11. Marine and Coastal Ecology

Executive Summary: Chapter 11. Marine and Coastal Ecology

The following potential impacts to nature conservation features will arise either in the short-term, during capital dredging and disposal, or in the long-term, as a result of hydrodynamic and sedimentary changes brought about by the proposed channel:

1) Potential Impacts Due to Direct Removal of the Subtidal Habitat

The overall impact to marine invertebrates is considered to be insignificant given the low exposure to an already disturbed environment and the fact that the biological communities that would establish following removal would be of a similar nature to that currently existing in the channel.

The impact to UK BAP subtidal sands and gravels is considered to be insignificant at the Nab Channel and minor adverse significant at the Thorn Channel, depending on the nature of the underlying substrate that will become exposed following the dredge.

There are unlikely to be any oysters in the proposed channel dredge areas due to the existing high levels of disturbance by shipping and/or maintenance dredging, therefore, the impact is considered to be insignificant.

The impact of the removal of a very small area of UK BAP subtidal chalk is considered to be minor adverse significant, given that the underlying substrate is the same and will rapidly be recolonised by similar fauna.

2) Potential Impacts to Intertidal Due to the Predicted Effect on Hydrodynamic Processes

There will be an overall gain in intertidal habitat across Southampton Water and the Solent. Although this is a potential benefit for intertidal nature conservation features, it is of a scale that is considered to be insignificant with respect to the entire study area.

The effects of the dredge will not exacerbate the existing predicted effects of future sea level rise and although there will be a negligible offset of predicted sea level rise in Southampton Water, the impact is of such a scale as to be considered insignificant.

The impact of the negligible changes in water levels is considered to be insignificant to benthic communities as they will not be discernable from background wave variability.

3) Potential Impact Due to Predicted Effect on Sedimentary Processes

The small increase in the net sediment import into Southampton Water and, therefore, potential sedimentation over shallow subtidal and intertidal areas in Southampton Water will be of marginal benefit for maintaining mudflat levels. However, given that the changes are unlikely to be discernable from background, the impact is considered to be insignificant.

4) Potential Impacts Due to Deposition of Sediment
During dredging, the temporary impact of the small scale and transient accumulation of fine material on benthic infaunal communities is considered to be insignificant.

Given the sensitivity of shellfish and nature conservation status of oysters, the impact although temporary and short-term, will be moderate adverse significant to beds within Southampton Water and insignificant to beds outside the estuary in the Central Solent.

The exposure of eelgrass beds in the Hamble Estuary and along Calshot to Stanswood Bay to deposition during dredging will be negligible, and the impact is considered insignificant.

The temporary exposure of saltmarsh habitat to deposition during dredging will be transitory and rapidly re-eroded with the tide, and, therefore, the impact is considered insignificant.

During the disposal of arisings, the impact of deposition of material on reef and subtidal rocky habitats off the southeast coast of the Isle of Wight is considered to be insignificant to minor adverse significant.

5) Potential Impacts Arising as a Result of the Effects on Water Quality

During dredging, the impact of changes to water quality on marine invertebrate communities is considered to be insignificant to minor adverse significant.

The impact of changes to water quality during dredging is considered to be moderate adverse significant to the oyster beds in Southampton water and insignificant to minor adverse significant to beds in the Central Solent.

The negligible to low exposure of eelgrass beds to changes in suspended sediment levels during dredging is considered to be insignificant to minor adverse significant.

The impact of changes to water quality on saltmarsh is considered to be insignificant to minor adverse significant, given their low sensitivity to the predicted levels of suspended sediments and potential release of contaminants and organic material into the water column during dredging.

Reef and rocky habitats are not considered to be sensitive to the changes in water quality during disposal of arisings and, therefore, the temporary impact is considered to be insignificant.

The temporary exposure to increased nutrient levels during dredging and disposal and the potential depletion of oxygen due to the formation of algal blooms is considered insignificant.

6) Potential Impact During Future Maintenance Dredging

The change in future maintenance dredging work is expected to be small compared with existing annual variability. As a consequence, the impact on the marine and coastal ecology is considered insignificant.

7) Potential Impacts Due to Ship Wash

The overall impact from ship wash is considered to be minor beneficial significant, with respect
to potential bed and bank erosion effects and stability of shallow subtidal and intertidal habitats.

8) Potential Impacts to Indigenous Species Through Introduction of Non-Native Species

The overall number of shipping movements is not expected to increase above present levels, subject to annual fluctuations, given that the number of berths at the port is remaining the same. Furthermore, the deeper-draughted vessels arriving in the estuary are unlikely to be using any ballast water. The risk of introducing alien species in comparison to the existing situation is, therefore, negligible and the impact considered insignificant.

Mitigation

For the water quality impacts that have been assessed as being of moderate adverse significance to oysters within Southampton Water, an adaptive management strategy has been agreed with the Environment Agency as mitigation for the dredge. With the proposed mitigation measures in place, the residual effect to oysters in Southampton Water will be minor significant.

Conclusion

On the whole, the scale of impacts to marine and coastal features will be insignificant to minor adverse significant. During dredging, the impact of changes in water quality and smothering is considered to be moderate adverse significant for oysters occurring within Southampton Water and will be mitigated by the implementation of an adaptive management strategy, which will reduce the impact to acceptable levels. Following the channel dredge, the majority of impacts during operation are considered to be insignificant, with some impacts being minor beneficial significant, including a marginal reduction in the potential effects of ship wash.

Baseline Information

11.1 The broad distribution of coastal habitats in Southampton Water and the Solent is shown in Figure 11.1. The importance of these habitats for nature conservation and their designated status has been reviewed in Chapter 6 and in more detail in Appendix E. The following sections review the baseline conditions of habitats and benthic communities in the areas that could be subject potentially, to direct and indirect impacts by the proposed dredge:

- Subtidal Habitats;
- Intertidal Habitats; and
- Invertebrates.

Subtidal Habitats

*Southampton Water and the Test, Itchen and Hamble Estuaries*

11.2 The subtidal sediments of Southampton Water, the Test and Itchen Estuaries are predominantly mud and muddy sands, with patches of sandy sediments (Velegrakis, 2000). The subtidal zone outside the main navigation channel in Southampton Water and the Test Estuary supports a relatively undisturbed habitat, whilst the habitat within the navigation
channel is highly modified, being disturbed through vessel movements and/or annual maintenance dredging, depending on location. The subtidal sediment of the Hamble Estuary is mainly sand with some mud, becoming predominantly muddier in the upper reaches.

**Solent**

11.3 The subtidal habitat of the Solent is mainly composed of sands and gravels, which is a UK Biodiversity Action Plan (BAP) priority habitat. The diversity of flora and fauna living in this habitat varies according to the level of environmental stress to which they are exposed. Sandier sediments are mainly found in the central Solent, which are typically colonised by burrowing worms, crustaceans, bivalve molluscs and echinoderms. Where coarse material is present in more stable environments, epifaunal attached species are likely to include foliose algae, hydroids, bryozoans and ascidians. Shallower sandy regions are considered important nursery areas for fish and feeding grounds for seabirds. These occur at the entrances to the Langstone and Chichester Harbours, the north coast of the Isle of the Wight and the entrance to the Beaulieu River (Figure 11.1).

11.4 Commercial shellfish beds of the native oyster, *Ostrea edulis*, lie around the entrance to Southampton Water, around the approach channel in the Central Solent, and along the shallow subtidal shores of the East and West Solent (Chapter 14). Oyster communities in the Solent can include substantial populations of the non-native and invasive slipper limpet, *Crepidula fornicata* (English Nature, 2001a). Considerable quantities of dead oyster and slipper limpet shells also make up a substantial portion of the substratum around the Solent, providing attachment sites for ascidians and marine algae (English Nature, 2001a).

11.5 Sheltered muddy gravels, another UK BAP priority habitat, occur in the Solent (UK BAP website) and are mainly found in areas protected from wave action and strong tidal streams, such as within harbours and estuaries, including Langstone and Chichester Harbours. In fully marine conditions this habitat can be extremely species-rich on the lower shore because the complex nature of the substratum can support a high diversity of both infauna and epifauna. Such areas include the northeast coast of the Isle of Wight.

11.6 Subtidal eelgrass generally occurs on the more open Solent shores on shallow subtidal sand and gravel, and is uncovered only during extreme low water (LW) spring tides (Hampshire Biodiversity Partnership, 2003). Beds consisting of *Zostera marina* have been found in patches on the western Solent shore at Calshot Spit and Stanswood Bay (Hampshire Biodiversity Partnership, 2003), as well as in the entrance to the Medina and to the east, along the north coast of the Isle of Wight.

**Nab Deposit Ground and Surrounding Area**

11.7 The seabed at the Nab deposit site consists predominantly of fine sand and gravel with finer sediments, probably the ‘residue’ of deposited material. The area is situated approximately 40m below CD and is surrounded by aggregate extraction areas. The Nab has been used for many years for the disposal of dredged material without any significant reduction in depths being recorded, indicating the environment to be highly dispersive (ABP Research, 2000a). Further afield, there are a variety of subtidal habitats, including both inshore limestone and
chalk reefs, and various mixtures of sediment, from shell to gravel and rocky substrates. These habitats and their distribution are reviewed below.

11.8 The large reefs of harder limestone off the eastern coast of the Isle of Wight, namely at Bembridge and Whitecliff Bay, comprise horizontal and vertical faces, as well as crevices, which provide a range of habitats with rich and diverse faunal communities. The fauna includes a rich turf of sponges, hydroids, bryozoans and piddocks (Soberman & Foster-Smith, 1995). The bedrock is extensively bored by a number of bivalves and sponges and the holes they create provide shelter to other species. The tide-swept channels of this area are a UK BAP priority habitat.

11.9 Extensive sublittoral beds of shell from *Mytilus edulis* and *Crepidula fornicata*, and rock gravel have been recorded along the southeast coast of the Isle of Wight (Soberman & Foster-Smith, 1995). Plains of lower infralittoral to circalittoral cobble/gravel and boulder with shelly sand and silt have also been mapped off the eastern shores of the Isle of Wight, between Bembridge and Sandown. The rocks have coralline crusts, *Pomatoceros triqueter*, and a sparse faunal turf of hydroids, soft corals and bryozoans (Soberman & Foster-Smith, 1995). Further offshore, a rich and similar turf of fauna is found on cobble and gravel substrate (Soberman & Foster-Smith, 1995).

11.10 Areas of littoral and sublittoral chalk, the latter of which is a UK BAP priority habitat, occur mainly off the south-western end of South Wight. These provide a sufficiently stable substratum for long-lived, slow-growing species of axinellid sponge and soft corals, such as *Alcyonium digitatum*, whilst remaining soft enough to support burrowing piddocks, such as *Pholas dactylus* (English Nature, 2001b). These communities of fragile sponge and anthozoan communities are a UK BAP priority habitat.

**Intertidal Habitats**

*Southampton Water and the Test, Itchen and Hamble Estuaries*

11.11 The main intertidal habitats found throughout Southampton Water are mudflats and sandflats. Muddy material is predominant along the western side of Southampton Water, with localised muddy sand areas upstream of Hythe and sandy sediments on the outer part of the Fawley Power Station outfall (Wood, 2007). The eastern shore is more exposed and the prevalence of low cliffs, such as Netley Cliff, combine to introduce a sandier component to the intertidal flats between Weston and Netley, becoming muddier in the more sheltered estuaries of the Itchen and Hamble (Wood, 2007).

11.12 Saltmarsh occurs most notably along the western shore of Southampton Water and in the Hamble Estuary (Figure 11.1). Pioneer saltmarsh vegetation colonises intertidal mud and sandflats in areas protected from strong wave action and is an important precursor to the development of more stable saltmarsh vegetation. The most extensive areas of pioneer saltmarsh are found in the Hythe to Calshot Marshes, as well as in the Hamble Estuary. Cordgrass, *Spartina* spp., is another important saltmarsh precursor species, which colonises a wide range of substrates from very soft muds to shingle, in areas sheltered from strong wave action. There is a fragmented population of the North American-introduced, and UK rare, smooth cordgrass, *S. alterniflora*, at Bury Marsh, which is being lost to erosion and the invasion
of the common cordgrass, *S. anglica* (Raybould *et al.*, 2000). There is also a well-established population of the sterile hybrid, *S. x townsendii*, at Hythe, which does not appear to be receding (Raybould *et al.*, 2000). Atlantic salt meadow, *Glauco-Puccinellietalia*, develops when salt-tolerant vegetation colonises intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation occurs with decreasing frequency and duration. The vegetation varies depending on the climate and position in the tidal frame (i.e. the frequency and duration of tidal inundation). Atlantic salt meadow vegetation occurs along the western shore of Southampton Water and in the Hamble, the latter of which exhibits an unbroken saltmarsh transition to semi-natural habitats. There is a continuing trend for major losses of saltmarsh habitat in the estuary as a result of sea level rise, with 58-75% loss estimated by 2100 in the full Solent Coastal Habitat Management Plan (CHaMP) area and many areas being replaced by mudflat (Bray & Cottle, 2003).

11.13 Small oyster beds, *Ostrea edulis*, are found along the eastern shore of Southampton Water and around the entrance to the Hamble Estuary. *O. edulis* is a UK BAP species and naturally occurring oyster beds are a nationally scarce habitat (MarLIN website). The unmanaged oyster beds of the Weston and Netley Shore have become more productive in recent years, with commercial quantities of oyster being identified (Chapter 14).

11.14 Other intertidal habitats that are known to occur in Southampton water include a chenier bank, which is formed by the deposition of broken shells by wave action on the saltmarsh edge, with driftline vegetation in Hythe Marshes and stabilised shingle beaches in Weston Shore, Woolston and Hook Spit (Hampshire Biodiversity Partnership, 2003). Areas of low maritime cliff or steep coastal slopes occur along the Netley shore. Eelgrass beds also occur on the sandier sediments of the Hamble Estuary and around the outer Calshot Spit area. Eelgrass beds are a nationally rare and UK BAP priority habitat that can help to stabilise the sediment and contribute to primary productivity. They also provide an important feeding resource for overwintering waterfowl, and spawning, nursery and refuge areas for fish.

**Solent**

11.15 Intertidal mudflats cover extensive areas seaward of saltmarsh and within saltmarsh creeks in all of the estuaries of the Solent (Figure 11.1). These mudflats are host to highly abundant communities of marine polychaete worms, such as *Nereis diversicolor* and *Manayunkia aestuarina*, crustaceans, such as the amphipod, *Corophium volutator* and the marine snail, *Hydrobia ulvae*, and the green algae, *Ulva* spp. and *Enteromorpha* spp.. Intertidal sandflats, including areas of muddy sand, are also significant in the Solent, such as within Chichester and Langstone Harbours, and in patches along the northeast coast of the Isle of Wight (Figure 11.1). High numbers of a range of benthic invertebrates occur in the sandflats, including polychaete worms, such as *Arenicola marina*, bivalve molluscs, such as the common cockle, *Cerastoderma edule*, and amphipod species, such as *Bathyporeia* spp. and *Urothoe brevicornis*. Both mudflat and sandflat habitats provide a valuable roosting and resting area for overwintering and local bird populations, as well as a vital food source in the form of infaunal invertebrate communities and surface algal and plant growth. These intertidal areas are also important to fish, providing an important food source, and sheltered spawning and nursery grounds. Marine predators, such as crustaceans, also depend upon the ecological functioning of these intertidal sediments.
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11.16 The most extensive areas of pioneer saltmarsh (Salicornia spp. and Suaeda maritima) are found in Lymington and Keyhaven Marshes, Beaulieu River, the eastern regions of Chichester Harbour and Newtown Harbour, Langstone Harbour, River Yar, Medina Estuary and King’s Quay Shore on the Isle of Wight (Burd, 1989, cited in English Nature, 2001a). This habitat provides an important feeding area and food source for many species of waterfowl. The native small cordgrass, Spartina maritima, has a predominantly southern European distribution, and is rare in the UK. A large population of S. maritima is found at Newtown Harbour on the Isle of Wight and a few plants have been recorded on the northern shore of the Solent at Northney on Hayling Island (Raybould et al., 2000). S. x townsendii is considered to be scattered throughout the Solent at the landward fringe of S. anglica-dominated saltmarshes (Raybould et al., 2000). S. anglica is still common throughout the Solent even though populations have been declining since the 1930s as a result of ‘die-back’ (Raybould et al., 2000).

11.17 With respect to the mid to upper reaches of saltmarshes, the Solent has the second largest aggregation of Atlantic salt meadows in south and southwestern England, representing 33% of the marsh in this region, and almost 3% of England’s total saltmarsh resource (English Nature, 2001a). This habitat is particularly extensive from inside Hurst Spit to Lymington and Keyhaven, inside the Beaulieu River, and inside Portsmouth, Langstone and Chichester Harbours (Hampshire Biodiversity Partnership, 2003). The Atlantic salt meadows of the Solent are notable as being representative of the ungrazed type and subsequently support a range of communities dominated by sea purslane, Halimione portulacoides, common sea lavender, Limonium vulgare, and thrift, Armeria maritima, as well as Puccinellia spp. Within the Solent, this saltmarsh type provides a valuable habitat for a range of marine and terrestrial fauna and flora, including invertebrates and birds.

11.18 Natural unbroken transitions from Atlantic salt meadows to transitional and terrestrial seminatural habitats within the Solent occur on the mainland at Chichester Harbour, the Beaulieu Estuary, and on the Isle of Wight, in the Yar Estuary, Newtown Estuary, the Medina and King’s Quay Shore (English Nature, 2001a).

11.19 There is a transition from intertidal mudflats and sandflats to vegetated shingle in many areas of the Solent. These driftline habitats, also known as strandline habitats, can be found on a variety of coarse substrates, including shingle beaches, shingle spits, shingle islands and chenier banks. Annual vegetation of drift lines on these habitats supports a number of specialist plant and invertebrate species. Shingle beach vegetation can be found at Stanswood Bay and spits occur at many of the mouths of the Solent’s estuaries. Shingle islands can be found at the mouth of the Beaulieu River and in the eastern harbours of the Solent. Chenier banks can be found at the outer edges of saltmarsh banks.

11.20 A number of other, less prominent, coastal habitats can be found across the entire Solent area. These include vegetated dunes, boulder and cobble shores, intertidal reefs, saline lagoons and areas of low maritime cliff or steep coastal slopes. Vegetated dunes occur mainly on the south coast of Hayling Island, in the western Solent. Boulder and cobble shores and intertidal reefs occur along the Isle of Wight coastline, mainly on the northeastern coast at, for example, Bembridge Ledges. Saline lagoons that are protected behind shingle and sea walls occur at certain locations in the Solent, particularly in the western Solent and in the eastern Solent harbours. Low maritime cliffs and steep coastal slopes occur along parts of the western and
central Solent coast, including Stanswood Bay, Solent Breezes, Hill Head and along Lee-on-Solent.

**Invertebrates**

11.21 To investigate the benthic communities present in the study area that will be directly and indirectly affected by the channel deepening proposal, a project-specific survey was carried out between 29 October and 1 November 2007. The benthic survey and laboratory analysis methodologies are included in Appendix F. During this survey, a total of 98 Day Grab (0.1m²) samples were collected from 69 sites (Figure 11.2). In summary, 33 were from the container terminal to Dock Head, 25 from Dock Head to Fawley, 19 from the Thorn Channel, 8 from the Nab Channel and 13 from the disposal ground.

11.22 The abundance, biomass, number of species and diversity of the fauna recorded across the survey area are summarised in Table 11.1 and Figures 11.3-11.6. A wide variety of organisms were found within the benthic samples, with a total of 423 species recorded overall. The samples were numerically dominated by polychaetes, oligochaetes and crustaceans, which are typical of shallow mud and sand communities. The mean number of species in each sample was approximately 31, with a mean population density of 707 individuals per 0.1m² and mean (wet weight) biomass of 42g per 0.1m². The majority of the replicates had a high within-sample variability, indicating a high level of inter-site variability and heterogeneity of the seabed fauna, which has previously been found in the estuary by Wood (2007).

11.23 A maximum number of 7914 individuals per 0.1m² were recorded at Site 22A, located on the intertidal sediments at Dock Head. This sample was mainly composed of nematodes and oligochaetes. The highest biomass of 802g per 0.1m² was found at Site 50A, located in the Central Solent, to the east of the Thorn Channel. The majority of this biomass comprised the slipper limpet *Crepidula fornicata*, with a total of 162 individuals found at this site. In general, the highly abundant samples had a lower community biomass as they were composed of smaller-sized organisms, such as nematodes. In contrast, the high biomass samples generally comprised fewer but larger-sized organisms, which can be indicative of more stable systems.

11.24 The invertebrate diversity was very low across the areas sampled in Southampton Water and the Solent. The least diverse samples were from the container terminal to Dock Head area and the Nab Deposit Ground. On average, the most diverse samples recorded were from Thorn Channel area, with a mean Shannon Weiner Diversity Index of 2.7, which is a very low diversity value. This diversity index, however, only provides an indication of relative diversity, with higher numbers indicating higher diversity and a potentially less disturbed community. The invertebrate abundance and diversity in the main channel and its margins were very low as would be expected. Only nematodes, oligochaetes and a few species of polychaetes, were found directly in the channel. Either side of the main channel, abundance was sometimes higher in the shallow subtidal and even higher in the intertidal. However, species diversity for the most part continued to be low. The highly abundant samples were largely typified by nematodes and oligochaetes *Tubificoides* spp., with lower numbers of polychaetes e.g. *Chaetozone gibber* and *Melinna palmata* and the bivalve mollusc *Corbula gibba*. The dominant presence of *Tubificoides* spp. reflects a degree of bed disturbance since it is often encountered in relatively large densities in disturbed habitats.
11.25 Other animals found in relatively large numbers in Southampton Water and the Thorn Channel were the bivalve molluscs *Abra nitida* and *Nucula nitidosa* and the American slipper limpet *Crepidula fornicata*, which was found along the northeastern half of the estuary, tending to increase in numbers towards the mouth and out in the Solent, and contributing significantly to the overall biomass. The relatively large number of taxa in some of the samples may be attributable to the heterogeneity of the sediment. The presence of *C. fornicata*, for example, attests to the presence of coarse sediment within the samples, since this species prefers a stable substratum on which to settle and grow.

11.26 Multivariate analysis was undertaken on the biological data in order to describe the infaunal community composition and its variability within the survey area. The methods and more detailed results of this analysis are included in Appendix G. Seven community assemblages are identified and the distribution between samples is shown in Figure 11.7. The majority of the samples from Southampton Water and the Thorn are statistically more similar in terms of community composition and were grouped together in the same assemblage (Assemblage g). There was no discernable difference in the communities comprising intertidal, shallow subtidal or subtidal habitats, in different parts of Southampton Water. The other assemblages represent the more variable benthic community at the fully marine and mixed sediment sites in the Nab channel and Nab Deposit Ground (Assemblages a-f).

| Table 11.1 Summary of average invertebrate community characteristics October/November 2007 |
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|
| **Location**                      | **Abundance**   | **Biomass**     | **Species**     | **Shannon Diversity** |
|                                  | **per 0.1m²**   | **(g per 0.1m²)** | **per 0.1m²**   | **Index**        |
| Subtidal (channel)               | 397             | 7 (<0.5-46)     | 23 (4-78)       | 1.93 (1.04-3.41) |
| Shallow subtidal (proposed widening) | 559             | 70 (1-639)      | 27 (2-60)       | 2.01 (0.69-2.86) |
| Subtidal (berth pockets)         | 195             | 2 (1-4)         | 12 (8-16)       | 1.79 (1.27-2.18) |
| Shallow subtidal                 | 948             | 82 (1-802)      | 36 (7-91)       | 2.29 (1.07-3.69) |
| Intertidal                       | 1558            | 27 (0.5-169)    | 58 (23-96)      | 2.71 (1.43-3.43) |
| Subtidal                         | 50              | 1 (<0.5-4)      | 14 (1-40)       | 1.91 (0-3.33)    |
| Subtidal (disposal ground)       | 54              | 14 (<0.5-41)    | 15 (8-25)       | 1.91 (1.58-2.15) |

Minimum to maximum are provided in brackets

(Source: Appendix G)

**Long-Term Trends**

11.27 Over the last decade or so, benthic surveys that have been undertaken in Southampton Water include a survey of subtidal sediments in 1994, prior to the last channel deepening in 1996/7 (ABP Research, 1995) and a number of intertidal surveys along the Southampton Water foreshores in 1997/98 (EPR, 1998a,b; 1999) and 2003 (Wood, 2007).
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11.28 The most widespread subtidal assemblage identified during the 1994 survey was impoverished and characterized by the polychaetes *Nephtys hombergii* and *Nephtys cirrosa*, and the common cockle *Cerastoderma edule*, occurring mainly on the eastern shore of Southampton Water and in the area between the container terminal and Dock Head. As with the present survey, abundance and diversity in the main channel between Fawley and the Docks was found to be low. Only oligochaetes, a few species of polychaetes, the cockle and the sand gaper *Mya arenaria* were found directly in the channel. Abundance increased on either side of the channel, although species diversity for the most part continued to be low. Diversity also remained low above Dock Head with animal communities being dominated by *Nereis diversicolor*, the oligochaete *Tubificoides benedii* and the amphipod *Melinna palmata*.

11.29 The intertidal surveys undertaken in 1997/98 found high numbers of taxa that thrive in organically enriched sediments at Bury as a result of the sewage discharge located there. These included high numbers of *Hydrobia ulvae*, *Tubificoides pseudogaster*, *T. benedii* and *Nereis diversicolor*. The littoral and shallow sublittoral surveys at Dibden found a relatively high diversity of organisms, with the greatest number of individuals accounted for by small oligochaetes and polychaete worms. The high densities of tubificid oligochaetes suggested high organic content of sediments, particularly in the northern end of the area. The assemblage inhabiting the littoral sediments of Weston was very similar to that at Dibden. The intertidal benthic community at Hythe were found to be very stable, with a low number of taxa tolerant of organic enrichment, characterised by *T. pseudogaster* and *T. benedii*, as well as *Nereis diversicolor*.

11.30 The detailed intertidal benthic surveys undertaken in 2003 found that the most abundant taxa were again the polychaete *N. diversicolor*, the crustacean *Corophium volutator*, and the molluscs *C. edule* and *H. ulvae*. This study found that surface grain size had the greatest influence on the nature of the benthic assemblage present on the seabed. The muddy habitat patches along the western shore of Southampton Water and in the Test, Itchen and Hamble Estuaries were defined by the presence of *Hydrobiidae*, *Nereidae*, *Scrobiculariidae*, and *Tellinidae*, all of which are found commonly in soft substrata and often in black-muddy sand under brackish conditions (Hayward & Ryland, 2000). The mixed muddy sand habitat patch between Marchwood and Hythe was defined by the presence of *Cardiidae*, which are associated with sandy mud, sand, or fine gravel (Hayward & Ryland, 2000). The sandy habitat patch along the eastern shore of Southampton Water was defined by the presence of *Terebellidae*, which prefer sandy beaches and muddy sand (Hayward & Ryland, 2000).

11.31 The species that have consistently been found to dominate the subtidal sediments in Southampton Water over the past decade are *Nephtys hombergii* and *Melinna palmuta*. *N. hombergii* is a polychaete that lives infaunally in muddy sand in the intertidal and shallow sublittoral. It may also be found amongst gravel, rocks, and occasionally in *Zostera* beds. This species has a moderate to high tolerance, high recoverability rates and low sensitivity to a range of physicochemical disturbances (MarLIN website). The polychaete *M. palmata* inhabits muddy sediments of infralittoral temperate waters and is a species that can rapidly recolonise an area after dredging (Guillou & Hily, 1983). Both these species, therefore, reflect the already disturbed nature of the channel environment in Southampton Water.
Impact Assessment

Key Impact Pathways

11.32 The potential for impact to marine and coastal ecological features arises from the direct and indirect effects to subtidal and intertidal habitat during the construction and operational phases of the development.

11.33 The key impact pathways for both direct and indirect changes during construction and after completion of the works (operational phase) are addressed in the following sections:

- Potential Impact Due to Direct Removal of the Subtidal Habitat;
- Potential Impact on Intertidal Habitat Due to the Predicted Effect on Hydrodynamic Processes;
- Potential Impact Due to Predicted Effect of Sedimentary Processes;
- Potential Impact Due to Deposition of Sediment;
- Potential Impact Arising as a Result of the Effects to Water Quality;
- Potential Impacts During Future Maintenance Dredging;
- Potential Impacts Due to Ship Wash; and
- Potential Impacts to Indigenous Species Through Introduction of Non-Native Species.

11.34 The marine and coastal ecology impact assessment has been undertaken based on the results of the hydrodynamic and sediment modelling (Appendix C), the physical processes impact assessment (Chapter 8), and the water and sediment quality impact assessment (Chapters 9 and 10), in the context of the statutory and non-statutory designations in the study area (Chapter 6 and Appendix E) and the previous review of the baseline environment. The subsequent impacts on fish, birds and commercial fisheries are covered in Chapters 12, 13 and 14 respectively.

Potential Impact Due to Direct Removal of the Subtidal Habitat

11.35 The proposed capital dredge involves the physical removal of bed sediments causing a modification of subtidal habitats. The fauna associated with the material that is removed by the dredging process may be damaged, killed, or relocated to the deposit ground, where the habitat at that location will also be modified.

11.36 The approach channel dredging work will be undertaken over an area of around 740ha of subtidal habitat, comprising 130ha in the Test Estuary, 230ha in Southampton Water, 240ha in the Thorn Channel and 140ha in the Nab Channel. Most of the proposed dredge area will be within the existing approach channel, although there will be some widening of the channel in three key areas in Southampton Water, comprising approximately 80ha of currently undredged seabed. The majority of the proposed dredge area is, therefore, within the footprint of the existing navigational channel, which is subject to a regular maintenance dredging programme undertaken twice a year.
Invertebrates

11.37 The faunal assemblages present within the existing channel are mainly characterised by species that can colonise mobile sedimentary habitat and are able to respond rapidly to disturbance from regular maintenance dredging. These include a range of polychaetes (e.g. *Nepthys hombergii*) and oligochaetes (*Tubificoides* spp.), as well as nematodes. These disturbance-tolerant species can occur in high numbers and are capable of rapidly recolonising disturbed habitats, many within a few weeks following the disturbance event (MarLIN website). A review of dredging works in coastal areas world-wide showed that recovery of benthic communities following dredging in soft sediment habitats generally occurred within a year (Newell *et al.*, 1998). Although the proposed widening areas would remove virgin material that has never been dredged before, these channel margins are still dynamic environments, subject to relatively high levels of disturbance from deposition and water quality impacts as a result of maintenance dredging works and the commercial use of the estuary. The assemblages present are, therefore, not considered particularly sensitive and would still be capable of rapid recovery. Given the low sensitivity and indirect importance of the marine worms to features of nature conservation (e.g. waterbirds and fish) that compose the majority of the benthic assemblage, as well as the fact that the exposure to the direct impact will be low, the impact can be considered to be insignificant.

11.38 The geotechnical investigation indicates that following the Southampton Approach Channel Dredge an area of seabed material will become exposed in the proposed widening area between Dock Head and Fawley that will be different to the existing nature of the seabed, which is currently predominantly alluvium and some gravels. The underlying habitat that will become exposed following the dredge will mainly be stiff sandy clay and also gravelly habitat, both of which already occur at the base of the existing main navigation channel in Southampton Water. This area of habitat is, therefore, likely to be colonised by similar species that currently inhabit the channel sediments e.g. *Nepthys hombergii* and *Tubificoides* spp. The sediment at the Thorn Channel is also expected to change following the dredge, with around half of the existing sandy gravel bed being removed by the dredge and exposing underlying layers of stiff sandy clay, which is similar to the habitat in the navigation channel in Southampton Water and is, therefore, likely to be colonised by a similar community following the dredge. The sediment at the Nab Channel and the non-widening areas of Southampton Water are not expected to expose substrate of different nature and, therefore, no impact is predicted. Given that the biological communities that would establish in the widening areas of Southampton Water and the Thorn Channel would be of a similar nature to those currently existing in the channel, the overall impact to benthic communities is considered to be insignificant.

Subtidal Sands and Gravels

11.39 The deepening and widening areas of the navigation channel lie outside the boundaries of all the designated sites and, therefore, these sites will not be directly affected by this proposal (Chapter 6). However, there are areas of the channel proposed for dredging that are subject to non-statutory management and protection under the UK Biodiversity Action Plan (Appendix E). These include the priority BAP habitat, sublittoral sands and gravels (revised name: subtidal sands and gravels), which occur in the Thorn and Nab Channel. The existing action plan’s objectives and targets for this habitat are to protect the extent and quality of a representative range of sublittoral sand and gravel habitats and communities. Sand and gravel habitats such
as those that are exposed to strong tidal currents or wave action have low diversity and are inhabited by robust, errant fauna specific to the habitat, such as the ascidian, *Dendrodoa grossularia*, that can rapidly recolonise, and mobile predatory species that can actively avoid the disturbance (UK BAP website). Although there is a high probability of change given that the existing habitat will be permanently removed, as mentioned earlier, the underlying sediment type at the Nab Channel is of a similar nature and, therefore the magnitude of the impact is considered to be small and the overall exposure to change will be low. Given the low sensitivity and high recoverability of the characterising fauna, the impact to UK BAP subtidal sands and gravels is considered to be **insignificant** at the Nab Channel.

11.40 At the Thorn Channel, around half of the subtidal habitat that will become exposed following the deepening will be the same as at present and half will be composed of stiff sandy clays, similar to that which is found presently in the navigation channel within Southampton Water. The magnitude of the impact at the Thorn Channel is, therefore, considered to be medium and the exposure to change will be medium. The resulting impact at the Thorn Channel is considered to be **minor adverse significant**, with around half the area dredged becoming re-colonised by a community similar to that present in the navigation channel within Southampton Water.

**Shellfish**

11.41 No oysters or clams were recorded in the detailed benthic survey that was undertaken as part of this assessment and therefore, if there are any within the dredged areas, they are likely to be isolated individuals. The high levels of shipping disturbance in the channel and along its margins, coupled with the effects of ongoing maintenance dredging, will make it unlikely for oysters to be able to settle and colonise successfully. Given that the likely exposure to any direct removal of shellfish, including the native oyster UK BAP species, will be negligible, the impact is considered to be **insignificant**.

**Subtidal Chalk**

11.42 At the entrance to the Nab Channel, a very small area of subtidal chalk (0.6ha), which is a UK BAP habitat, is to be removed as part of the proposal. Although the dredge will permanently remove this small area of habitat and associated fauna, such as the tube-building worm *Polydora ciliata*, the remaining chalk habitat will recover rapidly (MarLIN website). Considering the low sensitivity of subtidal chalk to substratum loss and their high importance for nature conservation, the impact of the direct removal of the chalk high spot will be **minor adverse significant**.

**Potential Impact to Intertidal Habitat Due to the Predicted Effect on Hydrodynamic Processes**

11.43 The results of the hydrodynamic modelling studies have shown that the proposed channel will cause very small (millimetric) changes to water levels in Southampton Water and the Solent (Paras 8.95 to 8.107). The levels of calibration achieved by the numerical models that were developed for this assessment have demonstrated a high degree of confidence (Appendix C). The regional (Solent) and local (Southampton) models have predicted similar trends and magnitudes of changes in water levels where they overlap in extent, thus providing further confidence in their predictions. These changes, predominantly occurring around LW, will result
in a marginal reduction in tidal range in Southampton Water, upstream of Cadland, and a slight increase in tidal range in the Solent. The changes in designated intertidal habitat area in Southampton Water and the Solent have been calculated down to mean low water springs (MLWS) and are presented in Table 11.2. The areas of habitat change based on the distribution of marine and coastal habitats are included in Table 11.3.

Table 11.2 Potential net losses and gains in designated intertidal habitat as a result of the proposed dredge

<table>
<thead>
<tr>
<th>International Designations Affected</th>
<th>Net Change in Intertidal (+ Gain/ - Loss) (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southampton Water</td>
</tr>
<tr>
<td>Solent and Southampton Water SPA</td>
<td>- 2.0</td>
</tr>
<tr>
<td>Solent and Southampton Water Ramsar</td>
<td>- 2.0</td>
</tr>
<tr>
<td>Solent Maritime SAC</td>
<td>- 0.3</td>
</tr>
<tr>
<td>Chichester and Langstone Harbours SPA</td>
<td>-</td>
</tr>
<tr>
<td>Chichester and Langstone Harbours Ramsar</td>
<td>-</td>
</tr>
<tr>
<td>Portsmouth Harbour SPA</td>
<td>-</td>
</tr>
<tr>
<td>Portsmouth Harbour Ramsar</td>
<td>-</td>
</tr>
<tr>
<td>Total Designated Intertidal</td>
<td>- 2.1</td>
</tr>
<tr>
<td>Total Intertidal</td>
<td>- 2.3</td>
</tr>
</tbody>
</table>

Table 11.3 Potential net losses and gains in intertidal habitat as a result of the proposed dredge

<table>
<thead>
<tr>
<th>Intertidal Habitat Type</th>
<th>Net Change in Intertidal (+ Gain/ - Loss) (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southampton Water</td>
</tr>
<tr>
<td>Mudflat</td>
<td>- 2.6</td>
</tr>
<tr>
<td>Saltmarsh</td>
<td>+ 0.2</td>
</tr>
<tr>
<td>Sandflat</td>
<td>-</td>
</tr>
<tr>
<td>Total Intertidal</td>
<td>- 2.3</td>
</tr>
</tbody>
</table>

11.44 The decrease in tidal range in Southampton Water would have the effect of marginally decreasing the area of exposed intertidal and increasing the area of permanently submerged shallow subtidal habitat. These water level changes equate to an overall net loss of 2.3ha of intertidal habitat on spring tides, 2.1ha of which comprises internationally designated habitat down to MLWS. The majority of this loss occurs between Dock Head and Fawley, and is mudflat habitat that is of high nature conservation importance to overwintering and passage waterbirds, particularly on the western side of the estuary (Chapter 13). The area of existing mudflat habitat in Southampton Water and its sub-estuaries was estimated to be 1020ha in 2001 (Bray and Cottle, 2003). The predicted net loss from the channel dredge, therefore, comprises around 0.2% of this total mudflat resource in the estuary. The indirect loss of internationally designated habitat comprises 2.0ha (0.04%) of the Solent and Southampton Water SPA/Ramsar and 0.3ha (0.003%) of the Solent Maritime SAC.

11.45 The change in the pattern of inundation and exposure over the intertidal was calculated for a range of tides (i.e. including more extreme tides than MLWS). The proposed channel will result in an overall slight reduction in exposure of intertidal over a tidal cycle (up to 25 minute
reduction over a 15 day period), largely due to a reduction in exposure of mudflat at the mid tide elevation level (around -0.8m ODN). There will also be an increase in the exposure of lower intertidal mudflat (around 15 minutes over a 15 day period) in the mid to upper estuary, and no measurable change in the exposure of saltmarsh. The exposure of intertidal habitats in Southampton Water to a change in tidal range is considered to be low to negligible, given that the change will be permanent (i.e. high probability of occurrence) but the magnitude will be low to negligible. Although, the sensitivity of the existing mudflat environment to the change in emergence regime is considered to be very low (MarLIN website), the importance of the existing habitat features is high for nature conservation. In view of these considerations, the changes to intertidal mudflat habitat brought about by the hydrodynamic effects of the proposed channel are expected to be of insignificant to minor adverse significant in Southampton Water.

11.46 In the Solent, the marginal increase in tidal range will increase the area of tidally exposed habitat, resulting in overall net gain of 3.8ha of intertidal habitat on spring tides, 3.3ha of which is internationally designated down to MLWS. The majority of this gain is intertidal sandflat (2.9ha) and mudflat (0.8ha), as well as a small area of saltmarsh (0.2ha) (Table 11.3). The greatest areas of mudflat would be gained in the Central Solent, approaches to Southampton Water, West Solent in the area of Lymington, Newtown and Keyhaven, and around Wootton on the northeast coast of the Isle of Wight. Intertidal sandflat would be further exposed in the West Solent in the area of Beaulieu and Lepe, and in patches on the north coast of the Isle of Wight, and outside the entrances of the Langstone and Chichester Harbours. The potential gain in area of intertidal mudflat and sandflat habitat in the Solent brought about by the hydrodynamic effects of the proposed channel is expected to be insignificant to minor beneficial significant.

11.47 Taking account of the net loss of intertidal habitat in Southampton Water and net gain in intertidal in the Solent, there is an overall net gain in intertidal habitat of 1.5ha, of which 1.3ha would be adjacent to internationally designated sites. The quality of the intertidal mudflat habitat that would be gained is likely to be similar to that which would be lost in Southampton Water and, therefore, there will be an offset of the loss caused. There will also be a further gain of intertidal sandflat and mixed sediment habitat in patches around the East and West Solent. The overall gain in intertidal habitat in Southampton water and the Solent will be of potential benefit for intertidal nature conservation features, but given its relatively small scale, the impact is considered to be insignificant.

11.48 Although the reduction in intertidal area in Southampton Water is a one-off event, which would fully manifest itself on completion of the capital dredging, it can be considered as semi-permanent given that over the long-term this area of intertidal loss will reduce with future sea level rise (Chapter 8). In other words, the effects of the dredge will not aggravate the existing effects of future sea level rise. Furthermore, the marginal reduction in the predicted mean HW levels within Southampton Water would be equivalent to offsetting between ¼ to ¾ of a year of predicted sea level rise, according to regional net sea level rise allowances advised by Defra (2006). Given that the impact of changes in water levels to intertidal habitats will reduce over the long-term and offset some of the current losses due to sea level rise, the overall impact of the dredge with sea level rise is considered to be insignificant.
The changes to the hydrodynamic regime brought about by the proposed dredge will result in slight modifications to the intertidal margins. The loss of intertidal habitat in Southampton Water will result in a small increase in shallow subtidal mudflat habitat (2.6ha), i.e. a small gain in the capacity of the estuary, and to a far lesser extent, a gain in lower transitional (terrestrial) habitat above the upper saltmarsh communities (0.2ha). The gain in intertidal habitat in the Solent will result in a small decrease in shallow subtidal sandflat (2.9ha) and mudflat (0.8ha). The consequences of such a change on the benthic communities are nevertheless minor given that there is no clear demarcation in community type between the very low intertidal zone and the shallow subtidal area, and the habitat is already tolerant to changes in emergence regime. Furthermore, the changes are so marginal (millimetric) that they would not be discernable from natural variability. The impact of these changes in water levels will, therefore, be insignificant to the benthic communities in Southampton Water and the Solent.

**Potential Impact Due to Predicted Effect of Sedimentary Processes**

In the long-term, the proposed channel dredge is predicted to slightly change the tidal propagation, particularly within Southampton Water. This will marginally change the pattern and timing of the water levels, and flood and ebb flows. In turn, this will create an additional natural net import of about 1.5% of sediment (Chapter 8). Over the shallow subtidal and intertidal areas to the east and west of the main navigation channel between Dock Head and Fawley, potential sedimentation will increase by a rate of about 0.01 m/year. Although this minimal increase in potential sedimentation could be considered of minor benefit for maintaining mudflat levels, the changes will be transient throughout tides in most areas. Furthermore, as happens at present, this material is unlikely to accumulate on the mudflats and will be redistributed by disturbance from natural and anthropogenic waves. None of these changes are likely to be discernable from natural variability and, therefore, the impact to marine and coastal ecology will be insignificant.

**Potential Impact Due to Deposition of Sediment**

**During Capital Dredging**

During dredging, the subtidal/intertidal system will be subject to short-term periods of small depths (mostly millimetric) of increased depositions. These will vary in time and space depending on tidal state, range of tide, location of dredging and material type, lasting for a few minutes up to several days. Most of this material will be re-eroded over the period of the dredging, therefore, these periods of deposition will be transient and any material remaining will be re-worked by long-term processes. The scale of these short-term effects has been discussed in detail in Chapter 8.

Any chemical or microbiological contaminants associated with the sediments being removed during dredging may be dispersed, redistributed and deposited elsewhere in the estuary. The exposure to changes in chemical or microbiological quality of sediment has been assessed as being insignificant (Chapter 9) and, therefore, the impact to intertidal and subtidal habitats during dredging is considered to be insignificant.
Invertebrates

11.53 Dredging and the associated dispersion and deposition of sediment has the potential to smother benthic fauna if individuals are unable to migrate through any deposited sediment and their feeding and respiration apparatus becomes clogged (Elliott et al., 1998). Infaunal communities within intertidal and subtidal estuarine environments 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). Intertidal and subtidal habitats are, therefore, characterised by such perturbations and the biological communities of these environments are adapted to survival under fluctuating conditions. Although the deposition of fine material due to dredging represents a potential anthropogenic influence on benthic infaunal communities, the magnitude of the deposition that is predicted is generally within that which may be expected under natural conditions. Furthermore, the nature of the material that would settle on the surrounding intertidal areas is similar to that which already forms most of the intertidal areas within the estuary (i.e. mainly muds). Therefore, the impact of the predicted accumulation of fine material during dredging on benthic infaunal communities is considered to be insignificant.

11.54 Although a greater deposition is predicted in the immediate vicinity of the dredging activity, the overriding impact on the benthic community due to the works arises due to the physical removal of the benthic community by dredging. Any deposition would be temporary and occur at slack water. As tidal currents increase, dispersion of this material would occur. Therefore, the impact of deposition of fine material is considered to be insignificant.

Shellfish

11.55 There is a potential for material to deposit on the main shellfish (clam and oyster) beds present in the study area. These animals generally tolerate a light overburden of sediment, especially when the overlying sediment is native to their habitat (Maurer et al., 1981). Bivalve communities have been found to be tolerant of sedimentation rates of between 2.3-7cm per month (Oresund Konsortiet, 1998). Mortality generally increases, however, with the increasing depth and frequency of burial. The UK BAP oyster species are considered to be particularly sensitive to deposition of material given that they are epifaunal, as opposed to the clam which is infaunal, and are also likely to show very low recoverability (MarLIN website). American hard-shelled clam, which are located along the muddier western shore of Southampton Water, is a suspension feeding, infaunal bivalve. Adults typically burrow in muddy fine sands around 5-10cm deep, with juveniles occurring closer to the surface, in that their depth is limited by the need to keep their siphons in close contact with the sediment-water interface. Although, clams are mobile, inhabit more muddy estuarine sediments and are more tolerant of increased suspended sediments, they too are sensitive to an overburden of sediments through heavy siltation. Clam is considered to be a moderately fast burrower (43.7cm per hour) and in laboratory experiments, conducted by Maurer et al. (1980), clam M. mercenaria were observed to tolerate an overburden of at least 16 cm of sand under summer water temperatures (22-25°C). However, burrowing activity reduced gradually below 21°C.

11.56 The magnitude of the deposition that is predicted over the shellfish beds in the Central Solent and approaches to Southampton Water as a result of the capital dredging is not predicted to result in any substantial smothering of the shellfish beds (Chapter 8). The greatest risk of damage to shellfish beds are those closest to the main dredging of fine material in the estuary,
i.e. those scattered along the adjacent intertidal and shallow subtidal habitat of the eastern and western shores in Southampton Water.

11.57 During dredging, the maximum accumulations of material on the bed of the estuary at any time throughout a 15 day spring/neap cycle will be up to about 4cm along the eastern intertidal shore, with slightly less (1-2cm) occurring in the shallow subtidal areas. This sedimentation will be transitory and re-eroded, particularly on ebb flows and spring tides. Over neap tides net accretion occurs, predominantly at LW, however, as tidal ranges increase, what settles is completely eroded. The time that the material takes to be removed will also be dependant on the level of wave disturbance that is already occurring in the estuary (both natural and anthropogenic). The eastern shore, where the oyster beds are located, has a coarser substratum and, therefore, deposition is likely only to be temporary as the area is more exposed to the wave environment, with material redistributing and settling in areas where fine material already occurs. Therefore, although the exposure of oysters to deposition of material will be low to negligible in most cases, given their high sensitivity and nature conservation importance the impact would be moderate adverse significant to beds within Southampton Water and insignificant to beds in the Central Solent. For clams, the exposure along the western shore is considered to be low to medium as material is likely to remain in the more sheltered environment for longer periods. Given their relatively lower sensitivity to deposition and despite their indirect nature conservation importance as food for waterbirds and fish, the impact would be insignificant to minor adverse significant for the clam beds located in Southampton Water.

11.58 As an impact that is moderate adverse significant has been predicted, an adaptive management strategy has been proposed and agreed with the Environment Agency as mitigation for the dredging in the middle part of the estuary. This is described in more detail in Chapter 21. Taking account of the proposed mitigation measures, the residual effect to oysters in Southampton Water is considered to be minor adverse significant.

Eelgrass

11.59 Eelgrass is found in the Hamble Estuary and along Calshot to Stanswood Bay on areas of muddy and sandy mud sediment. Although eelgrass is sensitive to excessive smothering (Davison, 1998), the magnitude of the deposition on these areas that is predicted during dredging over a spring/neap cycle is up to a maximum of around 2cm in the outer Hamble Estuary, with maximum accretion at any time along Calshot to Stanswood Bay being generally less than 2mm. Again, this accretion is only transitory and would be re-eroded over the tide. This negligible exposure to the deposition of material during dredging is considered to be insignificant to eelgrass.

Saltmarsh

11.60 The potential exists for the deposition of some fine material within areas of saltmarsh in Southampton Water, particularly given that saltmarsh can have the effect of trapping sediment. This increase in sediment supply could be a potential benefit in the short-term by maintaining the levels of the marsh. It is predicted that the depth of sediment deposition within areas of saltmarsh in Southampton Water will be less than 5mm, and would only be transitory and quickly re-eroded with the tide. This is less than that predicted for intertidal mudflats due to the fact that the saltmarsh habitat is not covered by every tide and when saltmarsh is immersed it is only for a matter of a few hours over the high water (HW) period. There is, therefore, a
negligible potential for exposure of saltmarsh habitat and given their low sensitivity to any smothering (MarLIN website) and high nature conservation importance in Southampton Water, the impact will be **insignificant**.

**During Disposal of Dredge Arisings**

11.61 It is estimated that around 11.6 million m$^3$ in situ of capital material (plus around an additional 1.3 million m$^3$ of material in situ allowing for a maximum potential overdredge of 0.15m) will need to be disposed of as a result of the proposed dredge at the existing disposal ground at the Nab, subject to a beneficial use being identified. The intended spread of the material over the complete disposal ground is likely to cause humps on the sea bed up to 3-4m in height at different locations within the ground, which will reduce in height over time, leaving minimal trace on the seabed within a few weeks following cessation of the deposits. Simulation of the dispersal and deposition of sediments from the deposit ground indicates that the magnitude of the impact on shallow coastal waters of the East Solent, and around the east and south coasts of the Isle of Wight will be small to negligible (Chapter 8). Furthermore, the fauna that occur in the area of the Nab are already characterised by the effects of regular disturbance through the disposal of maintenance dredge arisings.

**Reef Habitats**

11.62 The key features of nature conservation interest of the South Wight Maritime SAC that have the potential to be exposed to these changes are reefs, including the biotope, *Sabellaria spinulosa* on stable circalittoral mixed sediment, which are considered to have a low sensitivity to smothering (MarLIN website). Even though these habitats are of high nature conservation value, the impact of deposition of material during the disposal of capital dredge arisings is considered to be **insignificant to minor adverse significant**.

**Subtidal Rocky Habitats**

11.63 There are also areas of the UK BAP habitat, fragile sponge and anthozoan communities on subtidal rocky habitats that will be exposed to smothering as a result of disposal activities at the Nab. The equivalent biotope (*Suberites* spp. and other sponges with solitary ascidians on very sheltered circalittoral rock) is considered to have a moderate sensitivity to smothering (MarLIN website) and, therefore, despite their high nature conservation importance, the impact to this habitat is considered to be **insignificant to minor adverse significant**.

**Potential Impact Arising as a Result of the Effects to Water Quality**

**Suspended Sediments**

**During Capital Dredging**

11.64 During dredging, there will be temporary increases in suspended sediments in the water column. The scale of these effects will vary in time and space depending on tidal state, range of tide and material type, as well as location, rates and methods of dredging. Suspended sediment levels are expected to return to background levels within one spring/neap cycle following the cessation of the dredging. The results of the dispersion modelling are presented in Chapter 8.
**Invertebrates**

11.65 The invertebrate communities present in subtidal and intertidal flats of the study area are relatively tolerant to changes in suspended sediments, particularly in areas with muddy sediments and those located adjacent to regularly disturbed areas, such as the main navigation channel. Given the low sensitivity and low exposure to a change in suspended sediment concentrations during dredging, and despite their indirect importance to nature conservation features, the impact to invertebrate communities is considered to be insignificant.

**Shellfish**

11.66 Filter-feeding bivalves are sensitive to physical damage of delicate respiratory and feeding structures through clogging with suspended sediments, particularly during spawning periods. Oysters are particularly sensitive to these effects given that they are epifaunal and sessile, as opposed to clams. American oyster, *Crassostrea virginica*, is reported to tolerate elevated suspended sediments of up to around 700-1000mg/l without any adverse effects. Experiments with oyster larvae indicate that the European oyster larvae, *Ostrea edulis*, are less sensitive than American oyster larvae (Stern & Stickle, 1978).

11.67 The dispersion modelling has shown that there is likely to be a temporary increase in suspended sediments in the areas where shellfish beds occur along the eastern and western shores of Southampton Water, and no significant increase in suspended sediments the vicinity of the main oyster beds in the Central Solent. The magnitude of the change in Southampton Water is considered to be small and given its very short duration and temporary nature, the filter feeders would have a low exposure to elevated levels of suspended sediments. Given the high sensitivity and conservation importance of the BAP species *O. edulis*, and despite the low exposure to the change in suspended sediments during dredging, the temporary impact is considered to be moderate adverse significant to the oyster beds in Southampton Water and minor adverse significant to beds in the Central Solent. For clams, their relatively lower sensitivity to elevated suspended sediments concentrations and indirect importance to nature conservation interest features, would suggest that the temporary impact will be insignificant.

11.68 As an impact that is moderate adverse significant has been predicted, an adaptive management strategy has been proposed as mitigation for the dredging in the middle part of the estuary, based around the monitoring of suspended sediment concentrations. This is described in more detail in Chapter 21. Taking account the proposed mitigation measures, the residual effect to oysters in Southampton Water would be minor adverse significant.

**Eelgrass**

11.69 An increase in turbidity can affect the ability of eelgrass species to photosynthesise, temporarily reducing productivity and growth rates (Parr et al., 1998). Eelgrass beds occur in the Hamble Estuary and along the western Solent shore between Calshot and Stanswood Bay (Hampshire Biodiversity Partnership, 2003). The dredge dispersion modelling shows that the increase in suspended sediment concentrations over this area during dredging will be very small and transient in nature (Chapter 8). Given the negligible to low exposure to elevated levels of suspended sediments, and their moderate sensitivity and despite high nature conservation importance, the impact upon eelgrass beds is considered to be insignificant to minor adverse significant.
Saltmarsh

11.70 Saltmarsh is considered reasonably insensitive to changes in turbidity (Parr et al., 1998). Although the saltmarsh in Southampton Water, which is of high nature conservation importance, will have a greater exposure to changes in suspended sediments during dredging activities than eelgrass, given their negligible to low sensitivity, the impact is considered to be insignificant to minor adverse significant.

During Disposal of Dredge Arisings

11.71 There will be short-term elevations in suspended sediment concentrations in the water column during the disposal of capital dredge arisings at the Nab Deposit Ground. The scale and extent of these impacts are described in Chapter 8. The fauna that occur in the area of the Nab are already characterised by the effects of regular disturbance through the disposal of maintenance dredge arisings. Simulation of the dispersal of sediments from the deposit ground during the main channel deepening indicates that the magnitude of the impact on shallow coastal waters of the East Solent, and around the east and south coasts of the Isle of Wight will be very small to negligible (Chapter 8).

Reef Habitats

11.72 The nature conservation interest features of the South Wight Maritime SAC that have the potential to be exposed to these changes are reefs, including the biotope, *Sabellaria spinulosa* on stable circalittoral mixed sediment, which are not sensitive to changes in suspended sediments and/or turbidity (MarLIN website). Therefore, the impact of the disposal to these reef habitats is considered to be insignificant.

Subtidal Rocky Habitats

11.73 There are also likely to be the areas of the UK BAP habitat, fragile sponge and anthozoan communities on subtidal rocky habitats that are exposed to elevated levels of suspended sediments during the disposal activities at the Nab Deposit Ground. The equivalent biotope (*Suberites* spp. and other sponges with solitary ascidians on very sheltered circalittoral rock) is not considered to be sensitive to changes in suspended sediment concentrations (MarLIN website) and, therefore, the impact to this habitat is considered to be insignificant.

Contaminants

11.74 When found in sufficient quantities, contaminants may cause genetic, reproductive and morphological disorders in marine animals. Furthermore, a mixture of contaminants can have different effects. Sub-lethal effects on marine invertebrates can reduce the fitness of individual species, and lethal effects may allow pollution-tolerant species to dominate, such as oligochaete worms (Elliott et al., 1998).

11.75 Any contamination associated with the sediments that will be dredged may be released during the dredging and disposal, making them temporary available for uptake in the water column by marine organisms and longer-term in the surface sediments where any contaminants are not removed. The chemical sediment sampling has indicated that for the most part there are negligible to very low levels of contamination in the sediments within the areas proposed for dredging, with levels largely falling below Cefas Action Level 1 (Chapter 9).
Invertebrates

11.76 Some marine invertebrates, such as polychaete worms and bivalve molluscs, which are abundant within mudflats, are poor at regulating the uptake of pollutants and may, therefore, bioaccumulate contaminants. Given the negligible to low exposure to chemical contamination during the dredging, these sensitive organisms will have a negligible to moderate vulnerability. Their importance in terms of nature conservation, indicates that any impact will be insignificant to minor adverse significant.

Shellfish

11.77 Shellfish are particularly sensitive to a range of toxic substances and are known to bioaccumulate contaminants, with larval and juvenile phases being more susceptible than adults (Connor, 1972). Given their high sensitivity to toxicity and the high nature conservation importance of oysters in particular, and that the levels of contaminated sediment are very small to negligible, the impact is considered to be moderate adverse significant for oysters in Southampton Water and insignificant for oysters in the Central Solent.

11.78 As an impact that is moderate adverse significant has been predicted, an adaptive management strategy has been proposed agreed as mitigation for the dredging in the middle part of the estuary. This is described in more detail in Chapter 21. Taking account of the proposed mitigation measures, the residual effect to oysters in Southampton Water will be minor adverse significant.

Saltmarsh

11.79 Saltmarsh is relatively tolerant of certain toxic contaminants and can act as a contaminant sink by bioaccumulating particular compounds (Holt et al., 1995). Their exposure to contaminated sediments will be low to negligible during the dredging, and given their low sensitivity and high nature conservation the impact is considered to be insignificant to minor adverse significant.

Reef and Rocky Habitats

11.80 The exposure of the nature conservation interest features of the South Wight Maritime SAC to any chemical contamination during the disposal of dredge arisings is also considered to be negligible, given the quantity of contaminated material, the high dispersion of material and rapid dilution of any contaminants as soon as the dredge load is released into the water column (Chapter 8). Therefore, the impact is considered insignificant to the interest features of the South Wight Maritime SAC.

Nutrients and Oxygen Depletion

11.81 The release of any nutrients associated with the sediments that require dredging will enhance levels in the water and could potentially stimulate the growth of phytoplankton and macroalgae during the growing season. Spring and summer phytoplankton blooms form part of existing natural seasonal plankton dynamics in northern temperate coastal areas. If there are no other factors limiting production, such as temperature and light, excessive nutrient enrichment could cause the formation of algal blooms, resulting in the depletion of oxygen from the surrounding water column as the blooms senesce and decay. In coastal and estuarine areas, tidal flushing, turbidity levels and grazing limit the potential formation of these algal blooms. Given the temporary, short-term nature of any potential elevation in nutrient levels and the uncertainty
and unpredictability in the stimulation of algal blooms by nutrients, however, the exposure to increased nutrient levels and the potential depletion of oxygen due to the formation of blooms as a result of the dredge and disposal activities is considered insignificant.

**Organic Enrichment and Oxygen Depletion**

11.82 The resuspension and subsequent settling of organic rich sediments could affect benthic assemblages by depleting oxygen from the surrounding water and sediments. The modelling has shown that the amount of re-settlement of this material is small (maximum of less than 1cm in the channel and less over intertidal areas) and will only be short-lived, with tidal exchange, re-dredging and subsequent erosion quickly replenishing the oxygen supply (Chapter 8).

**Invertebrates**

11.83 The marine worms that are found in the muddy sediments of Southampton Water can respond well to moderately increased organic levels, thus encouraging their proliferation (Elliot et al., 1998). Given the negligible magnitude of change and low sensitivity of the benthic fauna, the impact is considered to be insignificant.

**Saltmarsh**

11.84 Saltmarsh is unlikely to be particularly sensitive to changes in water quality due to increases in concentrations of organic material in the water column (Holt et al., 1995). Given that the exposure to suspended organic material will be low to medium in Southampton Water between Dock Head and Fawley, and that the habitat is of high nature conservation value, the impact to the saltmarsh will be minor adverse significant.

**Potential Impacts During Future Maintenance Dredging**

11.85 The main impacts to marine and coastal ecology will occur during the capital dredging and disposal of dredge arisings at the Nab Deposit Ground, as well as during the operational phase with the presence of the deepened and widened channel. The same potential impact to marine and coastal ecology applies during maintenance dredging as for capital dredging, although the scale of impact is substantially less. Furthermore, the effects of future maintenance dredging work are expected to be small compared with existing annual variability (Paras 8.256 to 8.261). Therefore, future maintenance dredging is considered to have an insignificant impact on the marine and coastal ecology of Southampton Water and the Solent. For these reasons, the above assessment of the pathways of change concentrate on the effects of the capital dredging works.

**Potential Impacts Due to Ship Wash**

11.86 The ship wash assessment is presented in Chapter 16. Even though the SACD works will allow deeper draughted vessels to access the Port, a reduction in average ship wave heights and total incident ship wave energy reaching the foreshore is predicted. The deepening and widening of the channel will marginally reduce the total energy reaching the shore and seabed from ship wash (vessel generated wave activity, water surface drawdown, backflow and vessel propeller wash). The predicted reduction in ship wash is unlikely to be discernable from background wind induced waves, which account for the majority of the wave energy reaching the shore. Overall, the impact from ship wash will be less compared to the baseline situation
and, therefore, considered to be **minor beneficial significant**, with respect to potential bed and bank erosion effects and stability of shallow subtidal and intertidal habitats.

**Potential Impacts to Indigenous Species Through Introduction of Non-Native Species**

11.87 The establishment of alien species from ballast water exchange has the potential to affect species indigenous to Southampton Water and the Solent. The channel dredge will improve the accessibility for deeper-draughted vessels to enter and leave Southampton Water. The overall number of shipping movements, however, is not expected to increase above present levels, subject to annual fluctuations, given that the number of berths at the port is remaining the same. Overall, as the deeper-draughted vessels arriving in the estuary will be fully loaded and unlikely to be using any ballast water, the risk of introducing alien species as a result of the dredge is negligible and the impact **insignificant**. There will be no additional risk, therefore, to indigenous species in the study area.

**Conclusions**

11.88 The potential impacts to the relevant marine and coastal ecology features that were identified in Chapter 6 and through consultation (Appendix A) have been assessed in accordance with the Marine Works (EIA) Regulations 2007. The findings of this assessment will also inform the Appropriate Assessment signposting document (Appendix D) for the purposes of the Habitats Regulations. The main impacts will occur during the capital dredging and disposal of arisings. On the whole, the scale of impacts to marine and coastal features will be insignificant to minor adverse significant. However, given the sensitivity and nature conservation status of oysters, the impact of the albeit transient and short-term changes in water quality and smothering during dredging, is considered to be moderate adverse significant for oysters occurring within Southampton Water. This will be mitigated by the implementation of an adaptive management strategy during the capital dredge, which is currently being discussed has been agreed with the Environment Agency. Following the channel dredge, the majority of impacts during operation will be insignificant, with some impacts being minor beneficial significant, including a small gain in intertidal habitat across the study area due to changes in the hydrodynamic regime and a marginal reduction in the potential effects of ship wash.