with loss of almost half (46%) of that present when the site first became legally protected (1970). The saltmarsh was in unfavourable condition at the time of first designation as the saltmarsh losses in the 1960s were approximately 18 hectares a year. As noted previously, the rate of loss has slowed, however, around 1 % of the area is still being lost every year (Parry and Hendy, 2022). There have been various predictions over the years as to when saltmarsh will have disappeared almost completely in the Harbour, with future years for this ranging between the 2054 (worst case, Parry and Hendy, 2022), via the mid-2100s (Bardsley *et al.*, 2020) and 2323 (best case, Parry and Hendy, 2022). The fact that saltmarshes were in the past lost at dramatic rates, and that they are still being lost is however undisputed, as is the anticipation that rates of loss will accelerate with human driven climate change and increased rates of sea level rise.

In addition to saltmarsh extent, the quality of the saltmarsh is also fundamental to the condition of the habitat and its resilience to climate change. To assess the quality and other condition measurements of the saltmarsh on site surveys were conducted in 2019. Field surveys were carried out by Natural England and colleagues, using six transects across the largest areas of remaining saltmarsh in Chichester Harbour (Bardsley *et al.*, 2020). West Itchenor, the proposed beneficial use site, was one of these areas.

All six sites within Chichester Harbour were surveyed on foot and were found to be experiencing coastal squeeze to some extent on their landward edge, where sea defences or raised ground were preventing landward transgression of the saltmarsh, and in some cases causing wave reflection affecting upper saltmarsh communities. Opportunistic macroalgae were observed at most of the survey locations. Additionally, bare areas of mud were present, and it was thought that this indicated pollution/water quality issues due to the anoxic nature of the muds seen.

The site

Saltmarsh

As noted in Section 2.2.2 previously, at West Itchenor, from the Quay to the west of Chalkdock Marsh, excluding the Chalkdock Marsh RTE, just under 2.4 ha of saltmarsh remained in 2016. A saltmarsh edge survey undertaken in 2022 showed that there had been some modest further retreat of the saltmarsh edge at the site between 2016 and 2022, such that now there are around 2.2 ha remaining.

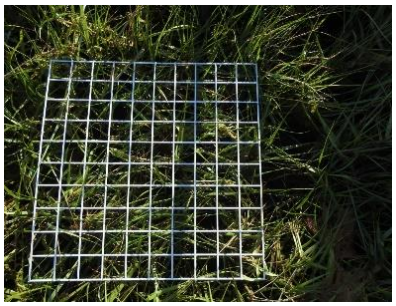
During the 2019 SSSI condition survey, a large amount of decaying brown algae was observed on the strand line of the saltmarshes. Several of the transects had indicators of local distinctiveness. Golden samphire, a rare saltmarsh plant, was observed at West Itchenor, the Lax variant of sea lavender and perennial glasswort was also found at West Itchenor. The pioneer zone also contained *Spartina anglica* (Bardsley *et al.*, 2020).

The 2016 saltmarsh extent mapping shown in Figure 4 indicates that, to the east of the trial area, there is a small area of high saltmarsh, fronted by a substantial area of marsh belonging to the mid to low zonation. The saltmarsh remaining at the trial area itself is also of the mid-low community. West of the trial area, the saltmarsh is dominated by *Spartina*.

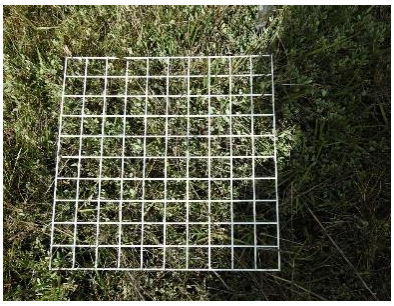
In July 2022, saltmarsh quadrant were also surveyed to gain insights into local plant communities. This determined that the thin strip of higher marsh at back of foreshore next to the Quay contained species such as sea club-rush *Bolboschoenus maritimus,* golden samphire *Inul crithmoides*, sea arrowgrass *Triglochin maritimum* and sea plantain *Plantago maritima*. The low to mid saltmarsh areas next to the

Quay and also at the back of the shore at the trial area were characterised by primarily sea purslane and common saltmarsh grass *Puccinellia maritima*. Patches of annual seablite *Suaeda maritima*, glasswort *Salicornia* spp. and sea *lavender Limonium vulgare* were also present. The lower shore was dominated by cordgrass (*Spartina* spp), as was the saltmarsh to the west of the trial area. A selection of quadrat photos are shown in Image 7.

10 % Sea purslane, 30% Common saltmarsh grass, 60 % Sea lavender (Quay saltmarsh)



100 % Spartina (western saltmarsh)



10 % Spartina, 70 % Sea purslane, 20 % Common saltmarsh grass (Quay saltmarsh)

Image 7. Selection of saltmarsh quadrat photos

Invertebrates

In July 2022, grab samples were taken on the foreshore at the project site (see Image 6 in Section 5.2 for location). The results from the benthic macroinfaunal survey are shown in Table 10. This table shows the abundance of invertebrate species in each of the seven sample sites (where a 0.01m^2 core sample was taken). It also shows the equivalent abundance per m^2 (derived from the abundance in each core multiplied by 100) and the biomass of the key invertebrate groups in each core sample. The results of the PSA from samples that were also collected from each of the sample sites have previously been shown in Table 5.

The result of the benthic invertebrate analysis work in Table 10 shows how there is a characteristic change in the composition of the benthic assemblages from the upper shore to the lower shore. This cross-shore spatial change in assemblage composition is an entirely expected and typical characteristic of intertidal mudflat habitats. In addition, and overlying this cross-shore change, there is also ecological patchiness across the habitat. This variability will be driven by a range of ecological physical processes.

As a result of the combined ecological and physical factors, the assemblages at the top of the shore (Sites 1 to 3) all have a low abundance and diversity. This includes areas within and adjacent to where the saltmarsh restoration would take place. Along this part of the shore, there were just 2 to 5 taxa in each sample. The mud snail *Peringia ulvae* (formerly *Hydrobia ulvae*) is profoundly dominant here (ranging from the equivalent of 400 to 15,500 per m^2). There are also modest numbers of the bivalve *Abra tenuis* (200 to 500 individuals per m^2), as well as incidental occurrences of a few other species (represented by single individual organisms).

This paucity of the invertebrate assemblages is characteristic of this part of the shoreline. It occurs because this part of the foreshore is subject to the relatively substantial environmental pressures. It is less frequently inundated by the tide, and the habitats and subject to large variations in temperature and salinity levels, as well as having more limited feeding opportunities. Also, much of the sediment is comparatively firm in this area because it is the unvegetated remnants from past saltmarsh habitats (see Image 8).

Table 10. Results of macroinfaunal analysis from July 2022 survey

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Mud-shore position	**upper**	**upper**	**upper**	**lower**	**mid**	**mid**	**low-mid**
Nematoda	1				1		
Glycera alba			1			1	
Hediste diversicolor							1
Nephtyidae						2	
Nephtys hombergii				4			
Pygospio elegans			1	4	13		1
Melinna palmata				14			
Ampharete acutifrons				25	22		
Tubificoides benedii		1		9	15		
Enchytraeidae	1						
Orchestia gammarellus			1			1	
Cyathura carinata	1						
Peringia ulvae	155	83	4	5	10	1	28
Retusa umbilicata				1			
Cardiidae				1			1
Abra tenuis	4		8	15	52	1	12
No. taxa	**5**	**2**	**5**	**9**	**6**	**5**	**5**
Abundance	162	84	15	78	113	6	43
Abundance/m²	**16,200**	**8,400**	**1,500**	**7,800**	**11,300**	**600**	**4,300**
Annelid Biomass (g)	0.0002	0.0091	0.0477	0.453	0.4527	0.0366	0.0177
Crustacea Biomass (g)	0.0134	0.0057	0.0259	-	-	0.0042	-
Mollusca Biomass (g)	0.5008	0.4036	0.0194	0.0497	0.1214	0.0073	0.0854

Taken by ABPmer, July 2022

Image 8. View of the upper shore proposed recharge area at Itchenor

Peringia ulvae and *Abra tenuis* (as shown in Image 9) were also the main species recorded, at similar abundances, on the same directly comparable upper-shore recharge sites at Boiler Marsh in Lymington (ABPmer, 2013 and ABPmer in prep). They are present in such conditions because they are opportunistic species that are tolerant of the environmental pressures of mudflat shores. The mud snail is a highly resilient and adaptable species that, on the upper shore, grazes on the microalgae growing over the surfaces of the firm sediment (former vegetated saltmarsh in this area). The bivalve *Abra tenuis* is often found in intertidal mud or clay (where it feeds on organic detritus through its siphon), and is tolerant of low salinities and the higher tidal elevations.

Away from the upper shore, the assemblages were slightly richer at Site 4 (on the low shore) and Site 5 (middle shore). Here, there were modest numbers of taxa (6 or 9), but a greater mix of species with different ecotypes/ecological niches. This includes predatory nepthyd polychaetes (including *Nephtys hombergii*), and deposit feeding *Ampharete acutifrons* and *Pygospio elegans,* which have adaptable/flexible feeding strategies.

The comparatively limited numbers of taxa and modest overall abundance of individuals is a sign that the habitats are subject to a degree of disturbance. This disturbance is in evidence at Sites 6 and 7, which are also on the middle shore areas (with Site 7 tending towards the lower shore), the assemblages are more impoverished. Here again, *Peringia ulvae* and *Abra tenuis* are the main species which indicates that the environment is subject to a degree of environmental 'stress'. There is limited evidence of any spatial variability in the physical conditions and the sediment is largely fine sediment with some coarser sand throughout. It is likely that the pressures, and the patchiness of the assemblages, are the result of combined actions, including regular surface sediment movements, salinity variations, and predation by fish and bird species. It does not appear to be imposed by organic enrichment. This is because there are only limited numbers of species such as *Tubificoides benedii* and the absence of other species that often dominate in organically enriched conditions.

The assemblages across the low and middle shore will provide some prey species for foraging waders, although the abundances of key species appear to be relatively low. For example, very few ragworm (only 1 individual) were recorded in the sample taken, and very few bivalve species were present. This will be a reflection of the disturbed nature of the environment and helps to explain why the abundance of feeding waders is relatively low on this habitats (see Section 5.7).

Photos of *A. tenuis* (top left), *Tharyx* spp. (top right), *Streblospio shrubsolii* (bottom left) and *P. ulvae* (bottom right)
Precision Marine Ltd, from ABPmer (2013)

Image 9. Invertebrates images

5.4.2 Impact assessment

The following impact pathways have been considered with respect to benthic ecology:

- Changes in habitat and loss of benthic organisms;
- Changes in water and sediment quality;
- Non-native species transfer and introduction; and
- Effects due to noise and vibration.

Changes in habitat and loss of benthic organisms

Intertidal and subtidal mudflat

The bottom placement of dredged material at the proposed beneficial use disposal sites will result in localised physical disturbance and smothering of intertidal habitats and species.

This will be temporary in the disposal and drag zones, though some very small lumps, as well as shallow films of new sediment, may be left behind after the final pull of the SRDB. The film would be of a maximum thickness of 0.05 m, with the expectation of this typically being around 0.01 m (1 cm). This is related to there being a small clearance between the skis and the bottom of the SRDB. Some small lumps of new sediment may remain along the sides of the final SRDB pull tracks. Any major remnant deposits temporarily left in the drag zone would however be scooped up by the SRDB. The skis may leave some minor consolidated tracks which would be expected to be quickly filled in with newly deposited sediment post works. It is estimated that during the first campaign in early 2023, up to around 2.5 ha of mudflat could be subject to temporary disturbance (due to low level smothering and compaction due to skis, leaving ski tracks), noting that the ski tracks would not affect this whole area, and would be minimised by utilising the most appropriate set of skis for the location (several sets are available and will be taken to the site, and the skis with the lowest compaction / track residue chosen during the first few drags). During future campaigns, similar cumulative extents of around 2.5 ha may be impacted; however, slightly different mudflat areas of the site would be impacted in any given year. These would be restricted to the zones fronting the given target saltmarsh restoration area. Thus, on the whole, the same mudflat areas would not be expected to be affected by disturbance in consecutive years (with the exception of small sections where tie in to past restoration zones occurs).

In addition to this temporary disturbance of small areas of mudflat in the drag zone, there will be habitat change at the saltmarsh restoration areas. In the initial year, this will be up to a maximum of 0.7 ha. In the saltmarsh restoration area, based on lessons learned at similar schemes (see Appendix C), the expectation is that full coverage saltmarsh will have established across at least 90 % of the restoration area within five to 10 years of the restoration taking place, with pioneer vegetation starting to colonise during the first summer (and substantial coverage likely in less than five years). Over subsequent winters, up to another 2.8 ha of mudflat may be restored to saltmarsh in areas where this habitat would have previously existed.

The potential smothering of benthic species in the drag zone may cause stress, reduced rates of growth or reproduction and, in the worst cases, the effects may be fatal (Pineda *et al.*, 2017). Habitats within estuarine and coastal environments have highly fluctuating conditions including the resuspension and deposition of sediments on a daily basis (through tidal action), lunar cycles (due to the differing influences of spring and neap tides) and on a seasonal basis (due to storm activity and conditions of extreme waves). Subtidal and intertidal habitats are, therefore, characterised by such perturbations and the biological communities of these environments are well adapted to survival under fluctuating conditions.

If the amount of sediment deposited is too great to allow species to survive burial, then recovery occurs via re-colonisation and/or migration to the new sediment surface (Bolam *et al.*, 2006a; 2006b). In general, the rate of recovery is dependent upon just how stable and diverse the assemblage was in the first place. A regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e. return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage. Furthermore, in cases where the quantity and type of sediment deposited does not differ greatly from natural sedimentation, e.g. of similar particle size, the effects are likely to be relatively small as many of the species are capable of migrating up through the deposited sediments (Budd, 2004).

The Marine Evidence based Sensitivity Assessment (MarESA) approach (Tyler-Walters *et al.*, 2018) found that benthic communities in both sandy and muddy estuarine sediments are typically considered to be tolerant to the deposition of up to 5 cm (0.05 m) of fine material in a single event, with burrowing species considered able to relocate to preferred depths through this level of deposition. Deposition of greater depths of fine sediment could result in some mortality although evidence suggests that some characterising species are likely to be able to reposition. Bivalve and polychaete species have been reported to migrate through depositions of sediment greater than 30 cm (0.3 m) (De-Bastos, 2016a; 2016b; Ashley, 2016). A previous review by the University of Hull also concluded that benthic invertebrates in sediments are able to adapt and readjust if sediment laid is placed as thin veneers over several days although they can also tolerate moderate amounts (20 cm / 0.2 m) of material being deposited at one time (IECS, 2001).

The temporary smothering of benthic invertebrates within the footprint of the proposed beneficial use disposal site is unavoidable. The smothering will be on a very localised scale, and temporary basis and the area of the seabed that will be affected will be very small for each winter campaign, up to a maximum of 2.5 ha has been estimated for each campaign.

The total area covered by the proposed new saltmarsh platform in the saltmarsh trial area is 0.7 ha p.a., and the maximum 5-year cumulative area is 3.5 ha; this is very small in the context of the Harbour and the relevant designated sites (Chichester and Langstone Harbours Ramsar; Chichester and Langstone Harbours SPA; Solent Maritime SAC; and Chichester Harbour SSSI); for example, it represents 0.06 % of the overall SPA area. Saltmarsh will establish here over time by natural colonisation, facilitated by raising the mudflat area in this area by up to 2 m, with the average raising being around 0.65 m.

A small proportion of the material that is placed on the lower mudflat areas at the proposed beneficial use site may be dispersed and re-deposited locally to the site. Dispersion of material is expected to be limited, given the restoration activities will take place as high up on the shore as possible, and as the material will arrive in a relatively consolidated fashion (as it will have been dredged using back-hoeing). The small volume that is moved beyond the proposed sites is likely to be either dispersed widely in the outer harbour and at very low concentrations or settle in the low flow areas of the tidal creeks and marshes. The scale of change is considered to be very minor and of a similar magnitude to deposition resulting from natural change, vessel movements and ongoing maintenance dredging in the wider area. Sedimentation away from the restoration area is unlikely to be measurable; and will be short-lived and transient in nature, and likely to be redistributed by natural physical processes and ongoing activities.

The mudflat benthic fauna recorded in the area of the proposed beneficial use disposal site comprise species that are capable of rapidly recolonising disturbed habitats. These species are also considered to be commonly occurring in the wider area, and tolerant to some sediment deposition. Benthic communities are, therefore, considered to have a low sensitivity to minor fluctuations in sedimentation, particularly in areas with muddy sediments and those located adjacent to regularly disturbed areas, such as the main approach channel into Chichester Harbour. Given the nature of the habitats and the

adaptable and opportunistic species that characterise it, this area that is likely to recover relatively rapidly from the SRDB and bottom placement disturbance.

Giving consideration to the scale, and nature of the beneficial use disposal and saltmarsh restoration activities, it is considered that any impacts on mudflat and associated benthic invertebrate populations are likely to be localised, largely temporary and **insignificant to minor adverse at worst**.

The proposed beneficial use disposal sites are not expected to cause significant changes to physical processes (e.g. water levels, flow rates, accretion and erosion patterns) (Section 5.1.2). Therefore, indirect changes to seabed habitat extent and quality as a result of the works will be **insignificant**.

Saltmarsh

The proposed beneficial use disposal activities at West Itchenor would lead to the restoration of saltmarsh in areas where there used to be saltmarsh in the recent past. This new / re-established saltmarsh area will have beneficial effects on the adjacent vulnerable saltmarsh habitats and associated invertebrates by providing shelter. It will also help offset ongoing coastal squeeze losses both locally and in the rest of the harbour. By undertaking beneficial use in the harbour, sediment is furthermore retained within the estuary system. Please note that a very small section of low saltmarsh (measuring less than 0.008 ha or 80 m^2) will be buried in sediment, but higher saltmarsh will establish in its stead in due course.

Some erosion of the newly deposited sediment is anticipated, although it is expected that this would chiefly affect the edges of the newly raised area, with rates being slightly more pronounced during the first year or two, whilst sediments consolidate and marsh plants establish. It is difficult to estimate how much of the newly deposited sediment might be re-distributed within the Harbour over the first few years post placement, as erosion activity is often dominated by storm and surge events, which are more or less likely in any given year / winter. It is considered unlikely that more than 10-20 % of the material (and around 5-10 % of the habitat area) will be eroded over the first five years; subject to no low probability storms/surges occurring during this time. The trial DTM has been designed with sustainability in mind, whilst incorporating remnant platforms and drainage patterns. In order to limit the erosion risk, it has been located as high up the shore as possible and without notable protrusions. In addition, maximum sediment thickness is such that, even if there was substantial lateral erosion, of up to around 0.5 m at the top (which is considered highly unlikely), elevations would still be suitable for saltmarsh plant colonisation.

Any eroded martials would then be washed away, with a substantial proportion being likely to settle on adjacent saltmarshes and mudflats The remainder may be effectively 'lost' from the target area, but some of it will remain present in low concentrations as an enhanced suspended sediment source for the wider saltmarshes in Chichester Harbour.

Overall, the proposed beneficial use disposal site and saltmarsh trial will provide a valuable contribution to offsetting or delaying ongoing natural saltmarsh habitat loss that has been recorded in and around the Solent, and in Chichester Harbour; the impact is considered to be of an **insignificant to minor beneficial** nature.

Changes in water and sediment quality

There is the potential for impacts associated with changes in water quality during the SRDB trial which would transport sediment from low shore and subtidal areas to higher marsh surfaces at the proposed beneficial use disposal sites, as a result of increases in SSC, changes to DO and the release of toxic contaminants bound in sediments.

Macrofauna living in estuarine systems which are subject to naturally high levels of SSC are considered well adapted to living in highly turbid conditions. An increased level of suspended sediments may result in an increase in food availability and, therefore, growth and reproduction for surface deposit feeders (such as certain polychaetes) within estuarine environments that rely on a supply of nutrients at the sediment surface. However, food availability would only increase if the additional suspended sediment contained a significant proportion of organic matter and the population would only be enhanced if food was previously limiting (De-Bastos, 2016b).

Greater energetic costs for benthic species could occur as a result of higher particle loads due to elevated suspended sediments stimulating the secretion of mucus to protect branchial or feeding structures of filter feeding organisms (Perry, 2016). The level of suspended sediment has been found to have a negative linear relationship with sub-surface light attenuation. Light availability and water turbidity are principal factors in determining depth range at which kelp and other algae are recorded. In addition, certain mobile epistrate feeders (such as the amphipod *Bathyporeia* spp) feed on diatoms within the sand grains and an increase in suspended solids that consequently reduced light penetration could alter food supply (Tillin *et al.*, 2019). However, longer-term changes in turbidity levels rather than temporary elevations are likely to be required to elicit any measurable changes in these species.

Elevated suspended sediment levels can also cause increased scouring and damage of epifaunal species due to the potentially abrasive action of the suspended sediment in flowing water. Increased suspended sediments may favour the development of suspension feeders such as bivalves over other species. However, it should be noted that many benthic invertebrates can switch feeding modes depending on environmental conditions. The negative effects of suspended sediment may be particularly important during larval settlement in spring, with settling stages potentially being more sensitive to effects such as scour. However, this is generally thought to be of less concern where fauna is adapted to naturally high levels of suspended sediments (Boyd *et al.*, 2004).

Any changes to SSC and DO will be temporary and intermittent, lasting the period of the proposed disposal activities associated with the maintenance dredge campaigns of nearby harbours and marinas (Section 2.2.4). Overall, the spatial and temporal magnitude of change in SSC is assessed as minor locally and insignificant further afield (Section 5.1.2). Any changes in DO are expected to be localised and temporary, and are assessed as insignificant (Section 5.2.2). The potential changes to levels of chemical contaminants in the water and the potential redistribution of sediment-bound chemical contaminants are assessed as insignificant (Section 5.2.2).

Thus, in physical terms, any plumes resulting from placement of material at the proposed beneficial use disposal sites are expected to have a minimal and very localised effect on water and sediment quality. Benthic species in the area are considered to be well adapted to survival under fluctuating conditions. The benthic community present within and adjacent to the proposed sites is, therefore, expected to be tolerant to the predicted changes in water and sediment quality. In other words, they are not sensitive to the magnitude of changes in water quality that are predicted. Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal process. Overall, the potential impact to benthic ecology arising as a result of changes in water and sediment quality during the placement of dredged material at the proposed beneficial use disposal sites is assessed as **insignificant**.

Non-native species transfer and introduction

There is a potential risk that the proposed beneficial use disposal sites could result in the introduction or spread of invasive non-native species (INNS). This is however reduced due to the deposited materials being local to Chichester Harbour. The vessels associated with the proposed disposal activities will not be carrying ballast water and, therefore, there is no risk that non-native invasive species will be

transported via this pathway. Non-native species, however, have the potential to be transported into the local area on the hulls of the vessels if they have operated in differing water bodies. Potential biosecurity risks will be managed through biosecurity management procedures if required.
Overall, given the scale and nature of the proposed recharge activities, the risk in terms of introducing or transferring INNS and potential impacts on marine habitats and benthic species is assessed as **insignificant**.

Effects due to noise and vibration

There is the potential for noise and vibration during the movements and operation of the SRDB trial to disturb benthic species. Marine invertebrates lack a gas-filled bladder and are thus unable to detect the pressure changes associated with sound waves (Carrol *et al.*, 2017). However, some bivalves, echinoderms and crustaceans have a sac-like structure called a statocyst which includes a mineralised mass (statolith) and associated sensory hairs. Statocysts develop during the larval stage and may allow an organism to detect the particle motion associated with soundwaves in water to orient itself (Carrol *et al.*, 2017).

Scientific understanding of the potential effects of underwater noise on marine invertebrates is relatively underdeveloped (Hawkins *et al.*, 2015). There is limited research to suggest that exposure to near-field low-frequency sound may cause anatomical damage (Carrol *et al.*, 2017). There is also increasing evidence to suggest that benthic invertebrates behaviourally respond to sediment vibration or particle motion (Roberts *et al.*, 2016; Spiga *et al.*, 2016; Tidau and Briffa, 2016). The vibration levels at which these responses were observed generally correspond to levels measured near anthropogenic operations such as pile driving and up to 300 m from explosives testing (blasting) (Roberts *et al.*, 2016).

The levels of noise and vibration that are anticipated from the barges, pontoon and SRDB operation are significantly lower than the levels of noise generated by the activities reported to have disturbed benthic invertebrates. Furthermore, the levels of noise and vibration from the proposed recharge activities are considered to be similar to maintenance dredging plant and the movement of vessels that are already regularly occurring in the area. Overall, therefore, the potential vibration effects on the benthic community are assessed as **insignificant**.

5.5 Fish and shellfish

5.5.1 Baseline description

Fish

Chichester Harbour is relatively sheltered, therefore, supports large and diverse populations of fish. The Sussex Inshore Fisheries and Conservation Authority (IFCA) has carried out biennial small fish surveys in Chichester Harbour since 2010, in collaboration with the CHC. So far, 48 species have been recorded (CHC, 2019). Several commercial species use the Harbour as a nursery area, including European seabass (*Dicentrarchus labrax)*, Black seabream (*Spondyliosoma cantharus*), Gilthead bream (*Sparus aurata),* Mullet (*Mugilidae* spp.), Mackerel (*Scomber scombrus),* Dover sole (*Solea solea*), and Plaice (*Pleuronectes platessa)*. Cuttlefish (*Sepia officinalis*) and Eels (*Anguilla spp.)* are also present in Chichester Harbour. The latter are protected by the Eels (England and Wales) Regulations 2009.

Other species found in Chichester Harbour include Common Carp *(Cyprinus carpio),* Corkwing wrasse (*Symphodus melops*), and Pipefish (Syngnathinae spp.), which are found among algal cover in sheltered areas of Chichester Harbour. Additionally, Smoothhounds which belong to the Hound Shark family, and Tope (*Galeorhinus galeus)* are also located in this area.

With regard to seabass, it is worth noting that Chichester Harbour is a Bass Nursery Area, with restrictions on fishing aimed at protecting juvenile bass (IFCA, 2020). These restrictions apply to both commercial and recreational fishers, between 30 April and 1 November

Shellfish

Native oysters (*Ostrea edulis*) used to be the only commercially exploited species in Chichester Harbour. However, the oyster fishery has been closed since 2021. This is due to the density of the oyster stock within Emsworth and Thorney Channels being below the threshold density. The Fishbourne and Bosham channels were already closed areas for brood stock and habitat protection (IFCA, 2021). Populations of native oysters in Chichester Harbour and the wider Solent area have declined significantly in recent years, following a series of recruitment failures (Vause, 2010).

In the past, there has apparently also been interest in harvesting other shellfish species in the Harbour, including Manila clams (*Tapes philippinarum*), American hard clams (*Mercenaria mercenaria*), native clams (*Tapes decussatus*) and cockles (*Cerastoderma edule*). Oysters occur throughout the main subtidal channels, whereas the clams and cockles occur in the intertidal areas (Cefas, 2013).

The precise distribution of clams and cockles within the harbour is uncertain, but they are thought to be widely distributed throughout the intertidal (Cefas, 2015). The harvest of cockles is closed from February to April inclusive within the Southern IFCA district. There are no closed seasons for clams within either district (Cefas, 2013).

There are currently no designated shellfish waters within 2 km of the proposed disposal site, however in previous years the Chichester Harbour (Thornham Channel) and Chichester Harbour (Chichester Channel) were previously designated within 2 km of the site. As these sites are no longer classified as shellfish production areas, they have not been considered further.

5.5.2 Impact assessment

The following impact pathways have been considered with respect to fish and shellfish:

- Effects of habitat change on fish and shellfish receptors;
- Effects of changes in water quality on fish and shellfish receptors;
- Effects due to noise and vibration; and
- Effects due to entrainment in the SRDB.

Effects of habitat change on fish and shellfish receptors

Disposal of maintenance dredge materials from Chichester marinas has the potential to result in temporary, localised, physical disturbance and smothering of seabed habitats and species. These changes have the potential to impact on fish and shellfish species through changes in prey resources and the quality of foraging, nursery and spawning habitats. Disposal also has the potential to result in changes to hydrodynamic and sedimentary processes (e.g. water levels, flow rates, changes to tidal prism, accretion and erosion patterns) which could affect the quality of marine habitats and change the distribution of marine species. However, these changes in physical processes are assessed as insignificant (Section 5.1.2) and impacts on benthic ecology (Section 5.4.2) are assessed as insignificant to minor adverse at worst.

Furthermore, only a small area of low intertidal habitat would be temporarily affected by disposal and SRDB activities. In addition, consideration is given to the mobile nature of the majority of fish and shellfish species and the widespread availability of other habitats and prey throughout the Harbour.

Most species are opportunistic and generalist feeders meaning they are not reliant on a single prey item. Therefore, a slight change in dietary composition as a result of the disposal activities is unlikely to alter the fish and shellfish population as species can adapt (Pearce, 2008).

The change of habitat from mudflat to saltmarsh will affect a very small percentage of the Harbour's extensive mudflats, noting that saltmarsh is continually being lost at what is expected to be higher rates than mudflat (see Section 2.2.2). It is of note that saltmarsh habitat provides an important nursery and feeding ground for juvenile fish, and thus, the restoration of saltmarsh is considered to have a slight beneficial effect in this respect.

Given the scale and temporary nature of the proposed dredging disposal activity, the changes in habitat on fish and shellfish overall are assessed as **insignificant** during the disposal of maintenance dredge material from the Chichester marinas, as well as the saltmarsh restoration works, at the proposed disposal and restoration site.

Effects of changes in water quality on fish and shellfish receptors

Changes in water quality during dredge disposal activities could potentially impact fish species, by increasing SSC, resulting in changes to DO and releasing toxic contaminants bound in sediments.

Fish and shellfish within Chichester Harbour are considered to be well adapted to living in an area with variable and often high suspended sediment loads. Any changes to SSC will be largely limited to the immediate vicinity of the proposed new disposal and restoration site and will be short-lived. The predicted changes in SSC will therefore not result in significant displacement or a barrier to migratory fish. Furthermore, fish, including migratory species, feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other prey resources.

Best practice pollution prevention guidelines will also be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal and restoration works.

Given the above, and also as the disposal, SRDB and saltmarsh shaping works have been assessed to have temporary, localised and insignificant effects on water quality (see Section 5.2.2), the potential for any adverse impact on fish from this pathway are considered **insignificant**.

Effects due to noise and vibration

Elevated noise and vibration levels can potentially disturb fish and shellfish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.*, 2015). The ability to detect and localise the source of a sound is of considerable biological importance to many fish species and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions. In laboratory settings, cuttlefish have been shown to change their behaviour under exposure of sounds of 130 dB or more underwater which may increase predation risk and decrease the chances of feeding and reproduction (Gibson-Hall and Wilson, 2018). Crustaceans and bivalves are also thought to utilise particle motion (vibration) in a similar way to fish.

Information on underwater noise levels associated specifically with disposal of dredged material is limited. On this basis, noise levels associated with dredging activity more generally has been used to inform the assessment. Dredging noise impacts on fish are likely to be restricted to behavioural responses, which are limited to a localised area around the dredger (Popper *et al.*, 2014). Assuming a peak behavioural response threshold of 159 dB re 1 µPa m based on field survey data of the responses

of free-living fish to impulsive noise sources (Hawkins *et al.*, 2014), behavioural avoidance of fish is anticipated to be limited to around 15 m from a dredger[11]. At Itchenor, split hopper barges and the pontoon will be present only intermittently and the works will be short term. As the vessels and pontoon are moving, fish are not physically constrained and will be able to move away from the source of noise and return once disposal and restoration activity has ceased. Noise levels at the site, and amounts of disturbance will thus be temporary and relatively low, as will the noise-related to the winching of the SRDB. Only some of the latter will happen within the water column, with the majority of it taking place entirely in the dry above the water line. The saltmarsh shaping works will also generally take place whilst the tide is out, or in very shallow waters.

Overall, underwater noise and vibration disturbance effects on fish and shellfish will be localised and temporary and is assessed as **insignificant**.

Effects due to entrainment in the SRDB

There is a risk that fish may get entrained in the SRDB and then dragged up the shore and out of the water column. This is however considered to be very unlikely given the fact that the box will be mostly filled with mud, and also as fish are expected to move away from the box due to the movement (and noise) of the machinery prior to the box moving up the shore. In the unlikely event that a fish or shellfish of noticeable size is dragged up the shore, then visual checks undertaken after each drag will identify these individuals and they will be transported back into the water column.

Given the expected low risk related to this pathway, and also low magnitude, entrainment impacts are assessed as **insignificant**.

5.6 Marine mammals

5.6.1 Baseline description

Chichester Harbour is considered to be of low importance for cetaceans (whales and dolphins). Bottlenose dolphins (*Tursiops truncates)* are only sporadically sighted[12] and harbour porpoise (*Phocoena phocoena)* are also occasionally recorded within the central English Channel but are only very rarely recorded within the Solent and its estuaries or harbours (DECC, 2016; Heinänen and Skov, 2015). Two seal (pinniped) species occur around the Solent area, with the common seal (*Phoca vitulina)* sighted more often than the grey seal (*Halichoerus grypus)* (Chesworth *et al.*, 2010).

Chichester and Langstone Harbours have the largest colony of harbour seals and grey seals in the Solent, with annual counts revealing that numbers are gradually increasing. Recent counts have shown there are around 40 common seals and 10 grey seals in late summer (CHC, 2019). Previous monitoring of the movement of seals (Solent Seal Tagging Project, 2010) proved that they were foraging throughout the Solent and along the Sussex coast. However, Chichester Harbour has the only known rookery in the Eastern English Channel and so they are considered regionally unique. The seals mate at sea in the autumn. One pup is born in June or July on an exposed rock or sandbank.

At high tide, the seals hunt in the water to find flat fish and crustaceans. Though seal foraging activity can change between seasons, the seals predominately forage in the Eastern Solent, between

[11] The predicted distance is based on applying a dredge sound source level of 180 dB re dB re 1 µPa m to a logarithmic spreading model with an attenuation or transmission loss (N) coefficient of 17.91 and absorption coefficient (α) of 0.00523 dB/m as previously recommended by the Environment Agency for use in underwater noise predictions in shallow water environments.

[12] The most recent sightings of bottlenose dolphins in Southampton Water were several records of small pods (1 to 4 individuals) in June 2017 (Sea Watch Foundation, 2021).

Southampton and Selsey Bill, often in the harbours, and regularly cross to the Isle of Wight (Chesworth *et al.,* 2010). In between dives, they can sometimes be seen bobbing in the water of Chichester Harbour with just their heads showing. Seals haul out at low tide throughout the Harbour, but key areas, where groups are regularly observed, are to the west and south of Thorney Island (Chesworth *et al.,* 2010); the closest such group location to Itchenor is just over 3 km away.

5.6.2 Impact assessment

The following impact pathways have been considered with respect to marine mammals:

- Effects of habitat change on marine mammal receptors;
- Effects of changes in water quality on marine mammal receptors;
- Effects due to visual disturbance;
- Effects due to noise and vibration; and

Collision risks due to vessel movements.

Effects of habitat change on marine mammal receptors

The works at Itchenor have the potential to alter the prey resource for marine mammals through changes to fish populations and habitats. Chichester Harbour supports a small population of common seals which breed and forage within the harbour.

However, changes to fish populations are predicted to be insignificant (Section 5.5.2) and the footprint of habitat change is considered to only constitute a very small fraction of the known foraging ranges of these highly mobile species. Therefore, the overall foraging resource for this species in the harbour is not expected to be altered and the overall effect of habitat change during dredge disposal and saltmarsh restoration works is therefore assessed as **insignificant**.

Effects of changes in water quality on marine mammal receptors

Marine mammals are considered to be well adapted to living in areas with a high suspended sediment load and are regularly recorded in such environments in the UK (including within the Harbour). Furthermore, marine mammals are highly mobile and can avoid areas of highly elevated SSC if required.

Localised changes in water quality will be temporary and very small scale, and changes are considered unlikely to be harmful to marine mammals or their prey (Sections 5.2.2, 5.4.2 and 5.5.2). Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal process. The overall effect of changes in water quality on marine mammals during dredge disposal and saltmarsh restoration works is therefore assessed as **insignificant**.

Effects due to visual disturbance

Disturbance stimuli caused by the visual presence of vessels can cause behavioural responses in marine mammals. This includes causing seals to flush from haul out sites and changes in foraging behaviour.

Seals haul out in relatively close proximity to the proposed new disposal and restoration site. However, disposals will occur at high water, when adjacent tidal flats are submerged. There is therefore no potential to cause disturbance responses for hauled out and foraging seals as a result of disposal activities. The restoration and SRDB works may take place at low tide, however, the foreshore is not one of the popular haul out sites, and outside of visual range of the main Harbour haul outs.

The overall effect of visual disturbance on marine mammals during disposal and restoration activities at Itchenor is therefore assessed as **insignificant**.

Effects due to noise and vibration

Information on underwater noise levels associated specifically with disposal of dredged material is limited, but information on underwater noise associated with dredging vessels is available. On this basis, noise levels associated with dredging activity more generally has been used to inform the assessment. Dredging vessels produce broadband and continuous sound[13], mainly at lower frequencies of less than 1,000 Hz and source sound pressure levels from around 160 to more than 180 dB re 1 µPa at 1 m (Thomsen *et al.,* 2009; World Organization of Dredging Associations (WODA), 2013).

To date, auditory and non-auditory injuries in marine mammals have not been observed or documented to occur in association with dredging vessels (Thomsen *et al.*, 2011). The source levels associated with dredging are well below the National Oceanic and Atmospheric Administration (NOAA, 2018) criteria for lethal effect or physical injury of marine mammals. However, at these lower sound levels, the behavioural response Sound Exposure Level (SEL) criteria proposed by Southall *et al.* (2007) for cetaceans and pinnipeds will be marginally exceeded. Factors such as age, condition, sex, behaviour, season and social state influence the level of stress experienced (Thomsen *et al.,* 2009).

At Itchenor, split hopper barges and the pontoon will be present only intermittently and the works will be short term. As the vessels and pontoon are moving, mammals are not physically constrained and will be able to move away from the source of noise and return once disposal and restoration activity has ceased. Noise levels at the site, and amounts of disturbance will thus be temporary and relatively low, as will the noise-related to the winching of the SRDB. Only some of the latter will happen within the water column, with the majority of it taking place entirely in the dry above the water line. The saltmarsh shaping works will also generally take place whilst the tide is out, or in very shallow waters.

Overall, noise and vibration disturbance effects mammals will be localised and temporary and is assessed as **insignificant**.

Collision risks due to vessel movements

Seals and cetaceans can potentially collide with vessel propellers and machinery, possibly leading to physical injury (such as propeller wounds) and, in the worst cases, fatalities (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), 2003; Pace *et al.* 2006). In general, incidents of mortality or injury of marine mammals caused by vessels remain a very rare occurrence in UK waters (ABP Research 1999; Cetacean Strandings Investigation Programme (CSIP), 2011). Vessels involved in disposal activities are likely to be mainly stationary or travelling at slow speeds (typically around 3-5 knots). Furthermore, marine mammals using the Harbour are regularly exposed to a high number of existing vessel movements and, therefore, routinely avoid collisions.

Overall, therefore, collision impacts are assessed as **negligible** for disposal activities and restoration works at Itchenor.

[13] Continuous sound is defined here as a sound wave with a continuous waveform, as opposed to transient/pulsed sounds such as pile driving that start and end in a relatively short amount of time.

5.7 Coastal ornithology

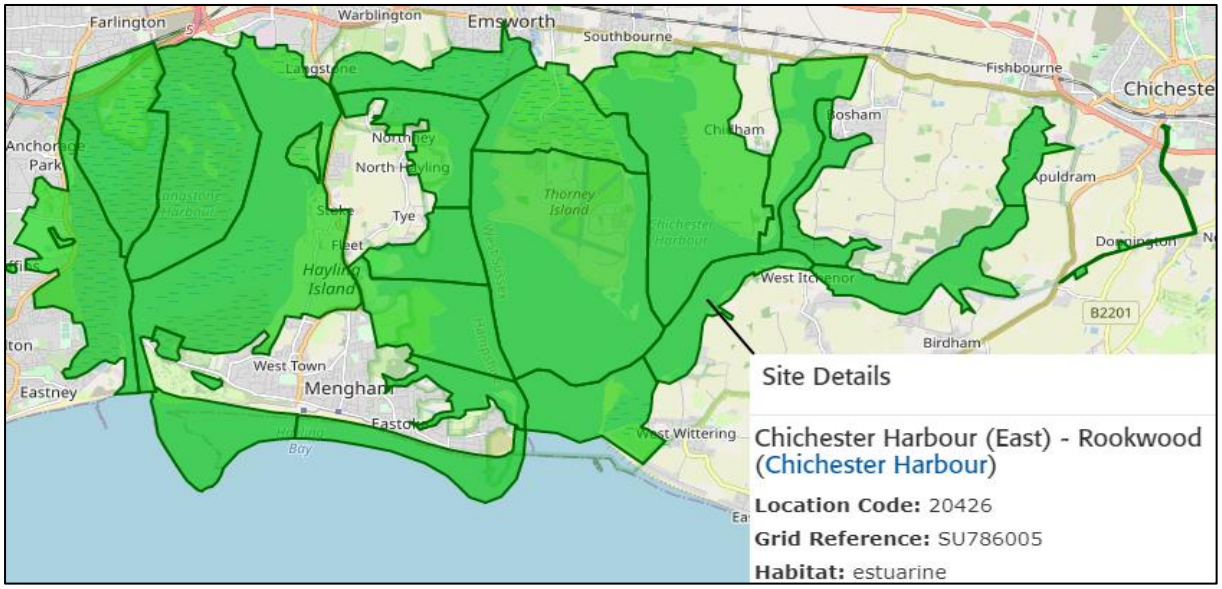
5.7.1 Baseline description

As described elsewhere in this report, Chichester Harbour contains extensive intertidal mudflats and sandflats, as well as areas of seagrass beds, saltmarsh, shallow coastal waters, coastal lagoons, coastal grazing marsh, shingle ridges and islands. These large and diverse habitats support internationally and nationally important numbers of overwintering, passage and breeding bird species. Features of designated sites have been listed in Section 5.3.1.

The wintering populations of birds in Chichester Harbour vary in their trends over time, but on average the assemblage is in unfavourable condition, as numbers of many species have declined, some species dramatically so (>70% long term). Nevertheless, the site remains nationally important for nine wintering species and internationally important for dark-bellied brent geese and black-tailed godwit. The national populations of four of the notified wader species have shifted range in response to climatic factors, which explains, in part, some of the declines seen. However, there are additional site-specific factors affecting these and the other bird species, including disturbance, pressures on high tide roosts and poor quality of habitat (opportunistic macroalgae). Consequently, some of the birds whose populations are doing well are species which can switch their foraging habitats away from the main intertidal area, such as brent geese (Bardsley *et al.*, 2020).

Information on bird use at and around the site has been obtained from the British Trust for Ornithology (BTO) Wetland Bird Survey (WeBS) scheme, which is the UK's national non-breeding waterbird monitoring scheme. Its aim is to monitor all non-breeding waterbirds in the UK in order to provide the principal data on which the conservation of their populations is based.

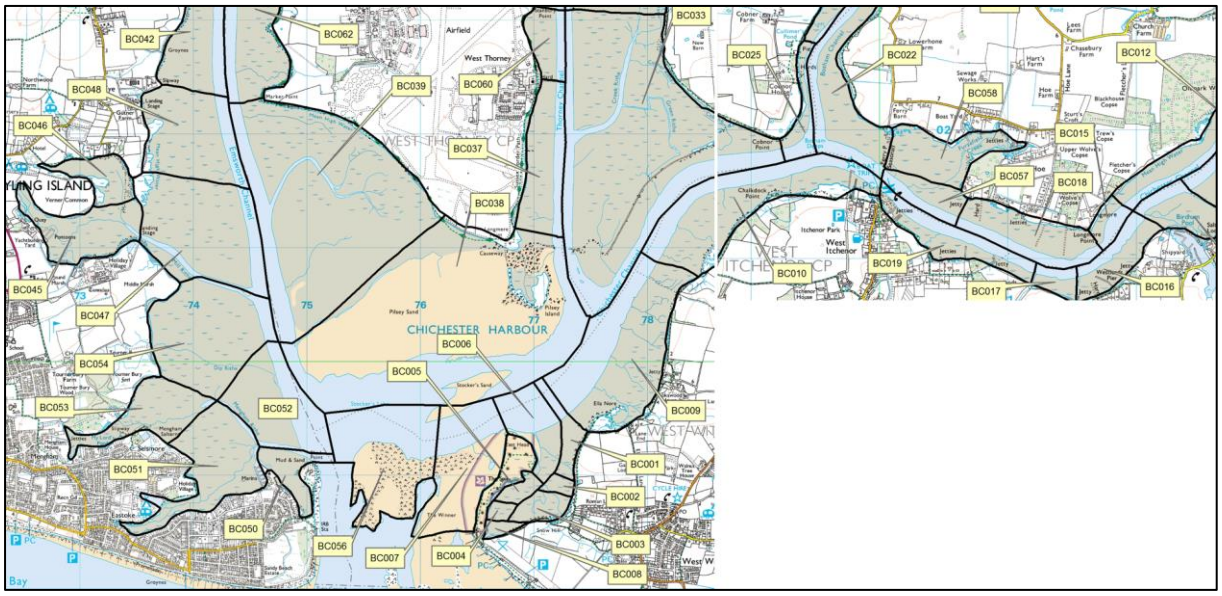
WeBS core counts are conducted once per month, particularly from September to March. Chichester Harbour is divided into 13 different count sectors, which are counted on synchronised dates, at high tide. West Itchenor is in the 'Rookwood' sector for core counts (Image 10). Whilst counts are only undertaken once a month, the value in the dataset is its long-term nature and consistency. Therefore, WeBS core count data can be used to assess trends in site, regional and national populations.



Source: BTO, 2022; copyright BTO and OpenStreetMap

Image 10. WeBS core count sectors in Chichester Harbour

The WeBS low tide counts scheme provides information on the numbers of waterbirds feeding on subdivisions of the intertidal habitats within estuaries; these counts identify key feeding areas. The surveys are not undertaken every year; in Chichester Harbour, they last took place in 2017/18. Coordinated counts of waterbirds are made by volunteers each month between November and February on pre-established subdivisions of the inter-tidal habitat in the period two hours either side of low tide. Chichester Harbour is divided into 70 low tide count sectors (Image 11). West Itchenor is in the BC010 sector (this effectively constitutes the northern half of the Rookwood Core Count sector).



Source: BTO (ABPmer merge and extract from two images provided by BTO); copyright BTO and OS

Image 11. WeBS low count sectors in southern Chichester Harbour

Tables 11 and 12 provide summary ecology information on Chichester Harbour. The wider Chichester Harbour supports over 60,000 wildfowl and waders on average. The peak average as shown by the most recent five year (2015/16 to 2019/20) is 60,392 from high water counts across sites within the Harbour (Table 11). A total of 87 species were recorded using Chichester Harbour over the five-year period covered by this recent WeBS data (Table 12). In Chichester Harbour, species which were present at levels of national importance include Bar-tailed Godwit, Black-tailed Godwit, Curlew, Dunlin, Greenshank, Grey Plover, Little Egret, Mediterranean Gull, Red-breasted Merganser, Redshank, Sandwich Tern, Shelduck, and Wigeon. Brent Goose are present at levels which are of international importance.

Table 11. Annual peak core counts of birds using Chichester Harbour at high water (WeBs data)

2015/16	2016/17	2017/18	2018/19	2019/20	Peak Average (2015/16-2019/20)
54,047	59,701	71,169	54,540	49,648	60,392

Table 12. Annual peak core counts of species at Chichester Harbour at high water (WeBs data)

Species	2015/16	2016/17	2017/18	2018/19	2019/20	Peak Average (2015/16-2019/20)*
Avocet	6	26	28+	45	44	30
Bar-tailed Godwit	760	721	609	330	458	576
Barnacle Goose	4	0	0	0	0	1
Barnacle Goose (naturalised)	4	0	0	0	0	1
Black Swan	0	6	1	3	1	2
Black Tern	0	0	0	0	3	1
Black-headed Gull	1,881	927	8,129	7,578	3,409	4,385
Black-tailed Godwit	807	698	512	644	850	702
Black-throated Diver	0	1	2	0	0	1
Brent Goose (Black Brant - nigricans)	1	1	1	0	0	1
Brent Goose (Dark-bellied - bernicla)	14,260	13,058	16,354	8,721	11,582	12,795
Canada Goose	159	257	340	132	166	211
Cattle Egret	0	3	1	5	10	4
Common Gull	134	178	431+	517	902	433
Common Sandpiper	4	6	5	6	7	6
Common Scoter	0	0	0	1	4	1
Common Tern	39	14	31+	62+	54+	40
Coot	273	244	380	453	375	345
Cormorant	59+	51	80	83	137	88
Curlew	1,125	1,372	1,595	1,025	1,246	1,273
Domestic Mallard	2	3	63	4	3	15
Dunlin	9,853	12,830	12,960	14,252	7,035	11,386
Eider	0	4	0	0	4	2
Eider (except Shetland)	0	4	0	0	4	2
Gadwall	85+	37+	48	102	42	69
Golden Plover	412	470	97	492	325	359
Goldeneye	11	26	7	11	10	13
Goosander	0	0	2	3	0	1
Great Black-backed Gull	6+	17	26	12	21+	19
Great Crested Grebe	37	27	57	36	51	42
Great Northern Diver	6	1	2	0	4	3
Green Sandpiper	0	0	0	5	1	1
Greenshank	101	84	70	86	50	78
Grey Heron	24	22+	25	24	24	24
Grey Plover	1,667	1,443	1,354	957	1,073	1,299
Greylag Goose	1	0	2	1	0	1
Greylag Goose (British/Irish)	1	0	2	1	0	1

Species	2015/16	2016/17	2017/18	2018/19	2019/20	Peak Average (2015/16-2019/20)*
Herring Gull	37+	170	258	196	200	206
Hybrid duck	6	5	0	1	0	2
Jack Snipe	1	1	1	0	4	1
Kingfisher	6	4	8	6	8	6
Kittiwake	0	0	1	1	0	0
Knot	1,254	4,006	1,411	1,456+	1,105	1,944
Lapwing	2,186	1,292	1,397	1,002	1,081	1,392
Lesser Black-backed Gull	22+	7	15	9	3	11
Little Egret	132	146	216	209	136	168
Little Grebe	43	70	108	62+	52	68
Little Gull	1	0	1	0+	0	1
Little Tern	18	15	23+	9+	57+	28
Mallard	405	404	375	462	415	412
Mediterranean Gull	36	71	202	926+	588+	365
Moorhen	41	96	85	62+	62	71
Mute Swan	237	253	284	245	244	253
Oystercatcher	1,463	1,567+	1,657	1,219	1,218	1,425
Pintail	117	128	246	154	72	143
Pochard	18+	3	2	15	2	8
Red-breasted Merganser	76	97	103	136	115	105
Redshank	1,649+	1,595	1,728	1,686	1,607	1,654
Ringed Plover	254	209+	271+	138	172	209
Sanderling	148	106	110	176	217+	151
Sandwich Tern	11	9	28+	54	29	26
Shelduck	340	499	656+	502	407	481
Shoveler	8	6	9+	9	2	7
Slavonian Grebe	6	0	0	0	1	1
Snipe	72	96	59	29	65	64
Spotted Redshank	4	3	9	5	4	5
Teal	987	1,325	1,083	1,005	950	1,070
Tufted Duck	48	52+	75	66+	65	64
Turnstone	206	324	287	198	219	247
Water Rail	4+	3	7	6	7	6
Whimbrel	108	47	100+	109+	96+	92
Wigeon	2,938+	3,387	2,356	2,821	1,993	2,699
Yellow-legged Gull	1	1	1	3	1	1

Cells shaded in green indicate 5-year averages greater than the National Threshold[14].
Cells shaded in blue indicate 5-year averages greater than the International Threshold.
* species with average below 0 not shown

Table 13 provides summary ecology information on key waterbird species occurring in the Rookwood sector, where the West Itchenor site is within Chichester Harbour. The 5-year average is presented

[14] The thresholds levels are available at: Species Threshold Levels (https://www.bto.org/volunteer-surveys/webs/data/species-threshold-levels). The thresholds are set as 1% of the biogeographic population (internationally important) or national population (nationally important).

(derived from the 5-year mean peak for the bird species from 2016/17 to 2020/21: the most recent 5-years of data available from the BTO), and the significance of the Rookwood sector bird population compared to the national and international threshold, the wider Chichester Harbour Estuary and the Chichester and Langstone Harbours SPA. In the Rookwood sector, those species which were present at levels of national importance include Dunlin, Grey Plover, Mediterranean Gull, Sandwich Turn and Whimbrel; Brent Goose levels were of international importance. Personal communication with an ecologist for the CHC reveals that the site itself is not an important roost for waders, instead, the areas around the corner near Horse Pond tend to be favoured by larger numbers of birds. Brent Geese may utilise the arable fields to landward of the site for occasional roosting and feeding, provided these are seeded with crops preferred by these birds.

Table 13. Core count birds species in the Rookwood sector (as per WeBs sector descriptions), where the West Itchenor site resides

Species	2016/17	2017/18	2018/19	2019/20	2020/21	Peak Average (2016/17-2020/21)	% Chichester Harbour	% SPA*
Bar-tailed Godwit	157	157	51	0	17	76.4	**13.3**	**4.5**
Black-headed Gull	280	2,395	805	668	170	863.6	19.7	
Black-tailed Godwit	25	22	90	74	0	42.2	6.0	
Black-throated Diver	1	0	0	0	0	0.2	20.0	
Brent Goose (Dark-bellied - bernicla)	2,532	4,408	1,952	1,870	1,036	2,359.6	18.4	13.8
Common Gull	0	2	0	4	0	1.2	0.3	
Common Sandpiper	3	0	0	0	0	0.6	10.0	
Common Scoter	0	0	3	0	0	0.6	60.0	
Common Tern	2	4	2	5	4	3.4	8.5	10.3
Cormorant	11	4	0	5	1	4.2	4.8	
Curlew	246	192	219	252	10	183.8	14.4	9.9
Dunlin	397	4,445	3,377	13,123	1,339	4,536.2	39.8	No#
Great Black-backed Gull	1	0	3	2	0	1.2	6.3	
Great Crested Grebe	24	49	36	31	5	29	65.9	
Great Northern Diver	0	0	0	1	0	0.2	6.7	
Greenshank	2	3	0	0	0	1	1.3	
Grey Heron	4	6	5	13	2	6	25.0	
Grey Plover	44	229	842	549	45	341.8	26.3	8.9
Herring Gull	16	52	42	26	2	27.6	13.4	
Kingfisher	3	1	0	0	0	0.8	13.3	
Knot	0	0	0	20	0	4	0.2	
Lapwing	6	27	19	84	8	28.8	2.1	

Species	2016/17	2017/18	2018/19	2019/20	2020/21	Peak Average (2016/17-2020/21)	% Chichester Harbour	% SPA*
Little Egret	72	103	71	78	22	69.2	41.2	
Little Grebe	0	2	0	3	0	1	1.5	
Little Tern	4	0	0	20	0	4.8	16.0	4.8
Mallard	7	38	49	12	8	22.8	5.5	
Mediterranean Gull	5	610	301	9	4	185.8	50.9	
Oystercatcher	2,037	2,491	3,051	1,644	562	1,957	137.3	
Pintail	0	2	0	0	0	0.4	0.3	0.1
Red-breasted Merganser	27	35	79	12	4	31.4	29.9	10.6
Redshank	559	357	241	171	68	279.2	16.9	15.6
Ringed Plover	194	200	29	106	27	111.2	53.2	13.1
Sanderling	1	0	0	0	0	0.2	0.1	0.1
Sandwich Tern	6	3	7	11	1	5.6	21.5	18.1
Shelduck	225	164	67	20	17	98.6	20.5	4.1
Snipe	8	7	2	0	0	3.4	5.3	
Spotted Redshank	0	1	0	0	0	0.2	4.0	
Teal	139	60	52	5	0	51.2	4.8	2.8
Tufted Duck	0	0	25	0	0	5	7.8	
Turnstone	59	100	37	88	21	61	24.7	14.2
Whimbrel	0	57	29	4	7	19.4	21.1	
Wigeon	7	2	16	30	0	11	0.4	0.5

Cells shaded in green indicate 5-year averages greater than the National Threshold.
Cells shaded in blue indicate 5-year averages greater than the International Threshold.
*Chichester and Langston Harbours SPA designation in **bold**

Table 14 provides the low tide data for the whole of Chichester Harbour. Table 15 provides the low tide count data for the specific sector (BC010) within which the project site at West Itchenor resides. Both sets of data are from the winter of 2017/18, which is the latest data available from the BTO. In the count sector west of Itchenor, intertidal waders such as Dunlin, Redshank, and Black tailed Godwit were observed, as were low numbers of waterbirds such as Shelduck. Brent Geese were seen in relatively high numbers, again likely related to a flock feeding in adjacent arable, rather than in the count sector itself (CHC ecologist, personal communication). Low numbers of Gull species were also seen across all habitats. Personal communication with an ecologist for the CHC reveals that the site itself is not an important feeding site for waders or waterbirds, with the areas around the corner near Horse Pond again being considered more favoured. Brent Geese may utilise the arable fields to landward of the site for occasional feeding, provided these are seeded with crops preferred by these birds.

Table 14. Chichester Harbour monthly low tide count, whole site for winter 2017/18 (latest available data)

Species	Nov	Dec	Jan	Feb	Winter Max-imum*	Month of Max-imum
Brent Goose (Dark-bellied - bernicla)	9,588	9,216	5,446	5,455	9,588	Nov
Canada Goose	92	55	22	.	92	Nov
Mute Swan	123	110	42	32	123	Nov
Shelduck	434	445	629	469	629	Jan
Shoveler	.	.	8	.	8	Jan
Gadwall	11	23	5	8	23	Dec
Wigeon	1,414	1,291	1,454	598	1,454	Jan
Mallard	161	201	169	100	201	Dec
Pintail	58	53	9	131	131	Feb
Teal	405	539	574	514	574	Jan
Tufted Duck	19	36	20	33	36	Dec
Eider	15	.	.	.	15	Nov
Goldeneye	.	.	15	3	15	Jan
Goosander	.	5	3	.	5	Dec
Red-breasted Merganser	106	72	59	48	106	Nov
Red-throated Diver	.	2	1	.	2	Dec
Great Northern Diver	1	3	2	.	3	Dec
Little Grebe	21	39	74	24	74	Jan
Great Crested Grebe	103	94	110	34	110	Jan
Grey Heron	13	4	11	12	13	Nov
Little Egret	104	31	20	9	104	Nov
Cormorant	67	88	37	9	88	Dec
Moorhen	24	29	35	23	35	Jan
Coot	144	197	187	104	197	Dec
Oystercatcher	1,174	1,029	1,143	618	1,174	Nov
Avocet	.	30	65	2	65	Jan
Lapwing	200	64	198	244	244	Feb
Golden Plover	460	973	280	140	973	Dec
Grey Plover	325	374	402	611	611	Feb
Ringed Plover	153	56	61	37	153	Nov
Whimbrel	5	.	2	1	5	Nov
Curlew	683	438	581	488	683	Nov
Bar-tailed Godwit	483	291	521	294	521	Jan
Black-tailed Godwit	379	621	97	448	621	Dec
Turnstone	156	89	69	58	156	Nov
Knot	688	745	881	1385	1385	Feb
Sanderling	121	81	258	75	258	Jan
Dunlin	11,076	8,268	11,131	10,945	11,131	Jan
Snipe	3	5	.	.	5	Dec
Common Sandpiper	1	.	.	4	4	Feb
Redshank	894	672	528	594	894	Nov
Spotted Redshank	2	9	1	1	9	Dec
Greenshank	4	12	5	2	12	Dec
Black-headed Gull	999	797	1,139	1,313	1,313	Feb

Species	Nov	Dec	Jan	Feb	Winter Max-imum*	Month of Max-imum
Mediterranean Gull	.	.	.	4	4	Feb
Common Gull	244	17	31	29	244	Nov
Great Black-backed Gull	20	8	28	28	28	Jan, Feb
Herring Gull	170	70	65	130	170	Nov
Lesser Black-backed Gull	1	1	8	1	8	Jan
Sandwich Tern	5	.	.	2	5	Nov
Kingfisher	6	5	5	1	6	Nov
* species with maximum of 1 not shown						

Table 15. Low tide count for winter 2017/2018 (latest available data). Peak and mean densities for species in sector BC010 (as per WeBs descriptions)

Species	Preferred Habitat	Area of Preferred Habitat (ha)	Peak Count	Peak Density	Mean Count		Mean Density
					BC010	% Chichester Haroubr	
Brent Goose (DB)	All habitats	86	2,500	29.07	841	30.1	9.78
Shelduck	All habitats	86	12	0.14	8	2.2	0.09
Wigeon	All habitats	86	1	0.01	0	0.1	0.00
Eider	Sub-tidal	28	7	0.25	2	175.0	0.06
Goldeneye	Sub-tidal	28	2	0.07	1	33.3	0.02
Red-breasted Merganser	Sub-tidal	28	5	0.18	2	6.6	0.08
Great Crested Grebe	Sub-tidal	28	1	0.04	0	1.2	0.01
Slavonian Grebe	Sub-tidal	28	1	0.04	0	0.0	0.01
Grey Heron	Intertidal & non-tidal	58	1	0.02	0	9.1	0.00
Little Egret	Intertidal & non-tidal	58	2	0.03	2	4.2	0.03
Oystercatcher	Intertidal	54	2	0.04	2	0.2	0.03
Lapwing	Intertidal & non-tidal	58	1	0.02	0	0.5	0.00
Grey Plover	Intertidal	54	6	0.11	5	1.4	0.09
Curlew	Intertidal & non-tidal	58	39	0.67	17	6.9	0.29
Bar-tailed Godwit	Intertidal	54	8	0.15	5	2.0	0.09
Black-tailed Godwit	Intertidal & non-tidal	58	44	0.76	11	11.3	0.19
Turnstone	Intertidal	54	1	0.02	0	1.0	0.00
Dunlin	Intertidal	54	121	2.24	51	1.1	0.94
Redshank	Intertidal & non-tidal	58	17	0.29	15	2.5	0.25
Black-headed Gull	All habitats	86	5	0.06	3	0.5	0.04
Common Gull	All habitats	86	1	0.01	0	1.2	0.00
Great B.-backed Gull	All habitats	86	3	0.03	2	12.0	0.02
Herring Gull	All habitats	86	8	0.09	2	6.8	0.02

Breeding seabirds

Breeding terns within the SPA are monitored every year by the RSPB (in Langstone Harbour) and CHC (in Chichester Harbour), as part of the Seabird Monitoring Programme. The EU LIFE Little Tern project ran from 2014 to 2019 and established productivity monitoring in order to give a better picture of the health of the population.

Nesting terns are in unfavourable declining condition because nesting Sandwich Tern numbers have declined to zero, little tern numbers have declined dramatically, and the number of their chicks per nest successfully fledging is at or close to zero. A range of complex factors, including predation (both mammalian and avian), habitat changes and climate change / sea level rise are the causes, despite concerted conservation action taken by the CHC as site managers. However, there have been recent successes for Common Terns using artificial rafts deployed by CHC at Thorney Deeps, which, if this continues, will enable the population to recover (Bardsley *et al.*, 2020). Terns do not breed at West Itchenor, nor in its immediate vicinity. They have in the past bred at Stakes Island, which is a minimum of 0.7 km from the site, although there have been no successful attempts in recent years.

5.7.2 Impact assessment

The following impact pathways have been considered with respect to coastal ornithology:

- Effects of changes to intertidal and subtidal habitats on overwintering birds;
- Effects of changes in water and sediment quality on overwintering birds; and
- Visual and noise disturbance to overwintering birds.

There are not expected to be any impacts on breeding marine birds as the works will be completed in the winter months. Whilst there is a small possibility that some of the shaping works could spill over into the month of April, if unexpected delays are encountered, this would not be expected to impact breeding marine birds, as none are thought to breed along the trial foreshore (CHC ecologist, personal communication), or in close proximity.

Effects of changes to intertidal and subtidal habitats on overwintering birds

Disposal of dredged material from nearby marinas, and SRDB saltmarsh restoration works at Itchenor, could affect the quality of marine habitats and change the distribution of marine species, which in turn have the potential to impact on overwintering birds (chiefly intertidal birds) through changes in habitat extent and prey resources.

However, as discussed in Section 5.4.2, the proposed works are only expected to cause *de minimis* temporary disturbance of mudflat habitats in the deposit and drag zones, and small changes of habitat in the saltmarsh restoration zone. The area of existing habitat that will be changed through the direct placement of material will be approximately 0.7 ha of intertidal mudflat in the first year, and up to 3.5 ha over the course of the proposed five-year licence.

As noted previously, saltmarshes are believed to be lost at higher rates than mudflats in the harbour, and thus, the proposed works will restore some of the historic balance and are expected to help to return the saltmarsh habitats in the Harbour towards favourable condition. Furthermore, the restoration works will result in the creation of what will be ultimately more sustainable habitat than what is there at present. Subtidal habitats are not expected to be impacted, as the deposition would take place over the lower intertidal, and the rest of the works along the mid and upper intertidal. As previously noted, monitoring works will be undertaken to ensure the subtidal channel adjacent to the proposed site will not be affected.

Only small numbers of waders are thought to roost and feed in the winter at West Itchenor, with Dunlin, Redshank and Godwits likely being the most common.

There is therefore considered to be no substantial change in the functionality or extent of feeding resources for waders, other intertidal feeding birds and roosting species. Impacts on benthic habitats and species are also assessed as insignificant to minor adverse at a local level (Section 5.4.2), and impacts on fish as insignificant (Section 5.2.2). Based on these factors, the impact of changes in bird habitat as a result of disposal and saltmarsh restoration activities is considered to be **insignificant**.

Effects of changes in water and sediment quality on overwintering birds

As detailed in Sections 5.2.2, the potential effects resulting from an increase in SSC and the release of sediment bound contaminants are assessed as insignificant. Localised changes in water quality as a result of the presence of increased contaminants within the water column will be temporary and unlikely to be harmful to waterbirds. The disposal activities are predicted to have at worst insignificant to minor adverse effects on the benthic and fish prey species of these birds (Sections 5.4.2 and 5.5.2). Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the dredging and disposal process.

The overall effect of changes in water quality on overwintering birds during the works is therefore assessed as **insignificant.**

Visual and noise disturbance to overwintering birds

The visual presence of the disposal vessels, pontoon, SRDB and excavators (two of which will be used), and associated noise, may cause disturbance to bird species.

Research has shown that disturbance to birds from vessel movements generally occurs within 50 to 100 m of a receptor, with sensitive sites such as breeding colonies, foraging grounds and roosting sites most susceptible to disturbance (Institute of Estuarine and Coastal Studies (IECS), 2009; Chatwin *et al.,* 2013).

Evidence suggests that waterbirds generally show a flight response to construction activities and a presence of people on the foreshore at distances of between 20 m and 100 m. Distances over 200 m have also been recorded for some sensitive species (IECS, 2009). The level of disturbance stimuli is dependent on the type of activity being undertaken. In general, human presence on the foreshore (e.g. walking) is considered to cause greater disturbance than vehicles, and waterbirds are more easily disturbed by irregular movements than the regular and defined presence of machinery and other vehicles (IECS, 1997; McLeod*, et al.,* 2013; Guay *et al.,* 2014; Glover *et al.,* 2015). The greater effect of human presence as opposed to general construction works and machinery is also supported by IECS (1997), in that a person approaching feeding birds on the mudflat caused birds to fly when the person was approximately 300 m from the birds, whereas machinery could approach birds up to 50 m before the birds moved away. Other research has also indicated that, in general, birds appear to habituate to continual noises (such as engine noise), as long as there is no large amplitude 'startling' component (IECS, 2009), such as piling, which will not take place as part of the SRDB works.

The specific responses that waterbirds will have to disturbance varies between species as well as between birds of the same species due to a range of factors including the level of habituation and environmental conditions (Gill et al., 2001a Mullner et al., 2004; IECS, 2009; Collop et al. 2016).

The available waterbird data indicate that during the overwintering period, the foreshore at Itchenor is not an important feeding or roosting area, though it is utilised by low numbers of waders and gull species. This relatively low usage is likely due to a combination of factors, notably the fairly narrow nature of the intertidal in this area, disturbance from existing activities, and also a relative paucity of prey species in the mud (as discussed in Section 5.4). Brent Geese may feed or roost on the adjacent arable field.

Works at the site will take place during the overwintering bird season, with the trial works envisaged for end of February and March 2023 (for a period of 3 to 4 weeks maximum), and future campaigns expected to follow similar schedules. These works have been deliberately scheduled to take place as late in the winter as possible (maintenance dredging any later than March is not commercially viable). Thus, whilst the majority of the core overwintering period is avoided, some disturbance of overwintering birds cannot be avoided. As a mitigation measure, it is proposed that works at the site do not take place / stop should winter conditions be particularly cold / harsh. Specifically, a temporary cessation of all activities would be implemented should there be seven consecutive days of freezing (zero or sub-zero temperature) weather conditions. The restriction would not be lifted until after 24 hours of above freezing temperatures and also provided that Meteorological Office weather forecasts indicate that freezing conditions will not return for the next five days.

In addition, to mitigate disturbance to birds grazing on the arable field, movement of land based machinery to and from the site across the arable field will be kept to a minimum, by not moving the excavators off the foreshore for the duration of the works (once brought in), and only refuelling around once a week.

Overwintering birds in Chichester Harbour will be accustomed to a level of disturbance from a variety of sources already; this includes farming, commercial and recreational boating activity (see Section 5.8.1 for more detail), and walkers. For example, the path adjacent to the site is a popular footpath, and the field adjacent to the foreshore is used for arable farming (with associated frequent presence of related machinery).
Any disturbance that does occur due to the proposed works will be temporary, and is expected to only cause responses in a localised area in the direct vicinity of the works. Such responses include increased vigilance, flight responses and localised avoidance. There will be no piling or similar sudden noise which birds are particularly sensitive to. At the site, the two excavators, and the SRDB winching will be the key noise sources. Across the arable field, the occasional movement of the site plant will also cause noise. However, such noises are not especially loud. For example, a typical backhoe digger has a source noise level of around 85 dBA.

The available evidence suggests that the response of waterbirds to disturbance stimuli is relatively limited at distances over 200 m, particularly in areas subject to relatively high levels of existing anthropogenic activity (as found along the Itchenor foreshore). It is also worth noting that visual disturbance associated with anthropogenic activity will in some situations create a disturbance effect before any associated noise starts to have an effect particularly in those species sensitive to visual stimuli (McLeod et al., 2013; Smit and Visser, 1993; IECS, 2013).

On this basis, for species considered more sensitive to bird disturbance such as Godwits, Redshank, Curlew and Shelduck, the proposed works could mean that the low numbers of birds which are thought to occur within this area could be potentially regularly disturbed or temporarily displaced as a result of SRDB restoration activity. Less sensitive species such as Dunlin and gulls would be expected to be disturbed less frequently and feed closer to construction activity.

However, rather than being displaced from the local area completely, birds would be expected to redistribute to nearby foreshore west and south west of the Itchenor foreshore (which is believed to be

more popular), and continue to feed and roost in these alternative locations following dispersal. In addition, while energetic costs might be increased slightly due to disturbance, the available literature suggests that the energetic costs of individual disturbance events are relatively low and even relatively frequent disturbance only causes a small reduction in the time available in a day for feeding. Furthermore, birds are known to forage nocturnally and might potentially change foraging patterns to utilise the area during nocturnal periods when limited construction activity is occurring.

The zone of potential disturbance is also considered very small in the context of the Chichester Harbour SPA/Ramsar. In any given restoration year, the restoration area and a 200 m buffer around it, for example, will only represent 0.4 % of the SPA/Ramsar and 0.2% of intertidal foreshore habitats of the Harbour. Furthermore, most species occur in numbers that only represent a very small proportion of the Harbour-wide populations that typically occur.

Impacts are assessed as **minor adverse** at a local level, at worst; this includes the above noted proposed mitigation measures.

5.8 Commercial and recreational navigation

5.8.1 Baseline description

The only commercial vessels that operate within the harbour are small commercial fishing vessels and others associated with the tourism industry. Chichester Harbour has not lost any substantial areas to land claim schemes for ports or other large developments, though there are substantial areas of claimed, low lying, land which are utilised for agriculture.

Chichester Harbour encloses extensive areas of sheltered water at high tide, making it an ideal location for small boat sailing. There is extensive use of the area for dinghy sailing, and the Harbour is also popular with larger recreational cruising vessels that take advantage of easy access to the Solent, Channel ports and deep-water anchorages. The Harbour has 2,000 marina berths and around 3,200 harbour authority licensed mooring points to accommodate these vessels. In addition to the significant recreational community, there is also a small commercial fishing fleet, charter anglers, visiting workboats and dredgers. The harbour also hosts an array of other smaller craft including, kayaks, canoes, personal watercraft and stand-up paddleboards (SUPs).

Marinas and recreational clubs

There are two large marinas close to the project area, located on the eastern end of Itchenor Reach (around 3 km upstream); namely Premier Marina providing over 1,000 berths and Birdham Pool Marina which has 290 berths. Both marinas are accessed through locks with vessel hoists, slipways and hard storage provided.

There are two boatyards in Itchenor which provide a wide variety of marine services. Northshore Shipyard, within 0.2 km of the proposed works, maintains a small jetty with seven berths, a slipway and extensive onshore facilities for vessel maintenance, repair and construction. Haines Boatyard (some 0.5 km distant) provides general marine services, is a provider of maintained moorings and lets out 129 moorings in the immediate area. The maintained shingle hard at Haines Boatyard is in constant use during working hours in the summer season, with large numbers of vessels being brought out of the water for regular cleaning and maintenance.

Itchenor Sailing Club (some 0.6 km away) hosts large racing fleets throughout the season. The club offers full tidal access to its members through use of its own slipways, floating pontoons and nearby moorings which are available mainly for keelboats.

River moorings

There are 656 laid mooring in Itchenor Reach from the Fairway Mark at the western end to the Birdham Pool mark at the eastern end. The vessel traffic from these moorings transits by the project area to access the wider harbour to the west. Most of these moorings are used by the recreational sector, with a small number being used by commercial fishing vessels. These moorings range from deep-water moorings that can take keeled vessels up to 18 m length overall (LOA), to moorings that do not dry out completely when the height of tide is under 2.5 m CD and are only suitable for vessels with less than a 6 m LOA. Currently, these moorings are over 99% let with many of the vessels used regularly throughout the main season of 01 April to 31 October. There are around 40 moorings within 0.2 km of the proposed deposit zone.

Aids to navigation

The West Itchenor and wider Chichester Harbour area contain a number of navigational lights and marks to provide warnings of hazards and provide a clear indication of navigable water for vessels. The aids to navigation in the study area comprise:

- Two unlit buoys at the western extent of the moorings that act as a guide towards the beginning of the main navigable channel at the Fairway buoy;
- Fairway buoy (Port hand lateral buoy, lit);
- Deep End (Piled South Cardinal mark, unlit);
- Jetty Extent Vertical Green Lights (Northshore Jetty, Harbour Office Jetty);
- Unlit port and starboard withies; and
- CHC is currently in consultation with Trinity House for the addition of an unlit South Cardinal to mark the extent of the ferry hard on the north shoreline of the channel, opposite the Harbour Office Jetty.

The aids to navigation at Chichester Harbour are maintained by CHC as the harbour authority and Local Lighthouse Authority.

Recreational vessel navigation

With large numbers of river moorings, and the proximity of marina berthing and marine services, the primary use of the Itchenor Reach is recreational. Mooring and berth holders transit the area to access the wider harbour and the Solent. Day visitors and regular harbour users launch smaller vessels at the full tide launching hard adjacent to the Harbour Office in Itchenor. Larger visiting recreational vessels from other ports come to Itchenor to make use of the visitor buoys and midstream pontoon berthing provided by the Harbour Authority. At the Harbour Office Jetty, waste facilities, fresh water supply and waste pump-out are also available. Vessels access this jetty to use these facilities during daylight hours throughout the season. Vessels that are launched from the adjacent slipway also utilise the Harbour Office Jetty at the start and end of day trips to load/offload equipment and stores, and to embark/disembark passengers.

The area has increased vessel traffic from 09:00 to 11:00 hr for vessels leaving the harbour and from 16:00 to 18:00 hr in the opposite direction as vessels return to their berths. During off-peak weeks, the busiest days are Saturdays and Sundays, however during peak times (i.e. school holidays and bank holidays), and especially during periods of good weather, Itchenor Reach has significant amounts of vessel traffic. The launching hard at Itchenor is noticeably busier during the morning and at the end of the day. This is because the majority of boats using the hard are launched and recovered at these times.

Itchenor Sailing Club conducts racing throughout the season. Large, peak season events are run including Schools Week, Points Week and the annual regatta where there are large numbers of different classes of sailing dinghies taking to the water and transiting to the South Harbour. During off-peak times, while racing does occur during the week, larger quantities of vessels associated with the clubs are more commonly seen during weekends. Despite the large number of sailing club vessels that use the harbour, there is significantly more use by private vessels that navigate through this area on a regular basis.

Vessels transiting the area are encouraged to keep to the main navigable channel unless accessing a mooring, jetty or slipway (annual Local Notice to Mariners (LNTM) Number 1, Speed of Vessels and Care). Smaller sailing vessels choose to sail through the southern mooring trots normally attempting to find a slower tidal flow. This however causes further congestion for vessels accessing the jetty and slipway, causing interaction with the ferry, charter vessels and passenger vessels operating in the study area.

Commercial vessel navigation

Charter Fishing vessels operate within the Harbour Area, where they collect and drop off passengers at the Harbour Office Jetty. Four small commercial fishing vessels are resident on harbour moorings and transit the area at any time of day throughout the year. During the winter season, the Selsey fishing fleet uses Itchenor Reach to shelter from the weather, and as a base of operation for working in the local area.

A solar powered passenger vessel operates from the Harbour Office Jetty with the embarkation and disembarkation of up to 50 passengers per journey. The vessel is used for sightseeing around Chichester Harbour, including bird watching and seal safari trips. Haines Boatyard operates three dories which are used to service the keelboat fleet that sail from Itchenor Sailing Club. The dories are also used to tow the sailing vessels to and from their moorings.

There is also infrequent use of the area by bathymetric survey vessels, fisheries and police enforcement vessels. Dredging vessels do sometimes transit the study area, although usually in the winter months. In the case of dredging operations and known bathymetric surveys, Local Notices to Mariners are issued.

Harbour authority vessels

The Harbour Authority operates several vessels throughout the year: two Rigid Hull Inflatable Boats (RHIBs) that are used for harbour patrol and enforcement, predominantly during the summer months, and a small fleet of dories as well as a mooring barge. The barge is used for maintaining moorings and harbour infrastructure, including Aids to Navigation. All the Harbour Authority vessels are berthed in the Itchenor Reach, the majority berthing alongside the Harbour Office jetty. The Authority's vessels are active within the area throughout the year.

5.8.2 Impact assessment

The following impact pathways have been considered with respect to commercial shipping and recreational navigation:

- Barge accident or incidents; and
- Water quality impacts resulting from accidents, incidents or spillages.

Barge accident or incidents

The presence of the barges and the pontoon have the potential to introduce an increase in accident and incident risk. Potential risks include:

- Collisions (between pleasure boats, fishing vessels, commercial vessels and other dredgers/barges/pontoon working within the area);
- Contact (between the barges/pontoon and floating objects such as debris or snagging of the drag head on seabed items e.g. underwater obstructions etc.);
- Equipment Failure (e.g. to the bottom doors, presenting limitations of manoeuvrability); and
- Personnel Injury (from shipboard operations).

In addition, the transit of the barges between the maintenance dredge areas and the proposed beneficial use disposal site, creates the potential for collision of the barges/pontoon with other vessels, or a marine incident. Possible navigational hazards include:

- Collisions (between the barges/pontoon and other vessels);
- Contact (between the barges/pontoon and fixed/moored objects such as a navigation buoy or a floating object such as debris).

As noted in Section 2.2.3, the proposed works are anticipated to involve between 15 and 20 barge deliveries, and thus around 30 to 40 vessel movements, to and from the proposed disposal site. Furthermore, bringing in , and removing, the pontoon, will require movements, and the pontoon will also need to be moved away (and back) whenever a sediment barge comes in with a delivery. For this pontoon movement, a waiting area away from any moorings will be designated.

These vessel movements represent a very small percentage of the overall traffic in the study area. Furthermore, controls are in place to safeguard navigational safety, principally management of operations by Vessel Traffic Services (VTS). A Notice to Mariners will be produced in advance of the proposed disposal activities to inform vessels navigating in the vicinity of the presence of the barges/pontoon, and the intended operations. With this measure in place and the embedded vessel traffic management measure in Chichester Harbour, navigational risks through potential collisions with the operational barges will be kept to a minimum.

Overall, the movement of the barges are unlikely to cause a disruption to general shipping and recreational activities and the potential risk of an accident or incident are assessed as **insignificant**.

Water quality impacts resulting from accidents, incidents or spillages

There are potential risks of water quality impacts associated with any vessel accidents, collisions and spillage. These risks will be minimised through existing compliance with the local, national and international regulations. Furthermore, best practice pollution prevention guidelines will be followed

to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal and SRDB restoration process.

Overall, therefore, the potential risk of water quality impacts from accidents and spillages is assessed as **insignificant** for the proposed beneficial use disposal sites.

5.9 Other users and marine infrastructure

5.9.1 Baseline description

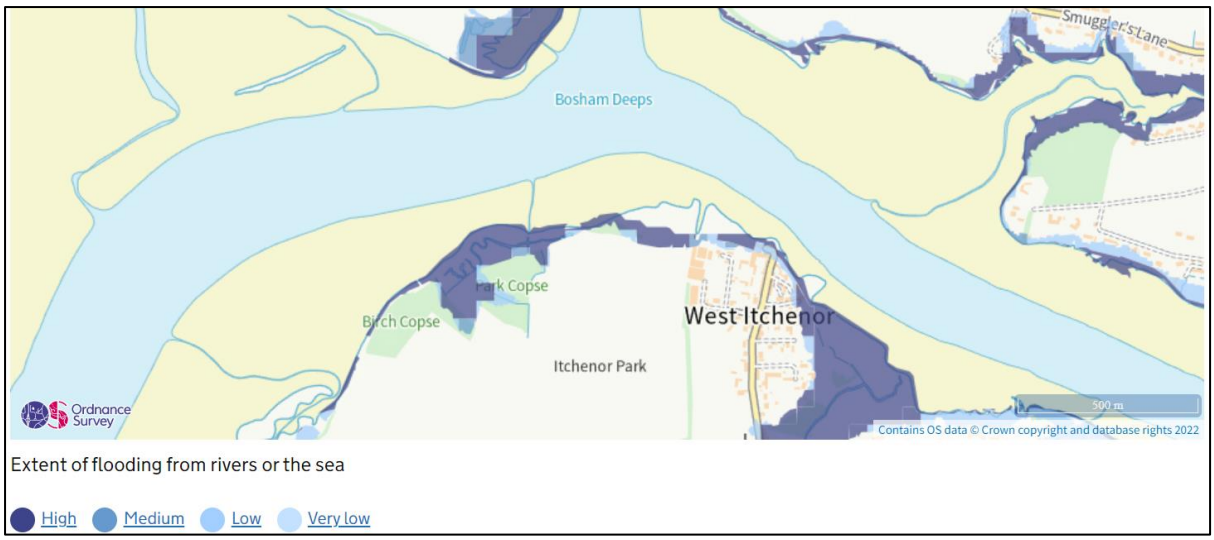
Immediately adjacent to the site, the Itchenor to West Withering Coastal Path (Birch Copse) designated footpath runs along high land and an embankment. In the wider Chichester Harbour area, there are over 56 miles of public footpaths, with a further 7 miles of permissive routes across the AONB. West Itchenor has one of the 19 key AONB viewpoints in the Harbour. Many of these paths run right along the shoreline, whilst others cut across farmland and through Harbour villages. Numerous types of visitors access the Harbour via these footpaths; these include:

- Dog walkers;
- Walkers without dogs;
- Runners/joggers;
- Birdwatchers;
- Wildlife photographers;
- Visitors with limited mobility; and
- Recreational cyclists.

At Itchenor Reach, the Itchenor Ferry runs throughout the year. As previously discussed (section 5.8), dinghy sailing is popular in the Harbour, and larger recreational cruising vessels also pass the site. In addition to the recreational community, there is also a small commercial fishing fleet, charter anglers, visiting workboats and dredgers. The harbour also hosts an array of other smaller craft including, kayaks, canoes, personal watercraft and stand-up paddleboards (SUPs).

Chichester Harbour is mostly unsuitable for swimming; it is not a designated bathing water.

Aside from the footpath, the other nearby coastal infrastructure includes the quay at Itchenor, which is just under 0.2 km away from the project area. In part, the trial area fronts an embankment which used to protect Chalkdock Marsh from tidal inundation. However, this area was opened to tidal influence in 2000, when the flap gate was removed from the outfall pipe, and a regulated tidal exchange scheme instigated. Thus, this outfall is no longer a functioning freshwater outfall. No other outfalls or flood defence structures are present along the project/disposal site frontage. As can be seen in Figure 3 above, the hinterland behind the site quickly rises, and only very small areas of the adjacent arable field are at risk of flooding during extreme events (see also Image 12, noting that areas of high risk are mostly already tidal, e.g. the Chalkdock RTE area).



Source: https://check-long-term-flood-risk.service.gov.uk/

Image 12. Flood risk (from rivers and sea) at Itchenor

5.9.2 Impact assessment

The following impact pathways have been considered with respect to other users:

- Interaction with other users (due to the number of barge movements using navigation routes, the restoration and as well as land based machinery movements); and
- Interaction with other marine infrastructure.

Interaction with other users

Saltmarshes attenuate waves better than mudflats, as noted above (Moeller *et al.*, 2014), and thus having saltmarshes restored at Itchenor would provide slightly enhanced protection to the hinterland and its users. However, as noted above, at the site, flood risk is relatively limited, and this saltmarsh service would thus only benefit footpath users (and the authority charged with maintaining it), as well as the farmer of the adjacent arable field (of which fairly small sections are in the flood risk zone).

The dredge disposal and restoration works themselves are not expected to significantly impact navigation or water users, as assessed in Section 5.8.2, as long as the described mitigation measures are followed.

With regard to land based users, the footpath users and farmer may also be impacted by the construction machinery movements and noise. The latter is expected to be short term and would only impact footpath users for the short periods when they would be in the immediate vicinity of the works, and then only when SRDB winching and saltmarsh shaping takes place. Machinery movement to and from the site would be limited, as described in Section 2.2.3, with the excavators proposed to remain on the upper shore for the duration of the works, and refuelling only taking place around three or four times. The movements would be coordinated with the farmer (who has been consulted and is supportive of the project), as well as CHC. Appropriate controls will be put in place to safeguard the safety of footpath users during those short periods when vehicles/machinery will use the footpath to get to site.

Given the above factors, impacts on other users are assessed as **insignificant**, provided appropriate safety / risk management measures are implemented whilst moving machinery in public areas.

Interaction with other marine infrastructure

As noted above, the quay is within 0.2 km of the site, and the site is backed by rising land, a footpath, and a remnant flood defence embankment at the Chalkdock RTE. There are expected to be slight benefits with regard to better protection to the footpath (which has in the past had to be repaired / shored up at the trial area), as well as the landward arable field, related to the presence of the newly raised area(s), as well as the eventual presence of saltmarsh vegetation.

These impacts are assessed as **insignificant to minor beneficial** at a local level.

5.10 Coastal archaeology

5.10.1 Baseline description

In Roman times, Chichester Harbour was a significant focal point for military and commercial shipping. Fishbourne Roman Palace is a well-known archaeological site, and many of the Harbour's churches are also visited regularly. Bosham has links to King Harold and the Bayeux tapestry and to King Canute, whose daughter is said to be buried in the churchyard.

An advanced search using the Heritage Gateway[15] reveals that, in the area of West Itchenor, there is only one existing maritime archaeological record, concerning an assemblage of three hulked vessels in the intertidal zone, north of West Itchenor. However, according to this record, this assemblage was removed after the instillation of the Itchenor jetty. In the wider Chichester Harbour, there are 31 boat wreck records and two aeroplane wreck records, however these have largely been removed or do not affect the project area.

5.10.2 Impact assessment

The following impact pathway has been considered with respect to coastal heritage:

- Direct or indirect damage to unknown coastal archaeological resources.

Direct or indirect damage to unknown coastal archaeological resources

Whilst there are no known historic sites at, or finds from, the proposed SRDB site, given the history of the Harbour, there is the potential for unknown archaeological resources being present, buried in the intertidal sediment. However, as no excavation will take place as part of the works, and as compaction from the SRDB (skis) would be minimal, no impacts on buried archaeological resources are predicted. Unknown archaeological receptors may be subject to some increased burial at the restoration site, and also elsewhere (due to smothering and slightly increased nearby accretion rates in relation to briefly elevated SSC), but such receptors are not considered to be sensitive to this pathway.

Given these factors, impacts on coastal archaeology are assessed as **insignificant**.

5.11 Cumulative and in-combination effects

The potential effects that can be attributed to the proposed works Itchenor are very localised and considered to be insignificant for most receptors (with the exception of three pathways which were assessed as insignificant to minor adverse at worst, related to local level impacts on SSC, intertidal mudflats (and associated benthic communities), and overwintering birds (due to disturbance). Given

[15] https://www.heritagegateway.org.uk/

the scale of the proposed works, it is also unlikely that the proposed works would result in any significant cumulative/in-combination effects on these receptors with other activities, plans or projects in Chichester Harbour.

The only known projects in the vicinity of the proposed Itchenor beneficial use and saltmarsh restoration site are as follows (as derived from a search of the MMO's public register):

- Shingle recharge at Stakes Island, Chichester Harbour (MLA/2021/00554); and
- Southern Water: 10-year licence for minor maintenance works on coastal outfalls (MLA/2019/00027).

A search of the local planning authority's (Chichester District Council's) planning portal revealed no relevant open applications in the vicinity of Itchenor, with local applications restricted to modifications to residential buildings or trees.

Table 16 summarises the potential cumulative and/or in-combination effects that could arise due to the proposed SRDB related activities at Itchenor.

Overall, the proposed works are not predicted to result in any adverse cumulative or in-combination effects.

Table 16. Summary of cumulative and on-combination effects with known projects

Project	Summary of Predicted Cumulative/In-combination Effects
Shingle recharge at Stakes Island, Chichester Harbour (MLA/2021/00554)	CHC is depositing up to 1000 tonnes of washed shingle on the south end of Stakes Island, raising an area of approximately 350 m^2 by approximately 1 m. The majority of the material will be deposited on the highest part of the ridge, above mean high spring tide level. The material will be sourced from a local aggregate company in the Solent, delivered by barge over the high tide period. Works will be carried out by 15 October 2022. The location of the proposed Itchenor works is 1.5 km from the Stake Island recharge location. There will be no temporal overlap between the works, and thus there is no potential for significant cumulative and/or in-combination effects to occur.
Southern Water: 10-year licence for minor maintenance works on coastal outfalls (MLA/2019/00027)	Southern Water hold a 10-year licence (for use in both a planned and reactive manner) for minor maintenance works on coastal outfalls across the Southern Water region. The application states that it would not be possible 'to provide specific programme information'. A precautionary method statement, listing mitigation measures for sensitive habitats and species, accompanied the application. The three outfalls where maintenance works might take place are some 1.6 km (two outfalls, both near Bosham Hoe) and 5.3 km (near Apuldram) distant from the proposed works at Itchenor. Given that timings of the Southern Water works are unclear, but also given these are unlikely to result in any significant marine environmental effects, then there is considered to be no potential for significant cumulative and/or in-combination effects to occur.

6 Mitigation and monitoring

6.1 Mitigation

Standard best practice procedures, sensible design, and dedicated impact reduction measures have been considered as part of the application to minimise the potential impact(s) on different receiving environments. These can be summarised as follows:

- **Morphology/navigation**: Pre- and post-trial bathymetry surveys to be undertaken and compared. Should noticeable changes have occurred in the subtidal immediately adjacent to the trial area which can clearly be attributed to the trial, then Land and Water will rectify this and reinstate the pre-trial subtidal bathymetry.
- **Water quality**: Best practice pollution prevention guidelines are to be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal and SRDB restoration process.
- **Ornithology**: No works are to take place, should winter conditions be particularly cold / harsh (enacted whenever there have been seven consecutive days of freezing (zero or sub-zero temperature) weather conditions. The restriction would not be lifted until after 24 hours of above freezing temperatures and also provided that Meteorological Office weather forecasts indicate that freezing conditions will not return for the next five days.
  It is also worth noting that the works have been deliberately scheduled to take place as late in the winter as possible, so that the majority of the core overwintering period is avoided.
- **Benthic habitats and species**: Compaction due to the SRDB skis, and formation of ski tracks, is to be kept to a minimum by choosing the lowest impact set of skis.
- **Navigation**: Standard controls which are in place to safeguard navigational safety are to be employed, including management of operations by VTS and Notice(s) to Mariners.
- **Other users (land based machinery)**: Machinery movements to and from the site will be limited as much as is reasonably practicable (this will also benefit bird features). Movements which do take place will be coordinated with the farmer and CHC, and appropriate controls put in place to safeguard the safety of footpath users.

6.2 Proposed monitoring

As the proposed works are novel, effectively adopting an adaptive management approach is envisaged. Adaptive management is an evolving process of phased 'learning by doing' that is carried out to provide assurance regarding the effects and effectiveness of proposed actions. It is a well-established approach to managing natural resources and complex coastlines and issues. For the proposed SRDB project, the adaptive management process will incorporate regular monitoring and consultations with key stakeholders before and after each campaign. The details of the monitoring programme will be discussed with the key stakeholders, however it is expected to mainly include the following:

- **Overwintering Birds:** Monthly overwintering bird surveys are to be undertaken at the site, commencing in November 2022, to confirm usage of the site. These will focus on the site frontage, as well as a 0.3 km buffer zone around it. The necessity/timing/frequency for surveys during subsequent winters is to be determined after the trials, in consultation with regulators. Preliminary results from the November 2022 – early January 2023 surveys could be written up in January to help inform the HRA.
- **Benthic Invertebrates:** After the first winter (in June 2023), sampling is to be undertaken in the impact zone, as well as at two reference samples adjacent. Six samples in total are envisaged.

It is proposed that benthic sampling of the restoration site(s) is repeated in Years 2, 3 and 5, to investigate colonisation rates.

- **Bathymetry / hydrographic survey** of the adjacent subtidal channel: this will stretch from around 0.1 km west of the site to the Quay at Itchenor, and also slightly into Bosham Channel. A baseline survey will be undertaken immediately before the works, and another immediately after the works (to confirm no substantial changes in subtidal).
- **Topography**: Readings will be taken before the works commence, and as soon as the shaping works are completed (to proof that the DTM has been followed). Then, after three months, in June 2023, a repeat survey is proposed, to help determine how much of the material remains, and what level of compaction has taken place. Subsequent monitoring frequency is to be determined in an adaptive manner, in collaboration with relevant government agencies.
- **Accretion**: once the trial works are complete, stakes, feldspar marker horizons, or similar mechanisms, will be put in place to facilitate monitoring of accretion at the initial restoration site.
- **Vegetation**: Initially, in June 2023, a vegetation survey is to be undertaken to determine the level of pioneer vegetation which has established. Subsequent monitoring frequency is to be determined in an adaptive manner, in collaboration with relevant government agencies. Please note that a baseline survey has already been undertaken, confirming plant communities and saltmarsh extent along the frontage (as well as benthic communities; see Sections 2.2.2 and 5.4.1).

This monitoring will have the purpose of verifying the impacts and the success of the proposed technique. The surveys which are proposed for three months after the trial are to inform a monitoring report which in turn would facilitate a decision by the MMO, regulators and their advisors, as to whether or not further phases of beneficial use and SRDB saltmarsh restoration can proceed at the site under the proposed five-year licence. Bird survey results from the first winter would also be presented at this stage. A minimum monitoring programme will be agreed and written into the marine licence. It is proposed that persistence of the sediment will be used as the key indicator of the success of the trial after such a short period of time, as vegetation establishment will take longer than 3 months (though some signs of pioneer plant establishment would be expected, and reported on if found). A percentage change figure will be reported on, noting that some compaction would also likely take place (and has been accounted for in the design).

The approach, frequency and detail of all these surveys will be dictated by advice from stakeholders as part of the adaptive management process. To oversee this adaptive management programme, therefore, it is proposed that a technical group is set up that includes representatives from Natural England, CHC and possibly the Environment Agency. The advice received from this board will then inform the scope of the campaigns and the monitoring for the next stages. This board would meet in August or September every year. This will allow results for be evaluated and plans to be made for the next winter.

Other aspects may well be monitored and researched at the site, as several academic institutions have expressed an interest to research various facets of the site and its development; details for this are to be confirmed in due course, but are not considered necessary for the purposes of the marine licence application.

7 Summary

Land and Water are applying for a five-year licence for a combined dredge disposal and saltmarsh restoration site west of Itchenor in Chichester Harbour, where they are aiming to trial their new SRDB technique this winter. Silt materials dredged from the nearby Northney Marina, whose owners hold an existing licence to dredge and dispose of materials (albeit the latter not yet at Itchenor), are to be used at the site. Given available data presented in this report, it is considered that the materials dredged at Northney should be suitable for deposit at West Itchenor (although the MMO and Cefas will need to confirm this in due course).

This combined disposal site characterisation and environmental appraisal report finds that the potential effects that can be attributed to the proposed works are localised and assessed as insignificant for most receptors. This is with the exception of three pathways which were assessed as insignificant to minor adverse at worst, related to local level impacts on SSC, intertidal mudflats (and associated benthic communities), and overwintering birds (due to disturbance). Also, three pathways were considered to lead to insignificant to minor beneficial impacts at a local level, specifically those related to water quality (N and P removal), the restoration of additional saltmarsh, and the improved protection afforded to the footpath and arable field.

With regard to cumulatively/in-combination with other plans, projects and ongoing activities, these were assessed as insignificant.

A summary of the proposed works' compliance with the respective legislative requirements is provided below:

- Environmental Impact Assessment: Given the size, nature and location of the proposed works, it is considered that an EIA is not required. Section 4 of this report supports this conclusion.
- Conformance with Marine Plan Policies: The proposed works fall within the area covered by the South Marine Plans. The proposed works are considered to be consistent with the South Marine Plans, UK Marine Policy Statement and the principles of sustainable development. A marine plan conformance assessment has not been prepared given the scale of the works (subject to confirmation with the MMO).
- Habitats Regulations Assessment: Given the potential for a LSE cannot be ruled out, the information required to inform an Appropriate Assessment (AA) has been provided in Appendix A. Based on the information provided, it is considered that the proposed works at Itchenor will not have an AEOI either alone or in-combination with other plans and projects.
- Marine Conservation Zones: There are no MCZs in close proximity to the proposed works, and no MCZ assessment has thus been required.
- WFD Regulations: A WFD compliance assessment has been prepared in order to comply with the requirements of these regulations, and is provided in Appendix B. The proposed works are unlikely to result in permanent effects on WFD parameters and will not result in a deterioration to the current status of any water body.

8 References

ABP Research (1999). Good Practice Guidelines for Ports and Harbours Operating Within or Near UK European Marine Sites. English Nature, UK Marine SACs Project. ABP Research & Consultancy Ltd, Southampton, 120p.

ABP Research and Consultancy Ltd. (2001). Geomorphological Analysis of East Head and Chichester Harbour. Research Report R893. ABP Research & Consultancy Ltd, Southampton.

ABPmer (2000). Climate Change and Coastal Erosion. ABP Marine Environmental Research Ltd, Report No. R.1111. ABPmer, Southampton.

ABPmer (2011). Wallasea Wetland Monitoring Programme; Morphological, Benthic Invertebrate and Saltmarsh Vegetation Monitoring Results. ABPmer, Southampton, 64p.

ABPmer (2013). Variation to Southampton Approach Channel Dredge Marine Licence: Supplementary Information. ABP Marine Environmental Research Ltd, Report No R.2198. ABPmer, Southampton.

ABPmer (2020a). Lymington to Yarmouth Ferries: Mitigation and Monitoring (2020), Five-year update and 10th Report for the Environment Management Panel. ABPmer, Southampton, 70p.

ABPmer (2020b). Beneficial Use of Dredge Sediment in the Solent (BUDS) Phase 2, Feasibility Review for Sediment Recharge Project(s) on the West Solent Saltmarshes. ABPmer, Southampton, 152p.

ABPmer (2022). Itchenor Pontoon, Navigational Risk Assessment, ABPmer Report No. R.3689. A report produced by ABPmer for Chichester Harbour Conservancy. ABPmer, Southampton.

Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) (2003). Disturbance to Cetaceans by Shipping: Ship Collisions with Whales. 10th Advisory Committee Meeting Document AC10/Doc. 7(P)Bonn, Germany, 9 - 11 April 2003.

Ashley, M. (2016). [Nephtys hombergii] and [Streblospio shrubsolii] in littoral mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 23-11-2020]. Available at: https://www.marlin.ac.uk/habitat/detail/1100 [last accessed April 2021]

Bardsley, L., Brooksbank, J., Giacomelli G., Marlow, A., and Webster E. (2020). Review of Chichester Harbour sites: intertidal, subtidal and bird features. Natural England Research Report, Number 090.

Binnies (2021). Water Framework Directive Compliance Assessment In support of a Marine Licence Application (Dredging and Disposal Activities) Project no. 123038-3301 26 May 2021. Binnies, Redhill.

Black and Veatch (2017b). Lymington Harbour Commissioners Saltmarsh Recharge by Bottom Dumping – Phase 3 Final Monitoring Report, June 2017. Black & Veatch. 27p.

Blue Marine Foundation (2014). Bass: Defining the Economic and Environmental Values of Sea Bass, Final Report, Available at: https://www.bluemarinefoundation.com/wp-content/uploads/2020/01/20141128-Final-Bass-Report-BMF-MRAG.pdf [last accessed September 2022]

Bolam, S.G., Rees, H.L., Somerfield, P., Smith, R., Clarke, K.R., Warwick, R.M., Atkins, M., and Garnacho, E. (2016a). Ecological consequences of dredged material disposal in the marine environment: a holistic

assessment of activities around the England and Wales coastline. Marine Pollution Bulletin 52(4), 415-26.

Bolam, S.G., Schratzberger, M., and Whomersley, P. (2016b). Macro- and meiofaunal recolonisation of dredged material used for habitat enhancement: temporal patterns in community development. Marine Pollution Bulletin 52(12), 1746-55.

Boyd, S.E., Cooper, K.M., Limpenny, D.S. and Kilbride, R. (2004). Assessment of the rehabilitation of the seabed following marine aggregate dredging. Sci Ser Tech Rep 121. Cefas, Lowestoft.

British Trust for Ornithology (2022). WeBS sites. Online content available at: https://app.bto.org/websonline/sites/data/sites-data.jsp#lon=-4.5263672&lat=54.8006849&zoom=5 [last accessed August 2022]

Budd, G and Hughes, J. (2005). *Nephtys hombergii*. A Catworm. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/generalbiology.php?speciesID=3897 [last accessed August 2022]

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M. and Bruce, B. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine Pollution Bulletin, 114(1), 9-24.

Cefas (2013). Classification of Bivalve Mollusc Production Areas in England and Wales - Sanitary Survey Report Chichester Harbour. Cefas, Lowestoft, 137p.

Cefas (2015). Chichester Pilsey Sands RMP Assessment. Cefas report on behalf of the Food Standards Agency, to demonstrate compliance with the requirements for classification of bivalve mollusc production areas in England and Wales under EC regulation No. 854/2004. Cefas, Lowestoft, 14p.

Cefas (2015). Southampton Water Sanitary Survey. Review. January 2015. Available online at: https://www.cefas.co.uk/media/kr1peyyc/southampton-water-sanitary-survey-report-review-2015-2009-report.pdf [last accessed August 2022]

Cetacean Strandings Investigation Programme (CSIP) (2011). Final Report for the Period 1 January 2005 – 31 December 2010. Cefas, Lowestoft, 98p.

Charted Institute of Ecology and Environmental Management (CIEEM) (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland (Terrestrial, Freshwater, Coastal and Marine). CIEEM, London, 94p.

Chatters, C. (2017). Saltmarsh (British Wildlife Collection). Bloomsbury, London, 384p.

Chatwin, T.A., Joy, R., and Burger, A.E. (2013). Set-Back Distances to Protect Nesting and Roosting Seabirds off Vancouver Island from Boat Disturbance. Waterbirds, 36(1), 43-52.

Chesworth, J. C., Leggett, V. L. and Rowsell, E. S. (2010). Solent Seal Tagging Project Summary Report. Wildlife Trusts' South East Marine Programme, Hampshire and Isle of Wight Wildlife Trust, Hampshire.

Chichester Harbour Conservancy (CHC) (2019). Chichester Harbour Management Plan 2019 – 2024. CHC, Itchenor, 108p.

Chichester Harbour Conservancy (CHC) (2021). Harbour Life - Winter 2020/21. CHC, Itchenor, 26p.

Chichester Harbour Conservancy (CHC) (2022). Water Quality Information. Website content available from: https://www.conservancy.co.uk/page/water-quality-information#:~:text=Storm discharges from Budds Farm,also discharge during storm conditions. [last accessed August 2022]

Chris Blandford Associates (CBA) (2004). Cobnor Point Sea Defences – Managed Breach & Habitat Creation Scheme Environmental Statement.

Collop, C., Stillman, R.A., Garbutt, A., Yates, M.G., Rispin, E., and Yates, T. (2016). Variability in the area, energy and time costs of wintering waders responding to disturbance. Ibis, 158(4), 711-725.

Cope, S.N.M., Bradbury, A.P. and Gorczynska, M. (2008). Solent Dynamic Coast Project. A tool for SMP2. Channel Coastal Observatory, Southampton, 405p.

Costanza, R., Perez-Maqueo, O., Martinez, M.L., Sutton, P., Anderson, S.J. and Mulder, K. (2008). The value of coastal wetlands for hurricane protection. Ambio 37, 241–248.

De-Bastos, E. and Hiscock, K. (2016b). [Aphelochaeta marioni] and [Tubificoides] spp. in variable salinity infralittoral mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 10-03-2021]. Available at: https://www.marlin.ac.uk/habitat/detail/201 [last accessed April 2021]

De-Bastos, E.S.R. (2016a). [*Nephtys hombergii*] and [Tubificoides] spp. in variable salinity infralittoral soft mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 26-11-2020]. Available at: https://www.marlin.ac.uk/habitat/detail/200 [last accessed April 2021]

Defra (2018). South Inshore and South Offshore Marine Plan. July 2018. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726867/South_Marine_Plan_2018.pdf [last accessed September 2022]

Defra and Environment Agency (2016). Pollution prevention for businesses. Available at: https://www.gov.uk/guidance/pollution-prevention-for-businesses [last accessed May 2021]

Department of Energy and Climate Change (DECC) (2016). UK Offshore Energy Strategic Environmental Assessment 3: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage. Available at: https://www.gov.uk/government/publications/strategic-environmental-assessment-3-supporting-documents [last accessed September 2022]

Department of the Environment, Transport and the Regions (DETR. (1994). Planning Policy Guidance Note 9 on Nature Conservation. DETR, London, 57p.

Environment Agency (2015). Part 1: South West river basin district. River basin management plan. Environment Agency, Bristol, UK. 99p.

Environment Agency (2019). Medmerry Managed Realignment - Five-Year Review. Environment Agency, Worthing, 37p.

Environment Agency (2022). Catchment Data Explorer. Online content available at: https://environment.data.gov.uk/catchment-planning/ [last accessed September 2022]

Gibson-Hall, E. and Wilson, E. (2018). Sepia officinalis Common cuttlefish. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1098 [last accessed September 2022]

Gill, J.A., Norris, K. and Sutherland, W.J. (2001a). Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation, 97, 265-268.

Glover, H.K., Guay, P.J., and Weston, M.A. (2015). Up the creek with a paddle; avian flight distances from canoes versus walkers. Wetlands Ecology and Management, 1-4.

Guay, P.J., McLeod, E.M., Taysom, A.J., and Weston, M.A. (2014). Are vehicles 'mobile bird hides'?: A test of the hypothesis that 'cars cause less disturbance'. The Victorian Naturalist 131, 150-155.

Harlow, D.A. (1980). Sediment processes, Selsey Bill to Portsmouth, and a coast protection strategy for Hayling Island. Havant Borough Council Technical Services Dept. Internal report.

Hawkins, A.D., Pembroke, A., Popper, A. (2015). Information gaps in understanding the effects of noise on fishes and invertebrates. Reviews in Fish Biology and Fisheries, 25, 39-64.

Hawkins, A.D., Roberts, L., Cheesman, S. (2014). Responses of free-living coastal pelagic fish to impulsive sounds. The Journal of the Acoustical Society of America, 135.

Heinänen, S. and Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area, JNCC Report No. 544. JNCC, Peterborough.

HM Government (2011). UK Marine Policy Statement. The Stationery Office, London, 51p.

Hooke, J.M., Bray, M.J. and Carter, D.J. (1995). Sediment transport analysis as a component of coastal management – a UK example. Environmental geology 27, 347- 357.

HR Wallingford (1991). A macro review of the coastline of England and Wales. Volume 5. The south coast. Selsey Bill to Portland Bill. Report SR 172.

HR Wallingford (1997). East Solent Shoreline Management Plan. Report EX 3441. HR Wallingford, Wallingford, 133p.

HR Wallingford (2004). Beneficial Use of dredged material in Chichester Harbour. Detailed Assessment of the preferred sediment disposal site. Report EX 5009. HR Wallingford, Wallingford

HR Wallingford (2011). Chichester Harbour Baseline Document – Dredging Protocol. Report Ex6221 Release 3.0. HR Wallingford, Wallingford

Hudson, R., Kenworthy, J. and Best, M. (eds) (2021). Saltmarsh Restoration Handbook: UK and Ireland. Environment Agency, Bristol, 57p.

Inshore Fisheries and Conservation Authority (IFCA) (2020). Species Specific Fisheries Information Reports. Sussex IFCA Report. 16p.

Inshore Fisheries and Conservation Authority (IFCA) (2021). Closure of the Chichester Harbour Oyster Fishery for the season beginning 1st November 2021. 1p document available at: https://www.sussex-ifca.gov.uk/ [last accessed September 2009]

Institute of Estuarine and Coastal Studies (IECS) (1997). Saltend Development Cumulative Impact Study: Ornithological Impacts. Report to Consultants in Environmental Sciences Ltd. Report No. ZO80-97-F. IECS, University of Hull, 28p.

Institute of Estuarine and Coastal Studies (IECS) (2001). Impacts of sediment disturbance and deposition on intertidal biota. Final Report to English Nature September 2001.

Institute of Estuarine and Coastal Studies (IECS). (2009). Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance. Institute of Estuarine and Coastal Studies Report to Humber INCA.

Institute of Estuarine and Coastal Studies (IECS) (2013). Waterbird Disturbance Mitigation Toolkit Informing Estuarine Planning and Construction Projects.
Institute of Estuarine and Coastal Studies (IECS) (2009) Construction and Waterfowl: Defining, Sensitivity, Response, Impacts and Guidance. Institute of Estuarine and Coastal Studies Report to Humber INCA.

Jickells, T., Andrews, J., Samways, G., Sanders, R., Malcolm, S., Sivyer, D., Nedwell, D., Trimmer, M., and Ridgway, J. (2000). Nutrient fluxes through the Humber estuary e past, present and future. Ambio 29, 130-135.

Joint Nature Conservation Committee (JNCC) (1996). Coasts and seas of the United Kingdom. Region 9 Southern England: Hayling Island to Lyme Regis. JNCC, Peterborough.

Local Government (2022). Nutrient Neutrality (NN) and the planning system. Website content available at: https://www.local.gov.uk/pas/topics/environment/nutrient-neutrality-nn-and-planning-system#:~:text=A%20growing%20number%20of%20local,it%20is%20%22nutrient%20neutral%22. [last accessed July 2022].

Luoma, S. N. (1983). Bioavailability of trace metals to aquatic organisms—a review. *Science of the Total Environmen*t, 28, 1-22.

Manning, W.D., Scott, C.R and Leegwater. E. (eds) (2021). Restoring Estuarine and Coastal Habitats with Dredged Sediment: A Handbook. Environment Agency, Bristol, UK, 43p.

Marine Management Organisation (MMO) (2022). Guidance Deposits. Marine Management Organisation. Online content available at: https://www.gov.uk/guidance/deposits#deposit-of-any-substance-or-object [last accessed September 2022]

McLeod, E.M., Guay, P.J., Taysom, A.J., Robinson, R.W., and Weston, M.A. (2013). Buses, cars, bicycles and walkers: the influence of the type of human transport on the flight responses of waterbirds. PLoS One, 8(12), e82008.

Möller, I., Kudella, M., Rupprecht, F., Spencer, T., Maike, P., Wesenbeeck, B.K. van, Wolters, G., Jensen, K., Bouma, T.J., Miranda-Lange, M., Schimmels, S. (2014). Wave attenuation over coastal salt marshes under storm surge conditions. Nature Geoscience, 7, 727–731.

Mullner, A., Linsenmair, K.E. and Wikelski, M. (2004). Exposure to ecotourism reduces survival and effects stress response in hoatzin chicks (*Opisthocomus hoazin*). Biological Conservation, 118, 549-558.
National Oceanic and Atmospheric Administration (NOAA) (2018) Marine Mammal Acoustic Technical Guidance. Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing. National Marine Fisheries Service, Silver Spring (USA), 178p.

Natural England (2013). HRA Habitats Regulations Assessment (HRA) (NESTND026). Online content available at: http://publications.naturalengland.org.uk/publication/8740045 [last accessed July 2022]

Natural England (2017). A review of existing benthic habitat survey reports from within the Solent European Marine Sites (EMS).

Natural England (2019a). Natural England Standard. Habitats Regulations Assessment (HRA) Standard. 15p. Available at: http://publications.naturalengland.org.uk/file/5479463940259840 [last accessed August 2022]

Natural England (2019b). Conservation Advice for Marine Protected Areas: guidance and supporting material. Online content available at: https://designatedsites.naturalengland.org.uk/marineguidance.aspx [last accessed June 2020]

Natural England (2020). Condition of SSSI Units for Site Chichester Harbour SSSI ('littoral sediment' rows). Online content available at: https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S1003245&ReportTitle=Chichester%20Harbour%20SSSI [last accessed August 2022]

Natural England (2021). Conservation Advice for Marine Protected Areas: guidance and supporting material. [Online] Available at: https://designatedsites.naturalengland.org.uk/MarineGuidance.aspx (Accessed February 2022).

Natural England (2022). Advice for development proposals with the potential to affect water quality resulting in adverse nutrient impacts on habitats sites. 25p Letter available at: https://www.cornwall.gov.uk/media/gbpk3k1y/ne-water-quality-and-nutrient-neutrality-advice-16_03_2022-issue-1-final.pdf [last accessed July 2022]

Nedwell, D.B., Jickells, T.D., Trimmer, M., and Sanders, R. (1999). Nutrients in estuaries. In: Nedwell, D.B., Raffaelli, D.G. (Eds.), Advances in Ecological Research Estuaries, vol. 29. Academic Press Inc, San Diego, 43-92.

North Solent Shoreline Management Plan (NSSMP) (2010). North Solent Shoreline Management Plan. Available: https://www.northsolentsmp.co.uk/media/1574/NSSMP-Summary-Booklet-Dec-2010/pdf/NSSMP_Summary_Booklet_Dec_2010.pdf?m=637514898113500000 [last accessed September 2022]

Pace, D.S., Miragliuolo, A., and Mussi, B. (2006). Vessels and Dolphins: Scars That Tell Stories. Fins 3(10, 19-20.

Parry, D. and Hendy, I. (2022). A Historical Investigation of Solent Saltmarsh as Key Coastal Nursery Habitat Areas. Natural England Commissioned Report NECR404. University of Portsmouth, Portsmouth, 155p.

Pearce, B. (2008). The Significance of Benthic Communities for Higher Levels of the Marine Food-Web at Aggregate Dredge Sites using the Ecosystem Approach. Marine Ecological Surveys Limited, Bath, 70p.

Perry, F. (2016). [*Sabella pavonina*] with sponges and anemones on infralittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, Plymouth: Marine Biological Association of the United Kingdom. [Online] Available at: https://www.marlin.ac.uk/habitat/detail/1088 [last accessed December 2020]

Pineda, M.C., Strehlow, B., Sternel, M., Duckworth, A., Den Haan, J., Jones, R. and Webster, N.S. (2017). Effects of sediment smothering on the sponge holobiont with implications for dredging management. Scientific Reports, 7(1), 1-15.

Popper, A.N., Hawkins, A.D., Fay, R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Lokkeborg, S., Rogers, P., Southall, B.L., Zeddies, D.G., and Tavolga, W.N. (2014).

Sound exposure guidelines for fishes and sea turtles: A technical report prepared by ANSI-Accredited standards committee S3/SC1 and registered with ANSI. Springer, SpringerBriefs in Oceanography, 76p.

Roberts, L., Hardig, H.R., Voellmy, I., Bruintjes, R., Simpson, S.D., Radford, A.N., Breithaupt, T., and Elliott M. (2016). Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving. Proceedings of Meetings on Acoustics. 27. 9p.

Rogers, Z. (2019). The responses of saltmarshes in Chichester Harbour between 2002 and 2016, relating to environmental factors. MSc Dissertation Department of Geography University of Portsmouth.

Smit, C.J. and Visser, G.J. (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bull. 68: 6-19.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr, C. R., Kastak, D., Miller, J.H., Nachigall, P.E., Richardson, W,.J., Thomas, J.A and Tyack, P.L. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33:411–521.

Spiga, I., Caldwell, G.S., and Bruintjes, R. (2016). Influence of Pile Driving on the Clearance Rate of the Blue Mussel, Mytilus edulis (L.). Proceedings of Meetings on Acoustics. 27. 9p.

Standing Conference on Problems Associated with the Coastline (SCOPAC) (2020). Coastal storms: detailed analysis of observed sea level and wave events in the SCOPAC region (southern England). 168p report available at: https://southerncoastalgroup-scopac.org.uk/pdf/SCOPAC_STORM_ANALYSIS_FINAL--11_JAN_2021.pdf [last accessed August 2022]

Thomsen, F., McCully, S., Wood, D., Pace, F. and White, P. (2009). A generic investigation into Noise Profiles of Marine Dredging in Relation to the Acoustic Sensitivity of the Marine Fauna in UK Waters with Particular Emphasis on Aggregate Dredging: PHASE 1 Scoping and Review of Key Issues. MEPF Ref No. MEPF/08/P21. Cefas, Lowestoft, 62p.

Thomsen, F., McCully, S.R., Weiss, L., Wood, D., Warr, K., Barry, J., Law, R. (2011). Cetacean Stock Assessment in Relation to Exploration and Production Industry Activity and other Human Pressures: Review and Data Needs. Aquatic Mammals 37, 1-93.

Tidau, S., and Briffa, M. (2016). Review on behavioural impacts of aquatic noise on crustaceans. Proceedings of Meetings on Acoustics. 27. 14p.

Tillin, H.M. and Garrard, S.M. (2019). [*Nephtys cirrosa*] and [Bathyporeia] spp. in infralittoral sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews [online]. Plymouth: Marine Biological Association of the United Kingdom. [cited 17-01-2020]. Available at: https://www.marlin.ac.uk/habitat/detail/154 last accessed April 2021]

Tubbs., C. (1999). The Ecology, Conservation and History of the Solent Packard Publishing Ltd, Chichester, 194p.

Tyler-Walters, H., Tillin, H.M., d'Avack, E.A.S., Perry, F., Stamp, T. (2018). Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide (2018). Marine Life Information Network (MarLIN). Marine Biological Association of the UK, Plymouth, 91p.

Vause, B. (2010). Chichester Harbour Oyster Initiative. Shellfish News 30 (Autumn/Winter 2010), 5-6.

Watson, S., Preston, J., Beaumont, N. and Watson, G. (2020a). Assessing the natural capital value of water quality and climate regulation in temperate marine systems using a EUNIS biotope classification approach. Science of the Total Environment 744 (2020), 16p.

Watson, S., Preston, J., Beaumont, N. and Watson, G. (2020b). Valuing the Solent Marine Sites Habitats and Species: A Natural Capital Study of Benthic Ecosystem Services and how they Contribute to Water Quality Regulation. University of Portsmouth for the Environment Agency. Environment Agency R&D Technical Report ENV6003066R. 107p.

Webber, N.B. (1979). Chichester Harbour Conservancy. An investigation of the dredging in Chichester Harbour approach channel & the possible effects on the Hayling Island coastline. Dept. of Civil Engineering, University of Southampton.

Whitcombe, L.J. (1995). Sediment transport processes with particular reference to Hayling Island. Thesis for degree of Doctor of Philosophy submitted to Southampton University.

World Organisation of Dredging Associations (WODA) (2013). Technical Guidance on: Underwater Sound in Relation to Dredging. WODA, Delft (The Netherlands), 8p.

9 Abbreviations/Acronyms

AA	Appropriate Assessment
ABP	Associated British Ports
AEOI	Adverse Effect on The Integrity
AL	Action Level
AONB	Area of Outstanding Natural Beauty
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
ATL	Advance the Line
BPEO	Best Practical Environmental Option
BTO	British Trust for Ornithology
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CHaPRoN	Chichester Harbour Protection and Recovery of Nature
CHC	Chichester Harbour Conservancy
CIEEM	Chartered Institute of Ecology and Environmental Management
CSD	Cutter Suction Dredger
CSIP	Cetacean Strandings Investigation Programme
Defra	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
EQS	Environmental Quality Standards
EU	European Union
EUR-Lex	European Union law and other public documents of the European Union
GCS	Good Chemical Status
GEP	Good Ecological Potential
GS	Good Status
HBCDD	Hexabromocyclododecane
HM	Her Majesty's
HMWB	Heavily Modified Water Body
HRA	Habitats Regulations Assessment
HTL	Hold the Line
HW	High Water
ID	Identification
IECS	Institute of Estuarine & Coastal Studies
IEMA	The Institute of Environmental Management and Assessment
IFCA	Inshore Fisheries and Conservation Authority
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
LiDAR	Light Detection and Ranging
LNRS	Local Nature Recovery Strategy
LNTM	Local Notice to Mariners
LOA	Length Overall
LSE	Likely Significant Effect
LW	Low Water
MarESA	Marine Evidence-based Sensitivity Assessment
MCMS	Marine Case Management System
MCZ	Marine Conservation Zone
MHW	Mean High Water

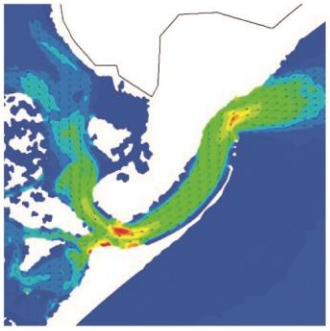
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
ML	Marine Licence
MLW	Mean Low Water
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPS	Marine Policy Statement
MR	Managed Realignment
MSL	Mean Sea Level
NAI	No Action Intervention
NERC	Natural Environment and Rural Communities
NPFA	No Public Funding Available
NVZ	Nitrate Vulnerable Zone
OD	Ordnance Datum
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Polybrominated Diphenyl Ethers
PFOS	Perfluorooctane Sulphonates
PSA	Particle Size Analysis
Ramsar	Wetlands of international importance, (Convention on Wetlands - Ramsar, Iran, 1971)
RBMP	River Basin Management Plans
RHIBs	Rigid Hull Inflatable Boats
RSPB	Royal Society for the Protection of Birds
RTE	Regulated Tidal Exchange
S41	Section 41
SAC	Special Area of Conservation
SCOPAC	Standing Conference on Problems Associated with The Coastline
SDCP	Solent Dynamic Coast Project
SEL	Sound Exposure Level
SI	Statutory Instrument
SMP	Shoreline Marine Plan
SPA	Special Protection Area
SRDB	Saltmarsh Restoration Drag Box
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
SUPs	Stand-Up Paddleboards
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UK	United Kingdom
VTS	Vessel Traffic Services
WeBS	Wetland Bird Survey
WFD	Water Framework Directive
WHA	Waste Hierarchy Assessment
WODA	World Organisation of Dredging Associations
WWTW	Wastewater Treatment Works

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices




Innovative Thinking - Sustainable Solutions

ABP mer

A Habitats Regulations Assessment (HRA)

A.1 Introduction

Land and Water are applying for a five-year licence for a combined dredge disposal and saltmarsh restoration site west of Itchenor in Chichester Harbour, where they are aiming to trial their new SRDB technique this winter. Silt materials dredged from nearby Northney Marina, whose owners hold an existing licence to dredge and dispose of materials (albeit the latter not yet at Itchenor), are to be used at the site.

ABPmer has been commissioned to undertake a Habitats Regulations Assessment (HRA). The information within this HRA report will assist the Competent Authority (the Marine Management Organisation, MMO) with their review under Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) (commonly referred to as the 'Habitats Regulations'), and with the production of an Appropriate Assessment (AA).

As the project/activity is a licensable activity taking place within European/Ramsar Sites and is not directly connected with the management of those sites, the proposed works will trigger the requirement for an HRA. Based on a review of the available evidence, there is considered to be no potential for an adverse effect on integrity (AEOI) on the interest features or conservation objectives of European/Ramsar sites either alone and/or in-combination with other plans and projects.

It should be noted that, whilst the proposed project/activity is not strictly directly connected to the management of the sites, the 2014 site improvement plan for the Solent European sites clearly states that habitat creation initiatives are required to combat coastal squeeze. Thus, the proposed trial and saltmarsh restoration at Itchenor is fully in-keeping with the management requirements for the sites.

A.1.1 Project description

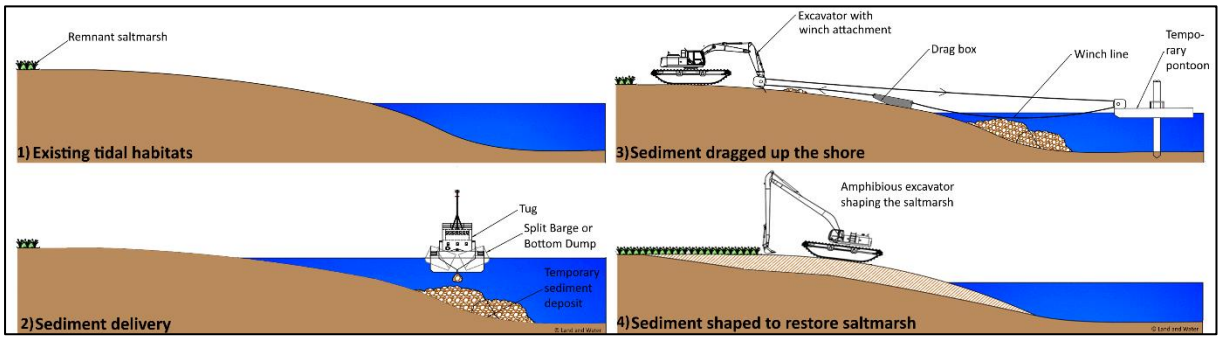
As noted in Section 2.2. of the main report (referred to as 'the main report' for the rest of this HRA), this project will involve beneficially using dredged sediment from elsewhere in Chichester Harbour to enhance and protect the harbour's eroding saltmarsh habitats at West Itchenor. The application is for a five-year marine licence, with the potential for restoring up to around 3.5 ha of saltmarsh at the site, using materials sourced from various marinas within the Harbour. However, in the first winter of 2022/23, a trial of the novel Saltmarsh Restoration Drag Box (SRDB) technique is to be undertaken, whereby up to 0.7 ha are to be restored with circa 4,500 m^3 of materials. A restoration and deposit zone has been drawn up; this is the maximum area within which sediment will be deposited, then dragged up the shore and reshaped to restore saltmarsh (more detail on this is provided below) (see Figure 2 of the main report).

Subsequent beneficial use and restoration campaigns would only take place if the trial during the first winter proved to be successful. Should the trials be successful, then annual campaigns of similar magnitude are envisaged, until around 3.5 ha have been restored at the site. Inclusive of the initial trial volumes, up to 25,0000 m^3 of materials may be required to achieve this level of restoration, with exact volumes to be confirmed once/if the initial trial has been successful (as, at present, a detailed Digital Terrain Model (DTM) has only been produced for the trial area – see Image 2 of the main report for further detail).

There have been substantial losses of saltmarsh habitat in Chichester Harbour historically, and the habitat is continuing to decline (see Sections 2.2.2 and 5.4.1 of the main report for further detail). At

the same time, the marinas within the harbour are regularly dredged, and the materials mostly taken offshore, instead of being used to rebuild the marshes. There are many financial, technical, regulatory and environmental reasons why dredged sediment has not been used to 'recharge' saltmarshes in the past. However, there is now a growing impetus to find ways of resolving these challenges.

This proof of concept trial seeks to resolve these issues. The scope and aims of this project have been developed collaboratively between Land and Water, Earth Change, and ABPmer. It has also been discussed with the Chichester Harbour Conservancy (CHC), Natural England, the Environment Agency and the MMO over the course of several meetings, and during a site visit to West Itchenor on 29 March 2022. This novel approach is illustrated in Image A.1.



Source: Land and Water

Image A.13. Illustrative graphics of the SRDB restoration process

Firstly, dredged materials will be deposited by spilt hopper barges on low shore (low mudflat) areas during high tide. Once the sediment has been deposited, the SRDB (which sits on skis) will drag the recently deposited sediment from the low shore areas to higher elevation surfaces. Using the SRDB approach will mean that dredged sediment can be placed on the upper intertidal areas (i.e. fronting eroding saltmarshes), in a much firmer consistency than could be achieved by pumping and without requiring the use of pipes and costly retainment bunds. Use of this novel SRDB approach could open opportunities for beneficially using a lot more of the sediment that is dredged from UK ports and harbours every year for habitat restoration. That is because it creates a way of ensuring that the efficiency or 'productivity' of dredging and disposal operations is not hampered, while also ensuring that dredged sediment is placed at these higher elevations that need it most.

A comprehensive construction method statement for the first year trial has been provided in Section 2.2.3 of the main report. It is envisaged that the works will be undertaken in late February and March 2023, with the potential for some of the shaping taking place in April if unexpected delays are encountered (e.g. if works have to be halted during extremely cold weather periods; this is a proposed mitigation measure). Depending on tidal states and dredging schedules, it is estimated that the works will take between 3 and 4 weeks to complete. Somewhere between 15 and 20 barge loads will likely be needed in total in order to deliver the sediment, with the number depending on how fully the barges will be loaded. Actual days on site likely will be somewhere between 15 and 20; as noted in Section 2.2.3, the dragging of 2 barges' loads of sediment is estimated to take 5 to 8 hours; thus, there will be 50 to 80 hours of dragging of sediment from the bottom of the shore up to the top.

A.1.2 Report structure

This report has been structured as follows:

Section A.1: **Introduction**: Provides a brief description of the proposed works and an overview of the need for an HRA;

Section A.2: **Stage 1 - Screening**: Reviews the location of the proposed works in relation to European/Ramsar sites and if the works are necessary for the management of those sites;

Section A.3: **Stage 2 – Test of Likely Significant Effect:** reviews the potential for the proposed works to result in an LSE on the interest features of European/Ramsar sites;

Section A.4: **Stage 3 – Appropriate Assessment:** Reviews the potential for the proposed works to result in an AEOI on the interest features of European/Ramsar sites, including in-combination effects; and

Section A.5: **Conclusions**: Presents a brief summary of the findings of this appendix.

A.1.3 Need for an HRA

The requirements of Council Directive 92/43/EEC (as amended) on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive') and Council Directive 2009/147/EC on the conservation of wild birds (the 'Birds Directive') have been transposed into UK legislation through, most recently, the Conservation of Habitats and Species Regulations 2017 (as amended)[16].

The Habitats Regulations provide for the protection of European designated sites including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). In addition, Natural England (2013) advice suggests that these regulations apply to Ramsar sites (designated under the 1971 Ramsar Convention for their internationally important wetlands), candidate SACs (cSAC), potential Special Protection Areas (pSPA), and proposed and existing European offshore marine sites. Collectively, these sites are referred to as European/Ramsar sites in this HRA.

As the proposed works have the potential to directly and/or indirectly affect European/Ramsar sites, the MMO (as the Competent Authority) is required to take account of the Habitats Regulations and produce an AA. As summarised above, Regulation 63 of the Habitats Regulations states that:

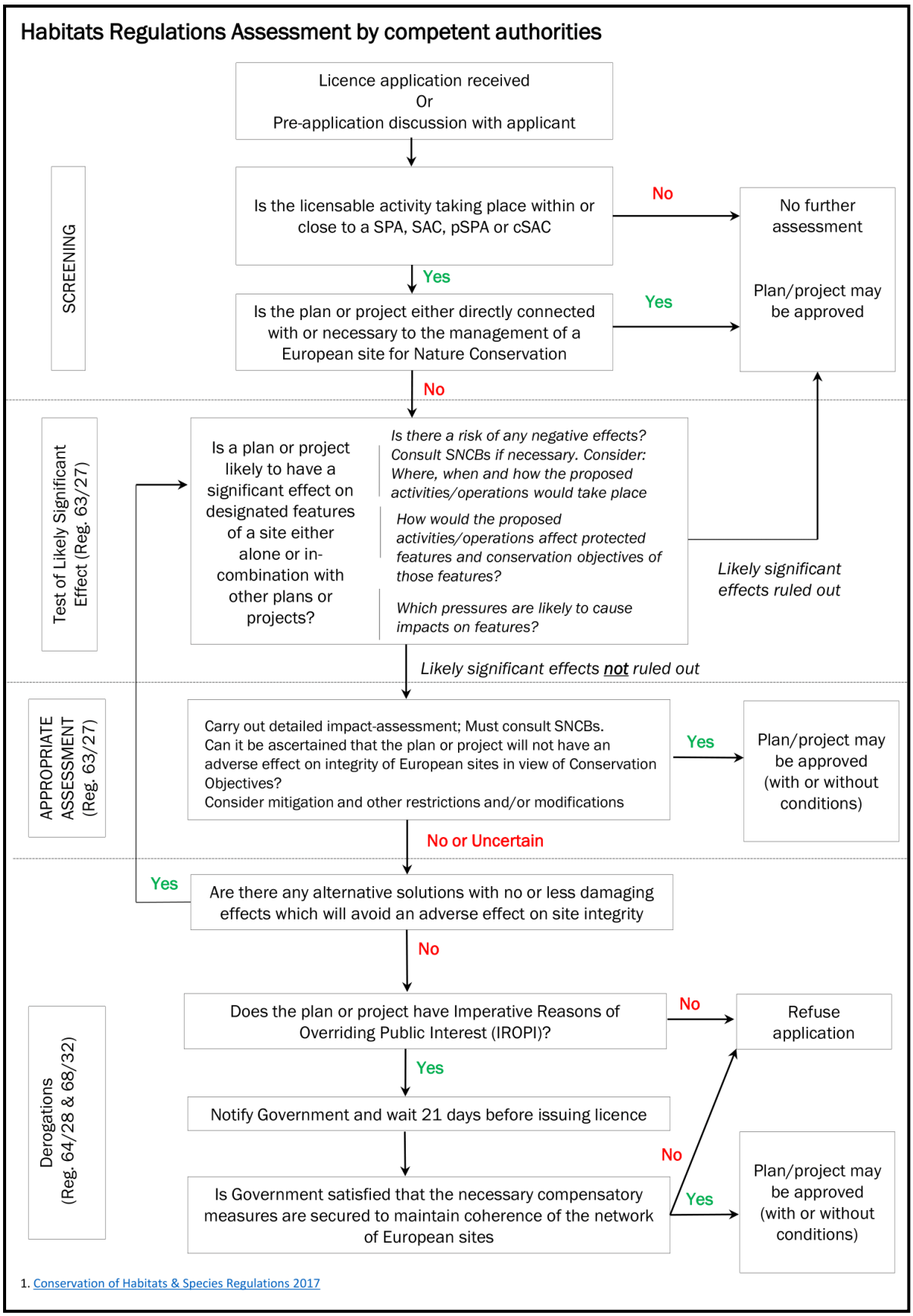
"A competent authority, before deciding to undertake, or give any consent, permission, or other authorisation for a plan or project which:

a) is likely to have significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects); and
b) is not directly connected with or necessary to the management of the site

must make an appropriate assessment of the implications for the site in view of that site's conservation objectives".

The decision as to whether a 'Stage 2' AA is required is based on a 'Stage 1' assessment of LSE (see Image A.2). LSE is recognised as being a 'coarse filter' judgement or a statement that the anticipated effects of the proposal will be more than trivial (i.e. that the anticipated changes resulting from a proposal have the potential to impact on an interest feature of a European/Ramsar site). If a project (or plan) could have an LSE on a European/Ramsar site, it does not automatically follow that an impact will occur. The decision of LSE is purely an indication of the need for an AA.

[16] Modified by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 on 31 January 2020.



Source: Natural England (2019b)

Image A.2 Summary of the key stages comprising an HRA

In an AA (as Stage 2 of the HRA process), it is necessary to determine whether the project or plan would result in an adverse effect on the integrity (AEOI) of the European/Ramsar site(s) in view of the site's conservation objectives. The integrity of a site has been defined as the coherence of its ecological structure and function, across its whole area that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified (Department of the Environment, Transport and the Regions (DETR), 1994).

Where it cannot be demonstrated that a project will not have an AEOI, or there is insufficient certainty of an avoidance of an adverse effect, the activities can only proceed if it can be demonstrated that there are no more suitable (less damaging) alternatives, and that there are Imperative Reasons of Over-riding Public Interest (IROPI) sufficient to justify the proposed project. In certain circumstances, the Secretary of State may be required to ensure that adequate compensation, usually in the form of replacement habitat, has been provided to protect the overall coherence of the Natura 2000 network (i.e. European sites).

The decision on whether integrity is affected will be made by the Competent Authority (in this case, the MMO) in consultation with Natural England.

The deposit and restoration zone lies within the following European/Ramsar sites (see Figure A.1):

- Chichester and Langstone Harbours Ramsar (the proposed site directly overlaps with this Ramsar site);
- Chichester and Langstone Harbours SPA (the proposed sites directly overlaps with this SPA); and
- Solent Maritime SAC (the proposed sites directly overlaps with this SAC).

An outline of the HRA process is shown in Image A.2, with the three main stages as follows:

- **Stage 1 (Screening):** determine if the proposed activity takes place within or close to a European/Ramsar site and is either directly connected with or necessary to the management of European/Ramsar site;
- **Stage 2 (Test of LSE):** determine whether the project is likely to have a significant effect on any European/Ramsar Site; and
- **Stage 3 (Appropriate Assessment):** if it is concluded that the work is likely to have a significant effect, then produce an AA which determines whether the project could or will adversely affect the integrity of any European/Ramsar site.

This report has been prepared to inform the Competent Authority's considerations of Stages 1 and 2 of the HRA process. This report is therefore designed to assist with this Regulation 63 review and achieve the following key goals:

1. **Act as an auditable checklist of AA information**. This report is designed to provide a confirmatory checklist, which ensures that all the relevant information that is needed for an AA is provided; and
2. **Assist the Competent Authority and its consultees**. The overall aim of this report is to provide a concise and readable document that will make it easier for the Competent Authority to consult on, and produce, an AA where required.

In producing this report, it is recognised that the scope of an HRA can vary on a case-by-case basis. However, the information provided here is considered to represent all the detail required to carry out the assessment. In particular, it is designed to meet the key requirements within the relevant Habitats Regulations guidance, such as:

- Habitats Regulations Assessment (HRA) Standard (4a); and
- Conservation Advice for Marine Protected Areas: guidance and supporting material (Natural England, 2019b).

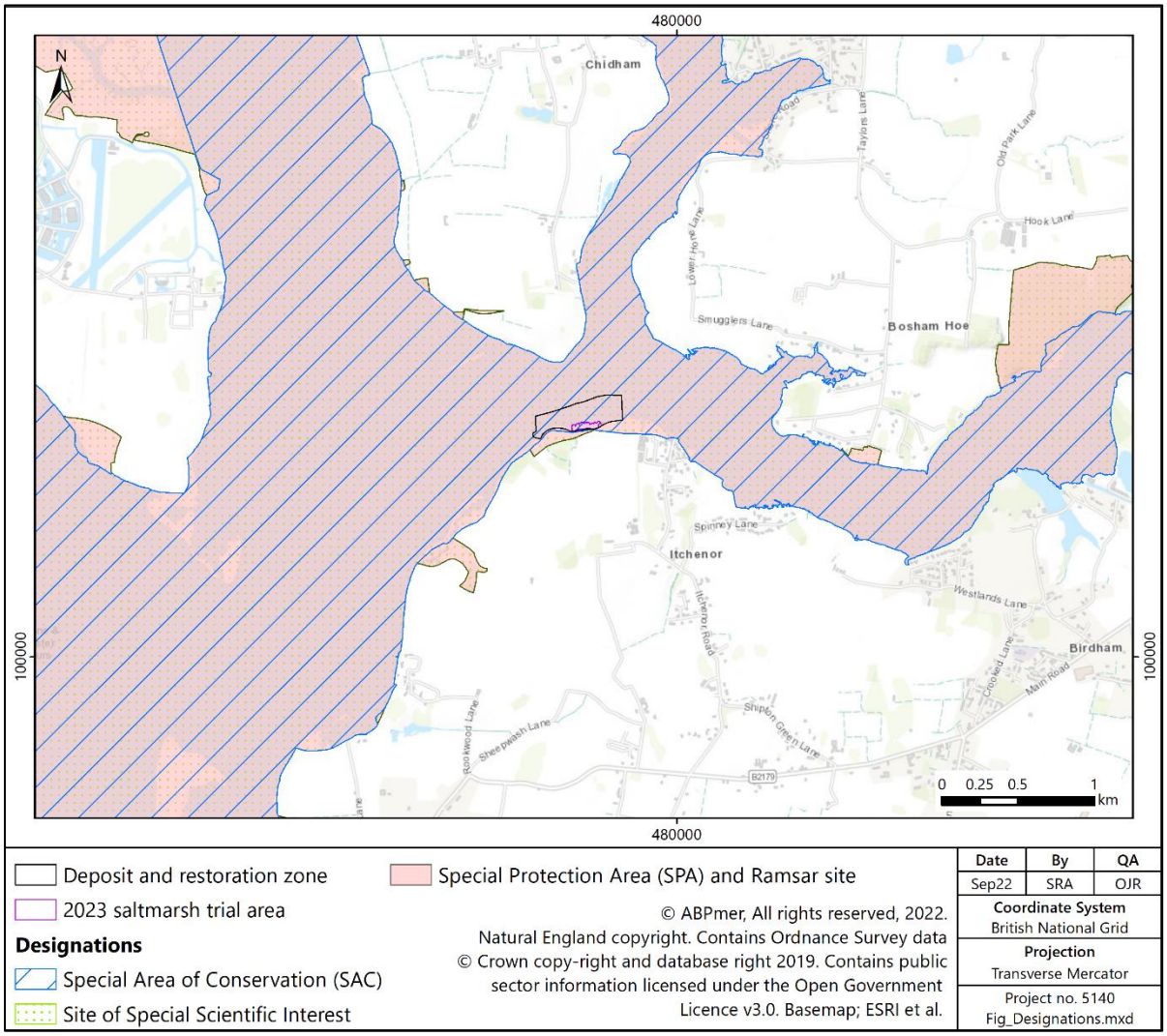


Figure A.1 International and national nature conservation designated sites in the vicinity of West Itchenor

A.2 Stage 1 (Screening)

In accordance with Natural England (2021) guidance and the flowchart detailing the HRA process (Image A.2), the screening stage involves considering if the proposed activity is taking place within or close to a European/Ramsar site.

The location of these sites in relation to the proposed works is shown on Figure A.1. As noted above, the proposed works overlap with the following European/Ramsar sites:

- Chichester and Langstone Harbours Ramsar;
- Chichester and Langstone Harbours; and
- Solent Maritime SAC.

The proposed works are neither directly connected with nor necessary to the management of these European/Ramsar sites and, therefore, there is a need to progress to the next stage of the HRA (Stage 2 - Test of LSE).

As previously noted, it is however worth highlighting that the 2014 site improvement plan for the Solent European sites clearly states that habitat creation initiatives are required to combat coastal squeeze in the above sites. Thus, the proposed trial and saltmarsh restoration at Itchenor is fully in-keeping with the management requirements for the sites.

A.3 Stage 2 (Test of likely significant effect)

This stage of the HRA involves considering if the plan or project is likely to have a significant effect on interest features of a European/Ramsar site either alone or in-combination with other plans or projects (Image A.2).

The proposed works lie within the Chichester and Langstone Harbours SPA and Ramsar sites, as well as the Solent Maritime SAC.

It is acknowledged that a potential LSE on the qualifying interest features and supporting habitats of these sites cannot be ruled out and, therefore, these sites should be taken forward to the next stage of the HRA (Stage 3 – Appropriate Assessment). Table A.1 presents the qualifying interest features and conservation objectives of these European/ Ramsar sites.

Table A.1 Qualifying features and conservation objectives of the European/Ramsar sites located close to Itchenor

Site	Features	Conservation Objectives
Chichester and Langstone Harbours SPA	▪ *Branta bernicla bernicla*; Dark-bellied brent goose ▪ *Tadorna tadorna*; Common shelduck ▪ *Anas penelope*; Eurasian wigeon ▪ *Anas crecca*; Eurasian teal ▪ *Anas acuta*; Northern pintail ▪ *Anas clypeata*; Northern shoveler ▪ *Mergus serrator*; Red-breasted merganser ▪ *Charadrius hiaticula*; Ringed plover ▪ *Pluvialis squatarola*; Grey plover ▪ *Calidris alba*; Sanderling ▪ *Calidris alpina alpina*; Dunlin ▪ *Limosa lapponica*; Bar-tailed godwit ▪ *Numenius arquata*; Eurasian curlew ▪ *Tringa totanus*; Common redshank ▪ *Arenaria interpres*; Ruddy turnstone ▪ *Sterna sandvicensis*; Sandwich tern ▪ *Sterna hirundo*; Common tern ▪ *Sterna albifrons*; Little tern	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring; ▪ The extent and distribution of the habitats of the qualifying features, ▪ The structure and function of the habitats of the qualifying features, ▪ The supporting processes on which the habitats of the qualifying features rely, ▪ The population of each of the qualifying features, and ▪ The distribution of the qualifying features within the site.
Chichester and Langstone Harbours Ramsar	▪ Black-tailed godwit, *Limosa limosa* - Passage ▪ Dark-bellied brent goose, *Branta bernicla* - Wintering ▪ Dunlin, *Calidris alpina alpina* - Wintering ▪ Grey plover, *Pluvialis squatarola* - Wintering ▪ Redshank, *Tringa totanus* – Passage ▪ Ringed plover, *Charadrius hiaticula* - Passage ▪ Shelduck, *Tadorna tadorna* - Wintering ▪ Waterbird assemblage - Wintering ▪ Estuary	See above

Site	Features	Conservation Objectives
Solent Maritime SAC	▪ Sandbanks which are slightly covered by sea water all the time ▪ Estuaries ▪ Mudflats and sandflats not covered by seawater at low tide ▪ Coastal lagoons ▪ Annual vegetation of drift lines ▪ Perennial vegetation of stony banks ▪ Salicornia and other annuals colonising mud and sand ▪ Spartina swards *Spartinion maritimae* ▪ Atlantic salt meadows *Glauco-Puccinellietalia maritimae* ▪ Shifting dunes along the shoreline with Ammophila *arenaria* ('White dunes') ▪ Desmoulin's whorl snail, *Vertigo moulinsiana*	Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring ▪ The extent and distribution of qualifying natural habitats and habitats of qualifying species, ▪ The structure and function (including typical species) of qualifying natural habitats, ▪ The structure and function of the habitats of qualifying species, ▪ The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely, ▪ The populations of qualifying species, and The distribution of qualifying species within the site.

A.4 Stage 3 (Appropriate Assessment)

This section provides a review of the potential for adverse effects from the proposed works on the interest features of European/Ramsar sites that were identified in Section 5. This review has been carried out in the context of the nature and scale of the activities, their geographic location relative to European/Ramsar sites and the sensitivities of the interest features.

Changes in habitat

The proposed works will cause temporary disturbance of small areas of mudflat habitats. This would be in the form of short term deep smothering where the sediments are deposited, as well as shallow smothering along the drag zone, with some modest compaction along the SRDB ski tracks. No more than 2.5 ha of mudflat habitat are expected to be temporarily disturbed over a given winter campaign, as noted in Section 5.4.2 of the main report. These environments are well adapted to survival under fluctuating conditions, and also can tolerate moderate levels of smothering; the mudflats are thus expected to recover quickly from the temporary disturbance (within days to a few months, depending on the level of smothering/disturbance).

At the top of the shore, up to 3.5 ha of saltmarsh habitat are to be restored on what is currently mudflat (with 0.7 ha envisaged for the initial trial year), but would have in the recent past been saltmarsh, as outlined in Section 2.2. of the main report. These habitats have multiple ecosystem services benefits, and high percentages of saltmarshes have historically been lost at high rates in Chichester Harbour, with losses still ongoing and expected to accelerate due to climate change. Saltmarshes are furthermore believed to be lost at higher rates than mudflats, and saltmarsh restoration has been identified as a desirable measure in the 2014 Solent European site improvement plan. In addition, the saltmarsh areas of the underlying SSSI are in an 'unfavourable declining' condition due to coastal squeeze and water quality issues. Thus, undertaking the SRDB works is considered in-keeping with the management of the site, although they have not been formally declared to be necessary for the management of the site. It would help restore 1 % of the Harbour's saltmarshes, should the technique be proven to be successful, and the full 3.5 ha be restored over the licence term.

The area of temporary disturbance where the dredged materials would be deposited and dragged directly overlaps with the Chichester Harbour SPA and Ramsar site. In any given year, the temporary disturbance would affect less than 0.05 % of these sites. It also overlaps with the Solent Maritime SAC; here, the percentage is less than 0.03 % for this site. Around 1 % of the saltmarshes of Chichester Harbour would be restored at the upper shore if all of the applied for area were to be achieved over the licence term. Overall, the change in seabed habitat and associated benthic communities is considered to result in **no potential for an AEOI on the interest features of European/Ramsar sites**.

The proposed works are not expected to cause significant changes to physical processes (e.g. water levels, flow rates, accretion and erosion patterns; see Section 5.1.2 of the main report). Therefore, indirect changes to habitat extent and quality as a result of the works will be insignificant and **will not result in a potential AEOI on European/Ramsar sites and features**.

Given the scale and nature of the proposed SRDB works at Itchenor, they are unlikely to result in any significant cumulative/in-combination effects with other activities in Chichester Harbour in terms of changes to seabed/intertidal habitats.

Increased suspended sediment concentrations

Away from the immediate zone of influence, there is potential for increases in Suspended Sediment Concentrations (SSC) in the local area as a result of the disposal and SRDB works. Any changes to SSC will be temporary, lasting a few hours after the disposal and drag operations. As noted in Section 5.1.2 of the main report, the fine sediment comprising the potential dredged material sources will generally be contained within the bulk of the dredged material and will primarily move as a cohesive mass from the hopper to the seabed. Due to this, and also as the material will be relatively consolidated, having been derived through back hoe dredging, the resuspension of materials is expected to be limited. This will be aided by the fact that the bottom placement of materials will take place on the highest tides and as high on the shore as possible, to minimise its dispersal by tidal currents and help maximise its retention. The maximum water depths at the site during the periods of bottom placement will be in the order of 3 to 4 m.

On the upper shore, some erosion of the newly deposited sediment at the saltmarsh restoration area is anticipated post shaping, as noted in Section 5.4.2 of the main report, although this is expected to be limited and would occur gradually, thus not raising local SSC in a measurable fashion.

Overall, sedimentation away from the SRDB area is likely to be negligible and not measurable; increased SSC will be short-lived and transient in nature, likely to be redistributed by the tides. Sedimentation of this scale would not result in smothering effects to faunal species, and as discussed above, recoverability is expected to be high. As noted in Sections 5.1.2 and 5.4.2 of the main report, intertidal and subtidal estuarine habitats and associated benthic communities are naturally adapted to fluctuating conditions and the resuspension and deposition of sediments on a daily basis (through tidal action), lunar cycles (due to the differing influences of spring and neap tides) and on a seasonal basis (due to storm activity and conditions of extreme waves). Benthic communities within the Chichester Harbour European sites are considered to have a low sensitivity to changes in suspended sediments and minor fluctuations in sedimentation, particularly in areas with muddy sediments and those located adjacent to regularly disturbed areas, such as the main navigation channels, berths and marinas.

In summary, overall, in any given restoration year, the spatial and temporal magnitude of change in SSC is assessed as insignificant to minor locally (see Section 5.1.2 of the main report), and negligible further afield. Any changes in dissolved oxygen are expected to be localised and temporary, and are assessed as insignificant (Section 5.2.2 of the main report). Thus, in physical terms, the plumes resulting from sediment release are expected to have a minimal and very localised effect on water and sediment quality, and benthic habitats by extension.

Overall, given the relatively negligible level of exposure and the low sensitivity of interest features, the temporary increases in SSC during SRDB activities is considered to result in **no potential for an AEOI on the interest features of European/Ramsar sites**.

Given the scale and nature of the proposed SRDB works at Itchenor, they are unlikely to result in any significant cumulative/in-combination effects with other activities in Chichester Harbour in terms of increases in SSC.

Potential remobilisation of contaminated sediments

There are strict legislation and sediment quality assessment requirements associated with obtaining permissions to undertake dredge disposal activities. If any contaminant concentration is deemed too high then disposal of that material may be restricted. Concentrations of contaminants in the dredged material will be assessed in the licences of the organisations which will be licensed to dispose at Itchenor. The first years' materials are anticipated to be dredged at Northney Marina (Hayling Island), and

concentrations of contaminants in the dredged material from this source are assessed as being low (see Section 5.2.2 of the main report).

The potential changes to levels of chemical contaminants in the water and the potential redistribution of sediment-bound chemical contaminants, in any given restoration year, are assessed as insignificant (see Section 5.2 of the main report). Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the dredge disposal an SRDB works.

Overall, therefore, **there is not considered to be a potential for an AEOI on the condition of any European/Ramsar sites** or features as a result of the re-suspension of sediments and release of sediment bound contaminants associated with the proposed works.

Given the scale and nature of the proposed SRDB works at Itchenor, they are unlikely to result in any significant cumulative/in-combination effects with other activities in Chichester Harbour in terms of remobilisation of contaminated sediments.

Effects of changes in water and sediment quality

Changes in water quality during disposal and SRDB operations could potentially impact fish and water bird species, by increasing SSC, resulting in changes to dissolved oxygen and releasing toxic contaminants bound in sediments. However, these related changes to water and sediment quality (see above and Sections 5.2.2 and 5.5.2 of the main report) are assessed as insignificant.

In any given restoration year, localised changes in water quality as a result of the presence of increased contaminants within the water column will be temporary and unlikely to be harmful to overwintering and water birds. In addition, the disposal SRDB activities are not predicted to have a significant adverse effect on the benthic and fish prey species of these birds (Sections 5.4.2 and 5.5.2 of the main report). Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the works.

The overall effect of changes in water quality are therefore **not considered to result in a potential AEOI on overwintering and water bird interest features.**

Given the scale and nature of the proposed SRDB works at Itchenor, they are unlikely to result in any significant cumulative/in-combination effects with other activities in Chichester Harbour in terms of changes to water and sediment quality.

Potential for noise and/or visual disturbance

The visual presence of the barges, pontoon, SRDB and excavators (two of which will be used),, and associated noise, has the potential to cause disturbance to bird species.

Research has shown that disturbance to birds from vessel movements generally occurs within 50 to 100 m of a receptor with sensitive sites such as breeding colonies, foraging grounds and roosting sites most susceptible to disturbance (IECS, 2009; Chatwin *et al.,* 2013).

Evidence suggests that waterbirds generally show a flight response to construction activities and a presence of people on the foreshore at distances of between 20 m and 100 m. Distances over 200 m have also been recorded for some sensitive species (IECS, 2009). The level of disturbance stimuli is dependent on the type of activity being undertaken. In general, human presence on the foreshore (e.g. walking) is considered to cause greater disturbance than vehicles, and waterbirds are more easily

disturbed by irregular movements than the regular and defined presence of machinery and other vehicles (IECS, 1997; McLeod*, et al.,* 2013; Guay *et al.,* 2014; Glover *et al.,* 2015). The greater effect of human presence as opposed to general construction works and machinery is also supported by IECS (1997), in that a person approaching feeding birds on the mudflat caused birds to fly when the person was approximately 300 m from the birds, whereas machinery could approach birds up to 50 m before the birds moved away. Other research has also indicated that, in general, birds appear to habituate to continual noises (such as engine noise), as long as there is no large amplitude 'startling' component (IECS, 2009), such as piling, which will not take place as part of the SRDB works.

The specific responses that waterbirds will have to disturbance varies between species as well as between birds of the same species due to a range of factors including the level of habituation and environmental conditions (Gill et al., 2001; Mullner et al., 2004; IECS, 2009; Collop et al., 2016).

The available waterbird data (see Section 5.7.1 of the main report) indicate that during the overwintering period, the foreshore at Itchenor is not an important feeding or roosting area, though it is utilised by low numbers of waders and gull species. This relatively low usage is likely due to a combination of factors, notably the fairly narrow nature of the intertidal in this area, disturbance from existing activities, and also a relative paucity of prey species in the mud (as discussed in Section 5.4.1 of the main report). Brent Geese may feed or roost on the adjacent arable field.

Works at the site will take place during the overwintering bird season, with the trial works envisaged for late February and March 2023 (for a period of 3 to 4 weeks maximum), and future campaigns expected to follow similar schedules. Thus, some disturbance of overwintering birds cannot be avoided.

Any disturbance that does occur due to the proposed works will be temporary, and is expected to only cause responses in a localised area in the direct vicinity of the works. Such responses include increased vigilance, flight responses and localised avoidance. There will be no piling or similar sudden noise which birds are particularly sensitive to. At the site, the two excavators, and the SRDB winching will be the key noise sources. Across the arable field, the occasional movement of the site plant will also cause noise. However, such noises are not especially loud. For example, a typical backhoe digger has a source noise level of around 85 dBA.

It is worth noting that the works have been deliberately scheduled to take place as late in the winter as possible, so that the majority of the core overwintering period is avoided.

As an additional mitigation measure, it is proposed that works at the site do not take place / stop should winter conditions be particularly cold / harsh. This would be enacted whenever there have been seven consecutive days of freezing (zero or sub-zero temperature) weather conditions. The restriction would not be lifted until after 24 hours of above freezing temperatures and also provided that Meteorological Office weather forecasts indicate that freezing conditions will not return for the next five days.

Furthermore, to mitigate disturbance to birds grazing on the arable field, movement of land based machinery to and from the site across the arable field will be kept to a minimum, by not moving the excavators off the foreshore for the duration of the works (once brought in), and only refuelling around once a week.

Overwintering birds in Chichester Harbour will be accustomed to a level of disturbance from a variety of sources already; this includes farming, commercial and recreational boating activity (see Section 5.8.1 of the main report for more detail), and walkers. For example, the path adjacent to the site is a popular footpath, and the field adjacent to the foreshore is used for arable farming (with associated frequent presence of related machinery).

The available evidence suggests that the response of waterbirds to disturbance stimuli is relatively limited at distances over 200 m, particularly in areas subject to relatively high levels of existing anthropogenic activity (as found along the Itchenor foreshore). It is also worth noting that visual disturbance associated with anthropogenic activity will in some situations create a disturbance effect before any associated noise starts to have an effect particularly in those species sensitive to visual stimuli (McLeod et al., 2013; Smit and Visser, 1993; IECS, 2013).

On this basis, for species considered more sensitive to bird disturbance such as Godwits, Redshank, Curlew and Shelduck, the proposed works could mean that the low numbers of birds which are thought to occur within this area could be potentially regularly disturbed or temporarily displaced as a result of SRDB restoration activity. Less sensitive species such as Dunlin and gulls would be expected to be disturbed less frequently and feed closer to construction activity.

However, rather than being displaced from the local area completely, birds would be expected to redistribute to nearby foreshore west and south west of the Itchenor foreshore (which is believed to be more popular), and continue to feed and roost in these alternative locations following dispersal. In addition, while energetic costs might be increased slightly due to disturbance, the available literature suggests that the energetic costs of individual disturbance events are relatively low and even relatively frequent disturbance only causes a small reduction in the time available in a day for feeding. Furthermore, birds are known to forage nocturnally and might potentially change foraging patterns to utilise the area during nocturnal periods when limited construction activity is occurring.

The zone of potential disturbance is also considered very small in the context of the Chichester Harbour SPA/Ramsar. In any given restoration year, the restoration area and the 200 m buffer, for example, will only represents 0.4 % of the SPA/Ramsar and 0.2% of intertidal foreshore habitats of the Harbour. Furthermore, most species occur in numbers that only represent a very small proportion of the Harbour-wide populations that typically occur. The mitigation measures mentioned above will help to further limit impacts.

Based on these factors, the impact of visual and noise disturbance during the proposed deposit and SRDB works at Itchenor, in any given restoration year, are **not considered to result in a potential AEOI on bird interest features using the Harbour and wider area**.

Elevated noise and vibration levels could potentially disturb fish and shellfish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.* 2015). This includes migratory species within the estuary such as Eel. The ability to detect and localise the source of a sound is of considerable biological importance to many fish species and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions.

At Itchenor, as noted in Section 5.5.2 of the main report, split hopper barges and the pontoon will be present only intermittently and the works will be short term, in any given restoration year. As the vessels and pontoon are moving, fish are not physically constrained and will be able to move away from the source of noise and return once disposal and restoration activity has ceased. Noise levels at the site, and amounts of disturbance will thus be temporary and relatively low, as will the noise-related to the winching of the SRDB. Only some of the latter will happen within the water column, with the majority of it taking place entirely in the dry above the water line. The saltmarsh shaping works will also generally take place whilst the tide is out, or in very shallow waters. Overall, underwater noise and vibration disturbance effects on fish and shellfish will be localised and temporary and is assessed as insignificant.

Overall, the displacement from disposal and SRDB noise will be localised and temporary, and is therefore **not considered to result in a potential adverse AEOI on fish in the Harbour** (which are prey to some of the overwintering and water bird species of the Chichester Harbour sites).

Given the scale and nature of the proposed SRDB works at Itchenor, they are unlikely to result in any significant cumulative/in-combination effects with other activities in Chichester Harbour in in terms of noise and visual disturbance.

In-combination effects

The Habitats Regulations require assessment of the potential in-combination effects of the proposed development on European/Ramsar sites with other plans and projects. These refer to effects, which may or may not interact with each other, but which could affect the same interest feature.

The potential effects on European/Ramsar sites and features that can be attributed to the proposed works at Itchenor are temporary, very localised and insignificant to minor adverse at a local scale at worst (negligible at a Harbour scale). The other known plans or projects in the vicinity of the proposed works at Itchenor are discussed in Section 5.11 of the main report. In summary, the proposed deposit and SRDB works at Itchenor are not anticipated to result in any significant adverse cumulative or in-combination effects. Consequently, **the proposed works will not have an AEOI on European/Ramsar sites either alone or in-combination with other plans and projects**.

A.5 Conclusions

This HRA report provides information to support the preparation of an AA for the proposed disposal and SRDB works at Itchenor. There are a number of potential impact pathways that link the sources of change from the proposed works to the interest features of European/Ramsar sites.

The proposed works are considered to have the potential to result in a LSE on European/Ramsar sites. As such, it was considered necessary to proceed to Stage 3 of the HRA to determine if the proposed development has the potential to in an adverse effect on the integrity (AEOI) on a European/Ramsar site in the context of the site's conservation objectives.

Based on a review of the available evidence, there is considered to be **no potential for AEOI on the interest features of European/Ramsar sites either alone and/or in-combination with other plans and projects**.

A.6 References

Please refer to the references section of the main report (Section 8) for references to this HRA.

B Water Framework Directive Compliance Assessment

B.1 Introduction

ABPmer was commissioned by Land and Water to undertake a Water Framework Directive (WFD) compliance assessment to determine whether the proposed beneficial use and saltmarsh restoration activities at Itchenor comply with the objectives of the WFD Regulations. The information presented in this appendix, together with the combined disposal site characterisation and environmental report presented above (henceforth referred to as 'the main report'), will support the marine licence application that will be submitted to the Marine Management Organisation (MMO) as part of the marine licensing process. Figure B.1 shows the location of the proposed works and surrounding WFD water bodies.

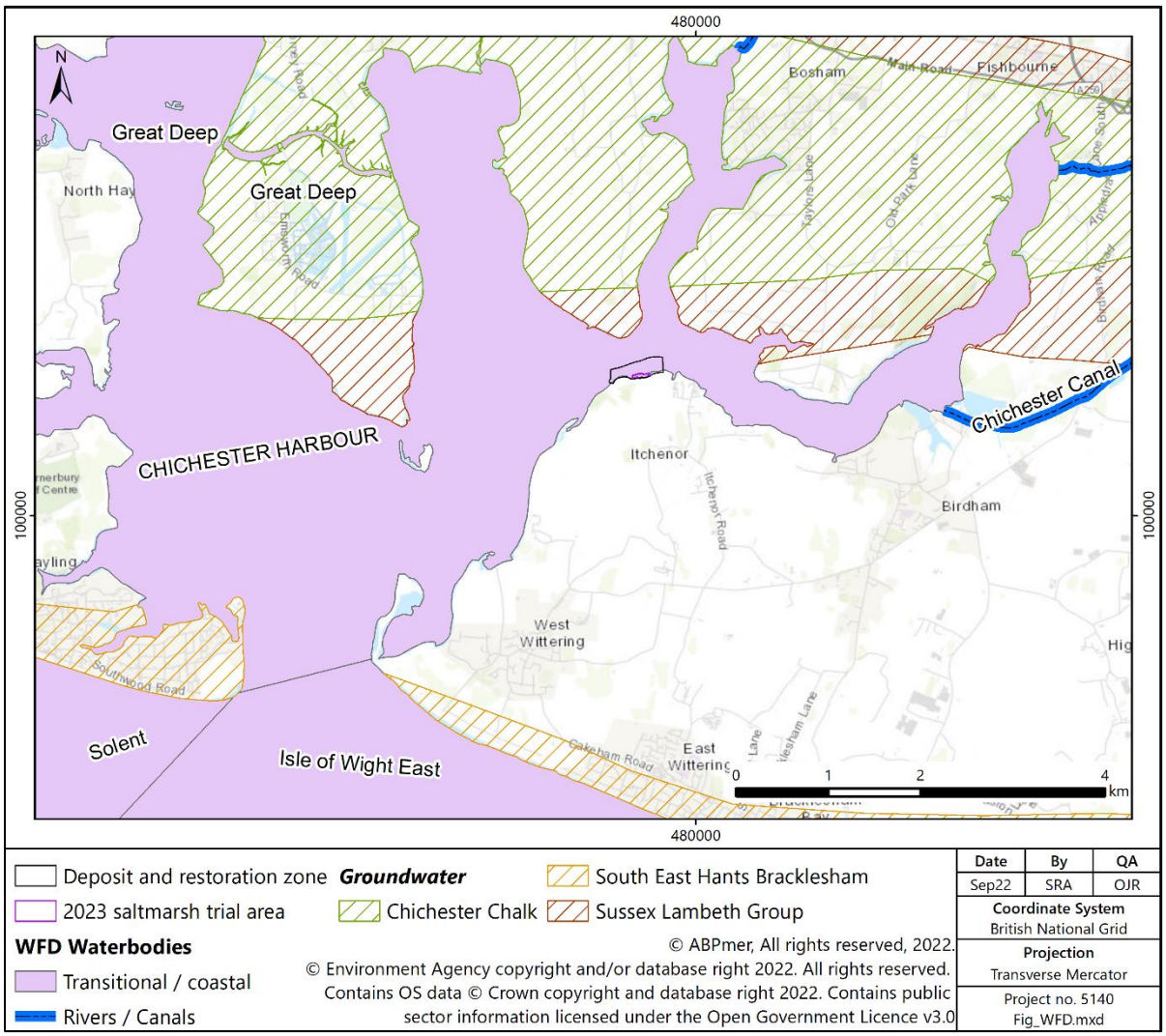


Figure B.1. Transitional and coastal water bodies in the vicinity of the proposed works

B.1.1 Project Overview

Land and Water is applying for a five-year marine licence for a combined dredge disposal and saltmarsh restoration site west of Itchenor in Chichester Harbour, where they are aiming to trial their new SRDB technique this winter.

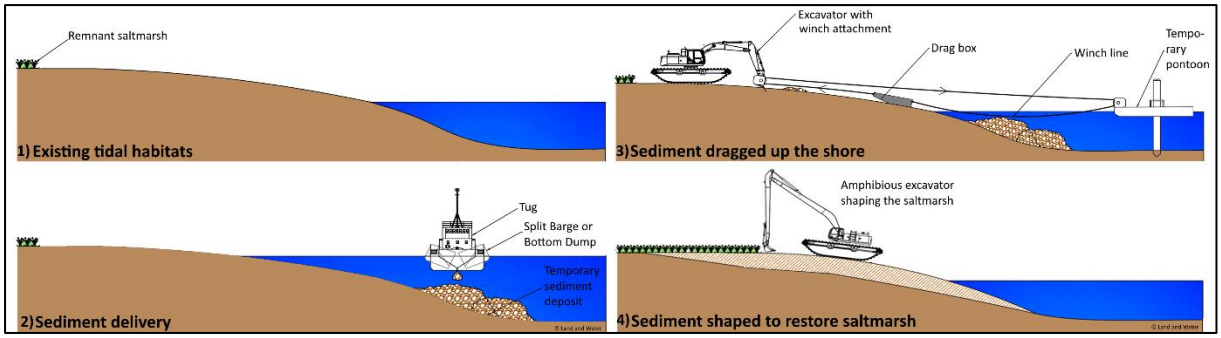
As noted in Section 2.2. of the main report, this project will involve beneficially using dredged sediment from elsewhere in Chichester Harbour to enhance and protect the harbour's eroding saltmarsh habitats at West Itchenor (see Figure 1 and 2 of main report for location and annotated aerial imagery of the site). For the first winter, it is anticipated that silt materials dredged from nearby Northney Marina, whose owners hold an existing licence to dredge and dispose of materials (albeit the latter not yet at Itchenor), are to be used at the site. Sediment sources for future winters are not yet confirmed, but all organisations wishing to dispose of materials at the site in the future would need to hold a licence to dredge and dispose of material, and would need to be added to the Itchenor licence by way of a licence variation (if not added for the initial licence).

Within the five years being applied for, up to around 3.5 ha of saltmarsh are to be restored at the site, using materials sourced from various marinas within the Harbour. However, in the first winter of 2022/23, a trial of the novel Saltmarsh Restoration Drag Box (SRDB) technique is to be undertaken, whereby up to 0.7 ha are to be restored with circa 4,500 m^3 of materials. A restoration and deposit zone has been drawn up; this is the maximum area within which sediment will be deposited, then dragged up the shore and reshaped to restore saltmarsh (more detail on this is provided below) (see Figure 2 of the main report).

Subsequent beneficial use and restoration campaigns would only take place if the trial during the first winter proved to be successful. Should the trials be successful, then annual campaigns of similar magnitude are envisaged, until around 3.5 ha have been restored at the site. Inclusive of the initial trial volumes, up to 25,0000 m^3 of materials may be required to achieve this level of restoration, with exact volumes to be confirmed once/if the initial trial has been successful (as, at present, a detailed Digital Terrain Model (DTM) has only been produced for the trial area – see Image 2 of the main report for further detail).

There have been substantial losses of saltmarsh habitat in Chichester Harbour historically, and the habitat is continuing to decline (see Sections 2.2.2 and 5.4.1 of the main report for further detail). At the same time, the marinas within the harbour are regularly dredged, and the materials mostly taken offshore, instead of being used to rebuild the marshes. There are many financial, technical, regulatory and environmental reasons why dredged sediment has not been used to 'recharge' saltmarshes in the past. However, there is now a growing impetus to find ways of resolving these challenges.

This proof of concept trial seeks to resolve these issues. The scope and aims of this project have been developed collaboratively between Land and Water, Earth Change, and ABPmer. It has also been discussed with the Chichester Harbour Conservancy (CHC), Natural England, the Environment Agency and the MMO over the course of several meetings, and during a site visit to West Itchenor on 29 March 2022. This novel approach is illustrated in Image A.1.



Source: Land and Water

Image B.14. Illustrative graphics of the SRDB restoration process

Firstly, dredged materials will be deposited by spilt hopper barges on low shore (low mudflat) areas during high tide. Once the sediment has been deposited, the SRDB (which sits on skis) will drag the recently deposited sediment from the low shore areas to higher elevation surfaces. Using the SRDB approach will mean that dredged sediment can be placed on the upper intertidal areas (i.e. fronting eroding saltmarshes), in a much firmer consistency than could be achieved by pumping and without requiring the use of pipes and costly retainment bunds. Use of this novel SRDB approach could open opportunities for beneficially using a lot more of the sediment that is dredged from UK ports and harbours every year for habitat restoration. That is because it creates a way of ensuring that the efficiency or 'productivity' of dredging and disposal operations is not hampered, while also ensuring that dredged sediment is placed at these higher elevations that need it most.

A comprehensive construction method statement for the first year trial has been provided in Section 2.2.3 of the main report. It is envisaged that the works will be undertaken in late February and March 2023, with the potential for some of the shaping taking place in April if unexpected delays are encountered (e.g. if works have to be halted during extremely cold weather periods; this is a proposed mitigation measure). Depending on tidal states and dredging schedules, it is estimated that the works will take between 3 and 4 weeks to complete. Somewhere between 15 and 20 barge loads will likely be needed in total in order to deliver the sediment, with the number depending on how fully the barges will be loaded.

B.1.2 Water Framework Directive

The WFD (2000/60/EC) came into force in 2000 and established a framework for the management and protection of Europe's water resources. It was implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2017 (the Water Framework Regulations) (as amended). The overall objective of the WFD was to achieve good status (GS) in all inland, transitional, coastal and ground waters by 2022, unless alternative objectives are set and there are appropriate reasons for time limited derogation.

The regulations divide rivers, lakes, lagoons, estuaries, coastal waters (out to one nautical mile from the low water mark), man-made docks and canals into a series of discrete surface water bodies. They set ecological as well as chemical targets (objectives) for each surface water body. For a surface water body to be at overall GS, the water body must be achieving good ecological status (GES) and good chemical status (GCS). Ecological status is measured on a scale of high, good, moderate, poor or bad, while chemical status is measured as good or fail (i.e. failing to achieve good).

Each surface water body has a hydromorphological designation that describes how modified a water body is from its natural state. Water bodies are either undesignated (i.e. natural, unchanged), designated as a heavily modified water body (HMWB) or designated as an artificial water body (AWB). HMWBs are defined as bodies of water which, as a result of physical alteration by sustainable human use activities

(such as flood protection and navigation) are substantially changed in character and cannot therefore meet GES. AWBs are artificially created through human activity. The default target for HMWBs and AWBs under the WFD is to achieve good ecological potential (GEP), a status recognising the importance of their human use while ensuring ecology is protected as far as possible.

The ecological status of surface waters is classified using information on the biological (e.g. fish, benthic invertebrates, phytoplankton, angiosperms and macroalgae), physico-chemical (e.g. dissolved oxygen and salinity) and hydromorphological (e.g. hydrological regime) quality of the body of water, as well as several specific pollutants (e.g. copper and zinc). Compliance with chemical status objectives is assessed in relation to environmental quality standards (EQS) for a specified list of 'priority' and 'priority hazardous' substances. These substances were first established by the Priority Substances Directive (PSD) (2008/105/EC) which entered into force in 2009. The PSD sets objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions.

As required by the WFD and PSD, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated PSD (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting biota EQSs for some existing and newly identified priority substances. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended), transpose the PSD into English law alongside any updates as a result of the European Union (Withdrawal Agreement) Act 2020.

In addition to surface water bodies, the WFD also incorporates groundwater water bodies. Groundwaters are assessed against different criteria compared to surface water bodies since they do not support ecological communities (i.e. it is not appropriate to consider the ecological status of a groundwater). Therefore, groundwater water bodies are classified as good or poor quantitative status in terms of their quantity (groundwater levels and flow directions) and quality (pollutant concentrations and conductivity), along with chemical (groundwater) status.

River Basin Management Plans (RBMPs) are a requirement of the WFD, setting out measures for each river basin district to maintain and improve quality in surface and groundwater water bodies where necessary. In 2009, the Environment Agency published the first cycle (2009 to 2015) of RBMPs for England and Wales, reporting the status and objectives of each individual water body. The Environment Agency subsequently published updated RBMPs for England as part of the second cycle (2015 to 2021), as well as providing interim water body classification results via the Environment Agency Catchment Data Explorer (http://environment.data.gov.uk/catchment-planning). The next RBMP stage is currently being consulted on, and this third stage of the RBMP approach to water body management intends to cover the period from 2022 to 2027

The proposed new deposit site is located in the South East River Basin District which is reported in the South East RBMP (Environment Agency, 2015).

Consideration of WFD requirements is necessary for works which have the potential to cause deterioration in ecological, quantitative and/or chemical status of a water body or to compromise improvements which might otherwise lead to a water body meeting its WFD objectives. Therefore, it is necessary to consider the potential for the ongoing maintenance dredging works to impact WFD water bodies, specifically referring to the following environmental objectives of the WFD:

- Prevent deterioration in status of all surface water bodies (Article 4.1 (a)(i));
- Protect, enhance and restore all surface water bodies with the aim of achieving good surface water status by 2015 or later assuming grounds for time limited derogation (Article 4.1 (a)(ii));

- Protect and enhance all HMWBs/AWBs, with the aim of achieving GEP and GCS by 2015 or later assuming grounds for time limited derogation (Article 4.1 (a)(iii));
- Reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances (Article 4.1 (a)(iv));
- Prevent or limit the input of pollutants into groundwater and prevent deterioration of the status of all groundwater water bodies (Article 4.1 (b)(i));
- Protect, enhance and restore all groundwater water bodies and ensure a balance between abstraction and recharge of groundwater (Article 4.1 (b)(ii));
- Ensure the achievement of objectives in other water bodies is not compromised (Article 4.8); and
- Ensure compliance with other community environmental legislation (Article 4.9).

The Environment Agency has published guidance ("Clearing the Waters for All") regarding how to assess the impact of activities in transitional and coastal waters for the WFD[17]. The guidance sets out the following three discrete stages to WFD assessments:

- **Screening**: excludes any activities that do not need to go through the scoping or impact assessment stages (Section B.2);
- **Scoping**: identifies the receptors that are potentially at risk from an activity and need impact assessment (SectionB.3); and
- **Impact Assessment**: considers the potential impacts of an activity, identifies ways to avoid or minimise impacts, and indicates if an activity may cause deterioration or jeopardise the water body achieving GS (Section B.4).

B.2 Screening

B.2.1 Potentially affected waterbodies

To determine which waterbodies would potentially be affected by the new disposal and saltmarsh restoration site and its repeat activities, all surface and groundwater water bodies located within 2 km of the project area were recorded. On this basis, the following water bodies were initially screened in:

- Chichester Harbour transitional water body (ID: GB580705210000);
- Chichester chalk groundwater water body (ID: GB40701G505200); and the
- Sussex Lambeth Group groundwater water body (ID: GB40701G505100).

Given the nature of the activities (i.e. operation of a new dredge disposal site and saltmarsh restoration works), it is considered unlikely that there would be a significant non-temporary effect on the Chichester chalk groundwater water body (ID: GB40701G505200) which lies beneath the majority of the terrestrial extent of the Thorney, Chidham, and Bosham peninsulas. This lies alongside the Sussex Lambeth Group groundwater water body (ID: GB40701G505100), which exists beneath the apexes of each peninsula; the same conclusions are reached for this water body. Therefore, groundwater water bodies have been screened out of the assessment and will not be discussed further as the new disposal site and its operation are unlikely to result in any adverse effects (e.g. saline intrusion).

Table B.1 provides a summary of water body status (based on 2019 interim classifications) for the Chichester Harbour transitional and coastal water body (ID: GB580705210000), which is the only water body which has been screened into the assessment. The Chichester Harbour water body is currently failing to achieve GS; due to a chemical status of fail, with an ecological status of moderate.

[17] https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters (Accessed June 2022).

Table B.1 Chichester Harbour transitional water body summary

Water Body Name	Chichester Harbour
Water Body ID	GB580705210000
Water Body Type	Transitional
Water Body Area	30.317 km^2
Hydromorphological Designation	HMWB
Protected Area Designations	Habitats Directive; Birds Directive; Shellfish Water Directive; Urban Waste Water Treatment Directive; Nitrates Directive
Overall Status	Moderate
Ecological Status/Potential	Moderate
Chemical Status	Fail
Parameters Not At Good Status	Dissolved inorganic nitrogen (moderate); Mitigation measures assessment (moderate or less); Mercury and its compounds (fail); Polybrominated diphenyl ethers (PBDE) (fail).
Higher Sensitivity Habitats	Intertidal seagrass (111.01 ha); Saltmarsh (332.75 ha); Subtidal seagrass (0.41 ha).
Lower Sensitivity Habitats	Intertidal soft sediments (1612.24 ha); Rocky shore (1.66 ha); Subtidal rocky reef (0.01 ha); Subtidal soft sediments (961.25 ha).
Phytoplankton Status	High
History of Harmful Algae	No

B.2.2 Protected areas

The WFD requires that activities are also in compliance with other relevant legislation, such as the Conservation of Habitats and Species Regulations 2017 (as amended), Wildlife and Countryside act 1981 (as amended), Ramsar Convention, Bathing Water Regulations 2013 (as amended), Nitrate Pollution Prevention Regulations 2015 (as amended), Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended), and the provisions of the Shellfish Water Protected Areas (England and Wales) Directions 2016 (as amended).

B.2.2.1 Nature conservation designations

The Conservation of Habitats and Species Regulations 2017 (as amended) transposed the Habitats Directive (92/43/EEC) and the Birds Directive (2009/147/EC) into English law. Article 3 of the Habitats Directive (92/43/EEC as amended) requires the establishment of a European network of important high-quality conservation sites known as Special Areas of Conservation (SAC) that will contribute to conserving habitats and species identified in Annexes I and II of the Directive. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds). In accordance with Article 4 of the Birds Directive (2009/147/EC), Special Protection Areas (SPA) are strictly protected sites classified for rare and vulnerable birds (Annex I of the Directive), and for regularly occurring migratory species. Ramsar sites are wetlands of international importance designated under the Ramsar Convention (adopted in 1971 and came into force in 1975), providing a framework for the conservation and wise use of wetlands and their resources.

As noted in Section 5.3.1 of the main report, the nature conservation interests of the Chichester Harbour and greater Solent area incorporate wading birds, saltmarsh extents and estuarine environments. The area is therefore designated with the following nature designations falling within 2 km of the proposed works:

- Chichester and Langstone Harbours SPA and Ramsar Site;
- Solent and Dorset coast SPA; and
- Solent Maritime SAC.

B.2.2.2 Bathing Waters Directive

The revised Bathing Water Directive (2006/7/EC) was adopted in 2006, updating the microbiological and physico-chemical standards set by the original Bathing Water Directive (76/160/EEC) and the process used to measure/monitor water quality at identified bathing waters.

The revised Bathing Water Directive focuses on fewer microbiological indicators, whilst setting higher standards, compared to those of the Bathing Water Directive. Bathing waters under the revised Bathing Water Directive are classified as excellent, good, sufficient, or poor according to the levels of certain types of bacteria (intestinal enterococci and Escherichia coli) in samples obtained during the bathing season (May to September).

The Bathing Water Directive was repealed at the end of 2014 and monitoring of bathing water quality has been reported against revised Bathing Water Directive indicators since 2015. The new classification system considers all samples obtained during the previous four years and, therefore, data has been collected for revised Bathing Water Directive indicators since 2012. The UK Government's target under the revised Bathing Water Directive is to achieve 'sufficient' for all bathing waters, as described under the Bathing Water Regulations 2013 (as amended) which transposes the revised Bathing Water Directive into UK law.

There are no designated bathing waters within 5 km of the proposed works, the closest bathing water is the West Wittering bathing water, which is 5.2 km to the south, outside the estuary and Chichester harbour; this currently (2022) has a designation of 'Excellent'.

B.2.2.3 Shellfish Waters Directive

The Shellfish Waters Directive (2006/113/EC) was repealed in December 2013 and subsumed within the WFD. However, the Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency (in England) to endeavour to observe a microbial standard in all 'Shellfish Water Protected Areas'. The microbial standard is 300 or fewer colony forming units of E. coli per 100 ml of shellfish flesh and intravalvular liquid. The Directions also requires the Environment Agency to assess compliance against this standard to monitor microbial pollution (75% of samples taken within any period of 12 months below the microbial standard and sampling/analysis in accordance with Directions).

There are currently no designated shellfish waters within 2 km of the proposed disposal site, however in previous years the Chichester Harbour (Thornham Channel) and Chichester Harbour (Chichester Channel) were designated within 2 km of the site. As these sites are no longer classified as shellfish production areas, they have not been considered further.

B.2.2.4 Nitrates Directive

The Nitrate Pollution Prevention Regulations 2015 (as amended) aim to reduce water pollution from agricultural sources and to prevent such pollution occurring in the future (nitrogen is one of the nutrients that can affect plant growth). Under the regulations, surface waters are identified if too much nitrogen has caused a change in plant growth which affects existing plants and animals and the use of the water body.

There are two designated Nitrate Vulnerable Zones (NVZs) within 2 km of the proposed deposit site:

- Broad Rife to Chichester Harbour Surface Water NVZ[18];
- Chichester, Langstone, and Portsmouth Harbours Eutrophic NVZ[19].

B.2.2.5 Urban Waste Water Treatment Directive (UWWTD)

The Urban Waste Water Treatment (England and Wales) Regulations 1994 (as amended) aim to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. It sets treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges. In general, the regulations require that collected waste water is treated to at least secondary treatment standards for significant discharges. Secondary treatment is a biological treatment process where bacteria are used to break down the biodegradable matter (already much reduced by primary treatment) in waste water. Sensitive areas under the regulations are water bodies affected by eutrophication due to elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients.

Chichester Harbour is a Eutrophic Sensitive Area under these Regulations.

B.2.3 Sediment Quality

There are no formal quantitative environmental quality standards (EQSs) for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority (hazardous) substances. Cefas has prepared a series of guideline Action Levels (ALs) to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Dredged material with contaminant levels between AL1 and AL2 requires further consideration before a decision can be made. The Cefas Guideline ALs should not be viewed as pass/fail thresholds. However, these guidelines provide an appropriate context for consideration of contaminant levels in sediments and are used as part of a 'weight of evidence' approach to assessing dredged material.

Sediment sampling was undertaken in July 2022; sediment samples were taken from seven locations at the site, and analysed for particle size. The particle size analysis (PSA) results are shown in Table B.2. Across all the sampling sites (see Image B.1 for locations), there was 60-80% fine sile (<63 µm) and the remainder was fine sediment in the range 2 mm to greater than 63 µm. All the sites were sandy muds with some additional coarser gravels also present at Sites 1, 2 and 7.

[18] https://environment.data.gov.uk/portalstg/sharing/rest/content/items/948e8196b5e443acb0089e1b8b3005ff/data (Accessed June 2022)

[19] https://environment.data.gov.uk/portalstg/sharing/rest/content/items/45f460c079494090a2486ab04d1605d5/data? (Accessed June 2022)

Table B.2 Particle size analysis (PSA) results from survey on 1 July 2022

Sample	Classification	Particle Size Distribution (%)		
		Gravel (>2 mm)	Sand (2 mm - >63 µm)	Silt (≤63 µm)
1	Gravelly Mud	10.5%	25.4%	64.1%
2	Slightly Gravelly Sandy Mud	0.1%	20.1%	79.9%
3	Sandy Mud	0.0%	40.8%	59.2%
4	Sandy Mud	0.0%	33.9%	66.1%
5	Sandy Mud	0.0%	41.0%	59.0%
6	Sandy Mud	0.0%	23.3%	76.7%
7	Lightly Gravelly Sandy Mud	0.1%	34.0%	65.8%

Image B.1. PSA (and benthic invertebrate) sampling locations

As noted above, the materials dredged at Northney consist of silt, and are thus considered suitable for deposit at West Itchenor. Contamination analysis undertaken on Northney Marina materials in 2011 and 2021 reveals that there was no exceedance of Action Level (AL) 2 at the site, but results were between AL1 and AL2 for some PAHs and heavy metals (specifically Arsenic, Chromium, Copper and Nickel); all exceedances are only slightly above AL1 levels. These ALs were deemed acceptable for disposal at sea, and the marina owners hold a licence to dispose at the Nab Tower until 2024. It is thus considered likely that the materials can be deposited at Itchenor as well, although the MMO and Cefas will need to confirm this in due course.

B.2.4 Water Quality

As noted above, the Chichester Harbour transitional water body (ID: GB580705210000) is a heavily modified water body (HMWB) and is currently (2019) at moderate overall status, based on moderate ecological potential and failing chemical status (Environment Agency, 2022). The biological elements, invertebrates, and macroalgae are at 'good' status; however, during all previous (RMBP cycle 2) reporting years, these two elements were set at 'moderate'. Phytoplankton has been assessed as being at 'high' status throughout the recent reporting period. Additionally, the levels of specific pollutants, arsenic, coper and zinc are considered to be at 'high' status. The moderate ecological potential is due to the physico-chemical quality element of dissolved inorganic nitrogen being classified as 'moderate'. Chemical status is failing to achieve good status due to priority hazardous substances, specifically, mercury and its compounds, and polybrominated diphenyl ethers (PBDE). However, levels of Benzo(a)pyrene, Cadmium and Its compounds, Dioxins and dioxin-like compounds, Hexabromocyclododecane (HBCDD), Hexachlorobenzene, Hexachlorobutadiene, and Perfluorooctane

sulphonate (PFOS) are classified as 'good'. Priority substances, Fluoranthene, Lead and its Compounds, and Nickel and its compounds are also classified as 'good' (Environment Agency, 2022).
A 2019 masters thesis on the Chichester Harbour responses of saltmarshes to environmental factors (Rogers, 2019) found a relationship between the localised erosion of saltmarsh in years where there were higher nitrate values in Chichester Harbour. Rogers' work furthermore determined a statistically significant relationship between higher nitrogen (nitrate) rates resulting in greater annual saltmarsh losses at a local level, when combined with other factors likely to correlate with high nitrogen such as increased wave action (as they are related to increased wind and rainfall). Though all attributes correlated to saltmarsh, wave action and nitrate levels had the strongest correlation to losses of saltmarsh, with the correlation to winter nitrate stronger than summer nitrate (however both were statistically significant).

Chichester Harbour has been identified as a catchment which is subject to nutrient neutrality strategic solutions (Natural England, 2022)[20]. Such areas have recently been identified in several English catchments; including all the catchments into the Solent and Poole Harbour (Local Government, 2022). In such nutrient advice areas, new developments in some catchments cannot proceed if they increase levels of nutrients; mitigation actions are typically required before permission is granted.

The CHC regularly monitors water quality against bathing water standards at 11 sites around the Harbour (CHC, 2022). 'Deep End' is the closest sampling point to the project site at West Itchenor. Since January 2015, samples testing for *Escherichia coli* and Enterococci has been 99.01% and 99.02% excellent (respectively) by EU bathing water standards. Samples are collected and analysed every two weeks during April to the end of October and monthly in the winter. Most of the time, Harbour waters do not appear unduly impacted from high levels of bacteria from these sources. However, after heavy rain, bacteria levels can increase. These enter the Harbour from several sources:

- Wastewater Treatment Works (WWTW). There are three wastewater treatment plants that discharge directly into the Harbour; at Apuldram, Bosham and Thornham. In addition, storm discharges from Lavant WWTW can impact the Harbour via the River Lavant, as can Southern Water activity pumping from the surcharged pipes into the River Lavant to take pressure off the wastewater system in upstream villages such as East Dean. Storm discharges from Budds Farm WWTW in Langstone Harbour are also likely to impact to some degree.
- A number of streams flow into the Harbour, many of which will pass through fields grazed by cows, sheep and horses. There will also be run-off from land around the Harbour during heavy rain. Yachtsmen and other Harbour users will also have some impact.
- Private package treatment plants and outputs from septic tanks from older properties contribute further.

B.3 Scoping

The "Clearing the Water for All" guidance provides a scoping template to record findings and consider potential risks for several key receptors, specifically:

- Hydromorphology;
- Biology (habitats);
- Biology (fish);
- Water quality;
- Protected areas; and
- Invasive non-native species (INNS).

[20] i.e. it is an area where poor water quality due to nutrient enrichment from elevated nitrogen and phosphorus levels has been identified as a primary reasons for habitats in designated sites being in unfavourable condition.

Each receptor is considered in the following sections and summarised in a table. Potential risks that have been scoped into the assessment are highlighted in red and considered within the impact assessment stage, while those scoped out of the assessment are highlighted in green.

B.3.1 Hydromorphology

Hydromorphology is the physical characteristics of estuaries and coasts, including the size, shape and structure of the water body and the flow and quantity of water and sediment. Table B.3 presents a summary of hydromorphological considerations and associated risk issues for the proposed works. As at least one hydromorphological consideration indicates that a risk could be associated with these ongoing works, this receptor has been scoped into the impact assessment (Section B.4).

Table B.3 Hydromorpholgy risk issues in the study area water bodies

Hydromorphology Considerations	Hydromorphology Risk Issue(s)
	Chichester Harbour
Consider if your activity could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status?	No (morphology status 'supports good'). Impact assessment not required.
Consider if your activity could significantly impact the hydromorphology of any water body?	Yes (possible changes to hydromorphology from sediment deposition and shaping). Requires impact assessment.
Consider if your activity is in a water body that is heavily modified for the same use as your activity?	No (reason for hydromorphological designation is 'Coastal protection' and 'Navigation, ports and harbours'). Impact assessment not required.

B.3.2 Biology (fish)

Activities occurring within an estuary could impact on normal fish behaviour such as movement, migration or spawning. Table B.4 presents a summary of biology (fish) considerations and associated risk issues for the proposed deposit site. As there are biology (fish) considerations which indicate that a risk could be associated with the proposed works, this receptor has been scoped into the assessment (see Section B.4).

Table B.4 Biology (fish) risk issues in the study area water bodies

Biology (Fish) Considerations	Biology (Fish) Risk Issue(s)
	Chichester Harbour
Consider if your activity is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary?	Yes. Guidance suggests "Continue with questions".
Consider if your activity could impact on normal fish behaviour like movement, migration or spawning (e.g. creating a physical barrier, noise, chemical change or a change in depth or flow)?	Yes. Requires impact assessment.

Consider if your activity could cause entrainment or impingement of fish?	Yes. Requires impact assessment.

B.3.3 Biology (habitats)

It is necessary to consider the impact of the physical footprint of an activity on nearby marine and coastal habitats. This specifically refers to habitats of higher sensitivity (e.g. intertidal seagrass, maerl and saltmarsh) and lower sensitivity (e.g. cobbles, gravel, shingly, intertidal soft sediments like sand and mud). Table presents a summary of biology (habitats) considerations and associated risk issues for the proposed works. As biology (habitat) considerations indicate that a risk could be associated with the proposed works, this receptor has been scoped into the assessment (see Section B.4).

Table B.5 Biology (Habitats) risk issues in the study area water bodies

Biology (Habitats) Considerations	Biology (Habitats) Risk Issue(s)
	Chichester Harbour
Is the footprint of the activity 0.5 km^2 or larger?	No (0.09 km^2 for total zone, around 0.035 km^2 on an annual basis; utilising the guidance[21], this is multiplied by 1.5 to equate to 0.14 and 0.05 respectively). Impact assessment not required..
Is the footprint of the activity 1% or more of the water body's area?	No (0.4% maximum at factor 1.5). Impact assessment not required.
Is the footprint of the activity within 500 m of any higher sensitivity habitat?	Yes (saltmarsh within <500 m of the proposed works). Requires impact assessment.
Is the footprint of the activity 1% or more of any lower sensitivity habitat?	No; whilst intertidal soft sediments (mudflats) measuring 9 ha max are within the deposit and restoration zone, this amounts to just under 0.5 % of the resource in Chichester Harbour.

B.3.4 Water quality

Consideration should be made regarding whether phytoplankton status and harmful algae could be affected by the proposed works, as well as identifying the potential risks of using, releasing or disturbing chemicals. Table B.6 presents a summary of water quality considerations and associated risk issues for maintenance dredging and disposal activities. As at least one water quality consideration indicates that a risk could be associated with these ongoing works, this receptor has been scoped into the impact assessment (Section B.4).

[21] https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters (Accessed June 2022).

Table B.6 Water quality (physical parameters) scoping summary

Water Quality Considerations	Water Quality Risk Issue(s) Chichester Harbour
Consider if your activity could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)?	Yes. Requires impact assessment.
Consider if your activity is in a water body with a phytoplankton status of moderate, poor or bad?	No (phytoplankton classification is high). Impact assessment not required.
Consider if your activity is in a water body with a history of harmful algae?	No (the is no known history of harmful algae). Impact assessment not required.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if the chemicals are on the Environmental Quality Standards Directive (EQSD) list?	Yes (potential for sediments to be disturbed during the works, and subsequently resuspended by tide). Requires impact assessment.
If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if it disturbs sediment with contaminants above Cefas Action Level 1?	
If your activity has a mixing zone (like a discharge pipeline or outfall) consider if the chemicals released are on the Environmental Quality Standards Directive (EQSD) list?	No (not applicable). Impact assessment not required.

B.3.5 Protected areas

Consideration should be made regarding whether WFD protected areas are at risk from your activity, including SACs and SPAs (European sites), as well as bathing waters, shellfish waters and nutrient sensitive areas. Table B. presents a summary of protected area considerations and associated risk issues for the proposed deposit site. As the protected areas considerations indicate that a risk could be associated with these ongoing works, this receptor has been scoped into the impact assessment (Section B.4).

Table B.7 Protected areas scoping summary

Protected Area Considerations	Protected Area Risk Issue(s) Chichester Harbour
Consider if your activity is within 2 km of any WFD protected area?	Yes (proposed works area overlaps with the Chichester Harbour SPA, Solent Maritime SAC, two NVZs and Eutrophic Sensitive Area). Requires impact assessment.

B.3.6 Invasive non-native species (INNS)

Consideration should be made regarding whether there is a risk the activity could introduce or spread INNS. Risks of introducing or spreading INNS include materials or equipment that have come from, had use in or travelled through other water bodies, as well as activities that help spread existing INNS, either within the immediate water body or other water bodies. Table B.8 presents a summary of INNS considerations and associated risk issues for the proposed disposal site. As the INNS considerations indicate that a risk could be associated with these ongoing works, this receptor has been scoped into the impact assessment (Section B.4).

Table B.8 Invasive non-native species scoping summary

INNS Considerations	INNS Risk Issue(s)
	Chichester Harbour
Consider if your activity could introduce or spread INNS?	Yes (potential for introduction or spread of INNS). Requires impact assessment.

B.4 Impact assessment

An impact assessment should be conducted for each receptor identified during the scoping stage as being at risk from an activity. The following receptors have been scoped into the impact assessment:

- Hydromorphology;
- Biology;
    - Habitats;
    - Fish;
- Water quality;
- Protected areas; and
- Invasive non-native species (INNS).

B.4.1 Hydromorphology

The material which is to be deposited will be dragged up the shore as soon as possible after the barges have departed (see Section 2.2 of the main report). New saltmarsh platforms will then be shaped on the upper shore, in areas where saltmarsh would have existed in the not too distant past. The scale of these changes is considered to be negligible and will not modify the way the tide propagates through the Harbour to the area, in terms of the shape of the tidal curve, water levels and tidal range. Changes to flows following the proposed works will also be negligible in magnitude and extent, and confined to the close proximity of the restoration area, will not result in a change in the hydrodynamic working of the Harbour (see Section 5.1.2 of the main report).

Bathymetric surveys will be undertaken immediately before and after the initial trial to ensure no noticeable volumes of material have slipped into the subtidal whilst the works were ongoing. This is considered unlikely, as the SRDB would be lowered a sufficient distance behind the deposits to ensure all of them are dragged up, and as the deposits will take place as high up the shore (as far away from the subtidal edge) as possible. Should the post-trial bathymetry survey show that noticeable changes

have occurred in the subtidal immediately adjacent to the trial area which can clearly be attributed to the trial, then Land and Water will rectify this and reinstate the pre-trial subtidal bathymetry.

Overall, the proposed works will not result in any changes in hydromorphology or associated coastal and flood protection. The proposed works are therefore not expected to lead to a deterioration of the assessed hydromorphological elements within the Chichester Harbour transitional water body, nor prevent this water body from meeting its WFD objectives.

B.4.2 Biology (habitats)

The status of the biological quality element 'Angiosperms', which includes saltmarsh, is not currently assessed for the Chichester Harbour transitional water body. Coastal saltmarsh (higher sensitivity habitat) is located along the edges of the project area (see Figure 4 of the main report). The works are to trial a saltmarsh restoration technique, and, in due course, restore up to 3.5 ha of saltmarsh in an area where this has been lost due to coastal squeeze over recent years and decades.

This new / re-established saltmarsh area will have beneficial effects on the adjacent vulnerable saltmarsh habitats and associated invertebrates by providing shelter. It will also help offset ongoing coastal squeeze losses both locally and in the rest of the Harbour. By undertaking beneficial use in the harbour, sediment is furthermore retained within the estuary system.

Overall, the proposed beneficial use disposal site and saltmarsh trial will provide a valuable contribution to offsetting or delaying ongoing natural saltmarsh habitat loss that has been recorded in and around the Solent, and in Chichester Harbour; as noted in Section 5.4.2 of the main report the impact is considered to be of an insignificant to minor beneficial nature (at a local scale).

In conclusion, the proposed works are not expected to lead to a deterioration of the assessed biological (habitat) elements within the Chichester Harbour transitional water body, nor prevent this water body from meeting its WFD objectives. They would in fact be expected to have slight beneficial impacts on the angiosperm biological quality element.

B.4.3 Biology (fish)

The status of the biological quality element 'fish' is not currently assessed for the Chichester Harbour transitional water body. The main impact pathways in which fish may be affected by the proposed beneficial use SRDB works at Itchenor relate to underwater noise and elevated suspended sediment concentrations (SSC).

Elevated noise and vibration levels could potentially disturb fish and shellfish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al.* 2015). This includes migratory species within the estuary such as Eel. The ability to detect and localise the source of a sound is of considerable biological importance to many fish species and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions.

At Itchenor, as noted in Section 5.5.2 of the main report, split hopper barges and the pontoon will be present only intermittently and the works will be short term. As the vessels and pontoon are moving, fish are not physically constrained and will be able to move away from the source of noise and return once disposal and restoration activity has ceased. Noise levels at the site, and amounts of disturbance will thus be temporary and relatively low, as will the noise-related to the winching of the SRDB. Only some of the latter will happen within the water column, with the majority of it taking place entirely in the dry above the water line. The saltmarsh shaping works will also generally take place whilst the tide is out, or in very shallow waters. Overall, underwater noise and vibration disturbance effects on fish and shellfish will be localised and temporary and is assessed as insignificant.

During the works, there is potential for increases in SSC in the local area as a result of the disposal and SRDB works. Any changes to SSC will be temporary, lasting a few hours after the disposal and drag operations. Fish within Chichester Harbour and the vicinity of the proposed works are considered to be well adapted to living in an area with variable and often high suspended sediment loads. Fish, including migratory species, feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other prey resources. Potential impacts on benthic ecology (including fish prey items) were assessed insignificant to minor adverse at a local (site) level (see Section 5.4.2), but would be expected to be negligible at Harbour scale. Furthermore, best practice pollution prevention guidelines will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the dredging process.

The change of habitat from mudflat to saltmarsh will affect a very small percentage of the Harbour's extensive mudflats, noting that saltmarsh is continually being lost at what is expected to be higher rates than mudflat (see Section 2.2.2 of the main report). It is of note that saltmarsh habitat provides an important nursery and feeding ground for juvenile fish, and thus, the restoration of saltmarsh is considered to have a slight beneficial effect in this respect.

There is a risk that fish may get entrained in the SRDB and then dragged up the shore and out of the water column. This is however considered to be very unlikely given the fact that the box will be mostly filled with mud, and also as fish are expected to move away from the box due to the movement of the machinery prior to the box moving up the shore. In the unlikely event that a fish or shellfish of noticeable size is dragged up the shore, then visual checks undertaken after each drag will identify these individuals and they will be transported back into the water column.

In conclusion, the proposed works are not expected to lead to a deterioration of the fish elements within the Chichester Harbour transitional water body, nor prevent this water body from meeting its WFD objectives.

B.4.4 Water Quality

Changes in water quality could potentially result from the sediment disposal and SRDB operations, by temporarily increasing SSC, resulting in changes to dissolved oxygen and releasing toxic contaminants bound in sediments.

There are no formal quantitative Environmental Quality Standards (EQS) for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority (hazardous) substances. Cefas has prepared a series of guideline Action Levels to assist in the assessment of dredged material (and its suitability for disposal to sea). In general, contaminant levels in dredged material below Action Level 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Dredged material with contaminant levels between AL1 and AL2 may require further consideration before a decision can be made. The Cefas Guideline Action Levels should not be viewed as pass/fail thresholds. However, these guidelines provide an appropriate context for consideration of contaminant levels in sediments and are used as part of a 'weight of evidence' approach to assessing dredged material.

As noted in Section 2.2 of the main report, the materials dredged at Northney consist of silt, and are thus considered suitable for deposit at West Itchenor. Contamination analysis undertaken on Northney Marina materials in 2011 reveals that there was no exceedance of AL2 at the site, but was between AL1 and AL2 for some PAHs and heavy metals (specifically Arsenic, Chromium, Copper and Nickel); all exceedances are only slightly above AL1 levels. These ALs were deemed acceptable for disposal at sea,

and the marina owners hold a licence to dispose at the Nab Tower until 2024. It is thus considered likely that the materials can be deposited at Itchenor as well, although the MMO and Cefas will need to confirm this in due course. It is also worth noting that the deposits are unlikely to cause a measurable change in the levels of chemical contamination in the water at or around the site given that the proposed bottom placement method of disposal is aimed at retaining as much sediment as possible at the proposed beneficial use disposal site and minimising the potential resuspension and dispersion of sediment (Section 5.1.2 of main report).

With regard to the 2019 failing levels of 'mercury and its compounds' and 'polybrominated diphenyl ethers (PBDE) in the Chichester Harbour transitional water body (Section 5.2.1), the issue extends beyond the zone of influence for potential impacts associated with disposal activities. This supports the finding that the contaminants are from other sources and, therefore, it is highly likely that dredging and disposal activities are not contributing to these failures (Binnies UK Ltd, 2021).

Accidental spillages of oil and other substances have the potential to occur during the bottom placement activities at the proposed beneficial use disposal sites. Best practice pollution prevention guidelines (Defra and Environment Agency, 2016) will be followed to minimise the risk of accidental spillages and the risk of introduction of contaminants throughout the disposal process to minimise the risk of accidental spillages and the risk of introduction of contaminants.

Overall changes to water and sediment quality as a result of the proposed works are assessed as insignificant (see above and Sections 5.2.2 and 5.5.2 of the main report). Overall, any changes in DO or SSC are expected to be localised and temporary, and are not considered to result in an effect at the WFD water body level.

There is also potential for accidental spills/leaks from plant to impact on the water quality during the proposed works. However, this will be managed through best practice to minimise the risk, such as 'Guidance for Pollution Prevention: Works and maintenance in or near water: GPP 5'[22].

It is worth noting that the restored saltmarshes, once vegetation has fully established, would be considered to be better nutrient cyclers and storers than mudflats. As noted in Section 5.2.2, saltmarshes are thought to remove almost 3 times more N and almost 8 times more P than bare mudflats.

In conclusion, the proposed works are not expected to lead to a deterioration of the assessed water quality elements within the Chichester Harbour transitional water body, nor prevent this water body from meeting its WFD objectives.

B.4.5 Protected areas

The proposed disposal site directly overlaps the Solent Maritime SAC, the Solent and Dorset Coast SPA, and the Chichester and Langstone Harbours SPA and Ramsar Site. The protected features of the Chichester and Langstone Harbours SPA and Ramsar Site are illustrated in Table B.9, whilst the designated features of the Solent Maritime SAC are illustrated in Table B.10.

[22] http://www.netregs.org.uk/media/1418/gpp-5-works-and-maintenance-in-or-near-water.pdf?utm_source=website&utm_medium=social&utm_campaign=GPP5%2027112017 (Accessed July 2021).

Table B.9. SPA and Ramsar features

Protected Area	Designated Feature	Breeding/ Non-breeding (SPA)	Passage/Wintering (Ramsar)
Chichester and Langstone Harbours SPA	Bar-tailed godwit, *Limosa lapponica*	Non-breeding	-
	Common tern, *Sterna hirundo*	Breeding	-
	Curlew, *Numenius arquata*	Non-breeding	-
	Dark-bellied Brent goose, *Branta bernicla bernicla*	Non-breeding	-
	Dunlin, *Calidris alpina alpina*	Non-breeding	-
	Grey plover, *Pluvialis squatarola*	Non-breeding	-
	Little tern, *Sterna albifrons*	Breeding	-
	Pintail, *Anas acuta*	Non-breeding	-
	Red-breasted merganser, *Mergus serrator*	Non-breeding	-
	Redshank, *Tringa totanus*	Non-breeding	-
	Ringed plover, *Charadrius hiaticula*	Non-breeding	-
	Sanderling, *Calidris alba*	Non-breeding	-
	Sandwich tern, Sterna sandvicensis	Breeding	-
	Shelduck, *Tadorna tadorna*	Non-breeding	-
	Shoveler, *Anas clypeata*	Non-breeding	-
	Teal, *Anas crecca*	Non-breeding	-
	Turnstone, *Arenaria interpres*	Non-breeding	-
	Waterbird assemblage	N/A	-
	Wigeon, *Anas penelope*	Non-breeding	-
Solent and Dorset Coast SPA	Common tern, *Sterna hirundo*	Breeding	-
	Little tern, *Sterna albifrons*	Breeding	-
	Sandwich tern, *Sterna sandvicensis*	Breeding	-
Chichester and Langstone Harbours Ramsar	Black-tailed godwit, *Limosa limosa*	-	Passage
	Dark-bellied brent goose, *Branta bernicla*	-	Wintering
	Dunlin, Calidris *alpina alpina*	-	Wintering
	Estuary	-	N/A
	Grey plover, *Pluvialis squatarola*	-	Wintering
	Redshank, *Tringa totanus*	-	Passage
	Ringed plover, *Charadrius hiaticula*	-	Passage
	Shelduck, *Tadorna tadorna*	-	Wintering
	Waterbird assemblage	-	Wintering

Table B.10 Features of the Solent Maritime SAC

Designated Feature
H1110 Sandbanks which are slightly covered by sea water all the time
H1130 Estuaries
H1140 Mudflats and sandflats not covered by seawater at low tide
H1150 Coastal lagoons
H1210 Annual vegetation of drift lines
H1220 Perennial vegetation of stony banks
H1310 Salicornia and other annuals colonising mud and sand
H1320 Spartina swards (*Spartinion maritimae*)
H1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
H2120 Shifting dunes along the shoreline with *Ammophila arenaria* ('White dunes')
S1016 Desmoulin's whorl snail, *Vertigo moulinsiana*

The habitats within the direct footprint of the proposed works are currently threatened by saltmarsh erosion at the site, with the proposed deposit site and restoration scheme restocking the saltmarsh with material from dredge arisings.

The proposed project area directly overlaps with 9.3 ha and 0.04% of the Chichester Harbour SPA and Ramsar site, and 0.02 % of the Solent Maritime SAC (though only some of this area will be affected during any given winter). The main impact pathways in which these designated sites may be affected by the proposed works are from the visual presence of machinery and vessels / disturbance, as well as habitat changes and water quality.

A HRA has been prepared and, based on the information provided, it is considered that the proposed works at Itchenor will not have an adverse effect on the integrity of the above sites, either alone or in-combination with other plans and projects (see Appendix A of the main report).

With regard to eutrophication, as noted previously, the creation of additional saltmarsh areas is considered beneficial for N and P cycling and storage.

In conclusion, the proposed works are not expected to lead to a deterioration of the assessed protected area designations within the Chichester Harbour transitional water body, nor prevent this water body from meeting its WFD objectives.

B.4.6 Invasive non-native species (INNS)

As with most activities which occur in the marine environment, there is potential risk that the proposed dredged disposal and SRDB works could result in the introduction or spread of INNS This is however reduced due to the deposited materials being local to Chichester Harbour. The SRDB vessels associated with the proposed disposal activities will not be carrying ballast water and, therefore, there is no risk that non-native invasive species will be transported via this pathway. Non-native species, however, have the potential to be transported into the local area on the hulls of the vessels if they have operated in differing water bodies.

Consequently, the probability of the introduction and spread of INNS from the proposed works is considered low and it is not expected to lead to a deterioration in status of the water body, nor prevent the water body from meeting its WFD objectives.

B.5 Conclusion

Based upon the information presented within this WFD compliance assessment, it is concluded that the proposed disposal and saltmarsh restoration site at Itchenor is not likely to have a permanent (i.e. non-temporary) effect on the status of WFD parameters that are significant at water body level. Therefore, deterioration to the current status of the Chichester Harbour transitional water body is not predicted, nor a prevention of this water body achieving future WFD status objectives.

B.6 References

Please refer to the references section of the main report (Section 8) for references to this assessment

C Lessons Learned at Similar Sites

C.1 Introduction

To date, more than 21 beneficial use projects utilising soft sediments have been undertaken, some of these have been ongoing for many years, whereas others were only recharged for one or two years. Most beneficial use projects undertaken in the UK to date remain small scale (<10,000 m^3) in comparison with what has been achieved internationally (Manning et al., 2021; ABPmer, 2022). Lessons on habitat establishment can also be learned from managed realignment sites, though these would tend to be more sheltered than beneficial use sites. Some 78 managed realignment and regulated tidal exchange schemes have to take been implemented in the UK, with three in Chichester Harbour and one nearby, at Medmerry, west of Selsey.

Below, lessons on vegetation establishment are summarised from a selection of representative sites. For information on other sites, please refer to ABPmer's Online Marine Register (OMReg): https://www.omreg.net/

C.2 Allfleet's Marsh, Wallasea Island (Essex)

At this 115 ha managed realignment scheme, a large-scale sediment recharge (550,000 m^3) was undertaken pre-breach at the back of the site to raise the land-form to create some 25 ha of saltmarsh. This was in addition to the mudflat that was created over the low-lying areas of the site without any need for land-forming

Detailed monitoring of several aspects took place for five years, including vegetation establishment over the saltmarsh recharge.

At Allfleet's Marsh, the recharge area successfully and quickly developed as a saltmarsh habitat; marsh plants rapidly colonised almost all areas of the recharge to a very high density within four years of the realignment being implemented (ABPmer, 2011) (see Image C.1). Within two to three months of the breaching, sea aster plants were also already growing throughout much of the area at the back of the recharge. It was thought that this may have reflected the fact that the walls were breached in mid-summer just before the main autumn period of dispersal of saltmarsh seeds/diaspore and therefore was ideally timed for rapid colonisation. Equally, the seeds may have been dormant within the wall build material (which was sourced on site) and thus able to respond rapidly to the changing salinity conditions introduced by the breaching.

By the time the first full survey was conducted in 2007 (15 months after the final breaching), the coverage of these species had greatly increased and around 5% of the recharge area had plant species on it. These plants were often widely distributed with a low density so that overall across the recharge there was <1% saltmarsh plant coverage one year post implementation. The main species in this first survey were again glasswort and included at least three different pioneer species.

By the second year after breaching (in 2008), samphire (Salicornia spp.) had become much more widespread along with annual sea-blite (Sueda maritima). Cord grass (Spartina anglica) was also present as occasional patches throughout the recharge area. During this second survey, an average of 6% was estimated across all survey transects.

Between the second and third years, there was further increase in the proportion of recharge area that was colonised by plants as well as a major increase in the overall plant density. In many areas, plants

were present across 100% of the transect and it was only in areas that had ponded water (as discussed further below) that plants had not yet colonised. There was 60% saltmarsh plant coverage in 2009 on average across all transects.

In 2010, this development was sustained and there was both 100% coverage (as in previous years) but also often high plant density levels (at or near 100%) in most areas. The only areas where plant coverage did not achieve this maximum were in those transects that still had discrete ponded water areas that discourage plant growth.

Image C.1 Saltmarsh development on recharge at Allfleet's Marsh (Year 1 to Year 5)

ABPmer (2011) concluded that the rapid colonisation by saltmarsh plant indicated that the habitat creation has been successful and, critically, that the elevation of the recharge was correct. This concurred with other studies which had indicated that plant colonisation on managed realignment sites is rapid where the correct elevation is achieved (Wolters et al., 2005).

Drainage was highlighted as being important and for the most part the 'gulleys' that were cut into the clay bund have allowed drainage to take place effectively. In some areas, however, they had not been cut deep or wide enough and there was some ponding of water on the recharge behind. This resulted in the marsh developing more slowly due to water logging and high salinity limiting plant growth. However, this 'ponding' was seen as a positive outcome and no management intervention was recommended in these areas. Instead, it was concluded that the ponded areas gave the habitat a natural appearance and would have ecological value in their own right for birds and invertebrates. They furthermore affected a small percentage of the restoration area.

It is of note that after four years, most of the species recorded on the marshes immediately outside the site were also represented within the site; this was with the exception of slower colonising mid to upper saltmarsh species, such as *Atripilex prostrata* (spear leaved orache), *Cochlearia anglica* (English scurvey grass), *Seriphydium maritimum* (sea wormwood), and *Triglochin maritima* (sea arrow grass).

C.3 Lymington recharges (Hampshire)

At Lymington, three soft sediment beneficial use projects have taken place to date; one of these is a bottom placement at mudflat elevations, and lessons on saltmarsh plant establishment can thus not be gained from this project (the Boiler Marsh Lymington Harbour Commissioners' (LHC) bottom placement scheme, which is still ongoing, having first started in 2012/13). Two schemes involved raising some areas to pioneer saltmarsh elevations (not higher), insights from those two schemes are summarised below.

C.3.1 Boiler Marsh Wightlink scheme

At Boiler Marsh, a recharge scheme was carried over two winters in 2012 and 2013 in the north-easterly section of this large marsh island. The site was initially prepared by installing a series of polder and hay bale fences across a decaying section of Boiler Marsh. These were designed to help retain sediment in place. The sediment was then pumped into this area over the two winter campaigns. Sediment was recharged at mudflat and pioneer saltmarsh elevations and, as such, widespread saltmarsh reestablishment was not the main aim of the scheme. Instead, its core objective was to slow the physical progression of the major channel though Boiler Marsh (which it has achieved).

The site was monitored for eight years until 2020, and a final monitoring report was prepared in December that year (ABPmer 2020a). This review concluded that the recharge mitigation site had performed well. It was found that most of the sediment deposited within the recharge area had remained in place, and that the area outside it, to the south, also had a greater volume of sediment than was present prior to the works being carried out. The quality of the habitats within and around the recharge area was enhanced relative to the baseline conditions. With regard to plant coverage, it was determined that mainly *Salicornia* spp. had established across patches of suitable elevation in the northern part of the site. When the deposited sediment was placed at this site in 2012 and 2013, it only reached an elevation that was suitable for marsh plant growth in areas close to the sediment discharge points on this north side. Elsewhere across the rest of the recharge area, marsh plants (again mainly *Salicornia*) were recorded in patches in and around the elevated clay mounds across the site

There were some modest changes in this recharge marsh coverage during 2020 (when compared to 2015). This was because there had not been widespread accretion of sediment. However, during the 2020 survey there was a slightly greater coverage of *Salicornia* in the central section of the recharge area and a denser plant cover along the northernmost fringes when compared with previous years. To illustrate this change, fixed point photographs which describe conditions at the top of the recharge area before, and in the years after, the recharge work are shown in Image C.2.

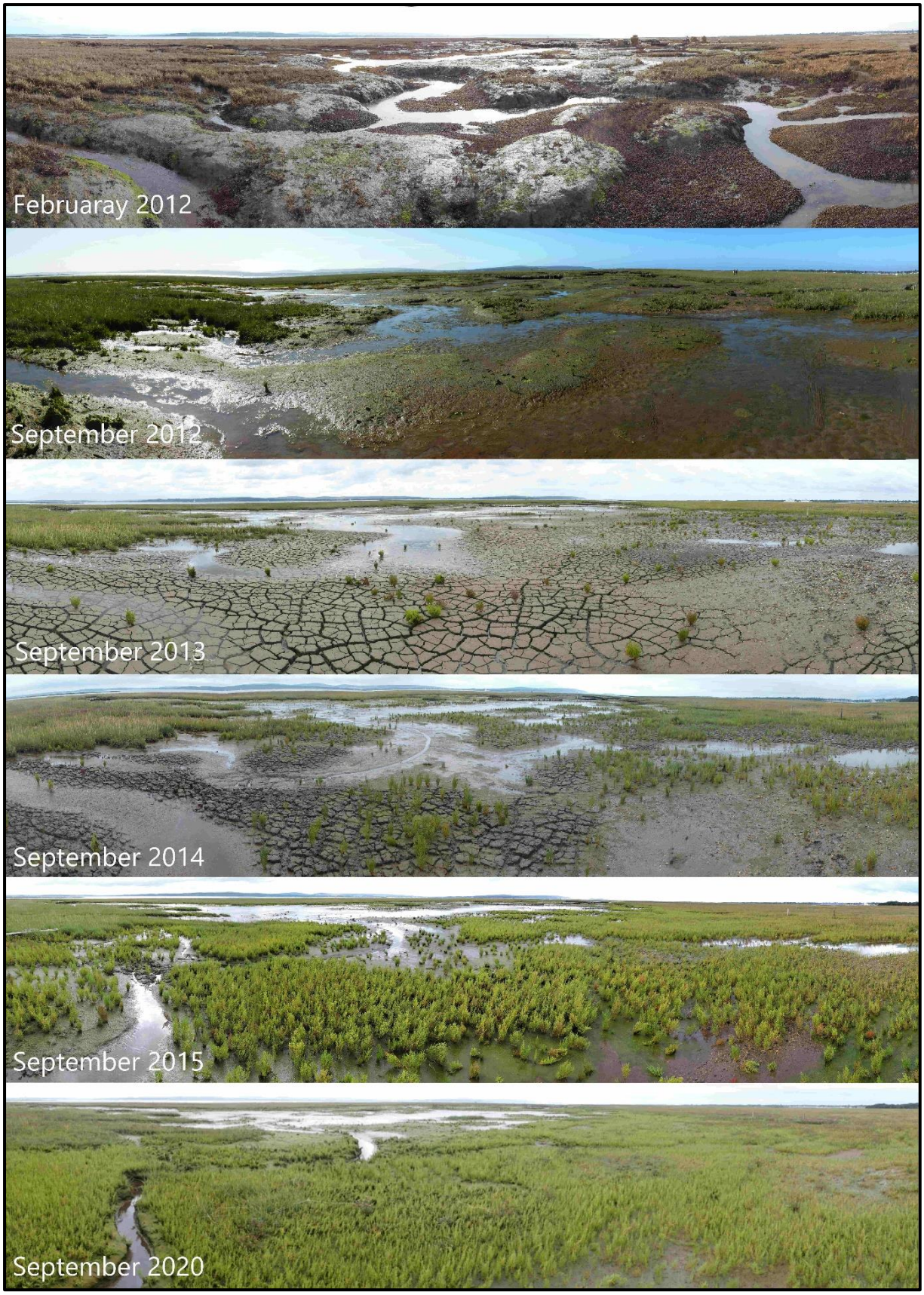


Image C.2 **View south from across parts of the Boiler Marsh recharge area, showing habitat change over time (pioneer saltmarsh elevations)**

C.3.2 Lymington Harbour Commissioners' Yacht Haven scheme

Habitat restoration on Yacht Haven marsh (see Image C.3) was undertaken as mitigation for the temporary residual significant effects of the Lymington Harbour Protection Scheme. It involved replenishing and raising 0.5 ha of intertidal mudflat using up to 2,500 wet tonnes of sediment from maintenance dredging.

Source LHC, 2013

Image C.2 Yacht Haven recharge area in August 2013

Vegetation establishment was not formally monitoired. However, Black and Veatch (2017) noted that, by August 2013 (six months after Phase II), sediment levels were between 9 cm and 19 cm higher than the pre-recharge levels. The works raised a large proportion of the recharge site to levels just high enough for saltmarsh pioneer plants to establish. In 2013, there was a covering of *Salicornia* spp. (Samphire) which had colonised much of the recharge site. To a lesser extent, *Spartina* sp. plants had started to grow. Plant colonisation was most prolific in the northern two thirds of the site, where mud levels were higher. There was also evidence of bird footprints, illustrating that the replenished habitat was ecologically functioning to the extent that birds were encouraged to the location (Black and Veatch, 2017a).

C.4 Medmerry managed realignment (West Sussex)

At this managed realignment site, saltmarshes have developed quickly over areas with a suitable elevation. Plant surveys undertaken during 2014 (one year post breach) showed that the upper intertidal areas were characterised by decaying terrestrial vegetation and mud. Two years post breach (by autumn 2015), many of these areas had already been colonised by pioneer marsh plants (such as Salicornia spp. and *Suaeda maritima*). By 2016 (Year 3), these species were covering and dominating many areas around the high tide mark (see, for example, Image C.4). While these pioneer species were found to be dominant, over the whole site, a variety of plant species were recorded. This includes 9 nationally scarce saltmarsh plants which had colonised areas of former arable field by 2016 (i.e. after 3 years).

Photos: RSPB

Image C.4 RSPB Fixed-point photograph 'Set 3' from 2014 (left) and 2016 (right)

That such a diverse range of different plant species had already established during these early stages in its development could reflect the fact that plants and dormant seed resources were already present within the site (and especially within the Site of Special Scientific Interest (SSSI) that formed part of the Medmerry footprint) prior to the construction and breaching. These pre-existing plants or seeds in the site are likely to have made a major contribution to the subsequent saltmarsh colonisation. However, it is also likely that many of the seeds were imported from external sources (either carried in on the tides, or by adhering to birds and other animals).

C.5 Depositions at Loder's Cut (Deben Estuary, Suffolk)

The Loder's Cut Island project involved using dredge arisings at a small-scale to restore a small marsh area. Sediment from Woodbridge quayside was excavated using a clam-shell bucket dredge and placed on a local area of marsh by the reverse process. In total 1,400 m^3 silt were placed over two campaigns (in 2015 and 2017). The recharge site was located alongside a small navigation channel that had been historically created (i.e. 'cut') by hand excavation in this part of the upper Deben estuary. The deposits raised a 1,369 m^2 area of marsh by around a 1 m which became a small 'island' at certain high tides. This island was quickly used by roosting birds and the deposits were relatively rapidly colonised by pioneer marsh plants. A visit in 2016 (a year after this first campaign) indicated that the placed material had remained stable and *in situ*. The upper margins of this deposited strip had a thick cover of Salicornia spp. as well as occasional Sea Aster (6-7 plants) and one Spartina plant. There were also signs of invertebrate burrows and bird feeding on the un-vegetated lower margins on the channel/cut side (ABPmer, 2020b).

Contact Us

ABPmer

Quayside Suite,
Medina Chambers
Town Quay, Southampton
SO14 2AQ

T +44 (0) 23 8071 1840
F +44 (0) 23 8071 1841
E enquiries@abpmer.co.uk

www.abpmer.co.uk