12 Ecology

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12.1 Introduction

12.1.1 Scope of assessment

This part of the Environmental Statement describes development impacts on the principal features of nature conservation interest in the Hayle Estuary and on land within and adjacent to the proposed development site. The scope of ecological assessment studies has been determined by reference to the scoping opinion received from Penwith District Council (see Annexe 1A) and through consultations with Natural England, the Environment Agency, Cornwall County Council, the Royal Society for the Protection of Birds (RSPB) and the Cornwall Wildlife Trust. Three key topics are dealt with:

i. potential impacts on terrestrial habitats and species within and around the harbour, arising from land-take, construction processes, and land use / management changes

ii. potential impacts on inter-tidal and sub-tidal estuarine invertebrates, fish populations and algae, arising from harbour construction works, reclamation, harbour management (including sluicing) and marina operation

iii. potential impacts on wintering and migratory bird populations in the estuary, arising from reclamation works, harbour construction and operation (including sluicing), land use / management changes, and changes in pedestrian and road traffic around the estuary

Section 12.2 provides: i) a brief overview of the habitats and species found in the estuary system and on land within and adjacent to the proposed development site; ii) a description of nature conservation designations applying to these areas, and; iii) the planning policy background to wildlife protection at national, regional and local levels, and; iv) details of relevant wildlife protection legislation.

Section 12.3 sets out survey methodologies employed to derive baseline data on terrestrial and aquatic habitats and species and wintering and migratory bird populations found in areas likely to be affected by the proposed development. The assessment methods used to identify the nature and significance of ecological impacts are also described.

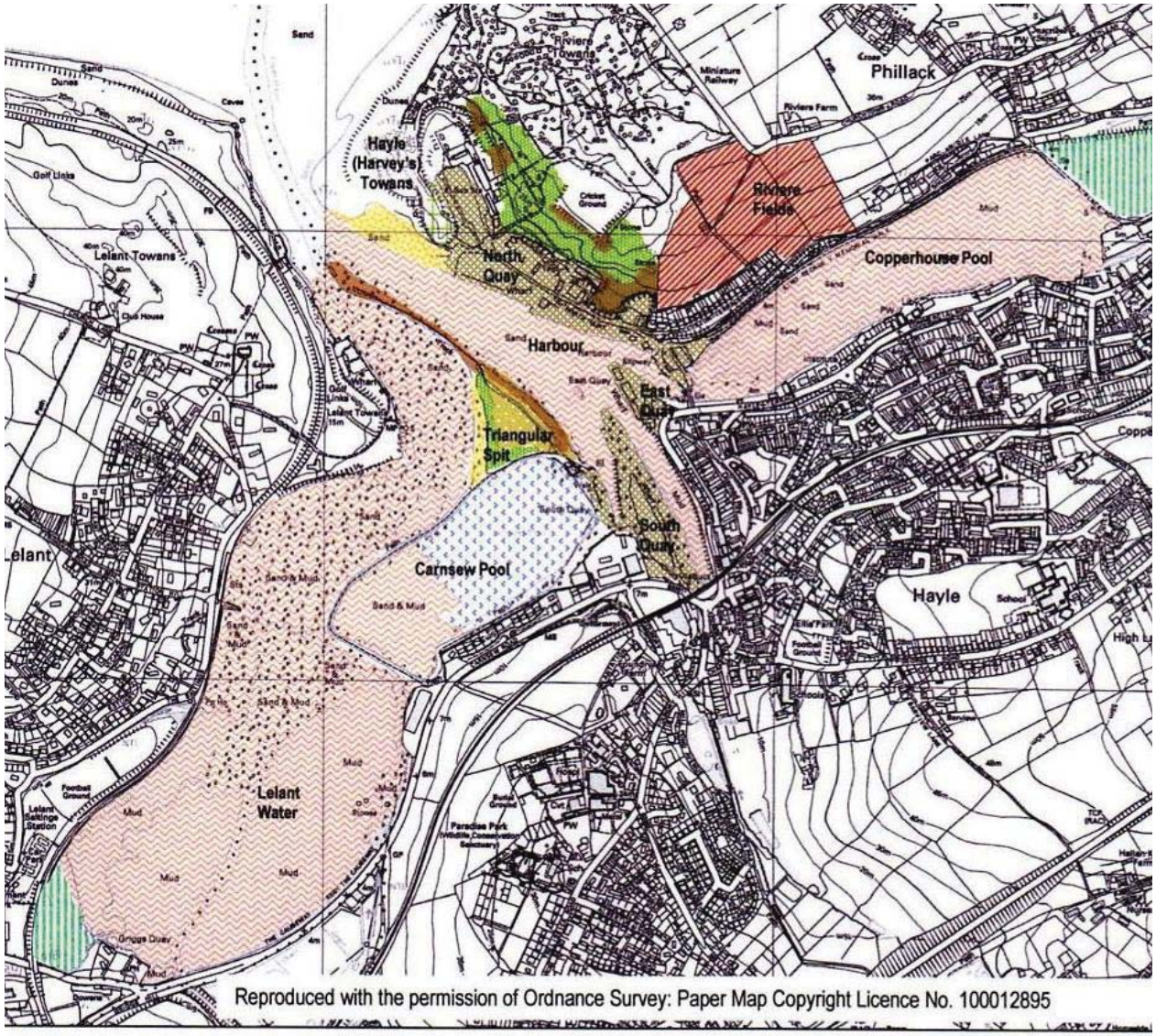
Sections 12.4-12.8 present the results of impact assessment studies for each of the three topic areas identified above, according to a common format:

- baseline information on the distribution of habitats and species in affected areas (including observations on current activities (eg harbour management, recreational activities) which affect ecological processes)
- an assessment of the scale and significance of development impacts

- description of measures proposed to mitigate significant adverse impacts
- indication of the nature of residual impacts remaining after mitigation
- proposals for ecological monitoring

12.1.2 Overview of the ecology of the Hayle Estuary

The Hayle Estuary is located in the wider area of St Ives Bay. Figure 12.1 indicates the distribution of broad habitat types and the location of the named sites mentioned in the following text.



KEY:

- Inter-tidal mud / sand
- Saltmarsh
- Permanent tidal deep water
- Commercial / post-industrial use
- Arable
- Dune grassland with scattered scrub
- Sparse grassland / bryophytes with scattered scrub
- Scrub blocks
- Mobile dune

Hayle Harbour

Broad habitat types within and adjacent to proposed development site

Figure 12.1
scale
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date November 2007

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Within the estuary complex, there are about 20 hectares of inter-tidal sand and mudflats, tidal open water and saltmarsh, which provide valuable feeding and roosting sites for regionally important populations of migratory and over-wintering wildfowl and waders. The estuary is the most south-westerly in Great Britain and normally escapes the extremes of winter weather when other estuaries within Britain are frozen; at these times numbers of certain waterfowl species at Hayle can reach national importance. The main estuarine habitats of value to birds are distributed within the three inter-tidal basins of Lelant Water, Copperhouse Pool and Carnsew Pool (see Figure 12.1). Lelant Water holds the greatest extent of intertidal mudflat, although the area of muddy habitat is gradually contracting owing to sand encroachment.

A build-up of sediment has occurred generally in the estuary over recent decades, probably associated with changes in sluicing operations, and these raised inter-tidal levels combined with heavy metal contamination from the harbour's past industrial use depresses the variety of estuarine invertebrates that occurs in the estuary sediments. The most diverse communities of invertebrate and algae occur in Carnsew Pool in the 'tidal rapids' where seawater enters the pool. Carnsew Pool is also noted as a nursery area for several species of both fully marine and brackish water fish including two (gilthead bream and golden-grey mullet) that are regionally notable. The estuarine habitats in the central harbour area at Hayle do not support significant bird, invertebrate or fish populations.

Terrestrial habitats within the development area comprise the following (see Figure 12.1):

- sand dunes, and dune grassland with associated scrub, at North Quay and the Triangular Spit
- disused, open land colonised by mosses / sparse grassland, on the Triangular Spit and small areas of South Quay
- disused quarries at North Quay which support areas of introduced and native scrub
- agricultural land east of North Quay

Land at North Quay supports the greatest variety of terrestrial habitats. Reptiles including common lizard, slow worm and adder occur here, and several regionally notable and Nationally Scarce plant species have been recorded from the area. The Triangular Spit supports a nationally significant population of a liverwort species, petalwort (*Petalophyllum ralfsii*), protected under Schedule 8 of the Wildlife & Countryside Act 1981; much smaller numbers of this plant are also found on South Quay and on the eastern shore of Carnsew Pool.

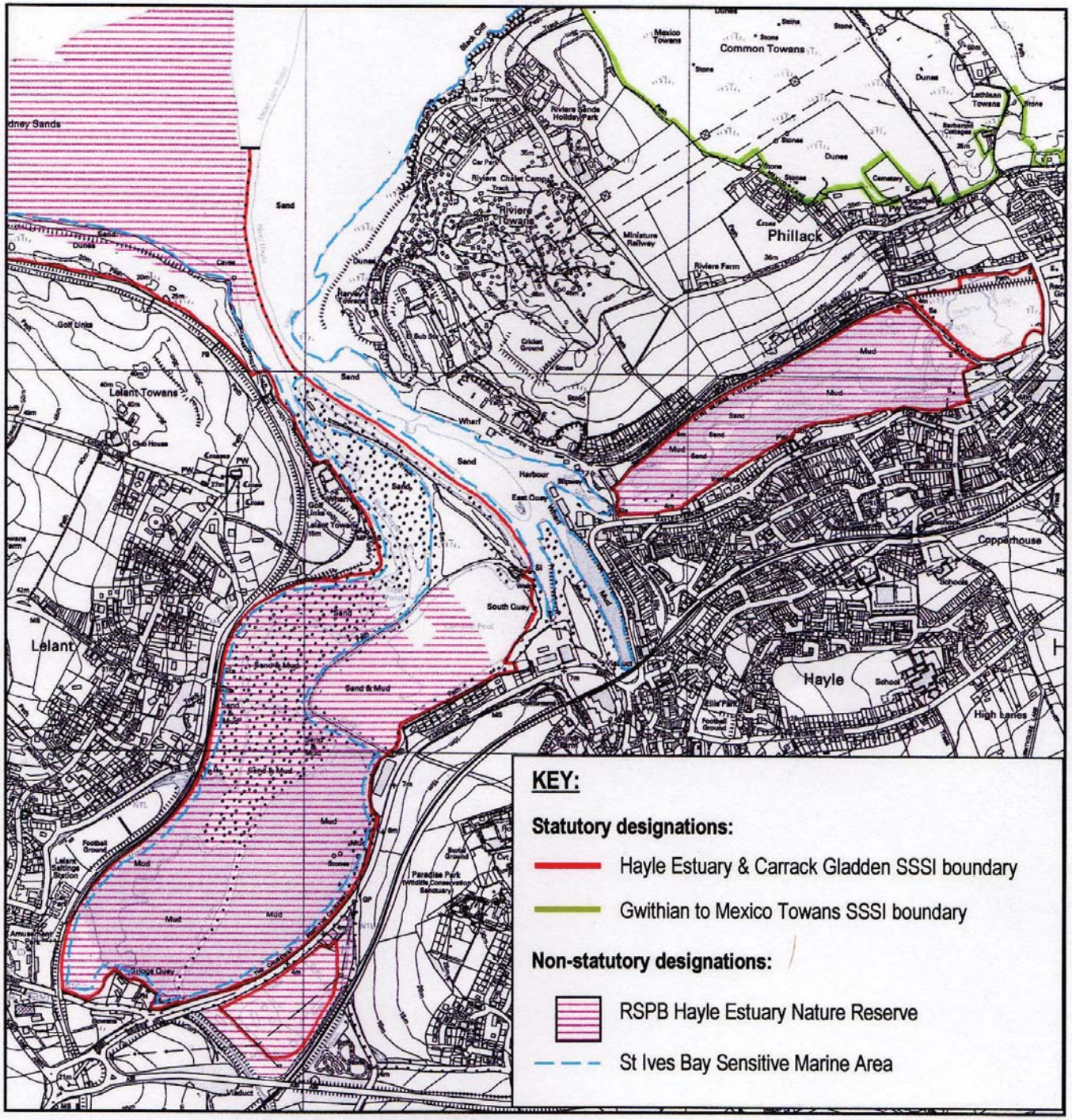
Detailed information on the occurrence and significance of habitats and species found at the Hayle Estuary is presented in section 12.4, derived from a combination of previously published studies and fieldwork conducted during 2004-07.

12.2 Legislation and planning policy guidance

12.2.1 Nature conservation designations

12.2.1.1 Statutory designations

There are two Sites of Special Scientific Interest (SSSIs) covering land within and adjacent to the Hayle Harbour planning application boundary. The SSSI boundaries are shown in Figure 12.2.



DO NOT SCALE THIS DRAWING.

Hayle Harbour

Hayle Estuary - nature conservation designations

Figure 12.2
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date November 2007

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- **The Hayle Estuary and Carrack Gladden SSSI** encompasses the Porth Kidney sand dune system west of the estuary mouth and the main inter-tidal basins of Lelant Water in the south-west of the estuary, Carnsew Pool south of the harbour, and Copperhouse Pool to the east. The primary reason for the SSSI status of the estuary lies in the populations of waterfowl and shorebirds that occur in winter and pass through on spring and autumn migration. The western end of Copperhouse Pool is the region of the SSSI where intertidal habitat is closest to the proposed development; piers of the proposed new bridge over the westernmost shore of the pool would lie within the SSSI. The main area of terrestrial habitat within the SSSI is the Triangular Spit, part of which is proposed as a parking area
- **The Gwithian to Mexico Towans SSSI** covers dune systems east and north of the village of Phillack on the east side of the estuary, and extends approximately 3km eastwards along the coast to Gwithian. The principal conservation interest of the site lies in its diverse dune flora. The minimum distance between the westernmost boundary of the SSSI and the application boundary is approximately 375m

SSSIs are of national importance for nature conservation and are designated under the Wildlife & Countryside Act 1981 (as amended).

12.2.1.2 Non-statutory designations

Hayle – Godrevy Area of Great Scientific Value

All estuary habitats at Hayle, including inter-tidal areas within the harbour, Lelant Water, and Carnsew and Copperhouse Pools, are included within an area designated by Cornwall County Council as the Hayle to Godrevy 'Area of Great Scientific Value' (AGSV). This is one of two AGSVs in the district of Penwith. North of the harbour, the designation continues eastwards from the existing Riviere Chalet Camp, encompassing land within and around the dune system of the Gwithian-Mexico Towans SSSI. Penwith Local Plan indicates that AGSVs are of County-level importance for nature conservation since they act as a buffer around the most important and sensitive habitats and provide links between protected sites, facilitating the movement of wildlife.

RSPB Hayle Estuary Nature Reserve

The Royal Society for the Protection of Birds (RSPB) holds freehold ownership of part of the Hayle Estuary, covering Lelant Water (and land to the south of this known as Ryan's Field), Copperhouse Pool, Porth Kidney Sands, and part of Carnsew Pool. This land, defined in Figure 12.2, constitutes the RSPB Hayle Estuary Nature Reserve. The reserve is managed to maintain and enhance habitat conditions for shorebirds and waterfowl, and to minimise human disturbance during the key periods of bird presence on the estuary.

St Ives Bay Sensitive Marine Area

Inter-tidal land in Lelant Water and within the harbour area at Hayle (but excluding Carnsew and Copperhouse Pools) falls within the boundaries of the St Ives Bay "Sensitive Marine Area" (SMA); see Figure 12.2. The SMA also extends seawards into St Ives Bay from St Ives Head to Godrevy Point. The SMA designation is applied by Natural England to sites which are nationally important and notable for their animal and plant communities or which provide ecological support to adjacent statutory sites; St Ives Bay is recognised as an SMA because of its subtidal marine wildlife including sponges, sea anemones and crustacea. SMAs are identified with a further aim of raising awareness and disseminating information to be taken into account in estuarine and coastal management planning. There are four such areas covering parts of the coast of Cornwall, and 27 in total around the coast of England.

12.2.2 Nature conservation planning policies

12.2.2.1 Planning Policy Statement 9

National government policy on nature conservation is provided in Planning Policy Statement 9, PPS9 (Office of the Deputy Prime Minister, 2005). The broad aim of PPS9 is to ensure that "planning, construction, development and regeneration should have minimal impacts on biodiversity and enhance it wherever possible". The statement sets out several key principles to which planning authorities must adhere to ensure the potential impacts of planning decisions on biodiversity are fully considered. In summary, these are:

- Development plan policies and planning decisions should be based on up to date information about the environmental characteristics of the area
- In taking decisions, authorities should ensure that appropriate weight is given to designated sites of international, national and local importance, protected species and to biodiversity interests in the wider environment
- Plan policies should promote opportunities for the incorporation of beneficial biodiversity features within the design of development
- Where a planning decision would result in significant harm to biodiversity interests which cannot be prevented or adequately mitigated against, or compensated for, then planning permission should be refused

PPS9 requires that regional spatial strategies and local development frameworks identify international, national and local nature conservation interests in their plan area, and include policies that are consistent with national, regional and local biodiversity priorities. With regard to SSSIs, PPS9 states that: "Where a proposed development on land within or outside an SSSI is likely to have an adverse effect on an SSSI planning permission should not normally be granted". An exception to this should only be made where the benefits of development clearly outweigh both the likely impacts on the features of the site that make it of special interest

and any broader impacts on the national network of SSSIs. In these cases," local authorities should use conditions and/or planning obligations to mitigate harmful aspects of the development and where possible, to ensure the conservation and enhancement of the site's biodiversity interest".

PPS9 is accompanied by Circular 06/2005 and a Good Practice Guide (ODPM 2006).

12.2.2.2 Cornwall Structure Plan 2004

The Cornwall Structure Plan (2004) contains one key policy that sets out requirements for protecting and enhancing the natural and built environment. This is ***Policy 2: 'Character Areas, Design and Environmental Protection'***, as follows:

> *"The quality, character, diversity and local distinctiveness of the natural and built environment of Cornwall will be protected and enhanced. Throughout Cornwall, development must respect local character and:*
>
> - *retain important elements of the local landscape, including natural and semi-natural habitats, hedges, trees, and other natural and historic features that add to its distinctiveness*
> - *contribute to the regeneration, restoration, enhancement or conservation of the area*
> - *positively relate to townscape and landscape character through siting, design, use of local materials and landscaping*
> - *create safe, aesthetically pleasing and understandable places*
> - *consider, where appropriate, a mix of uses that create vibrant and active places, including tenure, size and densities*
>
> *Local plans should define Character Areas to inform planning decisions taking into account Regional and County-wide landscape assessments.*
>
> *The conservation and enhancement of sites, areas, or interests, of recognised international or national importance for their landscape, nature conservation, archaeological or historic importance, including the proposed World Heritage Site, should be given priority in the consideration of development proposals.*
>
> *Within Areas of Great Landscape Value and other areas or sites of county-wide significance for their biodiversity, geodiversity or historic interest, development proposals will be required to respect those interests.*
>
> *The following areas are of Great Landscape Value and are shown on the Key Diagram:*

.....St Ives Bay...."

The Cornwall Structure Plan also contains a policy providing more generally for the protection of the maritime environment. This is ***Policy 4: 'Maritime Resources'***:

"An integrated and coordinated approach to the coast will be taken to support the economic importance and conservation value of the maritime environment.

Development relating to the coast, estuaries and maritime environment should be considered against the need to ensure the conservation of the environment for its own sake and for the economic importance of fishing and the other activities it supports. Development should avoid pollution of coastal or marine waters and minimise any harmful effects on coastal processes.

The undeveloped coast should be protected.

Local plans should designate coastal zones where appropriate to take account of economic and social opportunity and environmental protection".

12.2.2.3 Penwith Local Plan 2004

The Penwith Local Plan was adopted in 2004. Adopted policies providing for the protection of nature conservation interests in Penwith, including designated sites, are set out in the "Coast and Countryside" section of the Plan, and are reproduced below.

Policy CC-1

"Development will not be permitted where it would significantly harm the landscape character, amenity, nature conservation, archaeological, historic or geological values of the coast and countryside of Penwith".

Policy CC-2

"Proposals which maintain, enhance and facilitate the enjoyment and understanding of landscape character, amenity, nature conservation, archaeological, historic or geological values in the coast and countryside will be permitted".

Policy CC-7

"Proposals for development which would significantly harm the nature conservation value or geological interest of a Site of Special Scientific Interest will not be permitted".

Policy CC-8

"Development will not be permitted where it would significantly harm the nature conservation or geological interest of Areas of Great Scientific Value, County Wildlife Sites, County Geological Sites, Ancient

Woodland Sites and Local Nature Reserves. Where development is permitted any impact on such values must be minimised and conditions will be imposed, or planning obligations sought, to ensure that mitigating measures are undertaken."

Policy CC-9

"Proposals for development which would cause significant harm to a protected species or its habitat will not be permitted".

Policy CC-10

"Proposals for development which would have a significant adverse effect on the integrity or continuity of landscape features and habitats of major importance for wild flora and fauna will not be permitted. Where development which would have a more limited adverse effect is permitted, damage to nature conservation values must be minimised and, where appropriate, a planning obligation will be sought to ensure that compensatory measures are undertaken to retain the continuity or integrity of the features or habitats".

Policy CC-11

"The creation and management of landscape features and habitats which are of major importance for wild flora and fauna will be encouraged by:-

(i) management agreements with landowners and occupiers;

(ii) establishing Local Nature Reserves".

Policy CC-14

"Proposals for development which would have a significant adverse effect on the shoreline or adjacent coastal waters in terms of its landscape character, amenity, nature conservation, archaeological, historic and geological values will not be permitted".

12.2.3 Legislation protecting species and habitats

Legislation relating to the protection of selected flora and fauna in England is described below, since baseline survey data for the proposed development area (see section 12.4.1) indicates the presence here of several species that receive statutory protection. Legislation relating to hedgerow protection is also discussed.

12.2.3.1 Legislation relating to bats

All bat species and their roosts are fully protected by law from disturbance, damage or destruction. Under the Wildlife and Countryside Act 1981 it is illegal to intentionally kill, injure or take a bat (alive or dead) or to disturb a bat when it is roosting. Disturbance or destruction of a bat roost in advance of any otherwise legitimate development may be carried out under licence from Natural England, provided all reasonable steps have been taken to minimise the impact and any remaining damage will be adequately compensated for. All bat species

are also protected by the Conservation (Natural Habitat etc) Regulations 1994 (the Habitats Regulations) under which it is an offence to deliberately kill, capture or disturb a bat, or to damage or destroy any place that a wild bat uses for shelter or breeding. The Countryside and Rights of Way Act 2000 (the CROW Act) amends the Wildlife and Countryside to make it an offence to intentionally or *recklessly* damage, destroy or obstruct a place that bats use for shelter or protection, or to disturb a bat while using a roost. The term 'recklessly' has been defined by the case of Regina v Caldwell 1982 relating to the Criminal Damage Act 1981: this requires the prosecution to show that an unacceptable risk was deliberately taken or that an obvious risk was not noticed or considered.

12.2.3.2 Legislation relating to reptiles

In the UK the Wildlife and Countryside Act 1981 (as amended) and The Countryside and Rights of Way Act 2000 give legal protection to all selected reptile species, including the common (or viviparous) lizard *Lacerta vivipara,* slow-worm *Anguis fragilis,* adder (or viper) *Vipera berus*). Under these Acts these species are protected from intentional or reckless killing, injury or sale.

12.2.3.3 Legislation relating to nesting birds

Nesting birds, with certain exceptions, are protected from disturbance under the Wildlife and Countryside Act 1981 (as amended) and the Countryside and Rights of Way Act 2000.

12.2.3.4 Legislation relating to the protection of plants

Section 13 of the Wildlife and Countryside Act 1981 protects wild plants listed on Schedule 8 of the Act. Under this provision, it is illegal to pick, collect, cut, uproot or destroy the plants listed in schedule 8. However, Natural England has authority under section 16(3) of the Wildlife and Countryside Act to grant licences to carry out these activities for the purpose of science, education, conservation of wild plants or introduction of wild plants into particular areas.

12.2.3.5 Legislation relating to hedgerows

Hedges that can be classified as 'important' for nature conservation under criteria (concerning hedgerow age, length and plant species diversity) as defined in the Hedgerow Regulations 1997, are protected under this legislation from damage and destruction.

12.2.4 Biodiversity Action Plans

Non-statutory Biodiversity Action Plans (BAPs) have been prepared on a local and regional scale throughout the UK over the past 15 years. Such plans provide a mechanism for implementing the government's broad strategy for conserving and enhancing the most endangered ('priority') habitats and species in the UK for the next 20 years. The national BAP strategy is set out in *Biodiversity: The UK Action Plan* ('UK BAP', Department

of the Environment *et al*, 1994) and the list of priority habitats and species is published in the Countryside and Rights of Way Act 2000, section 74.

The "Cornwall Biodiversity Initiative", a voluntary partnership of organisations, businesses, local authorities, government agencies, and groups set up under the auspices of the Cornwall Wildlife Trust, has produced two 'Cornwall BAP' documents that identify species and habitats to be subject to county-specific conservation targets and Action Plans:

- "Cornwall's Biodiversity: Volume 2 Action Plans" (1998); this identifies *locally important* species and habitats and sets out Action Plans for their conservation in Cornwall
- "Cornwall's Biodiversity: Volume 3 Action Plans" (2004); this identifies all *UK BAP priority* habitats and species in the county and sets out Action Plans for their conservation in Cornwall

The ecological surveys and investigations carried out for this ES indicate that certain UK BAP priority habitats and species are known to be present, or have previously been found, at the Hayle estuary or on surrounding land areas. These habitats and species are listed below; an asterisk (*) indicates a species which has been recorded from the area during previous surveys but not during the surveys undertaken for this Environmental Statement.

Cornwall BAP, Volume 3 - Priority Habitats and Species found at Hayle:

Hedgerows

Coastal sand dunes

Mudflats

Sheltered muddy gravels

Tidal rapids

Saltmarsh

Petalwort (*Petalophyllum ralfsii*)

Western ramping fumitory (*Fumaria occidentalis*)

Purple ramping fumitory (*F. purpurea*)

Native oyster (*Ostrea edulis*)

Fan shell (*Atrina fragilis)*

Bumble bee (*Bombus humilis*)

Linnet (*Carduelis cannabina*)

Song thrush (*Turdus philomelos*)

European otter (*Lutra lutra*) *

Pipistrelle bat (*Pipistrellus pipistrellus*)

The status of UK BAP priority habitats and species in the statutory planning process is indicated in PPS9 and government Circular 06/2005, as outlined below:

PPS9:

"Through policies in plans, local authorities should also conserve other important natural habitat types that have been identified in the Countryside & Rights of Way Act 2000 section 74 list, as being of principal importance for the conservation of biodiversity in England and identify opportunities to enhance and add to them".

"Planning authorities should ensure that these species [identified in the Countryside & Rights of Way Act 2000 section 74 list] are protected from the adverse effects of development, where appropriate, by using planning conditions or obligations. Planning authorities should refuse permission where harm to the species or their habitats would result unless the need for, and benefits of, development clearly outweigh that harm".

Circular 06/2005:

"The potential effects of a development, on habitats or species listed as priorities in the UK BAP and by Local Biodiversity Partnerships… are capable of being a material consideration in the preparation of regional spatial strategies and local development documents and the making of planning decisions".

Also, the Natural Environment and Rural Communities Act 2006 extends a duty on all local authorities and public bodies in England and Wales to have regard, in the exercising of their functions, to the purpose of conserving biodiversity.

12.3 Methodology and assessment criteria

12.3.1 Collection of baseline data

12.3.1.1 Terrestrial ecology baseline data collection

Previous studies

Information on species previously recorded at Hayle was obtained in 2005 from the Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS). Species records were requested for the land areas within the application boundary, focusing on:

- legally protected species
- nationally rare and nationally scarce species
- national and local BAP priority species

In addition, reference has been made to data collected in previous years during surveys connected with past development proposals. The survey reports referenced for this purpose are as follows:

- The Environment Practice (1998). *Hayle Estuary, Cornwall: Rare Plant Survey.* Unpublished report, for Hayle Harbour Company
- The Environment Practice (2001). *Hayle Harbour Project, Rare Plants: Detailed Baseline Survey and Potential Mitigation Options*. Unpublished report, for Hayle Harbour Company

Field survey methods

The scope of field surveys appropriate for each of the land areas named in 12.1.2 was determined by reference to existing data on species' presence obtained from ERCCIS, and reconnaissance visits in late winter / spring 2005 to identify the broad vegetation types present and hence assess each area's potential for supporting particular habitats of interest and rare / protected species.

The surveys carried out for each land area are referenced below and a summary of the survey methods provided in each case; selected reports are presented in Annexes 12A-12D.

Survey type	Area(s) covered	Report reference and summary of survey method(s)
Bryophyte survey	Triangular Spit	*Bryophyte Survey at Hayle Harbour, with notes on the conservation of large populations of the liverwort Petalophyllum ralfsii.* (February 2005). Spalding Associates. See Annexe 12A. **Method summary:** A site search was conducted in optimal conditions for bryophyte survey (damp ground). Species' locations were marked on a photocopy of the 1:10 000 Ordnance Survey map during fieldwork, and checked and recorded as National Grid references using a Garmin GPS12.
	South Quay	*Bryophyte Survey at South Quay, Hayle*. (April 2005). Spalding Associates. **Method summary:** as above
	North Quay	*Bryophyte Survey at North Quay, Hayle*. (January & April 2005). Spalding Associates . **Method summary:** as above
Rare plant survey	East Quay, North Quay, South Quay & Triangular Spit	*Rare Plant Survey of Three Areas at Hayle, Cornwall* (July 2005). Spalding Associates. **Method summary:** The survey was carried out using the Trimble ProXRS GPS Receiver with handheld field computer (accurate to <1 metre). The position of the plants was recorded in the field either as an individual plant or a group of plants, in which case exact or estimated numbers were noted on the GPS. The information taken in the field was imported into the MapInfo GIS system.
Phase 1 Habitat	North Quay	*Phase 1 Habitat Survey of land at North Quay, Hayle, Cornwall.* (March 2005). Spalding Associates.

Survey type	Area(s) covered	Report reference and summary of survey method(s)
Survey		**Method summary**: Two walkover surveys were undertaken during which habitats were classified and mapped using the standard Phase 1 habitat survey methodology (JNCC, 1990). A list was compiled of vascular plants found at the site, and any significant physical features or habitat characteristics were annotated on field maps as 'Target Notes.'
	Agricultural land at Riviere Farm (east of North Quay)	*Phase 1 Habitat Survey of Fields near Riviere Farm, Hayle, Cornwall*. (September 2005). Spalding Associates **Method summary**: as above.
Reptile survey	North Quay, Triangular Spit	*Reptile Survey at North Quay & Triangular Spit, Hayle, Cornwall. (Sept 2005)*. Spalding Associates. **Method summary**: A series of eight monitoring days was undertaken between June and September 2005 at North Quay and the Triangular Spit, in order to establish the presence or absence of slow-worm (Anguis fragilis), adder (Viper berus) and common (or viviparous) lizard (Lacerta vivipara) at the sites. Two complementary methods were used to locate reptiles, comprising direct observations and setting out artificial refugia in habitats that were considered as potentially favoured sites for reptiles and were not heavily used by the public.
Breeding bird survey	North Quay	*Bird Survey at North Quay, Hayle, Cornwall.* (May & June 2005). Spalding Associates. **Method summary**: The breeding bird survey entailed early morning visits to the site on four mornings in May and June 2005. On each visit a transect route was walked and all species considered to be using the site for breeding or feeding purposes were recorded.

Survey type	Area(s) covered	Report reference and summary of survey method(s)
Invertebrate survey	North Quay	*Invertebrate Survey at North Quay, Hayle, Cornwall.* (August 2005). Spalding Associates. **Method summary**: A walk-over survey was made of North Quay on 27th June and 23rd August 2005 to survey for invertebrates. The principal habitats examined for invertebrate activity were the dune grasslands and the areas of scrub. A range of methods was used, including interception netting of flying insects, sweeping lower vegetation and searching; no moth trapping was carried out.
Bat survey	North Quay	*Bat Survey of Land at North Quay, Hayle, Cornwall*. (October 2005). Spalding Associates. See Annexe 12B. **Method summary**: A quarry face in the eastern region of North Quay and a stone chimney in the north-west of the site were surveyed in October 2005 for signs of bat activity, by visual inspection and by using a bat detector at dusk.
	North Quay, South Quay, Foundry Square	Bat and Barn Owl Survey of Quayside Buildings at Hayle. December 2006. Spalding Associates. See Annexe 12C. **Method summary**: Buildings planned for renovation or demolition as part of early Phase 1 construction works were examined to assess whether they possessed features that could support habitation by bats, and to provide guidance on whether later surveys to verify bat presence would be necessary. All building areas were searched for bat droppings as far as possible. All crevices, particularly within defective stonework, joints between buildings, and in gaps in lintels were searched with the aid of a torch and mirrors for bats.
	North Quay, Riviere Fields	*Survey and Assessment of Bat use of North Quay and Riviere Towans, Hayle.* (July 2007). Spalding Associates. See Annexe

Survey type	Area(s) covered	Report reference and summary of survey method(s)
		12D. **Method summary**: Buildings planned for renovation or demolition as part of finalised Phase 1 construction works were examined to assess whether they possessed features that could support habitation by bats, and to provide guidance on whether later surveys to verify bat presence would be necessary. Survey methods were as above. In addition, the semi-natural habitats of dune grassland above North Quay and farmland at Riviere Fields have been assessed for their value as bat foraging and commuting routes within the context of the surrounding landscape, in order to assess potential impacts and devise suitable mitigation methods.
National Vegetation Classification (NVC)	Copperhouse saltmarsh	*NVC Survey of Copperhouse Saltmarsh, Hayle.* (August 2007). Spalding Associates. **Method summary**: The saltmarsh was surveyed at low tide and vegetation communities assigned to NVC community types; a list of vascular plants found at the site was compiled. See Annexe 12E for map of NVC communities recorded.

Table 12– 1: Terrestrial ecology surveys conducted in relation to the proposed development at Hayle Harbour

More detailed survey of barn owl use was considered unnecessary based on the evidence from the two bat surveys undertaken on built structures in the locality.

A survey of otter use of the site was not considered necessary because although otters are likely to visit estuary habitats site to feed, it is almost certain to be on a casual basis; the site is not believed to provide suitable breeding or resting habitat within the footprint of the proposed development and the proposals are assessed as unlikely to produce a significant effect.

12.3.1.2 Aquatic ecology baseline data collection

Previous studies

An overview of the ecology of intertidal habitats in the Hayle estuary complex was derived from a report carried out on behalf of the Nature Conservancy Council (now Natural England) in June 1988 (Gill, 1989). The methods used were a combination of cores for sediment shores (concentrating on the lower shore) and walk-over surveys and assessment of the main habitats/communities present on rocky areas. The density of specimens on the rocky shores was assessed using the SACFOR (ie Superabundant, Abundant, Common, Frequent, Occasional, Rare) scale. The report concluded that the Hayle estuary complex is of local interest for its estuarine communities and that nearby parts of St Ives Bay have a lower species richness than expected for habitats of this type.

Field survey methods

The most recent surveys of the aquatic invertebrates and seaweeds of the Hayle area were conducted in: February 2000, when a variety of intertidal and subtidal habitats were surveyed using four survey techniques (Smith, 2000); December 2006, when intertidal habitats in Penpol and part of Carnsew Pool were examined in detail (Aquatonics Ltd 2007a; Annexe 12F), and; May 2007, when the area seaward of the harbour was examined (Aquatonics Ltd, 2007b; Annexe 12G).

Invertebrates and algae

The 2000-2007 surveys by Smith and Aquatonics Ltd. utilised the following methods:

- Invertebrates and algae were identified during walk-over surveys and by analysing various types of samples (eg cores and net samples) brought back to the laboratory. Net samples were obtained from main channels and pools using a standard FBA net. Sampling time was standardised to two minutes, unless the water body being sampled was very small, when it was reduced to about a minute
- Core samples (11.2 cm diameter in all surveys since 2000) were taken to a depth of 15 cm where possible and placed in labelled plastic bags. In the laboratory cores were sieved through a 0.5 mm mesh and the material remaining on the sieve was fixed in 4% buffered formaldehyde. Samples were later re-sieved and washed, then sorted under a binocular microscope under at least 7x magnification. Specimens were identified to species level where possible. Any difficult or unusual specimens were sent to Dr Peter Garwood (marine ecologist with specialist knowledge of benthic fauna) for external verification or identification. All species recorded were given the appropriate Marine Conservation Society code (Howson and Picton, 1997)
- Biotope matching was done mainly in the field for hard substrate habitats, but for the sediment shores most biotope matching was done during report preparation, when data from the cores could be included

Full details of sampling sites, methods and results are provided in the following reports: Smith, 1989 (and 2000; Aquatonics Ltd 2007a (Annexe 12F) and 2007b (Annexe 12G).

Fish

Fish surveys were carried out in 2001 by the Environment Agency, using seine nets of various sizes. The survey areas were Carnsew Pool, Copperhouse Pool, Hayle Harbour and Lower Lelant Water. Fish were identified to species level where possible, counted and returned to the site where they were obtained. Selected fish (flounder, bass, golden-grey mullet and gilthead bream) from Carnsew were measured and some were also weighed. Full details of sampling sites, methods used and fish species recorded are contained in the two reports prepared by Forster & Smith (Forster and Smith, 2001a and 2001b.

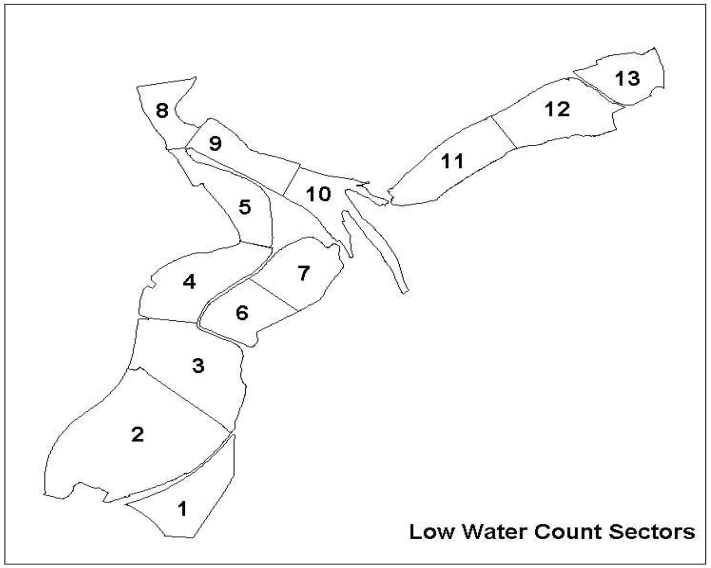
12.3.1.3 Ornithology baseline data collection

Previous studies

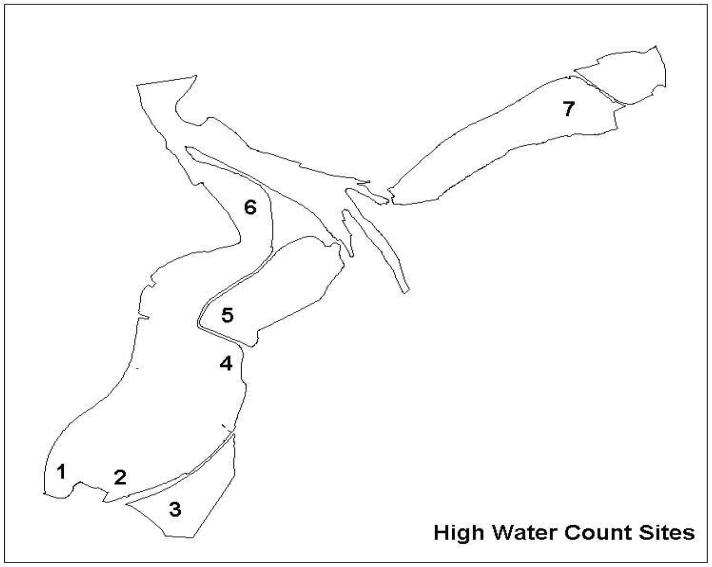
A number of ornithological monitoring programmes have been conducted within the Hayle Estuary in recent years, both in relation to potential development programmes in the estuary, and as part of the national Wetland Bird Survey (WeBS) programme. As part of a previous potential development plan for the site ornithological surveys were undertaken around the Hayle Estuary in 2000-2001 (Evans *et al* 2002), covering the entire estuary at different tidal states and on a sectoral basis. The findings of this study are summarised in Appendix 12T.

Ornithological survey methods

With the introduction of the current development proposal by ING Ltd, a targeted waterfowl monitoring programme was initiated at the site to run from December 2004 to November 2005. This programme recorded system usage by waterfowl on the same sectoral basis as the 2000/1 programme; see Figure 12.3 below. In addition, a greater emphasis was placed within the methodology on the collection of disturbance related information, based on standard methods (e.g. Bibby *et al*, 1992 & IECS, 1999), in the context of the changed proposals at the site.



Low Water Count Sectors



High Water Count Sites

LOW WATER

1. Ryan's Field
2. Lelant SW
3. Lelant SW of Carnsew
4. Lelant NW of Carnsew
5. Lelant N
6. W Carnsew
7. E Carnsew
8. Estuary Mouth
9. Outer Harbour
10. Inner Harbour
11. W Copperhouse
12. E Copperhouse
13. Copperhouse Saltings

HIGH WATER

1. Lelant Saltings
2. Grigg's Quay
3. Ryan's Field
4. Lelant Causeway
5. Carnsew Pool
6. Triangular Spit
7. Copperhouse Pool

Hayle Harbour
Count Sectors used in 2000 -01 and 2004 -05 ornithological survey programmes

Figure 12.3
not to scale
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Annexe 12H contains detailed information on the findings of the 2004/5 ornithological monitoring programme, as well as summarising findings from previous programmes on the Hayle estuary. The majority of the baseline characterisation and subsequent assessment has been based upon the 2004 to 2005 dedicated survey programme.

The 2004 – 2005 ornithological monitoring programme involved weekly waterfowl counts undertaken across the Hayle estuary site each month over a year. The site was divided into a series of count sectors, using the same site divisions as the original monitoring programme in order to maximise dataset comparability. Two main counts were then conducted across the estuary on each survey date, covering the low water and high water periods (c. 2 hours either side of high and low water). Species, activity and numbers were logged for each count sector and a general 'activity' score or descriptor given to each site per count. This score described the level of anthropogenic activity in the area. Where significant disturbance impacts were noted, descriptions of the activity and any avifaunal response were made. A general log of tide, weather and other factors (for instance impoundment of the Copper House Pool) was also maintained for each count.

Since a key component of the programme was to characterise the disturbance response of waterfowl to a number of stimuli, efforts were made to minimise surveyor disturbance at all times. Given the baseline nature of this work, and the potential use of the data in assessing potential impacts to avifauna from the development, including construction and operation, opportunities to observe *ad hoc* disturbance activity and avifaunal responses, including any potential habituation, were maximised. In detail:

- A series of single point counts were conducted across the already identified zones. Species and abundance within each zone were noted, together with activity (roosting, feeding, loafing *etc*). Where observed, the response of avifauna to a disturbance stimuli was noted, using a simple numerical magnitude response association, for instance:

Type 1 – no response observed

Type 2 – behavioural changes. Behaviour noted - heads-up, stopped feeding, distraction feeding etc

Type 3a – movement down or along shore in zone (walking). Settlement time noted

Type 3b – movement down or along shore in zone (flying). Settlement time noted

Type 3c – obvious existing displacement response within zone (for an existing response that commenced prior to arrival to carry out count)

Type 4 – movement out of zone into adjacent area (flying, walking or swimming). Settlement time noted

Type 5 – movement out of zone and out of area or view (flying). Direction of movement noted

- In all cases, species and numbers affected, as well as the type of disturbance stimuli, were noted (ie walker, dog walker, jogger, bird watcher, raptor/gull overflight by helicopter or aircraft, quad bike use, jet ski, sailboat, car/van, JCB, other type of vehicles), and judgement made on the frequency of the activity, ie for instance regular vehicle movements on the causeway, frequency of dog walkers on the path around Carnsew Pool. Noise related disturbance was also logged as appropriate (type, duration and frequency of occurrence) as well as the location of significant single disturbance events, the general level of activity for the count sector, and any variability in waterfowl response to similar activity over a tidal cycle

12.3.2 Definition of key terms in ecological impact assessment

Explanation of the term *impact*

The aim of the ecological impact assessment is to identify likely significant ecological effects, referred to as impacts, which would be produced in the natural (habitats, flora and fauna) terrestrial and/or aquatic environment. In line with the Institute of Ecological and Environmental Management (IEEM) this document uses the term impact rather than effect when referring to the way the ecology may be affected by a proposal (IEEM, 2006).

Explanation of the term *receptor*

The ecological feature which is being affected by the impact is termed the receptor; key ecological receptors are features that have been assessed as being of value within the context of the proposals and the EIA.

12.3.3 Assessment of conservation value of receptors

The IEEM assessment guidelines (2006) have been used to establish the value, or sensitivity, of terrestrial habitats and species impacted by development. For aquatic ecology and ornithology, published assessment criteria developed specifically for assigning conservation value to i) aquatic invertebrate and algae communities, and ii) waterfowl assemblages, have been used (references are given below).

12.3.3.1 Criteria for assessing conservation value of terrestrial ecology receptors

The approach to ecological evaluation advocated by the IEEM guidelines (2006) involves professional judgement, based on available guidance and information, together with advice from experts who know the locality of the project and/or the distribution and status of the species or features that are being considered. The analysis aims to assign value to an ecological resource or feature with reference to a defined geographical scale, ie:

- International
- UK
- National (ie England)

- Regional
- County
- District
- Local / Parish, and / or
- within immediate zone of influence only

Sites which are subject to statutory and/or non-statutory designation may be readily assigned a value on this scale, for example:

- Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are internationally important sites
- Sites of Special Scientific Interest (SSSI) are nationally important sites
- in Cornwall, County Wildlife Sites (non-statutory) are of county value

Where an area has more than one designation, the highest of these has been used to assign significance. Features of a site that are not the reasons for its designation(s) are assessed and valued according to their intrinsic value.

Where a site contains features which do not meet the criteria for sites of local value, but which nevertheless do have some biodiversity interest, it is assessed as being of value 'within the immediate zone of influence only'.

In assigning value to species, reference to a species' geographical distribution, and its population status (eg widespread, common, rare) and trends (eg. declining, stable) has been made. A species that is rare and declining may be assigned a higher level of importance than one that is rare but known to be stable. Species which have a significant proportion of their European population in the UK may also be highly valued.

Species and habitats that have been assigned action plans in the UK and Cornwall Biodiversity Action Plans have been highlighted; however the assignment of a plan does not in itself ascribe valuation but provides conservation actions that have been formulated for the species or habitat and therefore implies a measure of nature conservation concern.

12.3.3.2 Criteria for assessing conservation value of aquatic ecology receptors

Published conservation assessment categories were used to assign importance to aquatic invertebrates and algae found in the Hayle estuary complex. The definitions of Local, Regional, National and International importance have been defined by the JNCC (Davidson *et al,* 1991), as follows:

- **"International:** communities which are outstandingly good examples of their type in the north-east Atlantic; communities recorded at only a few locations in the north-east Atlantic; species which are recorded at only a few locations in the north-east Atlantic; species recorded in higher abundance in

the area under consideration than anywhere else in the north-east Atlantic or where the area is one of only a very few locations where large quantities are recorded

- **National:** communities which are outstandingly good examples of their type in Britain; communities recorded in only a very few similar physiographic situations in Britain (both of these definitions refer to communities which are or are likely to be widely occurring in other similar physiographic situations in the north-east Atlantic); species which are recorded at only a few locations in Britain but are more widespread in other parts of the north-east Atlantic; species recorded in higher abundance at locations under consideration than in any others elsewhere in Britain or where the site is one of only a very few locations where large quantities are recorded in Britain
- **Regional:** communities which are present in similar physiographic situations elsewhere in Britain but which are outstandingly good examples of their type in the location under consideration or are as good examples as similar communities present elsewhere in Britain; communities recorded at only a few locations in the same biogeographic region; species which are unrecorded or recorded at only a few locations in similar physiographic situations in Britain but which are widespread in other similar sites in other parts of Britain; species recorded in higher abundance in the area under consideration than in any other part of Britain or where the site is one of only a very few locations where large quantities are recorded in Britain
- **Local:** communities which are widespread throughout Britain with as good or better examples at several other locations. The selection of only species which are of higher than local importance precludes the use of this category in the species lists"

12.3.3.3 Criteria for assessing conservation value of ornithological receptors

Where applicable, standard criteria for conservation importance have been applied, based upon those described in Banks et al, 2006, whereby importance reflects a 1percent threshold: for International Importance this equates to a site supporting over 1percent of a population (geographic or fly-way) of a species and for National Importance, 1percent of the UK population of a species. In addition, Regional/Local Importance has been ascribed to a species representing 1percent or more of a system population (e.g. the Hayle Estuary or local coastal area).

12.3.3.4 Methods for assessing nature and significance of ecological impacts

Impact identification

The sensitivity (and recoverability) of receptors to an impact was identified, as far as current knowledge allows, during the EIA process. Generally this was, by necessity, a qualitative assessment based on published literature and best available scientific information.

Impact characterisation

Impacts were characterised by reference to the following terms and definitions:

- *positive* (with a beneficial biodiversity/nature conservation outcome)
- *negative* (with an adverse outcome)
- *direct* (usually the most obvious impacts, such as measurable habitat loss through removal)
- *indirect* (loss as a consequence of a direct impact)
- *temporary* (where a return to baseline conditions would occur after the impact)
- *permanent* (where a return to baseline conditions would not occur)
- *beneficial* (where there is gain in terms of nature conservation objectives or biodiversity)
- *harmful* (where there is loss in terms of nature conservation objectives or biodiversity)
- Other key characteristics of impacts identified in the assessment were:
- *magnitude*, referring to the size or amount of an impact (where possible this is quantified from data such as measure of extent or counts of population)
- *extent*, ie the area over which the impact occurs
- *duration* (in ecological assessment, the time over which the impact is predicted to last, normally defined in terms of relevant ecological characteristics (such as life cycles) rather than human timescales)

Consideration was given to the potential for impacts to interact with other impacts (either arising from the proposed development or a different (external) source), thus producing a cumulative effect (often of greater magnitude).

Impact significance

An impact may or may not be significant. An impact was assessed as being potentially significant when it was identified as potentially affecting:

- features of international or national importance such as designated sites or legally protected habitats or species
- features that are highlighted as being of nature conservation concern in national, regional and local policies

Residual impacts

During the EIA process the available means to avoid, minimise or mitigate for negative impacts were identified. Then, subject to their acceptability, these means were incorporated in the design of the proposal, so that the final assessment of impact identified impacts that would be left. The consequences for development control, policy guidance and legislative compliance were then identified from the predicted residual impacts.

Levels of confidence in assessment

There were limitations to the level of confidence with which predictions of impact were made. The limits arose from:

- the available information on the sensitivity of the receptor
- the current understanding of the impact process and its complexity

In line with the convention in ecological impact assessment, a level of confidence was attached to most predictions, although the assessment was in some instances based on expert judgement rather than documented evidence.

12.3.4 Consultations

Consultations with statutory and voluntary nature conservation agencies were undertaken during the course of the masterplan design stages. The principal method of consultation was 'round table' meetings with relevant agency officers, in order to identify potentially significant ecological impacts and the scope of mitigation measures required to address these. Dates of round-table meetings and an indication of consultee attendance are provided below.

26 July 2005	Natural England (formerly English Nature); Environment Agency; Cornwall County Council; RSPB; Cornwall Wildlife Trust.
12 January 2006	Natural England; Environment Agency; Cornwall County Council; RSPB.
23 May 2007	Natural England; Environment Agency, Cornwall County Council; RSPB.

In addition, individual meetings with selected agencies were undertaken when seeking advice on specific aspects of baseline surveys and/or possible mitigation strategies, for example:

- prior to the initiation of the 2004/05 ornithological monitoring programme, key issues were discussed in on-site meetings with Natural England and the RSPB, and based on the outcomes of these a robust data collection methodology was identified

- in 2007, meetings were held with Cornwall County Council to confirm the scope of past protected species surveys and contents of a potential mitigation strategy for reptiles; a meeting was also held with Natural England focusing on management options for the Triangular Spit (primarily relating to the Schedule 8 species petalwort, *Petalophllum ralfsii*)

12.4 Baseline conditions

Baseline conditions are described below for the three key ecological components relevant to the proposed development:

- terrestrial ecology
- aquatic ecology, ie. estuarine invertebrates, marine algae and fish
- ornithology, ie migratory and wintering aquatic bird species (terrestrial breeding birds are considered under the terrestrial ecology section)

Current site land uses and operational conditions relating to the harbour are described where these have a significant influence on species' distribution and/or abundance, or on habitat quality.

12.4.1 Baseline data for terrestrial ecology

Summary accounts of the results obtained from field surveys of separate areas of the proposed development site are provided below. See Figure 12.1 for locations of areas referred to.

12.4.1.1 Ecological characteristics of the Triangular Spit

(i) Habitat types

The Triangular Spit comprises a flat segment of land which separates the main harbour area to the north from Carnsew Pool and the channel of the River Hayle to the south and west. The broad range of habitats present comprises:

- A dune formation on the western side of the Spit, with a small area of open dune and dune grassland behind a narrow beach. The open dunes support abundant marram (*Ammophila arenaria*), sea spurge (*Euphorbia paralias*), sand sedge (*Carex arenaria*) and sea bindweed (*Calystegia soldanella*); abundant rest-harrow (*Ononis repens*) and ragwort (*Senecio jacobaea*) are characteristic of the stabilised dunes
- A central open area of sparse grassland dominated by a bryophyte flora and interspersed with loose-gravelled tracks and hardstanding

- Areas of ruderal vegetation and scrub along the Spit's southern and eastern margins, interspersed with small areas of grassland. The scrub includes bramble (*Rubus fruticosus*), gorse (*Ulex europeaus*), and non-native species such as sea buckthorn (*Hippophae rhamnoides*) and buddleja (*Buddleja davidii*).

All vegetation types are subject to intensive grazing pressure by the large rabbit population that occurs on the Spit.

(ii) Plant species of note

Surveys carried out in 2001 (The Environment Practice) and 2005 (Spalding Associates, 2005f) have recorded several vascular plant species of local and regional interest on the Triangular Spit. These are listed below with details of their population size on the Spit and conservation status in Cornwall.

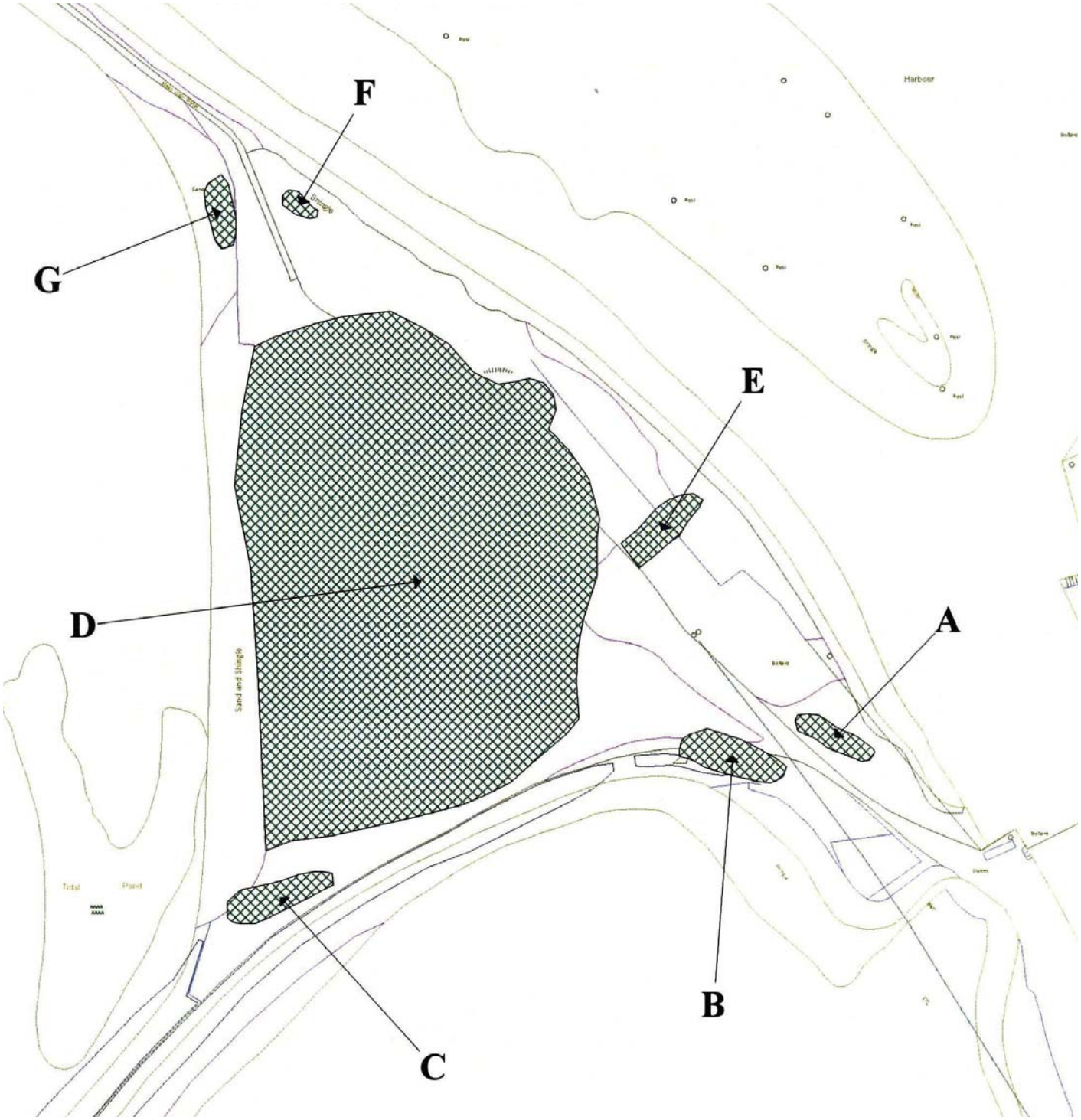
Species	Distribution / population on Spit[1]	Notes on conservation status[2]
Anacamptis pyramidalis Pyramidal Orchid	c.180 flowering spikes recorded in 2001, 60% of these in grassland adjacent to southern margin of Spit, remainder in NW and SE corners.	Distribution in Cornwall localised; most county records around Hayle area and further east at Penhale.
Eryngium maritimum Sea Holly	c.220 plants recorded in 2001 within dune formation on west side of Spit.	Frequent on north coast of county; characteristic of beaches / dunes.
Orobanche hederae Ivy Broomrape	c.20 plants recorded in 2001 at SE corner of Spit, and 121 in 2005 from the southern end of Middle Weir; associated with growth of ivy.	Described in Murphy (1999) as 'rare [in the County], but can be locally frequent'; persists in the same place year-on-year. Formerly 'Nationally Scarce' in UK, now of 'Least Concern' (JNCC 2005).
Scrophularia scorodonia Balm-leaved Figwort	100-150 plants recorded in 2001, concentrated at south shore of Spit; 891 plants recorded in 2005, in south-eastern and eastern areas of Spit.	Recent introduction to GB rather than native; formerly 'Nationally Scarce' in UK, largely confined to Cornwall; colonises disturbed land.

Table 12– 2: Vascular plants of conservation interest recorded at Triangular Spit

[1] Several of the above species also occur elsewhere in terrestrial habitats at Hayle (see below).

[2] Based on reference to Murphy, R.J. (1999), *Flora of Cornwall CD-ROM* (Cornish Business Systems) and JNCC (2005), *The Vascular Plant Red List for Great Britain* (Joint Nature Conservation Committee).

The 2005 survey for bryophytes (see Annexe 12A) recorded significant numbers of the Nationally Scarce liverwort species petalwort (*Petalophyllum ralfsii*) on the Triangular Spit. Eight areas supporting populations of the plant were identified; the largest area covers the central region of the Spit, as shown in Figure 12.4, and supports an estimated 216,000 'thalli' (stem-like structures regarded as individual components of the plant colony), while the other seven areas are distributed towards the three 'points' of the triangle of land and in total support a further c.10,000 thalli. The overall estimate of petalwort thalli on the Triangular Spit, of just over 227,000, exceeds the combined total for all other sites in Cornwall from surveys during the 2004-05 winter (Plantlife, unpublished data) and the combined total for all sites in England. An audit of UK petalwort populations and their protected status was carried out by Plantlife (2000), and the results imply that only seven populations in the UK exceed 10,000 thalli, within an overall total that is under 1 million. The Triangular Spit at Hayle Harbour thus supports at least 20% of the total U.K. population of the species.



Hayle Harbour
Plan of Triangular Spit, Hayle, showing location of colonies of petalwort Petalophyllum ralfsii (February 2005)

Figure 12.4
not to scale
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date November 2007

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Petalwort is accorded statutory protection in the UK since it is listed on Schedule 8 of the Wildlife & Countryside Act (1981). It is also listed on Annex II of the EC Habitats Directive, and the European *Bryophyte Red Data Book* lists it as 'Vulnerable'. Within the UK BAP, it is listed as a Priority species and the Action Plan for the species within the UK BAP has the following targets: T1 - Maintain the population size at all extant sites; T2 – Maintain the geographical range.

The Triangular Spit receives regular recreational use, primarily from people accessing the small beach on the western side of the Spit, and from dog-walkers. The latter use has potential to adversely affect petalwort growth through nutrient enrichment of the habitat and disturbance of rabbit-grazing (essential to maintain the short sward conditions preferred by petalwort).

(iii) Records of fauna

The dune formation and areas of scrub provide a limited area of habitat potentially suitable for reptiles, and hence a reptile survey was conducted here in 2005 (Spalding Associates 2005i). No reptiles were recorded, probably because migration of reptiles into the site is deterred by: (i) built-up land located between the Spit and the nearest suitable reptile habitat (North Quay); (ii) heavy use of the site by the general public resulting in a high level of disturbance.

Data supplied by ERCCIS indicate that evidence of otter (*Lutra lutra*) presence was recorded in 2004 in the vicinity of the Triangular Spit, at its southernmost extremity near the sluice tunnels that enter Carnsew Pool. The otter receives statutory protection in the UK as it is listed on Schedule 5 of the Wildlife & Countryside Act (1981) and also on Annex II of the EC Habitats Directive; the otter is also a UK BAP priority species, and a Species Action Plan has been published for the otter in the County BAP (see section 2.4). Consultation with the Cornwall Wildlife Trust indicates that otters are known to frequent the Hayle River and have been sighted in the reedbed / saltmarsh habitat that occurs at the southern end of Lelant Water; it appears likely that animals may move north along the shores of Lelant Water to forage for fish and shellfish in and around Carnsew Pool, although there is no suitable resting or breeding habitat here.

12.4.1.2 Ecological characteristics of South Quay

(i) Habitat types

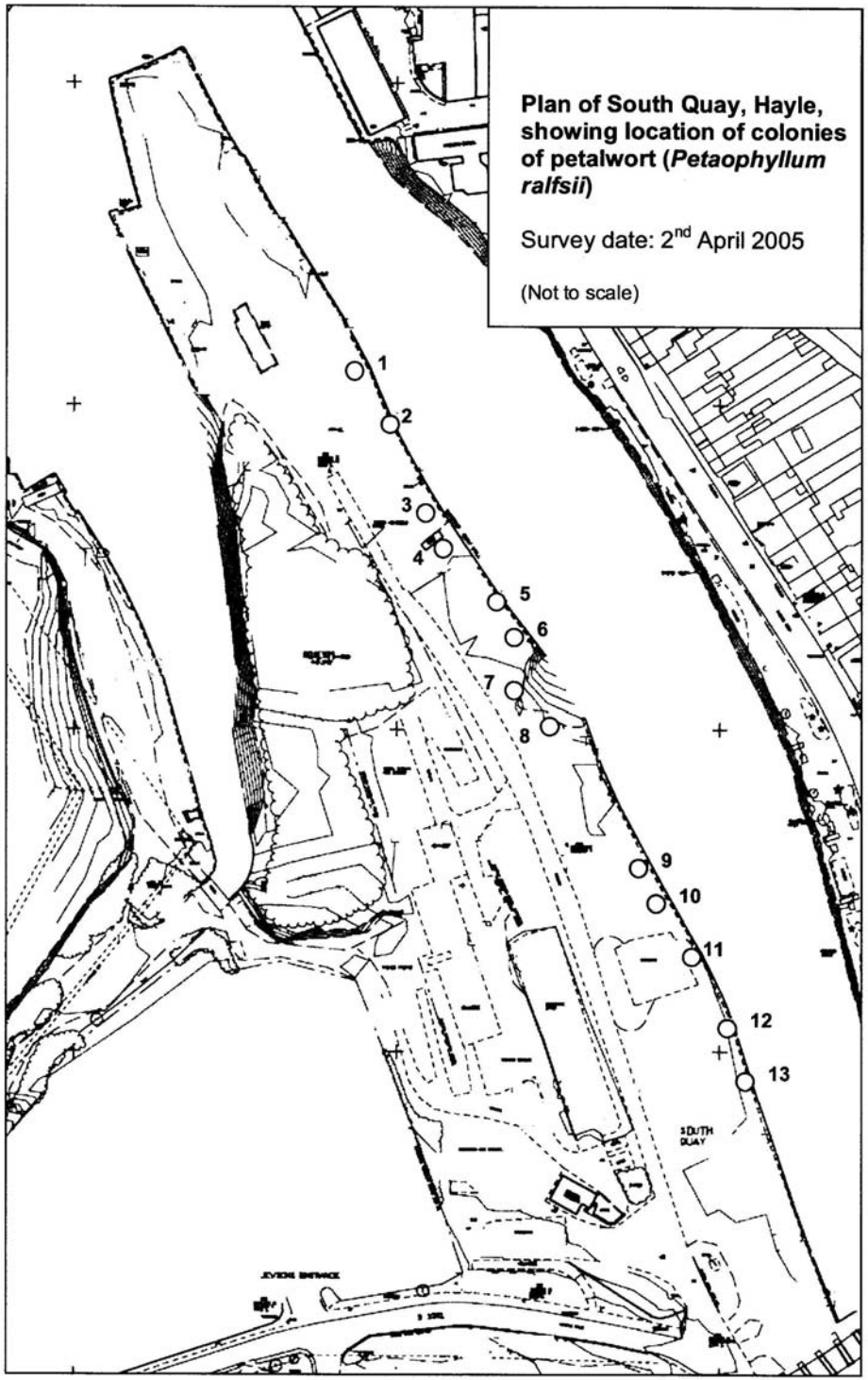
The majority of land at South Quay is open, unvegetated ground used for parking and vehicle access to the quaysides. Semi-natural habitats cover only c.15% of the site and consist of small areas of sparse grassland interspersed with bryophytes along a narrow strip on the eastern margin of the quay, along with sparse scrub and ruderal vegetation which has colonised tipped material on the western side of the quay.

Given the sparseness of semi-natural habitats and relatively high levels of access and disturbance, the potential for protected species of fauna to occur at the site was considered low and no faunal surveys were conducted on South Quay.

(ii) Plant species of note

A survey carried out in 2001 (The Environment Practice) recorded one plant species of local interest on South Quay, balm-leaved figwort (*Scrophularia scorodonia*); c.90 specimens were recorded, primarily from the western region of the Quay. A survey for rare plants in 2005 recorded 479 balm-leaved figwort plants here, distributed over a similar area, and also 71 specimens of ivy broomrape (*Orobanche hederae*).

The Nationally Scarce and protected liverwort species, petalwort (*Petalophyllum ralfsii*), was found on South Quay during a survey in April 2005 (Spalding Associates 2005d), in 13 small discrete colonies all located on open sandy soil that has accumulated along the harbour walls at the eastern margin of the site; see Figure 12.5. The number of thalli recorded at each colony varied from 1-17; given the scarcity of suitable habitat for the plant, the total size of the population here is estimated to be in the low hundreds.



Hayle Harbour

Location of colonies of petalwort on South Quay (2005)

Figure 12.5
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date November 2007

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(iii) Records of fauna

The sole building present on South Quay (known as Blue Haze) was examined during November 2006 to assess whether it could support roosting bats. This is a detached single-storey concrete block building with a flat roof. It was assessed externally only owing to access difficulties, but it was judged that it could be used by roosting bats since gaps between the roof and walls were apparent. (Emergence surveys would be carried out prior to demolition of the building).

12.4.1.3 Ecological characteristics of East Quay

(i) Habitat types

Almost all the land at East Quay currently accommodates commercial buildings and associated hardstanding for access and parking. A narrow strip of coarse grassland, ruderal vegetation and bramble scrub is present on the eastern side of the quay. Given the small area and disturbed nature of habitats here, and the relatively high levels of access and site use, the potential for protected species of fauna to occur at the site was considered low and no faunal surveys were conducted at East Quay.

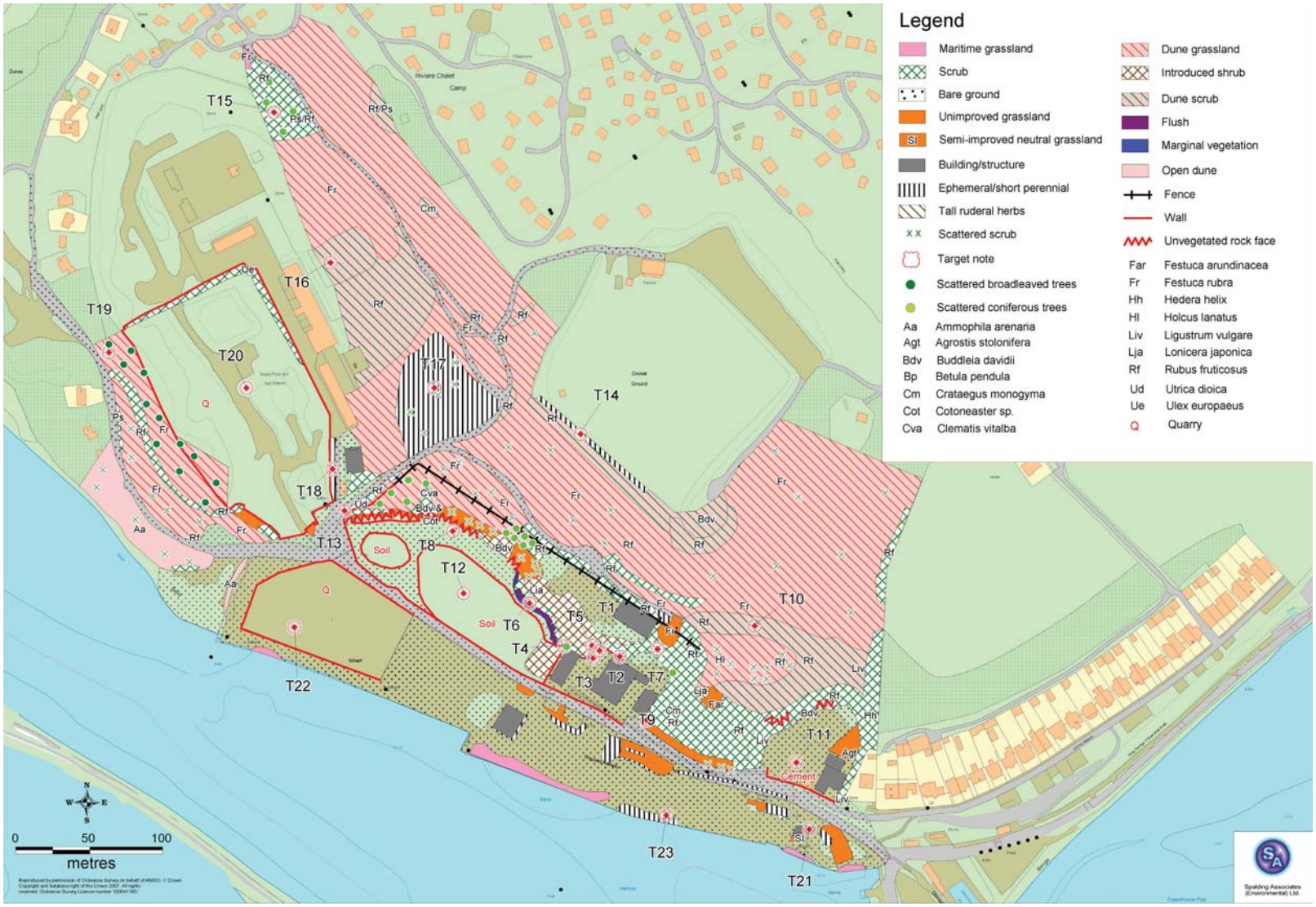
(ii) Plant species of note

Owing to the lack of suitable habitat for petalwort, a survey for this species was not conducted at East Quay. A survey for rare plants in 2005 (Spalding Associates 2005f) recorded 400 specimens of ivy broomrape (*Orobanche hederae*), found primarily in an alleyway between two buildings on the west side of the Quay.

12.4.1.4 Ecological characteristics of North Quay

(i) Habitat types

The area surveyed at North Quay lies immediately landward of the North Quay harbour walls, rising from the quay level over low hills to the southern margin of the Hayle cricket ground, beyond which lies the dune system of Riviere Towans. The survey area also encompasses the quaysides and derelict buildings, areas of land used for small scale industrial purposes, industrial buildings and enclosing walls, access tracks, land adjacent to the electricity substation, four quarried areas, and parts of the dune system on the margins of the cricket ground. All habitats within this area were classified and mapped using the standard Phase 1 habitat survey methodology (JNCC, 1990), and are shown on Figure 12.6; distinctive land use features and vegetation types are annotated as 'target notes'.



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Hayle Harbour

Map of Phase 1 Habitats at North Quay, Hayle

Figure 12.6
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date November 2007

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The principal habitat types identified were as follows (Spalding Associates 2005c).

- Dune grassland is the most common semi-natural habitat on the site, found on the higher levels of the site where blown sand overlies the soils. In total, the dune grassland in the surveyed area covers 7.9 hectares, and forms part of the Riviere Towan complex that extends beyond the northern part of the site. The dune grassland is dominated by red fescue grass (*Festuca rubra*) with varying amounts of marram grass (*Ammophila arenaria*) and associated herbs such as lady's bedstraw (*Galium verum*) and bird's-foot trefoil (*Lotus corniculatus*), a vegetation composition typical of fixed dune grassland in Cornwall. Such dune grassland is a European priority habitat, listed in Annex I of the EC Habitats Directive (coastal dune systems and their component habitats are threatened and declining in Europe); the UK Biodiversity Steering Group has produced a national Habitat Action Plan for this BAP Priority habitat, and there is also a Habitat Action Plan for county sand dune systems contained in the Cornwall BAP, Volume 3 (2004; see section 2.4)
- Unstable open dune habitat, covering 1.3 hectares, occurs on the unconsolidated sand of Hayle Towans, along the northern estuary shore. Here the vegetation has a higher component of marram and fewer plant species overall
- Throughout the site, extensive areas of scrub occur as both continuous stands and scattered patches. The scrub that occurs on the dune grassland covers 1.1 hectares and is largely dominated by bramble, but locally abundant growths of wild privet (*Ligustrum vulgare*) and blackthorn (*Prunus spinosa*) also occur, which gives it a distinctive dune habitat character. South of the dune grassland the scrub includes more abundant hawthorn (*Crataegus monogyna*), and there are local dominances of traveller's-joy (*Clematis vitalba*) and an extensive growth of ivy (*Hedera helix*) on the cliff faces of the quarries. Scrub adjacent to the industrial areas is dominated by non-native species, largely butterfly bush (*Buddleja davidii*) but with scattered cotoneasters (*Cotoneaster* spp.) and Japanese honeysuckle (*Lonicera japonica*). Tree growth on the site is limited to localised planting of young broadleaves and more mature plantings of Monterey Pine

Other, more localised, habitats at North Quay include small areas of neutral grassland associated with neutral soils from the underlying stone, maritime grassland which is largely restricted to the margins of the quays, several localised areas of ephemeral/perennial plant communities on open, disturbed ground, and small areas of wet seepage on vertical quarry faces that support common marginal vegetation and bryophytes.

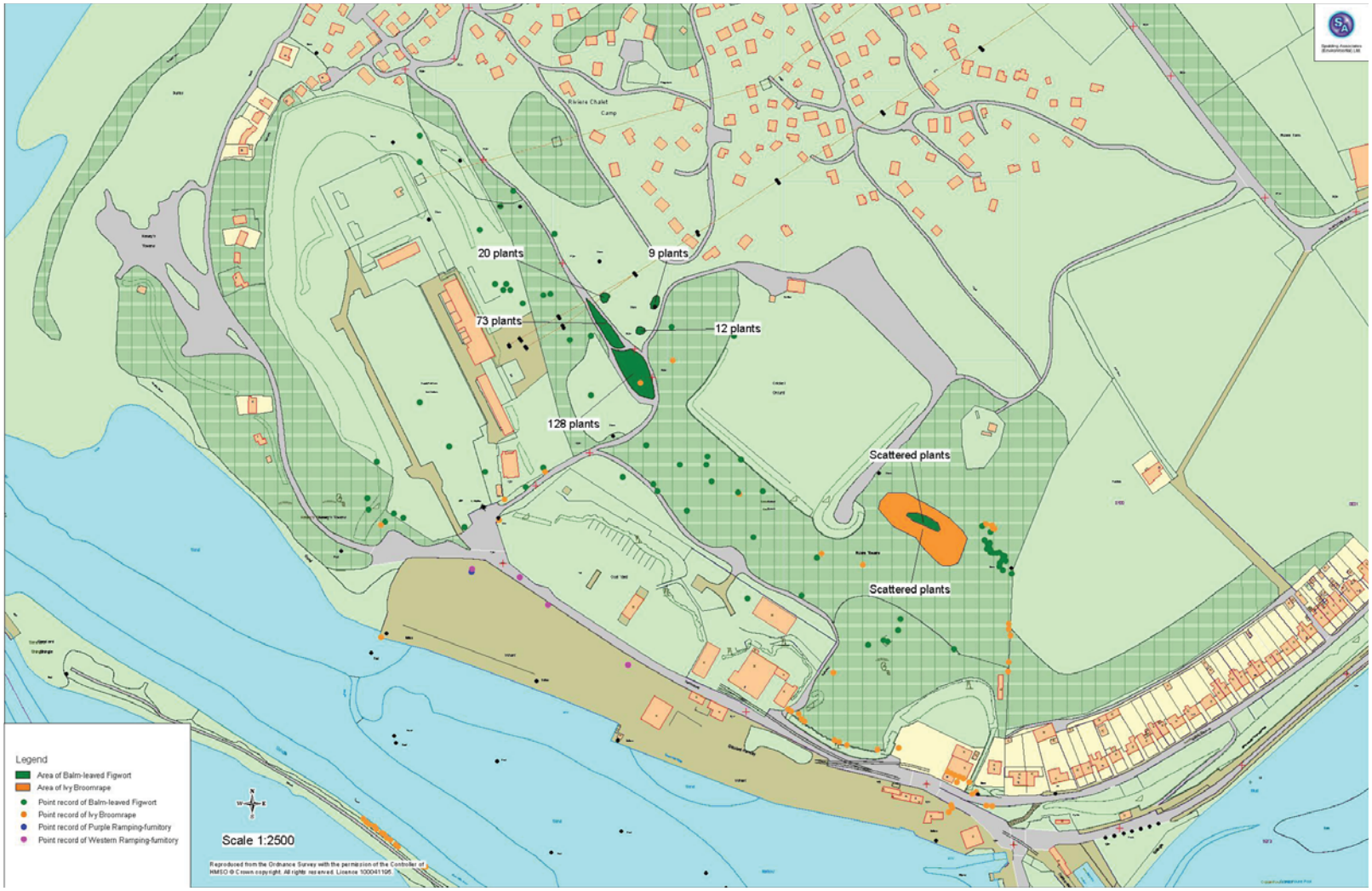
(ii) Plant species of note

No vascular plant species with statutory protection were found during the Phase 1 survey of North Quay, but past records of three rare species were held for the area by ERCCIS (2005):

- western ramping fumitory (*Fumaria occidentalis*)
- purple ramping fumitory (*Fumaria purpurea*)
- ivy broomrape (*Orobanche hederae*)

Surveys carried out in 2001 (The Environment Practice) confirmed the presence of ivy broomrape at North Quay, and recorded further species of interest including balm-leaved figwort, pyramidal orchid and sea holly. Further surveys for the fumitory species, ivy broomrape and balm-leaved figwort were conducted in 2005 (Spalding Associates 2005f) to provide up-to-date data on their presence and distribution at the site.

The results of the 2001 and 2005 surveys are provided in the table below, with details of plant population sizes at North Quay and the species' conservation status in Cornwall. Figure 12.7 illustrates the locations of rare plants recorded at North Quay during the 2005 survey.



Hayle Harbour

Records of rare plants at North Quay, Hayle (July 2005)

Figure 12.7
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Species	Distribution / population at N. Quay	Notes on conservation status[1]
Anacamptis pyramidalis Pyramidal Orchid	c.1800 flowering spikes recorded in 2001, 90% in dune grassland to south and SE of cricket pitch.	Distribution in Cornwall is localised; most county records around Hayle area and further east at Penhale.
Eryngium maritimum Sea Holly	One plant recorded in 2001 in open dunes at western end of quay.	Frequent on north coast of county; characteristic of beaches / dunes.
Orobanche hederae Ivy Broomrape	c. 1600 plants recorded 2001, in dune grassland with ivy scrub, south of cricket ground and south of power station site; 626 plants recorded 2005, mainly in dune grassland / scrub in east of site.	Described in Murphy (1999) as 'rare [in the County], but can be locally frequent'; noted to persist in same place year-on-year. Formerly classed as 'Nationally Scarce' in UK, but now 'Least Concern' (JNCC 2005).
Scrophularia scorodonia Balm-leaved Figwort	c.350 plants recorded in 2001, in dune grassland south of cricket ground and south of power station; 1231 plants recorded 2005, in dune grassland / scrub habitats.	Regarded as recent introduction to GB rather than native, but formerly classed as 'Nationally Scarce' in UK, and is largely confined to Cornwall; frequent coloniser of disturbed land.
Fumaria occidentalis Western ramping fumitory	32 specimens of the plant were recorded during the 2005 survey, primarily around the western end of the access road that runs between the quayside and former quarried areas.	Endemic; not under threat (Least concern) (JNCC, 2005). Almost entire population is in west Cornwall; a priority UK and Cornwall BAP species. Found widely in Hayle on disturbed (mainly arable) ground.
Fumaria purpurea Purple ramping fumitory	A single plant was recorded in the 2005 survey, at the western end of the North Quay access road.	Endemic: not under threat (Least concern) (JNCC, 2005). Regarded as persistent rather than casual in its habit in the Hayle area.

Table 12– 3: Vascular plants of conservation interest recorded at North Quay

[1] Based on reference to Murphy, R.J. (1999). *Flora of Cornwall CD-ROM* (Cornish Business Systems) and JNCC (2005). *The Vascular Plant Red List for Great Britain* (Joint Nature Conservation Committee).

(iii) Records of fauna

The dune grassland, scrub and other habitat features at North Quay potentially provide suitable habitat conditions for the following animal groups:

- breeding birds, which are likely to find breeding sites and shelter in shrubby vegetation, scrub habitat and buildings
- reptiles, principally common lizard, adder and grass snake, which may utilise the south-facing slopes where exposed, sunny banks and stone / vegetation cover is available
- invertebrates associated with dune vegetation and sandy substrates
- bats, which may utilise built structures / quarry faces as roost sites

Surveys for each of the se groups were conducted at North Quay in 2005-07 (Spalding Associates, 2005e, 2005g, 2005i and 2005j, 2006 and 2007a) to determine whether the site supports species of conservation significance. The results are summarised in the table below.

Breeding birds	A total of 29 bird species was recorded within the survey area; 21 showed evidence of breeding on site. The bird community included songbird species typical of urban, garden and hedgerow habitats. Dune scrub habitats and associated bushes and low vegetation provide a mixture of open habitat for feeding and nesting sites, particularly valuable for: • dunnock (*Prunella modularis*) - 12+ breeding pairs recorded • linnet (*Carduelis cannabina*) - 8+ breeding pairs recorded* • whitethroat (*Sylvia communis*) - 6+ breeding pairs recorded • song thrush (*Turdus philomelos*) - two breeding pairs recorded* • stonechat (*Saxicola torquatus*) - one breeding pair recorded * These species are UK BAP Priority species; individual Species Action Plans have been published for these birds in the County BAP (see section 2.4) Buildings present provide nesting sites for house sparrow (*Passer domesticus*), starling (*Sturnus vulgaris*) and possibly swallow (*Hirundo rustica*). The large chimney

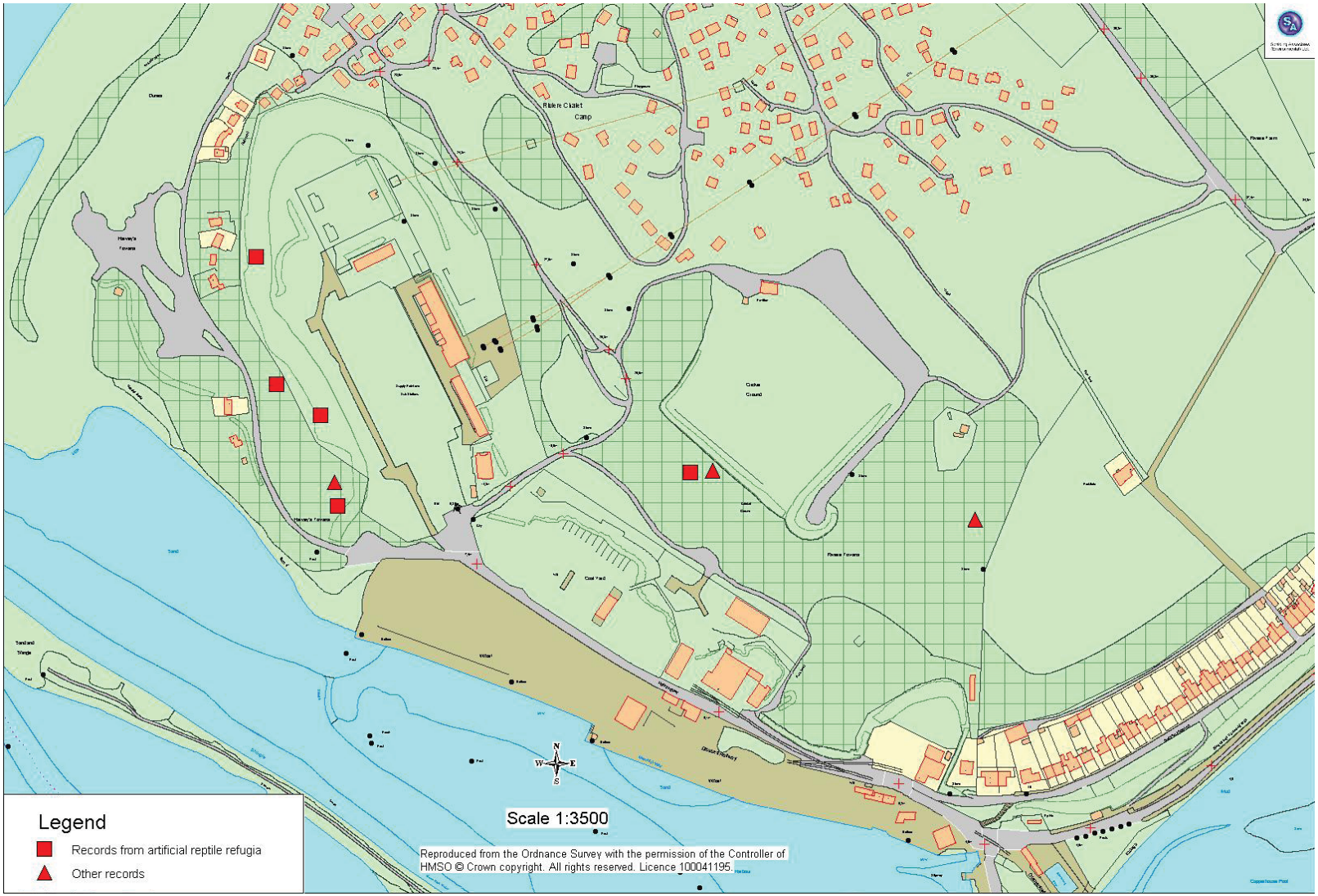
	at the western end of the site does not present nesting opportunities as the ivy growth is very sparse and there are no obvious gaps in the brickwork. The possibility of barn owls using the quayside buildings was investigated during the surveys of buildings for bats but no signs of use were found and the habitats and buildings were not considered suitable.
Reptiles	Adder (*Viper berus*), slow-worm (*Anguis fragilis)* and common lizard (*Lacerta vivipara*) were all recorded at the North Quay site and on adjacent land to the west; see Figures 12.8 – 12.10. During a total of seven survey visits, the highest number of any one type of reptile species recorded in a single visit was 61 slow-worm, five adders and 11 common lizards. Key locations for sightings were: • Adder – of nine basking sites recorded, five of these were in the dunes to the west of the electricity sub-station, with others amongst the dune grassland north of North Quay • Common lizard – this species did not show any particular habitat preference and were widely recorded in all types of habitat; it is likely that they use some of the range of built features found at the site, such as sections of built walls overgrown by scrub and grassland • Slow-worm – were only found under artificial refugia, either those set out specifically for the project or under waste material scattered over the site; animals probably occur throughout the site, since they were found in almost all localities except tall dune grassland in the east An initial evaluation of the importance of the site for reptiles based on guidelines provided by Froglife (1999) suggests that North Quay would qualify for status as a 'Key Reptile Site', given that it supports three reptile species and very high numbers of slow-worm. However, since the records were collected over a period of only eight visits they cannot be regarded as giving accurate figures for the true reptile population on the site, and the data are primarily of use in providing a good indication of the usage of habitat areas at North Quay by reptiles. In particular, while the count of adders was low, the likelihood is that data from the survey under-represents the adder population since the survey used felt refugia (due to the nature

	of the site), and most survey experts consider that adders are less inclined to use felt than tin refugia. The habitats used by reptiles at North Quay have open access and are subject to regular recreational use, primarily by pedestrians (eg accessing the Riviere Towans chalet camp) and dog-walkers; these activities probably cause continued low-level disturbance to the reptile populations.
Invertebrates	176 invertebrate species were recorded, including the nationally rare tachinid fly *Policheta unicolor,* the flea beetle *Ochrosis ventralis*, and the bumblebee *Bombus humilis*. The latter species is referenced in the Cornwall BAP, and has recently been found to be widespread in suitable habitat along the coasts of Cornwall, where it has probably been under-recorded in the past due to difficulties with identifications; North Quay is probably of local significance for this species. Three nationally scarce species were recorded: the ruby-tailed wasp *Chrysis illigeri*, the solitary wasp *Lestiphorus bicinctus* and the solitary leaf-cutter bee *Megachile dorsalis*. The main invertebrate interest lies in open habitat within the dune grassland, where large numbers of thermophilic insects (especially the bees and wasps) were recorded. All species recorded are likely to occur on the adjacent dune grasslands at Phillack, Mexico and Upton Towans.
Bats	A renovated industrial chimney, a quarry face, adjacent shale cliffs, and several buildings (three disused) at North Quay were inspected in 2006 and 2007 to determine their suitability as bat roost sites. Figure 12.11 shows these features. Key findings of the surveys were: • Chimney – exterior, where ivy is growing, could provide roost sites for bats, and the interior may be suitable (access was not possible); no bats were detected emerging from the chimney • Quarry wall and cliff face – provides crevices and areas of ivy cover which could provide suitable bat roost sites; pipistrelle bats were detected on the cliff face and in the quarry, possibly feeding, in July 2007 • Harbour office – a detached two-storey stone building, used as offices; building appears well sealed with no suitable access points for bats, but access to the

	roof space may be possible between slates and the internal panelling • Old canteen – a reinforced concrete and block building with a concrete flat roof, with some cavity walls; no evidence of bats found but bats could use the cavity walls • Old stables – a roofless stone structure generally closely mortared, partly covered by dense ivy; only possible places for roosting bats are within or over the window and door lintels and beneath the ivy, although there could be smaller crevices within some large joist holes • Old shell shed – a detached, roofless single-storey building, block walls rendered with concrete; no crevices were found in this building and there are no possibilities for roosting bats • Octel buildings, café and training centre – a flat roofed concrete building on the quayside located at the base of the shrubby cliff face; the roof is well sealed and does not offer any potential roost sites for bats, but a broken window on the upper storey and a large hole above a doorway, as well as slits along the sides of large warehouse-type doors, could be used accessed by bats Walked transects over the dune grassland at North Quay in July 2007 have shown that bats are moving across the dune grassland, and probably feeding over this habitat, in particular adjacent to a stand of conifers on the north-east side of the power station. See Figure 12.11. Further pre-development surveys to verify bat presence are planned for the buildings and structures identified above as having potential roost spaces. The scope of the detailed surveys comprises: • *Emergence surveys of specified buildings.* A summer dusk emergence survey will be undertaken on each building proposed for removal / alteration by the proposed development. Daylight (late afternoon) visual inspection will be followed by the dusk emergence survey with at least two personnel for each structure, possibly more for the larger buildings (the harbour office), and including one licensed bat worker • *Surveys of cliff and quarry features to investigate their use.* An autumn dusk survey to detect any swarming activity combined with a visual inspection from the ground will be carried out. A remote detection system (Anabat ™) will be placed in the quarry for a few days once a month in October and November

	2007 • *Autumn activity survey to inform details of construction plan, such as lighting, and design such as hedge and landscape design.* An evening survey will be undertaken on two autumn evenings, to assess the use of the adjacent dune grasslands by bats. This will involve a transect walked over two hours starting half an hour before sunset by two surveyors, to record all bat encounters and survey conditions. If lesser/greater horseshoe or barbastelle bats are found to be using the area then extra transects will be required. Additional transects will also be required if a greater horseshoe bat roost is discovered within four kilometres of the site. Information from the local bat group and Natural England will be sought

Table 12– 4: Summary of results of faunal surveys carried out at North Quay



Hayle Harbour

Location of Adder records at North Quay, Hayle

Figure 12.8
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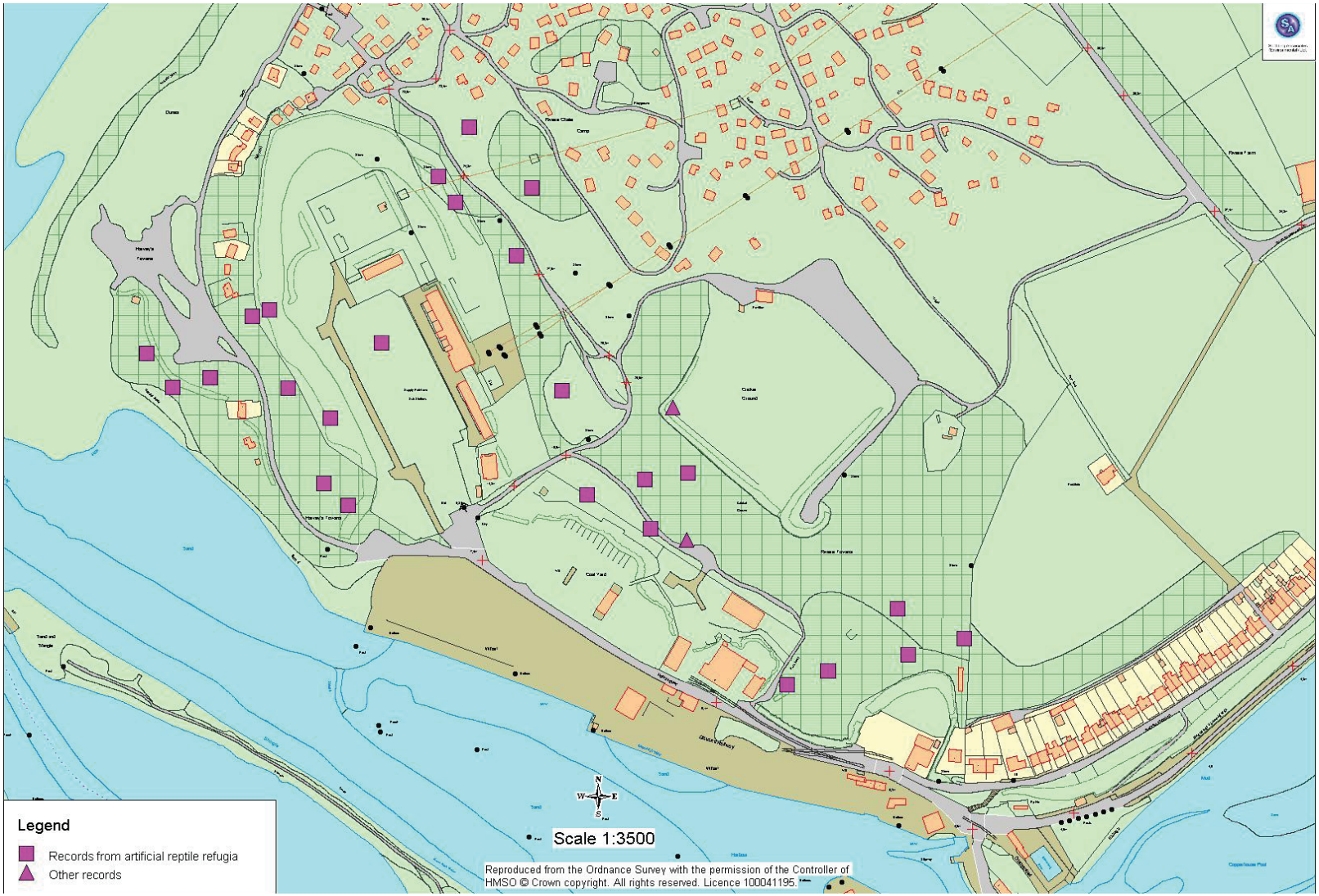

DO NOT SCALE THIS DRAWING.

Hayle Harbour
Location of Slow worm records at North Quay, Hayle

Figure 12.9

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date November 2007

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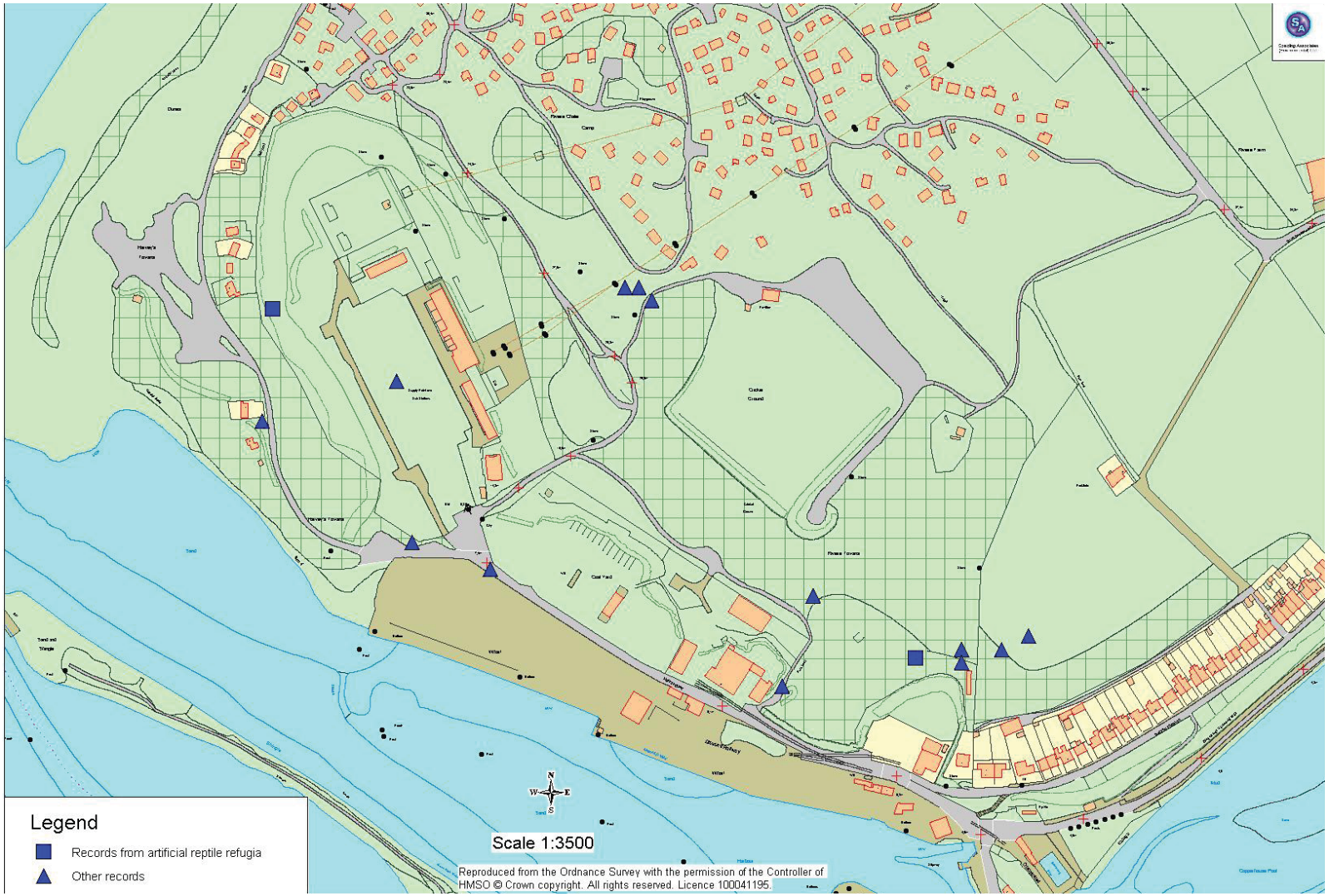

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Hayle Harbour
Location of Common Lizard records at North Quay, Hayle

Figure 12.10

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date November 2007

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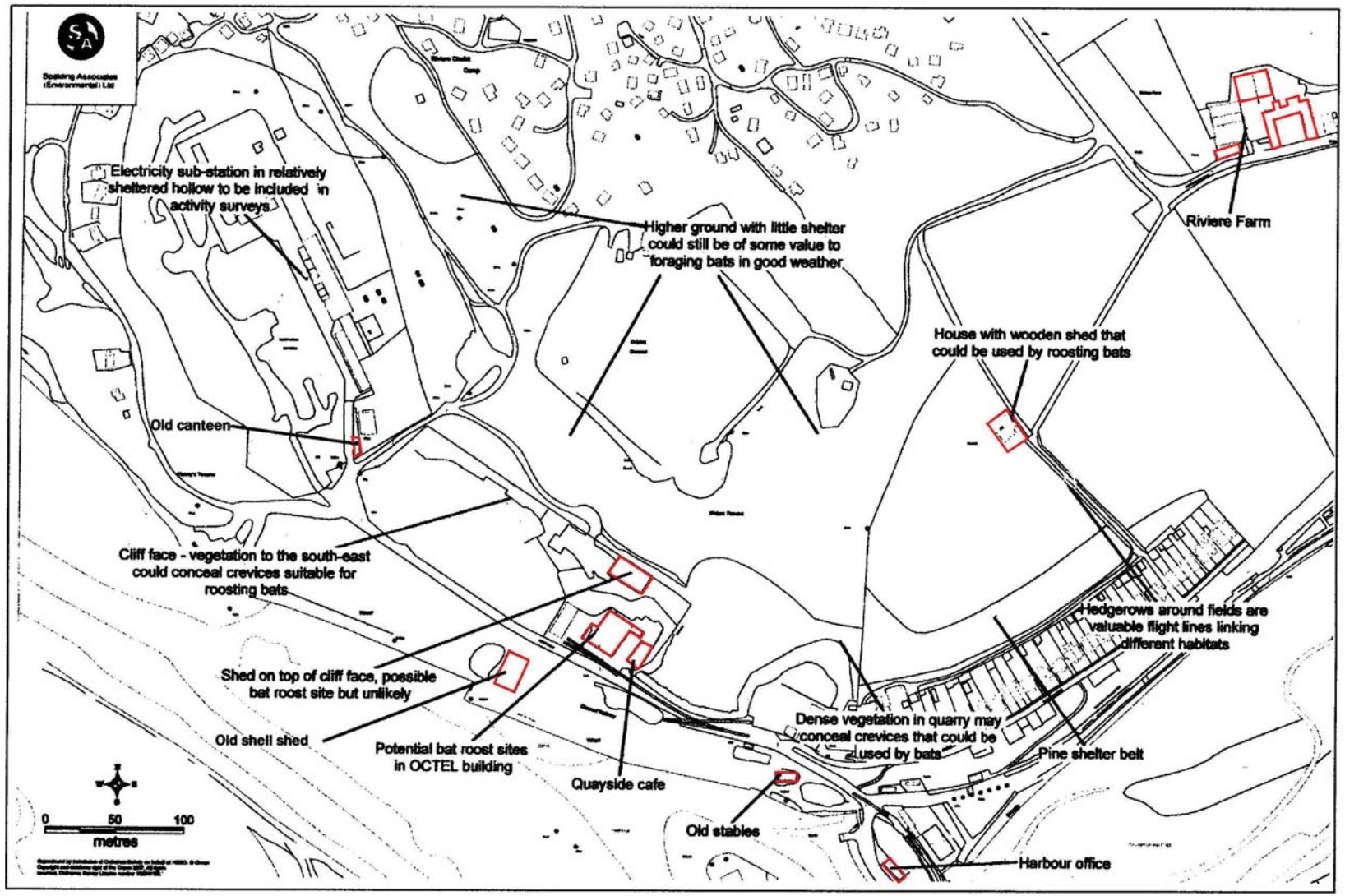

Hayle Harbour
Buildings and features of potential value to bats on North Quay & Riviere Towans

Figure 12.11
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Note to Figure 12.11: Buildings outlined in red are within the proposed development area and have been subject to external inspection surveys for bats

12.4.1.5 Ecological characteristics of agricultural land at Riviere Farm

Three agricultural fields within the holding of Riviere Farm, east of North Quay, are included in the development area. A summary of the habitat features present is given below (taken from Spalding Associates 2005h), and Figure 12.12 indicates the distribution of habitats recorded.

DO NOT SCALE THIS DRAWING.

Hayle Harbour

Phase 1 habitat survey of three fields at Riviere Farm Hayle

Figure 12.12
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date November 2007

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- **Plantation.** There is a broad belt of planted coniferous and deciduous woodland at the southern edge of the fields. Semi-mature Monterey pine (*Pinus radiata*) grow on the northern edge of the shelter belt; deciduous trees consist of frequent sycamore (*Acer pseudoplatanus*), locally frequent alder (*Alnus glutinosa*) with ash (*Fraxinus excelsior*), elm (*Ulmus* agg.) and oak (*Quercus* sp.). The scrub layer here comprises dense bramble, butterfly bush and scattered herbs, while ground cover under the pines is dominated by scattered ivy
- **Bracken.** There is a narrow strip of bracken (Pteridium aquilinum) dominated vegetation at the northern boundary of the survey site, on the outside of the field boundary
- **Neutral grassland**. There is a small area of neutral grassland on an open area at the north-east corner of the fields. The grassland here is short and trampled and dominated by common grasses and herbs. The north-east corner of the northernmost field, near the area of neutral grassland, is shown in data from ERCCIS to be the location of the last record at Hayle for the arable weed hairy-fruited cornsalad (Valerianella eriocarpa), a Red Data-Book (RDB) (2) species (last recorded at Hayle in 1988)
- **Boundary hedge**. The fields are bounded by Cornish hedge structures on most sides. These traditional field boundaries are generally constructed from earth and stone, with a range of woody and herb growth growing on both sides and on the top. The hedges within the survey area are narrow and well vegetated, being dominated by bramble and blackthorn (Prunus spinosa) with a good range of common herbs including nettle, pellitory-of-the-wall (Parietaria judaica), cleavers (Galium aparine), red dead-nettle (Lamium purpureum), wild madder (Rubia peregrina), and hart's-tongue fern (Phyllitis scolopendrium). Shrub and tree growth is limited to very sparse small hawthorn growth and elder with lines of garden privet on the more southerly hedge lengths
- **Arable fields**. The three fields hold sandy, well drained soils, and are currently planted with brassicas. The field edges have a 3m unplanted strip that currently supports a range of ruderal plants

Bat use of this part of the site has been assessed in on-going surveys during summer 2007 (see Annexe 12D). Survey results so far have shown that bats are feeding in the vicinity of the small farmhouse at the centre of the fields (at sodium vapour lights) and along the adjacent hedge lines; further surveys will be undertaken to establish whether they are roosting in the building at the centre of the fields.

Although the arable fields are of low nature conservation value, the hedge boundaries are important as local feeding habitat for bats, as well as providing navigation routes for bats through the landscape. They are also likely to be locally valuable as habitat for small mammals, reptiles and songbirds. The plantation, despite the high proportion of non-native species, is of sufficient extent and maturity to provide potential habitat for small mammals and birds, and may also form part of the navigation network for bats.

12.4.1.6 Ecological characteristics of Copperhouse Pool saltmarsh

Copperhouse saltmarsh is located at the easternmost end of Copperhouse Pool; the pool is maintained as a tidal habitat by a sluice. The saltmarsh habitat includes a diversity of semi-natural saltmarsh vegetation types including low, mid and upper marsh communities. The low saltmarsh communities are scattered within the more open central pool area, with the mid and upper saltmarsh communities restricted to the more sheltered habitat to the east. The saltmarsh habitat consists of the following National Vegetation Classification communities:

SM6 – *Spartina anglica* (common cord-grass) saltmarsh community

SM8 – Annual *Salicornia* (glasswort) saltmarsh community

SM9 – *Sueda maritima* (annual sea-blite) saltmarsh community

SM10 – Transitional low-marsh vegetation with *Puccinellia maritima* (saltmarch grass), annual *Salicornia* species and *S. maritima*

SM13 – *Puccinellia maritima* saltmarsh community

SM16 – *Festuca rubra* (red fescue) saltmarsh community

SM24 – *Elymus pycanthus* (sea couch) saltmarsh community

S4 – *Phragmites australis* (common reed) swamp and reeds

The vegetation communities show a typical transition from low to upper marsh communities; see Annexe 12E for map showing distribution of NVC saltmarsh communities on Copperhouse Pool.

Two plant species of nature conservation value were recorded on the saltmarsh. A single plant of purple ramping fumitory was found growing beside the Black Bridge (SW56653812). Small fruited rush *Juncus compressus*, is known to occur in the Copperhouse salt-marsh, and has been found there recently by Rosaline Murphy (former south-west Cornwall recorder for Botanical Society of the British Isles). In addition balm-leaved figwort spikes occur along the path running through the tall common reed.

12.4.1.7 Assessment of valued receptors for terrestrial ecology

Petalwort

Petalwort is a lower plant that is nationally scarce, protected nationally by law (Schedule 8 of the Wildlife & Countryside Act 1981; see section 12.3.2.1), listed as vulnerable within a European context, and is listed in the EC Habitats Directive (CEC, 1992), under which the UK government has an obligation to protect sites which support this species. Petalwort is a UK BAP priority species, and an action plan for the plant is included in the Cornwall BAP (2004).

The population of petalwort on the Triangular Spit is of considerable nature conservation value because of the status of the plant and the size of the colony: the estimate for the population here exceeds the combined total

for all other sites in Cornwall recorded to date, and only one population in the UK is larger (Brownslade Burrows, Pembrokeshire, recorded 2002). The numerical status of the population on the Spit is at least nationally important and in itself is probably sufficient to justify SSSI notification, and possibly qualify the site as important on a European-wide scale.

The plant also occurs on South Quay and on the southern shore of Carnsew Pool, but these populations are much smaller and of less significance numerically than those found on the Spit, and can be classed as being of district-regional value. However, since the species is protected under Schedule 8 of the Wildlife & Countryside Act (1981), any actions that would destroy or harm even these small populations would only be allowed under licence from Natural England.

Bats

All bat species (except possibly Daubenton's bat) are considered to be declining and vulnerable in Europe (Mitchell-Jones, 2004) and are therefore listed in Annex IV of the EC Habitats Directive. In the UK, all bat species and their roosts are fully protected from disturbance, damage or destruction by the Wildlife and Countryside Act 1981 and the Conservation (Natural Habitat etc) Regulations 1994 (see section 12.2.3.1).

Bats are known to occur within North Quay area and the fields and hedges on the adjacent Riviere Fields site. Surveys to date have identified that common pipistrelle bats (*Pipistrellus pipistrellus*) use the dune grassland, the sheltered areas of cliff face and quarry, and the hedges on Riviere Fields, for foraging. Bats use flight lines over these areas (particularly the cliff face and the tracks) and there is potential roost habitat in most of the buildings that would be affected in the proposals. Additionally it is possible that the cliff faces at the back of North Quay and the quarry walls may be used for winter hibernation.

The surveys to date indicate that the bat population using the site comprises pipistrelle bats only and that numbers present are small, suggesting that North Quay and adjacent farmland habitats are likely to be of local importance only for bats (although this assessment may require review if future surveys find large autumn or winter roost sites).

Coastal dune grassland

This habitat type (also known as fixed dune with herbaceous vegetation), is a European priority habitat for which the UK has special responsibility, being listed in Annex I of the EC Habitats Directive (CEC, 1992). The UK Biodiversity Steering Group has produced a national Habitat Action Plan for sand dune systems in the UK (UKBSG, 1995) which is closely linked to the Cornwall Biodiversity Initiative Habitat Action Plan for the county sand dune systems (Cornwall Biodiversity Initiative, 2004).

Approximately 8.9 hectares of coastal dune grassland occurs at North Quay, and the plant species composition of the habitat here is typical of fixed dune grassland in Cornwall. Overall, owing to the moderate size of the habitat area, its isolation from the wider Towans dune system (by an adjacent cricket pitch and the

Riviere Chalet camp to the north), and the extent of current recreational pressures, the quality of the dune grassland here is assessed as being of only regional significance.

Reptile communities

An assemblage of reptile species (comprising adders, slow worms and common lizards) is present at North Quay which would qualify the area as a 'Key Reptile Site', according to criteria established by the organisation Froglife (1999). The Key Reptile Site Register is a mechanism designed to promote the safeguard of important reptile sites; where these sites are identified they are often considered to be of at least county-wide significance for nature conservation (depending on the specific species concerned and their population sizes). The reptile community at North Quay has an exceptional population of slow worm, and overall the assemblage is assessed as being of county significance.

Nesting birds

A total of 21 bird species showed evidence of breeding in habitats available at North Quay. Of these, four are of conservation significance owing either to their unfavourable conservation status in Europe (stonechat; Tucker & Heath, 1994), or because their breeding status in Britain is currently of concern (house sparrow, song thrush, linnet; Anon 2002). Linnet and song thrush are also UK BAP priority species, and action plans for these species are included in the Cornwall BAP (2004).

The bird community is composed of typical species of urban, garden and hedgerow habitats, although dune grassland habitats with associated bushes and low vegetation are important for species such as stonechat and linnet. Overall, owing to the limited extent of breeding habitat and small breeding populations present, the breeding bird assemblage at North Quay is assessed as being of local significance.

Purple ramping fumitory and western ramping fumitory

The western and purple ramping fumitories are endemic to the UK and the core of their national distribution is located in Cornwall; western ramping fumitory is largely restricted to west Cornwall and is a UK and Cornwall BAP priority species. However, neither species is considered either critically endangered, endangered, vulnerable or near threatened (Cheffings and Farrell, 2005).

Both species occur on North Quay, western ramping fumitory being the more abundant (32 specimens recorded compared with one specimen for purple ramping fumitory). The status of their populations on the proposed development site is considered to be of local significance.

Ivy broomrape

Ivy broomrape is an uncommon species in Britain and in Cornwall. It is found within the proposed development site at East Quay in a small and very isolated stand, more extensively on North Quay, and sparsely on South Quay; within the county, and particularly in the more local area of the St Ives Bay dune system, there are larger colonies of the species in more extensive habitat.

The status of the ivy broomrape populations on the proposed development site is considered to be of local significance.

Otter

The otter is included on Annexes II and IV of the EC Habitats Directive. It is protected under Schedule 5 of the Wildlife & Countryside Act 1981 and Schedule 2 of the Conservation (Natural Habitats, etc.) Regulations, 1994. The European sub-species is also listed as globally threatened by the IUCN. The otter is identified as a priority species in the UK BAP, and an action plan for the species is included in the Cornwall BAP (2004).

Otters occur on the Hayle River catchment, in the Lelant Water region of the estuary, and at Carnsew Pool. The value of this latter region to local otter populations is difficult to determine owing to limited sightings of the species, but the pool probably has local significance as a foraging habitat.

Hedges and Cornish hedge banks

Hedges and Cornish hedge banks (earth banks, with or without stone walls, topped with woody shrubs) occur on the Riviere Fields portion of the proposed development site, comprising a total length of 1,150 metres. These hedges do not show features which would classify them as ancient or species-rich, nor are they unlikely to qualify as 'important' hedges under the Hedgerow Regulations 1997 (see section 12.3.2.5). However, the hedges and hedge banks are considered to be of at least of local nature conservation value due to the network of hedges that potentially provide habitat value for reptiles, birds and bats.

Saltmarsh

Saltmarsh is identified as a priority habitat in the UK BAP, and an action plan for this habitat is included in the Cornwall BAP (2004). Saltmarsh (termed 'Atlantic salt-meadow') is listed in the EC Habitats Directive (CEC, 1992), under which the UK government has an obligation to protect sites that support this habitat. The saltmarsh at Copperhouse Pool is of at least national importance, because it is part of the Hayle Estuary & Carrack Gladden SSSI, it contains vegetation communities which are of European value as a habitat, and it supports round-fruited rush (*Juncus compressus*) which is listed as 'near threatened' in the UK (JNCC, 2005).

12.4.2 Baseline data for aquatic ecology

12.4.2.1 Marine biotopes recorded

Biotopes are habitats and their associated biological communities. Annexe 12I summarises data from surveys of the Hayle Estuary by Aquatic Environmental Consultants and Aquatonics Ltd, and includes all the biotopes recorded (comprising a variety of hard substrate and sediment biotopes). In the UK, marine biotopes are classified using the marine biotope scheme developed by the Joint Nature Conservation Committee (Connor et al, 2004). Biotopes present at sites that were surveyed prior to publication of the JNCC biotope classifications have been assessed using the raw data from the relevant surveys.

Fourteen biotopes were recorded from the strandline, mixed and hard substrates, of which thirteen could be matched with JNCC biotopes. Fifteen biotopes were recorded from sediments, but only eleven could be matched with a JNCC biotope. The number of biotopes recorded in the Hayle estuary complex was unexceptional, given the variety of substrates and salinity zones present. However, many of them had a lower diversity than expected, which is presumably due to the influence of contaminants.

12.4.2.2 Aquatic invertebrate communities

Densities of the invertebrate species typically eaten by wading birds are summarised in Annexe 12I for different parts of the Hayle estuary complex. Many species were present at unusually low densities, even where the substrate and salinities were suitable. This is almost certainly due to the high levels of metal contamination in many parts of the Hayle complex, resulting from the site's industrial history of copper smelting and associated deposition of metal-rich slag on the shore in many areas. The only shorebird prey recorded at moderately high densities were ragworm (*Nereis diversiciolor*) and the amphipod *Corophium volutator*, and even for these species the areas that supported high densities were primarily in muddy areas of Copperhouse Pool.

Evidence for the importance of metal and other pollution in reducing invertebrate diversity and abundance comes from two main sources. Firstly, comparison of the Hayle fauna with other similar estuaries that are uncontaminated shows that the Hayle Estuary is unusually species-poor. Secondly, there are sediment guidelines that are useful for predicting whether concentrations of metals and other contaminants are at levels that would be expected to reduce invertebrate diversity. The standards that are most widely used were developed in Canada (Canadian Council of Ministers for the Environment, 1999) and are referred to here as Canadian Sediment Quality Standards; they provide Interim Sediment Quality Guidelines (ISQG) and Probable Effects Levels (PEL). Concentrations of copper, zinc and arsenic in sediments in various parts of the Hayle complex have been compared with the Canadian sediment quality guidelines, and many locations in the Hayle area contain sediment concentrations that are 2-10 times the PEL for each of these metals separately. It is therefore not surprising to find that the invertebrate fauna is very restricted. Annexe 12I contains detailed information on metal contamination of sediments and biota in Hayle estuary.

No Nationally Rare or Nationally Scarce invertebrates or algae have been found in several detailed surveys of the Hayle estuary complex. The invertebrates and algae in the Hayle estuary complex are predominantly common estuarine species. The only Biodiversity Species Action Plan for any aquatic invertebrate or alga that has been recorded in the Hayle estuary complex is for native oyster (*Ostrea edulis*). There is also a record of a single specimen of fan shell (*Atrina fragilis*) from near Hayle (Cornwall Wildlife Trust, 2004). The location is not stated, but was presumably in St Ives Bay rather than in the Hayle estuary.

There are marine habitats present (eg mudflats) which are Priority Habitats under the UK Biodiversity Action Plan (UK Biodiversity Group, 1999). These are discussed in Section 12.4.2.4.

12.4.2.3 Fish

Of the aquatic species present in the Hayle complex the most important component comprises fish. Surveys of fish carried out by Environment Agency staff on behalf of Aquatic Environmental Consultants (Forster and Smith, 2001a and b – Appendices 12R and 12S) confirmed the importance of Carnsew Pool, and to a lesser extent Copperhouse Pool, as fish nursery areas. Carnsew Pool supports adult and juvenile gilthead bream (*Sparus aurata*) and golden-grey mullet (*Liza aurata*), both relatively rare in the UK. Carnsew Pool contains juveniles of a wide range of species (eg bass *Dicentrarchus labrax*, pollack *Pollachius pollachius*, thick-lipped mullet *Chelon labrosus*, common sole *Solea solea*, plaice *Pleuronectes platessa*, brill *Scophthalmus rhombus*, tub gurnard *Aspitrigla cuculus*, ballan wrasse *Labrus bergylta* and corkwing wrasse *Crenilabrus melops*), suggesting it is an important nursery area for a range of fish species. Although large numbers of juvenile bass were caught in the survey the results for Carnsew Pool were not as high as would be expected for such an ideal habitat (Goodwin, 2002).

Adult gilthead bream were also caught in the harbour, immediately below the entrance to Carnsew Pool sluice, suggesting that they move between Carnsew and the harbour. The pool near the entrance to Copperhouse Pool is an important habitat for golden-grey mullet, juvenile bass and juvenile gilthead bream.

The harbour area is important for greater sandeel and lesser sandeel. There is also a wide variety of fish (particularly pipefish) associated with seaweeds in the harbour. A total of 36 different species of fish have been recorded by scientific surveys conducted to date in the Hayle estuary complex (including Copperhouse and Carnsew Pools).

Information from anglers and the Environment Agency on migratory fish (salmon, sea-trout and eels) in the tributaries of the Hayle estuary complex shows that salmon are not present, but sea-trout are caught by anglers. Eels are regularly caught in Carnsew Pool and are likely to occur in many of the tributaries of the Hayle estuary complex (eg Hayle river, Angarrack and Mill Leat). Annexe 12J gives further background information on the commercial and recreational fisheries interests in the Hayle Estuary.

12.4.2.4 Assessment of valued receptors for aquatic ecology

UKBAP Priority Habitats

Mudflats and sheltered muddy gravels

The mudflats of the Hayle estuary and the sheltered muddy gravel habitats (found in Penpol Creek and possibly small areas in Carnsew Pool) are poor examples of the habitat type due to the historical contaminants present. In the case of mudflats the relatively poor invertebrate diversity is not reflected in the diversity of wading and other water birds supported, and the mudflats are therefore best considered in terms of their importance to water birds.

Saline lagoons and tidal rapids

The tidal rapids which occur either side of the sluice tunnels at the entrance to Carnsew Pool are good examples of these habitats.

There is some confusion regarding whether the sluicing pools at Carnsew and Copperhouse are covered by the Biodiversity Action Plan for saline lagoons. According to Natural England (Roger Cover, email dated 10 July 2007) they are not. Instead they are considered "part of the estuarine system." A survey of Carnsew Pool by the Natural History Museum (Bamber and Evans, 2000) on behalf of the RSPB, Cornwall County Council and Natural England concluded that it is not a saline lagoon. Recent surveys have shown that neither Copperhouse Pool nor Carnsew Pool support species that are characteristic of saline lagoons. The Scoping Opinion provided by Cornwall County Council Natural Environment Service states that both pools are covered by the BAP for saline lagoons, although the Cornwall BAP contains no reference to these pools in the section on saline lagoons (Cornwall Wildlife Trust, 2004).

Sublittoral sands and gravels

The sublittoral sands and gravels that occur in the Hayle estuary complex are relatively small in area and are likely to be affected by the historical contamination. Their importance is probably greater for fish (eg sandeels) than invertebrates.

Seaweeds and Invertebrates

The survey by Gill (1989) did not find any sites within the Hayle complex that were of Regional or National conservation interest, though the report noted that the invertebrate and seaweed communities near the Carnsew tunnels were diverse. Other detailed ecological surveys of invertebrates and seaweeds carried out as part of the EIAs of various proposed developments of the Hayle harbour area have also failed to find sites of high conservation interest, but two (Smith, 2000; Aquatonics Ltd, 2007a - Annexe 12F) have noted that the areas just upstream and downstream of the Carnsew tunnels are probably intermediate between Local and Regional conservation importance. These areas experience high current speeds and have relatively coarse

sediments (and therefore low concentrations of contaminants). They support a relatively diverse range of seaweeds and invertebrates such as sponges and tunicates. The deep water region of Carnsew Pool is also relatively diverse for invertebrates and included several unusual species of polychaete worm in the sediments (Smith, 2000).

The key areas within the proposed development site are assigned the following classifications (by Aquatonics Ltd) according to the value of the invertebrate and algae populations they support:

- Harbour — Local (approaching Regional at outlet from Carnsew)
- Cockle Bank — Local
- Penpol — Local
- Carnsew Subtidal — Local (approaching Regional near weir)
- Carnsew Intertidal — Local
- Copperhouse Pool — Local
- Lelant Water — Intertidal Pools and Rocks – Local; Sandflats - Local

Fish

The most important area for fish in the Hayle complex is Carnsew Pool, which is considered to be of Regional conservation interest for fish. Carnsew Pool supports gilthead bream, golden-grey mullet (*Liza aurata*) and a wide variety of other marine species (Foster & Smith, 2001a). Twenty one species were caught using seine nets at Carnsew Pool by the Environment Agency Fisheries team in August 2001 (Foster and Smith, 2001a) and it is likely that the total number of species using this area throughout the year is considerably more.

Lower Lelant Water, the harbour area and the seaward part of Copperhouse Pool also support a wide range of estuarine and marine fish (Foster & Smith, 2001b). These populations are considered to be of Regional conservation importance.

Upper Lelant Water, Penpol and the middle and upper parts of Copperhouse Pool are likely to be important locally as nursery areas. They have not been surveyed for fish since no significant environmental impacts are expected there.

12.4.3 Baseline data for ornithology

12.4.3.1 Results of 2000 - 2001 ornithological survey programme

The ornithological monitoring programme, as described in Evans *et al* (2002), identified the extensive intertidal mudflat and saltmarsh of Lelant Water as being an important feeding and roosting ground for a number of

wildfowl and wader species, with between 60 and 120 shelduck (*Tadorna tadorna*) using the area during the winter months over the tidal cycle. The site was also of key importance for wigeon (*Anas penelope*) with flocks of around 500 regularly noted in the winter, and teal with around 100 birds present. Mallard (*Anas platyrhynchos*) also showed a strong preference for Lelant Water, with up to 20 birds present. Mute swan (*Cygnus olor*) were also recorded on the site over the majority of the year, with most birds either using the western end of Lelant Water or Copperhouse Pool. In general, Lelant Water, and in particular, the western end of the site, appears to have been the preferred site for wildfowl within the Hayle complex, with most birds showing a strong fidelity to the area over the tidal cycle, with both feeding and loafing flocks present over the tide and a low degree of movement into other areas in response to inundation.

Lelant Water was also found to be of key importance for a number of wader species during the 2000-2001 monitoring programme, with intertidal areas of the site being of particular importance for oystercatcher (*Haematopus ostralegus*), grey plover (*Pluvialis squatarola*), dunlin (*Calidris alpina*), lapwing (*Vanellus vanellus*), ringed plover (*Charadrius hiaticula*) and curlew (*Numenius arquata*). Wader flocks used the site during both low and high water periods depending on tide state, with the western sections of the site being of particular importance over the tidal cycle; at low water, wader concentrations were found principally on the south-western section of Lelant Water. Over the high water periods roosts were established on Lelant Saltings in particular Griggs's Quay, with the Causeway (see Figure 12.3 for locations) of slightly less importance for most species, and with flocks of some species (e.g. dunlin, redshank (*Tringa totanus*) and curlew moving onto Ryan's Field.

Carnsew Pool was identified as being of particular importance for wintering little grebe (*Tachybaptus ruficollis*), with survey data from the 2000-2001 season for the area indicating a peak usage during January with up to 20 birds present, and with over 10 birds present between December and February. Carnsew Pool supported around two thirds of this population, with birds present on the pool over the tidal cycle, with highest concentrations at low water. These maxima accord well with WeBS data for the area which suggest between 15 and 20 little grebe use the area between November and February. In addition, Carnsew Pool was used by diver species and other grebe species on occasion, as well as wildfowl. Small numbers of waders were also recorded within the Carnsew system, predominantly around low water when the area of mudflat at the western end of the site is exposed by the tide. Grey plover, dunlin and bar-tailed godwit (*Limosa lapponica*) were recorded on the site, although at a level below that of adjacent intertidal habitat.

Copperhouse Pool featured a relatively low level of waterfowl usage compared to Lelant Water, but within the context of the Hayle system, the area was of relatively high importance for mute swan, shelduck, oystercatcher, ringed plover and redshank, with usage recorded at both low and high water periods, the eastern sector of the pool increasing in importance around high water, and with areas of mud and marsh remaining uncovered on most tides.

Little egret (*Egretta garzetta*) were recorded around the Hayle site with no particular concentration recorded at low water, but with the south-western corner of Lelant Water featuring a concentration around high water. Up to around 20 birds were recorded in the autumn, but with a mean for the programme of six birds at low water.

The programme did not record any significant changes in usage on different tide heights (neap vs spring), and no relationship was noted between shorebird distribution and the height of high water. This would appear to indicate that sufficient roost area was available on all tides. Similarly, the programme did not identify any differences in waterfowl distribution under different weather conditions (particularly wind).

However, disturbance was recorded as being a significant influence on waterfowl behaviour and distribution. Dog walking was recorded as being the most frequent activity to elicit a behavioural response in waterfowl (a disturbance event) across the system as a whole, with Lelant Water featuring the greatest frequency of disturbance, both around high and low water, arising from a variety of sources. Disturbance events resulting from raptor or helicopter overflights were noted as having the widest impacts, often affecting the entire estuary. It was observed that roost activity by ringed plover, close to a public right of way around Carnsew Pool, increased during a period when the footpath was closed to the public, suggesting that in addition to directly identifiable disturbance events (flocks put to flight etc) there is a behavioural response to human activity in some instances that is not readily identifiable. Also, the RSPB (2007) report that walkers and anglers occasionally enter the Lelant Water mudflat from the Carnsew Pool perimeter footpath.

12.4.3.2 Results of 2004 - 2005 ornithological survey programme

A further survey programme was undertaken from 2004 to 2005, using a similar, but expanded, methodology to that of Evans *et al* (2002). In general, the 2004-05 study identified usage patterns similar to those of the 2000/1 programme, but with a few differences; see Appendix 12T for detailed accounts.

Little egret numbers and distribution remained broadly similar to the 2000/1 findings. Although no British population threshold has been set, a nominal importance threshold for this species has been employed by Banks *et al* (2006) and stands at 30 individuals. As such, although the Hayle estuary might be regarded as not being of national importance based on the monitoring study data, this assessment should be treated with caution in the absence of more definitive national population data.

Little grebe usage on the site was restricted to the areas of permanent, saltwater, and with usage concentrated to the winter months.

Wigeon were most numerous between Lelant village and Carnsew Pool, with between 500 to 600 birds per km^2 using this area at low water, but with the main area of Lelant Water also supporting a relatively high density, with between 250-500 birds per km^2 recorded. However, despite the relatively large flocks using the Hayle system, the species is not present in nationally important numbers, but the site is considered of regional importance for the species. The western end of Lelant Water was recorded as supporting the highest low

water density of teal (100-200 birds per km^2), but with Copperhouse Saltings supporting a density of between 50-100 birds per km^2. Around high water, feeding was carried out on Lelant Saltings, Grigg's Quay, Ryan's Field, Lelant Causeway and Copperhouse Pool, with Lelant Saltings and Grigg's Quay supporting the greatest number of birds and used more regularly over the winter.

The Hayle system was found to be of local importance for a number of wader species including oystercatcher, ringed plover and golden plover. Interestingly, the western end of Carnsew Pool was identified as the key feeding and roosting site for the grey plover at low water from the 2004/5 programme (compared to Lelant water from 2000/1), with up to 24 birds feeding in the zone. Around high water Carnsew Pool continued to be an important feeding resource (at the western end of the site) with up to 22 birds using the sector in February, with some feeding also on the Lelant Causeway section. The apparent shift in usage from the western end of Lelant Water to Carnsew Pool is of note and suggests some change in invertebrate prey, sediment conditions or vegetative cover. As with most species, usage on Carnsew was at the western end, where an intertidal mud/sand flat habitat is available. A similar shift in usage was noted for dunlin from the 2000/1 survey programme, with a reduction in activity on the western extent of Lelant Water and an increase in activity on Carnsew Pool and the section between Lelant village and Carnsew.

The 2004/5 programme recorded a relatively high level of usage by redshank on Copperhouse Pool at low water with around 20 to 30 birds regularly feeding on the reach, with Carnsew Pool again of importance with up to 32 birds on the western section in December and flocks present during the winter. The western end of Lelant water supported between 10 and 20 birds for much of the year, with Ryan's Field supporting up to 18 feeding birds at low water. Western Lelant also supported a flock of 34 roosting redshank in December, and the majority of the Lelant and Copperhouse sections supported a density of between 10 and 20 birds per km^2, with the middle Copperhouse and Carnsew key areas at 50 to 60 birds per km^2. At high water roosts were regularly established on Lelant Saltings, Ryan's Field and upper Copperhouse Pool, with flocks of up to 48 birds on the latter site in February. However, feeding also continued around high water, with feeding activity particularly concentrated on the areas of Copperhouse Pool still uncovered by the tide, with around 30 to 35 birds feeding in this area over the winter.

12.4.3.3 Assessment of valued receptors for ornithology

From the 2000/01 programme the Hayle estuary was not found to be of national importance for any key waterfowl species (using numerical thresholds given in Banks *et al*, 2006; see section 12.3.3.3). Concentrations of shelduck, wigeon, little grebe, ringed plover, lapwing and dunlin were of regional note; numbers of little egret are at the regional rather than national threshold value for the species, although the latter threshold value is not definitive at present and should be treated with caution. The 2004/5 programme recorded levels of usage for most species that were broadly similar to the 2000/01 results, although additionally teal were recorded at around a level of regional importance, and a number of waders, including

oystercatcher, and golden plover, were present at a level of local importance. Usage was predominantly concentrated in areas of Lelant Water as well as areas of Copperhouse and Carnsew Pools, these areas supporting feeding, roosting and loafing activities by a number of species of waterfowl.

As such, it is considered that the Hayle Estuary, comprising intertidal and subtidal habitats in Lelant Water and Carnsew and Copperhouse Pools, is of regional importance for a number of species, principally shelduck, wigeon, little grebe, ringed plover, lapwing, dunlin, and teal. Indeed, during periods of hard weather, these habitat areas may take on a national importance for some species, given the relatively unique conditions present in Carnsew Pool in particular.

Carnsew Pool was identified as an interesting area during much of the monitoring programme, the area of open seawater available over the entire tidal cycle supporting little grebe at a regional importance level and with an area of intertidal habitat exposed over each tide at the western end of the pool supporting feeding and roosting waterfowl.

12.5 Assessment of potential impacts

The following table provides definitions for the terms used to describe impacts in each of the sections below covering impacts on terrestrial ecology, aquatic ecology, and aquatic birds.

Impact Severity:	**Impact Periodicity:**	**Impact Extent:**
Major (adverse or beneficial) Moderate (adverse or beneficial) Minor (adverse or beneficial) Negligible	Temporary - during construction Short-term - within one year Medium-term - 1-3 years Long-term - 3-10 years Permanent - no recovery to previous state within lifespan of project	Localised – within 100m Site-specific – within the feature, eg within Carnsew Pool or Triangular Spit System-specific – within Hayle Estuary District-wide – within Penwith Regional – within the south-west National – national population context International – international context

Table 12– 5: Definition of terms used in assessment of ecological impacts

12.5.1 Assessment of impacts on terrestrial ecology

12.5.1.1 Overview

The features that have been determined as being key receptors for terrestrial ecology, and therefore requiring an assessment of the potential impact of development proposals, are as follows:

Feature	Location	Conservation value
i. Petalwort	Triangular Spit South Quay	National-international District-Regional
ii. Bats	North Quay Riviere Fields	Local (to be confirmed by survey) Local (to be confirmed by survey)
iii. Coastal dune grassland	North Quay	Regional
iv. Reptile communities	North Quay	County
v. Nesting birds	North Quay	Local
vi. Linnet	North Quay	Local
vii. Song thrush	North Quay	Local
viii. Western ramping fumitory	North Quay	Local
ix. Purple ramping fumitory	North Quay	Local
x. Ivy broomrape	North Quay East Quay South Quay	Local Local Local
xi. Otter	Carnsew Pool	Local
xii. Hedges	Riviere Fields	Local
xiii. Saltmarsh	Copperhouse Pool	National

Table 12– 6: Key receptors relevant to terrestrial ecology

The unmitigated impacts of the development proposals (as described in Chapter 3.0) on terrestrial ecology are considered below. Mitigation measures are identified in section 12.6.1 and summarised in 12.7.1.1; monitoring requirements are detailed in section 12.8.1.

12.5.1.2 Potential impacts on petalwort (*Petallophyllum ralfsii*)

Petalwort is known to occur in most abundance on the Triangular Spit, and in small scattered populations on the eastern edge of South Quay and on the path to the south of Carnsew Pool.

Factors on which petalwort depends

Petalwort in the U.K. is closely associated with sand dune areas having calcareous sand, where it occurs mainly in dune-slacks, with fewer records from near pond edges, along damp pathways, in small hollows and on former industrial sites adjoining dunes (Plantlife, 2006).

Petalwort is dependent on very short and open turf, with a degree of winter dampness, in order to survive. It tolerates only light shading, prefers firm or compacted substrata, and prefers sites that remain stable for several to many years. Typical sites with petalwort have persistently very low vegetation that includes many small perennials. This habitat is generally maintained by grazing, trampling, or both. Reduction in grazing pressure (which is nowadays mainly from rabbits) could therefore cause large losses of petalwort populations. The plant is tolerant of, and probably benefits from, low levels of trampling, but could be negatively affected by physical effects such as damage to the shallow turf in which it generally grows.

Prediction of future baseline conditions without development

There is no information available to suggest that the baseline conditions on the Triangular Spit or the path around Carnsew Pool would be changed significantly if the development did not take place, except for the possibility that recreational use may increase or that scrub might gradually encroach onto the more open areas occupied by petalwort. Recreational use may present a threat to the petalwort through physical effects from motorbike wheels and camp fires, and nutrient enrichment from dog excreta. Loss of the rabbit population from disease or disturbance would have a major negative impact on the petalwort. Scrub encroachment would also be detrimental since petalwort requires open ground and is intolerant of shading.

The dynamics of the petalwort population on the Triangular Spit are largely unknown since it was only discovered in 2005; however, it is understood that petalwort populations in west Cornwall and north Devon have generally increased over recent years (Plantlife, 2006).

On South Quay, the eastern sides of the quay where petalwort occurs are unstable and would possibly require remedial works in the future. If this is the case, the petalwort habitat would be lost as the quay sides crumble

or as remediation works become necessary for health and safety reasons, so that the prediction of changes in baseline conditions for these populations may be a long-term loss.

Predicted impacts from the development proposal

Before the petalwort population had been discovered, the proposal was to use the whole of the Triangular Spit for car parking in some form. However, on discovering the important population of petalwort on large areas of the Spit, and in light of the near certain potential for a significant adverse impact of high magnitude on the population of this internationally valued species from the car parking proposed, the proposals have been revised with the aim of ensuring that survival of the petalwort population and appropriate management of the Spit are part of the proposals.

The development proposal which is the subject of this assessment restricts parking (permanent) to the east side of the Triangular Spit, with no parking or vehicle access of any kind on the west side (see Figure 3.4), and propose to manage the parking and other uses of the Spit to avoid or minimise potential negative effects on the petalwort.

The proposals for South Quay consist of extensive development that will result in direct loss of the small scattered colonies of petalwort that occur on the quay margins at this site.

Currently there are no proposals identified in the masterplan that would affect the petalwort colonies on the south side of Carnsew Pool.

Impacts from the construction phase

Triangular Spit

This proposal would require clearance of areas of scrub and grassland on the east side of the Spit. This would result in a direct, adverse, permanent impact, owing to loss of scattered petalwort colonies mapped as colonies B (approximately 750 thalli in February 2005), A (approximately 300 thalli in February 2005) and E (approximately 17 thalli in February 2005); see Figure 12.4. The extent of the impact is very local and the magnitude moderate at most within the context of the local petalwort population. Overall, this is a moderate local permanent adverse impact on a protected species.

Construction activities have potential also to cause indirect impacts on the petalwort colony adjacent to the proposed car park, primarily by spillage of materials through poor management of works or accidents. It is possible that clearance works would temporarily disturb rabbit populations (grazing areas and/or warrens in scrub habitat), potentially leading to a reduction in grazing intensity which would be deleterious to petalwort survival. This probable impact has the potential to be a major, long-term adverse impact that is nationally significant.

South Quay

The proposals for South Quay consist of extensive development that is certain to result in a direct loss of the colonies during the construction phase. Petalwort is scattered in thirteen small colonies along the eastern edge of South Quay, with 78 thalli counted in February 2005 in total. Even if the colonies could be conserved *in situ* during construction, the increased use of the South Quay as a result of the proposed development would be certain to result in decline and loss of the petalwort there. The extent and magnitude of the impact is much smaller than the impact identified at the Triangular Spit, because of the relatively small population and the widespread distribution of petalwort in the district. Given also the doubtful future of the habitat on the edges of the South Quay, the significance of the adverse impact arising from loss of the colonies here is judged as minor, permanent adverse impact within the context of the local petalwort population; this is nevertheless a significant adverse impact at the national level because of the status of Petalwort.

Impacts from the operational phase

There is the potential for an indirect impact on the westernmost petalwort colony owing to habitat loss for the car park on the east of the Spit, through reduction of the extent of shelter and warren sites available to rabbits; this would adversely affect the quality of the petalwort grassland habitat owing to reduction/loss of grazing. In addition, the use of the Triangular Spit for parking would probably result in an increase in the disturbance pressures, both directly on the petalwort plants (from increased recreational pressure, nutrient enrichment and other factors) and indirectly through disturbance of the current rabbit grazing behaviour. There is therefore potential for a major permanent adverse impact that is nationally significant.

12.5.1.3 Potential impacts on bats

Bats are known to use the North Quay area. Surveys to date have identified that pipistrelle bats use the dune grassland, the sheltered areas of cliff face and quarry, and hedges on Riviere Fields for foraging; data collected so far indicate that the level of site use by bats is likely to be small. There is potential roost habitat in most of the buildings that will be affected in Phase 1 of the proposals; each of the buildings on the site has been subject to visual inspection to assess their potential for providing bat roost habitat, but emergence surveys and internal inspections are to be conducted to confirm roost presence/absence (see section 12.4.1.4). Additionally it is possible that the steep cliff faces at the back of North Quay and the quarry walls may be used for winter hibernation; autumn surveys to detect bat activity that would indicate use of these features as a hibernation roost will be conducted (see section 12.4.1.4).

Factors on which bats depend

Bats depend on suitable roosting sites, suitable feeding resources and a network of flight corridors that they use to navigate through the surrounding countryside.

Prediction of future baseline conditions without development

There is no information available to suggest that the baseline conditions for bats on the North Quay would change significantly if the development did not take place. Details of the proposed wave hub terminal to be built at Hayle Towans, west of North Quay, indicate that this is a small scale development that does not appear, in the operational phase at least, to significantly alter the baseline conditions.

Predicted impacts from proposals

Impacts from the construction phase

The construction phases of the proposed development would entail preparatory building demolition and site clearance works, including the stripping of vegetation growth and stabilising works on the quarry and cliff faces at North Quay, followed by building phases on North Quay and Riviere Fields. During these works, measures would be implemented to ensure that the construction activities comply with the law relating to protection of bats and their habitat (see section 12.2.3.1), such that potential to disturb, injure or kill bats and/or disturb, destroy or obstruct access to any confirmed roost(s) is avoided. Specified protective measures would be implemented under the terms of a European Protected Species (EPS) licence, to be sought from Natural England as required. Examples of potential protective measures that may need to be implemented under licence are:

- scheduling of work in the vicinity of the bat roost to avoid hibernation and breeding seasons
- a watching brief during work
- provision of alternative roost site(s) in the immediate locality

The results of the further emergence and hibernation surveys will inform the requirement for EPS licences for each building, the quarry and the cliff face.

Potential impacts of construction works on bat activity in the North Quay area are as follows:

- *Loss of potential roost habitat from stripping of vegetation, removal of cliff materials and stabilising treatment of cliff and quarry faces*

  Even if no bat roosts are found in the quarry and cliff faces at North Quay, stripping the vegetation growth and other stabilising works from these features would result in loss of potential roost habitat in vegetation and rock crevices. There is potential for a degree of reversibility in the loss of potential habitat; in the quarry some natural re-growth of vegetation on the faces (if allowed) would be expected within the medium- / long- term (3-10 years) which may restore roost habitat. The extent of these impacts would be restricted to the cliff and quarry face. Surveys so far indicate that the local population of bats may be small so that the possible magnitude of the unmitigated impact is minor

and local. The level of certainty will be increased when the current survey plan for bats is completed (see section 12.4.1.4) and plans for treatment of the quarry face are finalised.

- *Loss of bat foraging habitat through clearance of ground and erection of buildings*

  The clearance of the existing ground habitats, the preparation of the site and the construction of the new buildings will produce a range of unavoidable disturbance to bat activity in the locality of North Quay and Riviere Farm; the most significant are physical and visual obstruction of bat flight lines, loss of potential foraging habitat, (particularly where shelter trees are removed), loss of flight line features (such as hedge and tree lines and tracks), and potential visual disturbance from security lighting. These impacts would extend across North Quay, the surrounding Towans and the Riviere Fields, though the main extent would be in areas developed in phase 1 of the construction schedule. Surveys so far indicate that the population of bats here is small so that the potential magnitude of the unmitigated impact is probably moderate at most, though this must be confirmed. The loss of foraging habitat and some of the flight lines will be permanent but other constructional effects such as obstruction will be temporary; additionally impacts will vary according to the season. The level of certainty will be increased when the current survey plan for bats is completed (see section 12.4.1.4).

The severity of these impacts is likely to reduce over time as bats are likely to adapt by using other existing or new flight lines to access other foraging areas. However, bats are known to require continuity in flight lines; gaps of 10-30 metres cannot be negotiated by smaller species, so that removal of short lengths of hedge can effectively destroy an established flight line, at least temporarily.

There is potential for a moderate temporary, short term and permanent adverse impacts at local level (ie within the context of the local bat population). It is near certain that the construction activities would impact on any bats found to be roosting locally off-site (eg if present in the electricity sub-station) by affecting important post emergence foraging opportunities and flight lines into the surrounding landscape. The loss of foraging would be permanent but the disturbance to flight lines will probably be a short term impact. It is near certain that construction activities will cause a moderate adverse impact on bat habitat use at the local level.

Impacts from the operational phase

The installation of urban lighting, particularly street lighting, would be a part of the proposed residential development. Bats are affected by street and other municipal lighting; the impact varies according to the type and placing of lighting used, and the sensitivity of the species of bat that is affected. The Bat Conservation Trust recommend that bat roosts should not be illuminated directly (Jones, 2000). The sensitivity of bats varies between species and the potential for impact is therefore not predictable until the range of species using the site is confirmed. It is widely accepted that street lighting can affect feeding behaviour and that, more significantly, flood-lighting will deter bats from foraging areas.

The faster-flying species such a pipistrelle are attracted to street lights where they forage on flying insects, but slower-flying species such as long-eared bats will alter their behaviour to avoid street lighting. Since brown long-eared bat has been recorded at the site there is a small potential for adverse impact from operational lighting that affects foraging areas such as the hedges and tracks. There is also potential for adverse impact on roosts from lighting. There is a possibility of minor permanent local adverse impact from urban lighting which would be a significant adverse impact at the local level.

12.5.1.4 Potential impacts on coastal dune grassland

Coastal dune grassland habitat lies along the landward edge of the North Quay site. Within the surveyed area (extending over Hayle (Harvey's) Towans) there are approximately 10.3 hectares of dune habitat, comprising 7.9 hectares of dune grassland, 1.1 hectares of dune scrub and 1.3 hectares of open dune. (For the puposes of this assessment the dune scrub, which occurs in small stands that are closely associated with the dune grassland, is combined with the dune grassland: together the coverage is approximately nine hectares.)

Factors on which the dune grassland habitat depends

Dune grassland habitat develops where sand accumulations have been colonised by native grass and herbaceous plants; the habitat depends on continuing low nutrient and moisture conditions created by the sandy soils. At this site the dune grasslands depend on sandy soils that develop from sands blown on-land from the beach and, ultimately, St Ives Bay. Nutrient enrichment from dog excreta, vigorous growth by invasive non-native plant species and changes in local hydrology are impacts that have significant potential to degrade the quality of the dune grassland at this site, possibly resulting in loss of areas of dune grassland to less valuable habitat.

Prediction of change in baseline conditions

There is no information available to indicate that the baseline conditions on the dune grassland would change if the proposed development did not take place, except for the possibility that recreational use would increase. This increase in recreational use may degrade areas of the dune grassland through, for example, nutrient enrichment from dog excreta.

Predicted impacts from the proposed development

Impacts from the construction phase

Loss of extent owing to creation of parking and residential development within the proposed development

The proposed development includes the creation of car parking to the north east of the electricity substation on an area of dune grassland with dune scrub. This would result in the direct loss of approximately 1.3 hectares of dune grassland and dune scrub, the majority of which is dune grassland.

The residential development on the dunes would result in the direct loss of approximately 2 hectares of dune grassland and dune scrub the majority of which is dune grassland.

The overall loss of c.3 hectares of dune grassland represents a major extent of this habitat within the context of the Hayle Towans dune area and the development site, although it represents only a small percentage of the dune grassland habitat that occurs in the wider Towans dune system, of which these areas are a part. The severity of the loss in terms of the dynamics and integrity of the dune system is reduced by its location on the periphery of the Towans, such that it would probably not affect the functioning of this dune system and is therefore considered to be a minor permanent adverse impact in terms of scale. However, the loss is judged to be of moderate significance because of the regional importance of the habitat at this site.

Disturbance of dune grasslands within the immediate vicinity of construction sites

The construction activities for both the car park and the residential development are near certain to produce minor to moderate temporary, possibly short to mid term, adverse impacts on retained dune grassland and dune scrub habitats immediately adjacent to the construction areas. The extent is expected to be minimised by best practice construction methods but is as yet not quantifiable.

Impacts from the operational phase

The anticipated increase in recreational use surrounding the developments would possibly degrade areas of the remaining dune grassland through, for example, increased physical disturbance, local nutrient enrichment and, particularly near the residential developments, introduction of non-native plant species. The extent to which visitor numbers to the beach and dunes would change as a result of the development proposal has been estimated in a study by Roger Tym & Partners (2007); their conclusion is that: *"Although the overall increases in users of the beach may be significant, it is unlikely that there will be dramatic increases in usage away from the key access points to the beach at Hayle. Therefore, with management of visitor flows onto Hayle beach, the impact on the dune system as a whole is unlikely to change significantly as a result of the development around Hayle Harbour"*.

The potential for a long term, adverse visitor impact appears limited if this prediction is correct; measures to achieve management of visitor flows onto the beach are described in section 12.6.1.3.

12.5.1.5 Potential impacts on reptile communities

There is direct evidence of a community of common reptile species (adder, slow worm and common lizard) on the grassland habitats of the North Quay site, which, based on the criteria for assessing reptile communities devised by Froglife (Froglife, 1999), would qualify the area as a 'Key Reptile Site'.

Factors on which reptiles depend

All three reptiles require a varied topography that includes sheltering features, south facing habitat for basking and deeper frost free shelter for hibernation sites, combined with direct connectivity to similar habitat in the surrounding countryside and low levels of disturbance.

The survey conducted in 2005 (section 12.4.1.4) indicates that there is a thriving slow worm population on North Quay. The site provides an ideal mosaic of habitats for slow worm, including hard surfaces for basking and refuge, grassland for cover and foraging, scattered early succession scrub and abundant features for refugia and hibernacula. The species is commonly associated with semi-urbanised areas such as North Quay and its surrounds. There is little documented information on the range of an individual slow worm, but the habitat must contain a good population of soft-bodied invertebrates (as prey items). The results of the survey indicate that slow worm occurs throughout the survey site although they appear less common within the tall dune grassland on the eastern part of the site.

The adder is found in a wide range of semi-natural habitats where there is a good availability of prey items such as small mammals and lizards, sunny glades or slopes where it can bask, dense cover in which to take shelter and suitable features to use as hibernacula such as rabbit holes. Adders have large ranges, in the order of tens of hectares; within that range they favour particular areas according to the season and can range over one mile or more (particularly males).

The common lizard requires a similar habitat to adders, with a good population of invertebrates as food resource, basking sites, varied vegetation structure, refugia for shelter and hibernation and south facing basking sites.

Prediction future baseline conditions without development

There is no information available to indicate that the baseline conditions for reptiles on North Quay or the adjacent dune grasslands would change significantly if the proposed development did not take place, but it is possible that recreational use would increase. This increase may reduce the quality of the existing reptile habitat resource through disturbance and pollution.

Predicted impacts from the proposal

Impacts from the construction phase

The construction phases of the proposed development would entail preparatory building demolition and site clearance works and subsequent building phases on North Quay and Riviere Fields. During these works, measures would be implemented to ensure that the construction activities comply with the law relating to protection of reptiles (see section 12.2.3.2), such that potential to injure or kill reptiles is avoided. Protective measures to be adopted would include:

- At the site clearance stage, displacement of limited numbers of reptiles (to be defined for each species) into adjacent habitat; for adders priority would be given to mature individuals to minimise displacement stress
- Undertaking a translocation programme to move individual reptiles (particularly young adders) to another suitable site, when numbers found go above the limits defined for each species. A potential receptor site has been identified that is within the Towans dune system (at Gwithian); consultation with Cornwall County Council will be progressed to determine current reptile population levels here and hence the scale of translocations that would be possible
- Active discouragement of animals' return to the site following displacement, prior to and during the construction phase, by creation of unsuitable habitat or using barriers, as appropriate to the phase
- Avoidance of harm to reptiles during the removal of hedgelines in the construction phase at the Riviere Fields, primarily by adoption of suitable search techniques by a trained ecologist on site in order to remove as many reptiles as possible to adjacent suitable habitat, prior to and during the hedge removal

Potential for impacts on the size of the reptile community would arise from construction phase works, resulting from the loss of the undisturbed derelict areas and dune grassland at the North Quay site, which would cause a direct loss of habitat for all three species; the built development would offer little or no habitat resource. With regard to the adder population the loss will represent part of their range, although it is not known for certain how the areas to be lost are used within individual adders' seasonal movements, and the area to be lost may include the site of one or more winter hibernacula. The area to be lost is likely to represent the entire range for a number of individual slow worm and common lizard.

The impact would be a potentially moderate to major permanent, adverse impact on a reptile population of county significance.

Impacts from the operational phase

The potential for impacts on the reptile community remaining in adjacent habitat areas during the operational phase arises from the following factors:

- The increased human population size may produce increased levels of recreational disturbance in the adjacent habitat; this has the potential to produce a negative impact on the remaining populations of all three reptile species by reducing basking and feeding time. There is evidence that increasing levels of stress that result from high levels of disturbance are harmful to reptiles
- In addition there is potential for a general decline in the quality of the remaining habitat in a zone around the proposed development through urbanisation effects such as litter, disturbance and recreational activities

Overall, the potential operational impact is judged as a minor, long-term, adverse impact (although the size of the reptile population on adjacent habitat areas is unknown).

12.5.1.6 Potential impacts on nesting birds

Twenty-one bird species were recorded as showing breeding/nesting activity in scrub and dune grassland habitats on North Quay in 2005; these habitats at site, therefore, have local value as a nesting site for common species, and are notable for supporting two BAP priority species, linnet and song thrush.

Factors on which nesting birds depend

A wide range of potential nesting sites occurs on the site. On North Quay the areas of bushy scrub and the buildings were identified as providing nesting sites, as were similar features on the other areas of the development proposals, such as the hedges along the Riviere Farm fields.

Prediction future baseline conditions without development

There is no information that indicates particular changes in the baseline conditions for nesting birds in the future without the development, although increase in background disturbance from increasing recreational use of the site has the potential for negative effect on all nesting birds. Although a gradual increase in scrub, which could reasonably be anticipated at this site, may provide increased nesting resource it would reduce grassland feeding resource for many species.

Predicted impacts from the proposal

Impacts from the construction phase

Clearance of scrub, trees, hedges, grassland, ivy growth and buildings would take place during construction works at North Quay, Riviere Fields, South Quay, the Triangular Spit and East Quay. During these works, measures would be implemented to ensure that construction activities comply with the law relating to protection of breeding birds (see section 12.2.3.3), such that potential to disturb any nesting birds and confirmed nesting sites is avoided. Protective measures to be adopted would include:

- Vegetation clearance and building demolition would be planned outside the bird nesting season (March 1 to August 31) as far as possible (where the site is also a possible bat roost or hibernation site there would be additional constraints on the timing of work (see 12.6.1.2)
- If it is necessary to undertake works during the birds nesting season, features that could support nesting birds would be surveyed prior to any clearance or construction work, and any confirmed nests that are detected would be avoided

- If, during construction, nesting birds are found to be present in affected habitat/structures, then work would be stopped immediately, within the vicinity of the nest, and probably delayed at least until the nest is no longer occupied

Construction-phase removal of potential nesting habitat on North Quay, Riviere Fields, South Quay, the Triangular Spit and East Quay would result in a minor to moderate, adverse local impact on breeding birds.

Impacts from the operational phase

Increase in background disturbance from recreational use of the site has the potential to result in a minor, local, adverse effect on nesting birds.

12.5.1.7 Potential impacts on linnet

Linnet is listed on the red list as a species of conservation concern (2002 to 2007 list) because of its marked decline in the UK over the last 25 years; it is also a UK BAP priority species. Cornwall is, however, a stronghold for the species, where it is considered common.

Factors on which linnet depends

The linnet is generally associated with the scrub habitats on woodland edges which are close to grasslands, heathlands or farmlands; these provide the necessary seed-rich food resource for winter foraging and the low, dense thorny scrub for nesting habitat.

Prediction of future baseline conditions without development

The baseline conditions for this bird may alter gradually as the proportion of scrub in the landscape increases and the grassland on which it depends for its seed food is lost to scrub development.

Predicted impacts from the proposal

Impacts from the construction phase

Linnet would be affected by loss of both scrub and dune grassland habitats in the clearance of the North Quay site; this would reduce the extent of available nesting and feeding resource available to the local population. Linnet populations are particularly susceptible to loss of seed food resource in arable landscapes, such as reduction in oilseed rape crops or arable weeds where these are the main resource during nesting. The extent to which the linnet population relies on this resource in the Riviere Fields is not known, but the dune habitats (both the open dune and the grassland) would be expected to provide at least part of the feeding resource.

The breeding bird survey (see section 12.4.1.3) indicated the importance of the scrubby areas on and near the dune grassland habitats for nesting linnets. The construction phase also has the potential to disturb breeding pairs that are nesting in scrub adjacent to construction sites.

The potential impact on the population of linnet is assessed as a minor to moderate, local permanent adverse impact.

Impacts from the operational phase

The potential for operational impacts on linnet arise from the increased levels of disturbance from the proposed residential development adjacent to remaining habitat areas. The operational impact on the local population of linnet is assessed as minor to moderate permanent, local adverse impact.

12.5.1.8 Potential impacts on song thrush

Song thrush is listed on the red list as a species of conservation concern (2002 to 2007 list) because of its population decline in the UK (which has now stabilised) over the last 25 years; it is also a UK BAP priority species.

Factors on which song thrush depends

Although more generally associated with open woodland habitats, song thrush regularly occurs in areas where there is a good mix of trees, scrub and grassland with damp woodland type habitats, and a high population of invertebrates and abundant fruit in winter as food supplies. They require dense cover in trees and shrubs for nesting, and a shrub layer where there is high humidity and negligible management to provide feeding resources.

Prediction of future baseline conditions without development

The baseline conditions for this bird are unlikely to alter significantly although increasing background disturbance may produce a low level negative effect.

Predicted impacts from the proposed development

Impacts from the construction phase

Song thrush would be affected by loss of unmanaged scrub areas, woodland edge habitat and dune grassland habitat in the clearance of the North Quay site; this would reduce both the nesting and feeding habitat resource available to the local population. The construction phase also has the potential to disturb breeding pairs that are nesting in scrub adjacent to construction sites (see 12.5.1.6, above). The potential impact on the local population of song thrush is assessed as a minor permanent adverse impact.

Impacts from the operational phase

The potential for operational impacts on song thrush arise increased levels of disturbance from residences sited adjacent to remaining habitat areas. The impact is assessed as a minor permanent, local adverse impact.

12.5.1.9 Potential impacts on western ramping fumitory

At Hayle, western fumitory is associated with scattered disturbed areas of soil on North Quay.

Factors on which western ramping-fumitory depends

This species requires an open habitat with freely draining neutral to acidic soils and is largely dependant on regular but low level disturbance of the habitat to maintain the open vegetation.

Prediction of future baseline conditions without development

The scattered areas of open vegetation on which western ramping-fumitory was found are subject to regular physical disturbance, which is required to maintain typical habitat for this species. If the use of the site was to continue, at its present level, the species is likely to persist in and around the waste areas. The seed bank would persist in the soils and the species may colonise other waste areas within the locality. However, in their current location the plants are exposed and vulnerable to destruction so that the future of the population on North Quay is uncertain.

Predicted impacts from the proposal

Impacts from the construction phase

There would be a loss of known plants, and by inference the seed bank, from the clearance of materials during construction on the North Quay area during phase 1 works. This impact is assessed as a minor local adverse impact on a plant of county significance.

Impacts from the operational phase

The proposed development would result in a small loss of available waste ground habitat within a geographic area that is the stronghold for the species. The impact is assessed as minor because of the low density of plants and their vulnerability to destruction without management. Although it would not be possible to predict with any certainty, soil disturbance in other areas of the proposed development could result in the regeneration of other seed banks. Overall the impact is assessed as minor local adverse impact at the national (and county) level.

12.5.1.10 Potential impacts on purple ramping fumitory

At Hayle, this plant is associated with the piles of inland soils that are standing on North Quay (a typical waste ground habitat for the species), and less typically the open disturbed habitat on the edge of the Copperhouse Pool saltmarsh.

Factors on which purple ramping-fumitory depends

This species requires an open habitat with freely draining acidic soils and is largely dependant on regular but low level disturbance of the habitat to maintain the open vegetation.

Prediction of future baseline conditions without development

Without physical disturbance of the piled soil on which purple ramping-fumitory was found the plants would gradually decline and disappear under increasingly dense vegetation growth, although the seed bank would persist. However the species may also appear in the other waste ground areas within the immediate vicinity.

Predicted impacts from the proposal

Impacts from the construction phase

There would be a loss of known plants, and by inference the seed bank, from the clearance of materials during construction on the North Quay area during Phase 1. This impact is assessed as negligible adverse impact on a plant of county significance.

Impacts from operational phase

The proposed development would result in a small loss of available waste ground habitat within an area that is a stronghold for the species. Although this would not be possible to predict with any certainty, soil disturbance in other areas of the proposed development could result in the regeneration of seed bank. Overall the impact is assessed as a negligible, adverse permanent impact of local importance.

In addition the species occurs on Copperhouse saltmarsh. It is possible that the change in salinity levels resulting from the proposed tidal impoundment would result in the disappearance of this very small population associated with the marsh. This would be a negligible adverse impact at the national (and county) level.

12.5.1.11 Potential impacts on ivy broomrape

Ivy broomrape is scattered through the development site, on areas of well-developed Ivy growth on the ground.

Factors on which ivy broomrape depends

This vascular plant is fully dependant on areas of well-established Ivy growth in open habitat for its survival.

Prediction of future baseline conditions without development

The baseline conditions for this species are unlikely to change significantly.

Predicted impacts from the proposal

Impacts from the construction phase

A number of colonies of ivy broomrape would be lost on North Quay, East Quay and South Quay as the ground is cleared for the construction phases. The coastal populations of this plant in the west of Britain are regarded as stable so that the potential for impact on the species, either in population extent or local abundance is therefore assessed as of local importance. This loss would represent a minor local permanent adverse impact.

Impacts from the operational phase

The potential for impact in the operational phase arises from the loss of available habitat; the available habitat for ivy broomrape is very limited since it requires stable open areas of ivy dominated ground cover. This loss would represent a minor local permanent adverse impact.

12.5.1.12 Potential impacts on otter

Factors on which otters depend

Otters are wide ranging animals that can cover tens of kilometres and move between and through catchments, and onto the coast. Otters are known to use the Hayle river catchment including its lower areas, and are most likely to be present in the aquatic habitat of Lelant Water, to the west of the Triangular Spit, where they can fish. The sheltered undisturbed habitat that otters require for breeding is not available within the vicinity of the proposed development, and suitable resting places are very sparse.

Prediction of future baseline conditions without development

There is no specific information available to suggest that the baseline conditions for otter would change significantly. However the gradual migration of mobile sands into the Lelant Saltings water way could be expected to reduce the local availability of fish feeding for otters, probably the main reason for their presence in this area of the catchment.

Predicted impacts from the proposal

Impacts from the construction phase

The potential for direct impact through disturbance is assessed as low since they would almost certainly avoid any such areas; this is judged as a near certain negligible local and temporary adverse impact. There may be a temporary contraction in the available feeding areas due to local disturbance. Overall there is a potential for a negligible local temporary adverse impact.

Impacts from the operational phase

The potential for significant impact is assessed as low; otters are known to develop a tolerance to at least some types of human presence and activity, such as walkers, anglers and dogs (Jeffries, 1987 cited in Chanin, 2003) and would almost certainly avoid any areas of disturbance. However, the increase in general use of the area for recreational purposes such as boating may deter otter from visiting certain areas of the lower estuary,

and therefore produce a small contraction in the available feeding habitat for the local population. However, impoundment of Penpol Creek would increase the area of habitat in the harbour suitable for fish; it is possible that this may result in an improvement in the feeding resource for otters, which would be a beneficial impact. The overall significance of the potential impact is difficult to assess, but is probably in the range of a negligible adverse impact on feeding habitat availability.

12.5.1.13 Potential impacts on hedges

Hedge habitat is largely restricted to the Riviere Fields area where it forms a locally important network of semi-natural habitat in an arable landscape. The value of these hedges resides largely in their significance to the local bat population in providing flight navigation features through the landscape, and for smaller species of common reptile which may use the hedge structures for shelter, basking, feeding and hibernating.

Factors on which hedgerow habitat depends

The hedgerow habitat depends on regular but sensitive management to retain the integrity of its structure and the native vegetation cover. Grassland strips at its base increase habitat value and buffering from adjacent land use, and direct physical link with other lengths of hedge across the surrounding landscape increase the biodiversity value of the hedge. Planting with non-native species would probably decrease the biodiversity value.

Prediction of future baseline conditions without development

Any change in the baseline conditions would probably arise from changes in agricultural practices within the Riviere Fields site, such as removal of hedge lengths to increase field size, or neglect of the hedge structures.

Predicted impacts from the proposal

Impacts from the construction phase

During the construction phase, lengths of hedge at Riviere Fields would be removed in order to create the access infrastructure and place the intended housing. Of the existing 1.2 kilometres of hedge line, approximately 330 metres would be lost at the centre of the fields and short lengths would be lost where road access is put the through the hedge; in all, approximately 30 percent of the existing length is likely to be lost. This would result in a direct loss of seminatural habitat and the fragmentation of the hedges, an effect which compromises the hedges' biodiversity value through a loss of habitat continuity and integrity. There is also the potential for adverse impacts on bats that use the hedge habitat as foraging habitat and flight lines, and reptiles which may use the hedge structures for shelter, basking, feeding and hibernating. The loss is a minor to moderate local permanent adverse impact.

Impacts from the operational phase

There is at least a minor potential for adverse impact on the remaining hedge habitats as a result of the close proximity of the residential development and the tendency of residents to urbanise semi-natural features such as Cornish hedges. This would be a minor to moderate permanent adverse impact.

12.5.1.14 Potential impacts on saltmarsh

Factors on which saltmarsh depends

Saltmarsh habitat develops where specialised plants establish on muddy sediments in a sheltered, tidal environment. The level of salinity is generally lower than fully marine levels, due to the inputs of freshwater. A major influence on the character of the saltmarsh is the length of time it is inundated by tidal water and the salinity of that water. Longer periods of inundation and/or higher salinity water will decrease the diversity of plant species and change the vegetation community.

Prediction of change in baseline conditions

If the current tidal regime in Copperhouse Pool remains, the tendency, over several decades, would be for the existing saltmarsh to gradually develop into a grassland and scrub, as sediment deposition gradually raises the level of the mudflats and the plant community changes in response. This pattern would be affected by global rises in sea level; the saltmarsh habitat would gradually migrate with the higher tide levels as they flood onto higher adjacent ground. Where the saltmarsh is enclosed by steep faces, as it is at Copperhouse, the saltmarsh habitat would be gradually lost under an increasing tidal depth, unless sediment deposition and vegetation growth maintain marsh soil levels in relation to sea level. This model is affected by a number of unpredictable factors such as rate of sea level rise, change in current speed, change in sediment availability and deposition rates, mudflat erosion, change in tidal/freshwater regime, physical disturbance, dredging etc; this complexity lowers the confidence levels of any long term predictions.

Predicted impacts from the proposal

Impacts from the construction phase

The normal tidal cycle would prevail throughout the development construction phase, and so no changes to the hydraulic regime of the saltmarsh habitat would occur. No adverse impacts on the habitat are expected.

Impacts from the operational phase

The current intention is to retain spring high waters for three hours to allow effective sluicing in the lower estuary during the 15 April to 31 August period each year; this would occur for five days in a row on spring tides, effectively ten days in every 28 day tidal cycle.

This impoundment would probably have several effects. Overall these effects are unlikely to result in loss of salt marsh habitat, but there may be a slight loss in extent if the seaward edge of the lower marsh moves landward in response to erosion of sediments by increased current speeds. There may also be a change in species and community distribution in response to disturbance of the tidal and salinity regime; of concern would be the possible expansion of the cord grass growth which is generally detrimental to wintering waders (and usually not reversible once established, owing to resistance of cord grass growth to control). The impact is judged as a potentially minor to moderate long term adverse impact, on a habitat of national significance. However, changes to vegetation could potentially be reversed by re-establishing the existing tidal regime, if recorded changes in the distribution of some plant communities were deemed detrimental to habitat quality.

12.5.2 Aquatic ecology

12.5.2.1 Overview

The features that have been determined as being key receptors for aquatic ecology, and therefore requiring an assessment of the potential impact of development proposals, are as follows:

Feature	Location	Conservation value
Gilthead bream, golden grey mullet and bass	Carnsew Pool, Copperhouse Pool and harbour	Regional
Sandeels	Harbour and Lelant Water	Local to Regional
Tidal rapids and associated invertebrates and seaweeds	Immediately above and below Carnsew tunnels	Local to Regional
Intertidal invertebrates and seaweeds (food source for waders, waterfowl and fish)	Lelant Water, Carnsew Pool, Copperhouse Pool	Local to Regional (in terms of prey availability for birds)

Table 12—7: Key receptors relevant to aquatic ecology

The unmitigated impacts of construction-phase works on aquatic ecology are considered below on an area-basis, with reference to the itemised list of marine works described in Chapter 13, section 13.5.1.

The following operational activities have been assessed for their potential to have impacts on aquatic ecology:

- sluicing to remove sediment from the harbour, implemented by closing sluice structures at the mouths of Carnsew and Copperhouse Pools to hold water in the pools at high spring tides, followed by the release of this water into the harbour on the ebb tide (c.3 hours after high tide)
- maintenance dredging of the harbour
- boat traffic associated with the marina in the harbour

- operation of the half-tide gate at the seaward end of Penpol Creek

Mitigation measures are identified in section 12.6.2 and summarised in 12.7.2.1; monitoring requirements are detailed in section 12.8.2.

12.5.2.2 Construction impacts

The Harbour Works Description (Annexe 13G) provides information on the various construction works that could affect aquatic ecology. These works descriptions form the basis of our understanding of the location and scale of construction works and the materials and methods which would be employed. Hydraulic aspects, eg dispersion of fine sediments from dredging Cockle Bank, are considered in Annexe 13F.

Harbour Wall Repairs (Work Items 17-22)

Wall repairs, repointing and reconstruction would occur in several locations around the development site:

- Carnsew Wharf and Carnsew Quay (outside Carnsew Pool) (total length 176.5m); expected duration of repairs is four months
- South Quay (including the western edge of Penpol) (total length 626m); expected duration of repairs is four months
- East Quay (total length 330m); expected duration of repairs is three months
- North Quay (total length 523m) and North Quay Eastern (near entrance to Copperhouse, total length 27m); expected duration of repairs is five months

Details of the methods to be used and areas where work would be carried out are contained in the Harbour Works Description (Annexe 13G). As the impacts and recovery of these construction works are similar regardless of the location they are considered together

During the construction of Phase 1 of the development there would be temporary adverse impacts on intertidal invertebrates and seaweeds due to refurbishment of harbour walls. The upper parts of the harbour walls are above the intertidal, so no direct impacts on aquatic flora and fauna would occur during repair of the coping stones or other repairs to the upper 1.5m (approx) of seawall.

Aquatic flora and fauna on the middle and lower parts of the walls would be removed from areas of stones or scoria blocks that require reconstruction or pointing. Removal techniques are likely to be a combination of pressure washing and mechanical removal. In places where there are boulders and cobbles at the base of walls there would be impacts on invertebrates and algae from trampling (Brosnan & Crumrine, 1994). Pointing between blocks would be recessed and this will encourage more rapid recolonisation and higher final densities of invertebrates and algae. The new and refurbished areas of harbour wall would be quickly colonised by algae (eg *Enteromorpha* spp and *Fucus* spp.) and invertebrates (eg barnacles, limpets, mussels and periwinkles) and no impacts are likely to be visible within approximately two years of the repairs and renewals. The impacts of

this work on aquatic flora and fauna of the harbour walls are considered to be a minor adverse impact, localised and of medium-term duration.

Full reconstruction is required on sections of wall on South Quay and East Quay which have completely collapsed. Here the intertidal habitat is currently steeply sloping boulders with fucoid seaweeds (*Fucus* spp. and *Ascophyllum nodosum*) and associated invertebrates (eg periwinkles and shore crabs). Repair of these areas would result in an additional 220m^2 and 155m^2 respectively, of which approximately 65% (approximately 245m^2) would be in the intertidal zone. This additional intertidal vertical habitat is estimated to be about 5% of the total wall area in the development area that is intertidal. The overall ecological impact of the full reconstructions is negligible for seaweeds, invertebrates and fish.

During the works on the harbour walls there is a possibility of contamination due to spillages of lime-based mortars, hydraulic cements or other materials. These could cause minor, localised and temporary adverse impacts.

Harbour

Harbour - Works Item 10 (Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN)

These works are expected to take six months.

The main adverse construction impacts in the harbour are loss of the intertidal habitat at Cockle Bank (which would be removed) and dredging of the area around Cockle Bank. The subtidal sands (currently at about 0 m to -2.5m ODN) around Cockle Bank would be dredged to a maximum depth of -4.0m ODN. The western limit of the area that would be dredged is estimated to be 21m from the SSSI boundary (see Figure 12.13). The substrate that remains after dredging is expected to be sand with a similar particle size to that which currently occurs on the surface.

DO NOT SCALE THIS DRAWING.

Hayle Harbour

Extent of excavation of cockle bank, sediment rtap andf harbour area

Figure 12.13
not to scale
print at A3
date November 2007

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Cockle Bank is at about 0m to +1.0m ODN. It is fully exposed on low water spring tides, but most of it remains submerged on low water neap tides. Cockle Bank supports a restricted invertebrate and seaweed community due to the presence of contaminants in the sediments.

Swimming species recorded in net samples taken from close to Cockle Bank included mysid shrimp (*Praunus flexuosus*) brown shrimp (*Crangon crangon*) and occasional shore crabs (*Carcinus maenas*), plus smaller crustaceans. These are all likely to be important prey for the fish that inhabit the harbour area, eg sandeels. Many of the invertebrates found near Cockle Bank are associated with seaweeds, and the deeper area created by dredging would support less marine algae and so is likely to support lower densities of invertebrate prey for fish. This would be offset to some extent by the expected presence of high densities of red, brown and green seaweeds and associated invertebrates on the marina pontoons and piles. The species of fish that thrive in the dredged area around the marina are expected to be those that can feed on the algae and invertebrates found on or close to marina structures, eg pollack, ballan wrasse and various pipefish. Bottom-feeding specialists such as red mullet and flounder may decline in density but overall numbers in the harbour should not fall as there would be an increase in the subtidal benthic habitat available for them to feed in.

Dredging of the subtidal sandy habitat around Cockle Bank would remove sediments that contain invertebrates and sandeels (greater sandeel and lesser sandeel); the latter are important prey for many other fish and several species of seabird. Sandeels move into the Hayle estuary and harbour area in August and September and spawn mainly in September and October (pers. comm. Simon Toms, Environment Agency). The harbour area is known to be important for sandeel spawning (pers. comm. Simon Toms, Environment Agency) and reduction of the impacts of dredging on sandeels would be achieved by the timing of these works, which should be completed before the main sandeel spawning and larval period (see section 12.5.3.1).

Dredging would create sediment plumes with elevated concentrations of suspended solids and associated metals. Modelling of plume dispersion from dredging Cockle Bank does show some deposition of fines in lower Lelant Water, Carnsew and Copperhouse Pool but the settling velocity chosen for the fine material was low in order to show potential transport pathways (Hydraulics Research, 2007, Annexe 13F). Adverse impacts from the dredging are only expected in the harbour area, where the sediment plume may cause mortality of flora and fauna due to smothering, reduced concentrations of dissolved oxygen, solids and possibly higher metals in the water column. This would be a minor to moderate temporary adverse impact.

If dewatering of dredged sediments occurs on land the metal concentrations and suspended solids in any leachate returned to the harbour may have a localised impact on flora and fauna. This is a minor to moderate temporary adverse impact.

The loss of intertidal habitat at Cockle Bank is offset to some extent by the gain in an equivalent area of dredged subtidal habitat. Cockle Bank is of low ecological interest, with very low invertebrate diversity or usage by birds. Its replacement with dredged subtidal habitat is seen in overall terms as a minor adverse

impact. It is possible that the newly created subtidal habitat (ie beneath the existing Cockle Bank) would be suitable for sandeels, which would be a minor beneficial impact. The ecological value of this new subtidal habitat would be reduced by frequent dredging, ie intervals of less than a few years.

Subtidal sediments near Cockle Bank will be adversely affected by capital (ie construction-phase) dredging, but a good recovery is likely and within 1-2 years a deeper water version of the same subtidal sand biotope should be present.

Harbour - Works Item 12 (New fishermen's quay)

Construction of the pier adjacent to the fishermen's quay is expected to take nine months.

Construction of the new fishermen's quay could affect water quality during placement of temporary bunds and dewatering of the excavation area. This is a minor adverse temporary impact.

The fishermen's quay would result in the loss of intertidal sediment habitat and a gain in hard habitat on the slipway and sheet pile wall quay. This area has a low diversity and invertebrate biomass due to the mobility of the sands and is of relatively low conservation interest. Typical species in the sediment include *Melita palmata*, the spionid polychaete *Pygospio elegans,* enchytraeid oligochaetes and the isopod *Eurydice pulchra* were also present (Aquatonics Ltd, 2007b; Annexe 12G). The loss of sandy intertidal sediments is a minor adverse permanent impact. The gain in new intertidal hard habitat is a minor beneficial permanent impact.

Harbour – Works Item 23 (Slipway and associated land works)

Construction of the sailing centre and slipway could result in contamination due to spillages of lime-based mortars, hydraulic cements or other materials. This would be a minor, localised and temporary adverse impact.

The sailing centre and slipway would result in the loss of a small area of intertidal sediment habitat and gain of intertidal hard substrate habitat. It is likely that the concrete slip would be regularly cleaned and it would therefore have minimal ecological interest.

Harbour – Works Item 13 (Excavation and dredging of i) harbour area to the north-west of fishermen's quay, and ii) sand trap)

Excavation and dredging of harbour area to the north-west of fishermen's quay is expected to take three months.

The operation may generate plumes that could impact water quality at adjacent habitats. However, the sands are relatively clean and contain very little fines, so most of the sediment would settle out nearby. This is a minor adverse temporary impact. The dredging would result in a loss of biota from dredged area, including a few specialist species (eg enchytraeid oligochaete worms and the sand-hoppers) from the upper shore, and mainly annelids further down-shore in sandy sediments (Aquatonics Ltd, 2007b). Recovery from dredging is

expected to occur within 6-12 months. Some impacts on nearby spawning sandeels are possible. This is a minor to moderate adverse medium-term impact.

The total volume to be dredged north-west of the harbour is estimated to be 38,500 m^3. This sand would be relatively uncontaminated (similar to nearby beach sands) and would be reused on-site most likely for terrestrial habitat creation (see section 12.6.1) or beach recharge (via mechanical or hydraulic means). Beach nourishment has environmental benefits regarding erosion of the coastline and sand dunes. The main adverse effect of beach nourishment is the smothering of biota on the beaches. The biota on the beach primarily comprises invertebrates that are adapted to mobile sands. Biomass and diversity are low and recovery is expected to occur in 6-12 months. This is a minor adverse medium-term impact.

Dredging of the sand trap near the entrance to the harbour would extend to within approximately 12m of the SSSI boundary (see Figure 12.13). Dredging would create a sediment plume that may cause sedimentation on adjacent habitats (in this area it is unlikely that contaminants would be an issue). This would be a minor adverse temporary impact.

Dredging to create the sand-trap would remove most of the existing biota (eg invertebrates and sandeels) and affect those species that feed in this area, eg sandeels. The diversity and community composition of mobile sands recover quite rapidly from dredging, with estimates ranging from 16 months (Desprez, 2000) to 6 years (Boyd et al, 2005). The speed of recovery is likely to be relatively rapid at Hayle, due to the high bedload transport of sand and it is expected that diversity would recover within 1-2 years, but biomass and densities may take 2-3 years.

Dredging of the sand trap would produce c.10,000 m^3 of relatively uncontaminated sand that may be of sufficiently high quality for it to be used in nearby beach nourishment schemes, or for terrestrial mitigation (see section 12.6.3). The biota on nearby sandy beaches are primarily invertebrates that are adapted to mobile sands (Halcrows, 2006). Biomass and diversity is low and recovery of the intertidal biota is expected to occur in 6-12 months. This would be a minor adverse medium-term impact.

Harbour – Works Item 3 (excavation and renovation of Carnsew second sluice and road construction) and Item 2 (new fixed pedestrian bridge at Carnsew second sluice)

These two work items are likely to be combined in the development construction programme, and are expected to take eight months. The sluice construction and road-laying component of the works would probably run concurrently within a four month period.

Excavation and renovation of Carnsew second sluice would involve dewatering into the adjacent part of the harbour, which would introduce elevated concentrations of suspended solids and possibly other contaminants used in construction. This could impact on the relatively diverse, regionally valuable assemblage of algae and invertebrates in the harbour near to the existing sluice, and possibly on the viviers that are used by fishermen

to store live crustaceans. The latter is unlikely due to the high dilutions that would occur. Overall these impacts are assessed as moderate adverse temporary impacts.

Harbour – Works Item 5 (Excavation of harbour at Carnsew Quay/Carnsew Wharf)

Works items 5 and 6 are expected to take three months.

The impacts of the excavation of the harbour at Carnsew Quay/Carnsew Wharf depend on timing. If the works are carried out at the same time as Carnsew second sluice and channel works a temporary bund could be installed at the north end of Carnsew Wharf. This would reduce the possibility of contaminants entering the harbour area or reaching Carnsew Pool. However, the bund would mean that aquatic intertidal and subtidal habitats south of the bund would become dry (or at best damp) whilst the work is in progress. The ecology of this area is not known but is expected to be of moderately high quality. There would be major adverse temporary impacts in the area south of the temporary bund, with most flora and fauna expected to die.

Renovation of the existing South Quay harbour walls or construction of new walls would be carried out in the dry. This could result in minor, localised adverse impacts, but as the surrounding area is currently terrestrial there would be only a small possibility of impacts on existing aquatic ecology. There would be a negligible adverse localised impact.

The additional harbour walls at South Quay after excavation would provide new intertidal habitat. This would be a moderate beneficial permanent impact.

Harbour – Works Item 6 (Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN)

The expected quantity of material to be dredged is c.3,000m^3. Dredging works are expected to take three months.

Dredging of the basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN (-4.4m CD) would remove sediments with their associated flora and fauna. The area close to Carnsew tunnel is likely to be of moderately high ecological quality. The impacts depend upon the dredging method and whether the site would be already adversely affected by the bund for excavation of the harbour at Carnsew Quay/Carnsew Wharf. At worst a major adverse temporary impact is expected. Full recovery is expected to take 3-4 years.

If wet excavation is used there is likely to be some loss of fine sediments during dredging. These are likely to be contaminated and could affect water quality in the harbour and potentially Carnsew Pool. This is a moderate adverse localised impact.

Harbour – Works Item 11 (New floating pontoons for marina)

Construction of the marina pontoons is expected to take three months.

The floating pontoons for the marina would be attached to either steel piles within the marina area, or possibly a bed anchor system. During construction there is potential for polluting materials to enter the harbour. This would have negligible to minor temporary adverse impacts.

Construction of the marina would result in the loss of a small subtidal sediment habitat where steel piles enter the sediment or where bed anchors occur. There would be a slightly larger gain in vertical subtidal and intertidal habitat on the piles (if used). The loss of subtidal habitat due to piles is a negligible adverse permanent impact and the gain in vertical habitat on piles is a minor beneficial permanent impact. No mitigation is proposed. If piles are used there would be a minor beneficial permanent impact.

Harbour – Works Item 15 (Pedestrian bridge from East Quay to North Quay)

These works are expected to take nine months.

Construction of the new pedestrian bridge from East Quay to North Quay may introduce contaminants into the harbour area, with consequent impacts on aquatic species. This is a minor adverse temporary impact.

There would be a small loss of intertidal/subtidal sediment habitat due to construction of the bridge piers in the intertidal. There would be a larger gain in intertidal/subtidal hard substrate habitat on the piers. The loss of sediment habitat is a minor adverse permanent impact, whilst the gain of hard substrate habitat on the piers is expected to be a minor beneficial permanent impact. Overall this is a negligible but permanent impact.

Harbour – Works Item 9 (Half-tide gate at entrance to Penpol Creek; part)

These works are expected to take nine months.

Part of the new Penpol Creek half-tide gate and pedestrian crossing would be constructed behind a coffer dam extending approximately half the distance between the Penpol quayside and East Quay. Dewatering would result in a small discharge to the harbour, and disturbed sediments may be carried to the harbour on the ebb tide. Impacts on water quality in the harbour are expected to range from negligible to minor temporary. Elsewhere the impacts would be negligible due to dilution.

Penpol Creek

Penpol – Works Item 7 (Lifting/swing pedestrian bridge at Penpol Creek)

These works are scheduled to take six months.

The new lifting/swing pedestrian bridge at Penpol Creek would be partially supported on piers within Penpol Creek. This would result in a small loss of aquatic sedimentary habitat (all currently intertidal) and gain of a

larger area of hard substrate which would be intertidal and subtidal. Overall this would be a negligible beneficial permanent impact.

Penpol – Works Item 8 (Dredged area at south end of Penpol Creek)

These works are expected to take three months.

If dredging/excavation at the south end of Penpol Creek to a depth of approximately -1.0 m ODN (-4.4m CD) occurs at the same time as the construction of the half tide gate at the entrance to Penpol it is unlikely to adversely affect water quality in the harbour or elsewhere. Impacts on the quality of any water remaining in Penpol Creek (eg the freshwater channel) would be minor. Outside the freshwater channel the estuarine flora and fauna of Penpol Creek would have been killed by the closure of Penpol Creek two months previously.

Dredging/excavation at south end of Penpol Creek would remove flora and fauna in the sediments. The dredging works have been scheduled to coincide with the closure of Penpol to construct the half-tide gate (Works item 9). Therefore, by the time the dredging occurs Penpol Creek would have been severely affected by the lack of tidal exchange and most, if not all, species present would have died. The *additional* impact of the dredging is therefore negligible. A full recovery to pre-dredging conditions at Penpol Creek is not possible as the half-tide gate would change the tidal regime (ie. preclude a return to fully intertidal habitat).

Penpol – Works Item 9 (Half-tide gate at entrance to Penpol Creek; part)

Construction of the half-tide gate at the entrance to Penpol Creek is expected to take nine months.

The Penpol Creek half-tide gate and pedestrian crossing would result in the loss of some intertidal sediment habitat and a very small amount of subtidal sediment habitat due to half-tide gate and placement of stone erosion protection "blankets" each side of the tidal gate. There would be a gain in hard substrate habitat (intertidal and subtidal) on the newly constructed faces. Overall the impacts of habitat loss would be negligible, as the gain in hard substrate habitat would be greater than the loss of sediment habitat.

Tidal flows would be maintained in Penpol during gate contruction, so maintaining the biota of the creek during the works. Disturbed sediments may be carried into the creek with the tide. The impact on aquatic fauna would be a minor adverse, short-term impact.

Carnsew Pool

Carnsew Pool – Works Item 1 (Build new Carnsew second sluice)

These works are scheduled to take four months.

During the construction works of the second sluice in Carnsew Pool there would be no impacts on aquatic ecology of Carnsew Pool, as the construction site would be isolated from it. Groundwater at the construction

site would be discharged to the adjacent part of the harbour, and the impacts of this are considered in the harbour section.

Carnsew Pool – Works Item 2 (New fixed pedestrian bridge at Carnsew second sluice channel)

These works are scheduled to take eight months.

Aquatic impacts of the new fixed pedestrian bridge at Carnsew second sluice channel would depend upon on timing. If it is constructed after the channel consruction works there is potential for aquatic contamination, which could cause localised, short-term and minor adverse impacts.

Carnsew Pool – Works Item 4 (Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system)

These works are scheduled to take four months.

Refurbishment of the tunnels to Carnsew Pool and installation of the sluice gate system would result in the loss of a small area of intertidal and subtidal habitat due to construction. Stone erosion protection blankets may be constructed to each side of the tunnels. Some of these new surfaces would be colonised by marine species. The impact is a minor adverse localised but permanent impact.

Seaweeds and invertebrates on some lower parts of tunnel walls would be removed using pressure washing or physical methods. This is a minor adverse impact, with full recovery expected within 1-3 years.

Isolation of the tunnels from the harbour and Carnsew Pool would result in lower velocities upstream and downstream of the tunnels. The flora and fauna in this area require high velocities. In the harbour, downstream of the tunnels, the flows into and out of Carnsew through the second sluice may be sufficient to maintain a healthy flora and fauna. Impacts in Carnsew are likely to be higher and would range from reduced growth to death of some organisms that cannot escape. The impacts are assessed as minor to moderate, short-term but localised adverse impacts.

Copperhouse Pool

Copperhouse Pool – Works Item 14 (New vehicular bridge by Copperhouse Gate)

These works are scheduled to take ten months.

Construction of the piers in the intertidal to support the new vehicular bridge may introduce sediments and associated contaminants (eg copper, zinc and arsenic) into the water column. Very high levels of contaminants occur in Copperhouse Pool sediments (Smith, 1988), and some of the highest concentrations were found in sediments close to the proposed bridge site, eg copper maximum was 9315 ppm.

The works would be carried out with normal tidal cycles, which would allow contaminated material to enter the harbour area on the ebb tides. This would be a moderate adverse temporary impact to aquatic biota in the

harbour . In addition, the bridge piers would cause a small loss of intertidal sediment habitat and a larger gain in vertical intertidal habitat on the bridge piers. This would be a minor adverse permanent impact due to the loss of a small area of habitat. This would be balanced by a minor beneficial permanent impact due to uncontaminated hard substrate on the new piers that may increase the range of species that occur in Copperhouse Pool.

Copperhouse Pool– Works Item 16 (Copperhouse Pool sluice gates maintenance works)

These works are scheduled to take two months.

The Copperhouse Pool sluice gates works could result in spillages of harmful substances. Aquatic impacts would be negligible and temporary as works would either be carried out at low water or in the dry by installing temporary barriers at the gate housing and allowing water in and out of Copperhouse Pool through the by-pass culvert on the east side of the gate.

Lelant Water

No adverse impacts on aquatic species in Lelant Water are predicted during the construction phase. Modelling of plume dispersion from dredging Cockle Bank does show some deposition of fines in lower Lelant Water, but the settling velocity chosen for the fine material was low in order to show potential transport pathways. The settling of suspended material from dredging in these areas is expected to be negligible (Hydraulics Research, 2007; Annexe 13F).

12.5.2.3 Operational Impacts

Harbour

Marina Use

The floating pontoons and new vertical faces of the breakwater west of the harbour would provide additional intertidal and subtidal habitat for species such as barnacles, limpets, mussels, hydroids and seaweeds.

The proposed marina and new fishermens quay will bring increased numbers of boats into the harbour; the increase will be predominantly leisure craft rather than and commercial fishing vessels (see section 13.6.2.5). This may result in increased deposition of anti-foulants into harbour waters. The latest anti-foulant paints used to reduce fouling on vessel hulls are generally considered to be less damaging than those based on tributyl tin (TBT), which is now banned. However, all anti-foulant paints are toxic to marine life (they contain copper, zinc or organic biocides) and usually this is an important consideration for marina developments (Comber, 2002). In the case of Hayle this is a relatively minor issue, as the existing flora and fauna in the harbour area are adapted to the high metal concentrations in sediments and water and are unlikely to be adversely affected by copper and zinc leaching from vessels. There would also be organic biocides in some of the paints used and the marine flora and fauna at Hayle would not have experienced these at high concentrations, so some localised

impacts around the marina are possible. Studies of four booster biocides in the Blackwater estuary, Essex, showed that diuron could not be detected but Irgarol, dichlofluanid and chlorothalonil could be detected in sediments and waters (Voulvoulis et al, 2000). The concentration of Irgarol was high enough to theoretically inhibit the growth of algae such as *Enteromorpha* and sediment concentrations of the other biocides may have been high enough to affect benthic invertebrates. The study suggested that there was insufficient information of the toxicity of these biocides, especially after they had partitioned onto sediments (Voulvoulis et al, 2000).

Dredging

Maintenance dredging of the harbour area, including the sand-trap, would be required. There is little agreement about the period over which aquatic flora/fauna show recovery from maintenance dredging, with estimates ranging from as little as 28 days (McCauley et al, 1977) to impacts at sites 500m from the dredging and no significant signs of recovery of the dredged area after 100 days (Quigley and Hall, 1999). From knowledge of the invertebrate and fish fauna of the harbour, it is expected that the number of species present would recover within 2-3 years, but biomass recovery is expected to take longer, perhaps up to 5-6 years from cessation of dredging.

Buro Happold have estimated that maintenance dredging of the area around the marina is likely to be required approximately every 5 -10 years (given a sluicing regime as described in section 13.6.2.4). This would mean that relatively mature benthic communities will develop in the dredged area, before they are removed. The biomass supported by subtidal sediments in the dredged area would fluctuate with the dredging regime. Biomass in the dredged area would tend to be at a minimum immediately after dredging and at a maximum immediately prior to the next dredging event. This fluctuation in biomass would have some impacts on the biomass of fish that can be supported in the dredged area. However, the dredged area only represents part of the whole harbour and it is unlikely that the fish populations in the harbour as a whole would show discernible changes in biomass. A negligible adverse impact is expected.

Sluicing

The frequency of maintenance dredging of the sand trap would be largely determined by the sluicing regime that is adopted and the frequency of storm conditions that occurs in that period. The hydrodynamic modelling carried out by Hydraulics Research (Hydraulics Research, 2007, Annexe 13F) shows that sluicing can be combined with dredging of the marina and sand-trap to control sedimentation in the harbour, and this would be most effective if sluicing was conducted on each spring tide (ie approximately five days in a row, every two weeks). However, the possible impacts of the sluicing regime on the ecology of Carnsew and Copperhouse Pools (see below) mean that sluicing may need to be carried out less frequently than this. In this event, maintenance dredging of the sand-trap is likely to be required annually, so there would not be a full recovery within the dredged area in terms of diversity or biomass. There would be a moderate adverse impact on sand-eels which would continue until dredging ceases at some future date.

Downstream from Copperhouse Pool and the second sluice from Carnsew the maximum tidal currents are predicted to increase, due to the sluicing. This is likely to result in a coarsening of the sediment in these areas. This increase in peak current velocities would favour marine invertebrates that are adapted to living in high current environments (eg many tunicates, bryozoans and crustaceans). Some of the existing species that inhabit this area may not be able to tolerate the higher current speeds, but overall diversity is expected to increase slightly. Overall this would be a permanent, minor beneficial impact.

All invertebrates and fish show preferences in the type of sediment that they inhabit. In some cases these preferences are broad (eg the polychaete worm *Pygospio elegans*) but others require a very specific sediment type. A study of the sediment preferences of lesser sandeel (*Ammodytes marinus*) in the North Sea showed that it avoided sediments with a silt and clay content over 10% and was present at reduced in densities when the silt and clay content was in the range 2-10% (Wright et al, 2000). To maintain the sandeel habitat in the harbour it would therefore be necessary to ensure that the large areas of clean medium to coarse sand that currently occur do not become mixed with finer sediments. This is considered in the section on mitigation (12.6.2).

Penpol Creek

Penpol is the area where the greatest physical changes would occur, but it is also viewed by the study team and conservation bodies as the least ecologically important part of the Hayle estuary complex. The main change would be a reduction in intertidal habitat and a balancing increase in the amount of subtidal habitat. In general terms this would favour subtidal invertebrates, seaweeds and fish and would reduce populations of intertidal invertebrates and seaweeds. Flatfish may increase in density due to lower current speeds at the seabed, as happened upstream of the Oosterschelde storm-surge barrier (Hostens & Hamerlynck, 1994). Precise impacts are difficult to predict, as they depend on the detailed management of Penpol. For example, if water levels are managed primarily to allow deep-draughted boats to stay afloat this would result in water levels retained generally above the half-tide limit.

Densities of invertebrate prey items for birds that feed on the upper intertidal (eg strandline and immediately vicinity) are unlikely to be affected by the half-tide barrier. In the zone with fluctuating retained water levels the biomass of invertebrate prey is expected to diminish, but densities of small prey items such as oligochaete worms may increase.

A desk study by Hydraulics Research of the flushing of Penpol with the half-tide gate in place indicates that it would be poorly flushed during neap tides, but would flush almost completely during two or three spring tides (Annexe 13F). The HR report states that Penpol would effectively behave as a closed system for periods of about a week, separated by an interval of about a week. The HR report suggests that this period is probably too short for significant algal blooms to occur. However, this conclusion needs to be proven by the collection of additional data, as algal blooms are sometimes associated with neap tide conditions, even in relatively open

waters such as South San Francisco Bay (Cloern, 1991) and Southampton Water. An associated issue is the likelihood that any algal bloom may include species that are toxic to shellfish, fish, birds or mammals. This could have a significant adverse impact on the ecology and fisheries of the Hayle harbour area. Information on algal blooms and the impacts of toxic algal blooms and reduction in dissolved oxygen caused by collapse of algal blooms is included in Annexe 12I.

At present, the potential impacts that could arise from algal blooms occurring in Penpol Creek can be characterised as ranging from negligible (if no blooms occur) to major adverse short-term impacts. Impacts could also occur in the harbour as the water in Penpol is flushed out (either by deliberately lowering the gate or due to spring tides flushing out the contents). The possibility of impacts in Copperhouse Pool, Carnsew Pool and Lelant Water from toxic algal blooms flushed out from Penpol, are much lower, owing to the path of the ebb tide (theoretically a small part of the bloom could end up at these locations, as shown by HR modelling of fine sediments discharged from the Cockle Bank area (Annexe 13F)). The issue of potential algal blooms occurring in Penpol Creek would be further examined after outline planning permission is obtained. As a precautionary approach it is assumed that a major adverse impact is possible during the operational phase.

Carnsew Pool

Within Carnsew Pool there would be an additional area of high current speeds close to the second sluice. This would favour those species of invertebrates, algae and fish that prefer high current speeds and reduce the densities of those species that prefer low current speeds (eg flounder, plaice and sole). Overall this would be a minor beneficial impact on invertebrates and algae, and a minor adverse impact on many species of fish.

No major adverse impacts are predicted during the operational phase, but there may be moderate adverse impacts on the flora and fauna due to the retention of spring high water for three hours, followed by sluicing (there are no plans to sluice during neap tides). The effective loss of intertidal over a whole spring tidal cycle has been calculated to be 23% if water is retained for three hours (calculated from information provided in Annex 13E). This extended high water would have impacts on invertebrates and algae that are difficult to predict. Factors that are relevant are:

- Tidal cues for breeding may be disrupted
- Larvae of some species may settle too high up the shore during extended high water
- Invertebrates that feed on the surface would have an extended period for feeding during spring tides
- Predation by wading birds on the upper shore would be reduced
- The lack of any shallow water habitat around the time of high water spring may have an adverse impact on juvenile plaice and sole, which preferentially seek out shallow, warmer waters to feed and avoid predators

- Probable coarsening of sediments due to higher velocities during ebb tide
- There would be a longer period for dead phytoplankton, zooplankton and detritus to settle out of the water column, increasing food availability for those invertebrates that feed on this material
- The extended high tide during spring tides would favour those species that occur further down the shore, but these same species would be at a disadvantage during neap tides, when the uppermost parts of the shore would not be covered for many days.

Some of the most significant changes to tidal regimes have resulted from projects in the Netherlands. The impacts on mobile epifauna (invertebrates and fish) of the construction of a storm-surge barrier and compartmentalisation dams on the Oosterschelde estuary have been studied (Hostens and Hamerlynck, 1994). Other studies of the Oosterschelde barrier have examined the impact of protracted immersion (Hummel et al, 1986), emersion (not covered by seawater) for 2-8 days (Fortuin et al, 1989a) and protracted low water periods for 18 or 30 hours (Fortuin et al, 1989b). The results indicate that a protracted low water of 18 hours was survived by most species (provided that extremely high or low temperatures did not occur), but 30 hours caused high mortalities (Fortuin et al, 1989b). Two days of immersion could also be tolerated by most intertidal species provided that extremely low or high temperatures did not occur (Fortuin et al, 1989a). Prolonged periods of immersion were tolerated by most intertidal species (Hummel et al, 1986), however, the study did not examine the impacts of extended periods of immersion over a whole year on reproductive success. It has not been possible to locate any references to a development that resulted in changes in tidal regime similar to those proposed at Carnsew and Copperhouse. However, in Southampton Water there is an extended high water during all tides and surveys there (various reports for the Dibden Container Terminal proposal) do not indicate any problems with the flora and fauna of the upper shore.

Juvenile flatfish such as plaice and sole obtain much of their food supply in shallow intertidal areas whilst they are covered by high tides (Kuipers, 1975; Nicolas et al, 2007). The extended high water period could in theory be beneficial to these species, provided that their invertebrate food supply is unaffected by the scheme. However, the extended duration of high water would be coupled with a shift in the location of the upper shore, due to the predicted 0.6m rise in the height of high water spring tides. This increased height is due to the more rapid filling of Carnsew through two sluices. The habitat that would be covered by the additional 0.6 m is fairly steep cobbles and boulders, so there would be little benefit in terms of increased intertidal area for birds and fish to feed.

Limited data on the invertebrate species present at different tidal heights in Carnsew Pool are available (Smith, 1988). The upper shore sediments support very few species, mainly enchytraeid oligochaete worms. On the mid-shore the main species are ragworm (*Nereis diversicolor*) and low densities of the spionid polychaete worm *Pygospio elegans*. On the lower shore the main species are the cirratulid polychaete worm *Tharyx sp. A ,*

ragworm, (*Nereis diversicolor*) and low densities of other polychaetes (*Streblospio shrubsolii* and *Capitella capitata*).

Due to the complex interplay between the factors above (and others that may apply) it is impossible to make accurate predictions on the impacts of the amended tidal regime on invertebrates and algae. As invertebrates and, to a lesser extent algae, are food for birds and fish, this means that impacts on these two groups cannot be accurately predicted. The best estimate is that invertebrate diversity and the species present would be similar to current levels, and that densities and biomass would be:

- ±40% of current values on the upper shore
- ±20% of current values on the middle shore
- unchanged on the lower shore

Copperhouse Pool

No major adverse impacts are predicted during the operational phase, but there may be moderate adverse impacts on the flora and fauna due to the retention of spring high water for 3 hours, followed by sluicing. At present there are no plans to sluice during neap tides.

The effective loss of intertidal over a whole spring tidal cycle is calculated to be 26% if water is retained for three hours (calculated from information provided in Annex 13E). This extended high water would have impacts on invertebrates and algae that are difficult to predict. Factors that are relevant are:

- Tidal cues for breeding may be disrupted
- Larvae of some species may settle too high up the shore during extended high water
- Invertebrates that feed on the surface would have an extended period for feeding during spring tides
- Predation by wading birds on the upper shore would be reduced, but predation by fish such as juvenile plaice and sole would increase provided that their invertebrate food supply is unaffected
- Probable coarsening of sediments due to higher velocities during ebb tide
- There would be a longer period for phytoplankton, zooplankton and detritus to settle out of the water column, increasing food availability for those invertebrates that feed on this material
- The extended high tide during spring tides would favour those species that occur further down the shore, but these same species would be at a disadvantage during neap tides, when the uppermost parts of the shore would not be covered for many days
- There may be complex interactions between saltmarsh plants and species such as ragworm, which may result in the loss of saltmarshes, especially in the pioneer zone (Hughes, 1999), though this is seen as

unlikely by others (Morris et al, 2004). The retained high water spring tides could affect saltmarsh zonation in the upper reaches of Copperhouse Pool, mainly above Black Bridge. The impact on this habitat is covered in section 12.5.1

It has not been possible to locate any references to a similar change in tidal regime and experience from other locations is not readily available. However, in Southampton Water there is an extended high water during all tides and surveys there (various reports by Aquatonics Ltd for the Dibden Container Terminal proposal) do not indicate any problems with the flora and fauna of the upper shore.

Copperhouse Pool is kept inundated for several spring tides each summer for events and it appears that this has had no discernible impact on invertebrate prey for over-wintering birds. However, no definitive surveys have been undertaken. In 2007 the planned closure dates were:

- 17July - 19 July; 31 July - 6 August; 17 August - 20 August

Data are available on the species present at different tidal heights in Copperhouse Pool (Smith, 1989). In general the higher parts of Copperhouse Pool are well drained, with a high clay content and a covering of green filamentous algae (mainly *Enteromorpha* spp.) and high densities of enchytraeid oligochaete worms. There is also an area of saltmarsh near Black Bridge that is muddy and poorly drained, with high densities of ragworm (*Nereis diversicolor*) and the amphipod crustacean *Corophium volutator.* Mid-shore sediments at Copperhouse are dominated by the spionid polychaetes *Pygospio elegans* and *Streblospio shrubsolii*; whilst lower parts have higher densities of the cirratulid polychaete worm *Tharyx* sp. A. (Smith, 1988).

The best estimate is that invertebrate diversity and species present would be broadly similar to what they are now, that densities and biomass on the middle and upper shore would be ±30% of current values, and will be unchanged on the lower shore.

Lelant Water

No adverse impacts are predicted in Lelant Water during the operational phase of the proposed development. There is a likely minor beneficial impact since a slight reduction of import of sand into Lelant Water due to sluicing is predicted to occur (see section 13.5.1.2). It is widely believed that sand ingress into Lelant Water is reducing the suitability of the lower parts for wader prey and wading birds, so any measures that reduce sand ingress are likely to be better than the status quo.

12.5.3 Assessment of impacts on ornithology

12.5.3.1 Overview

The following assessment addresses the impacts of the proposed Hayle development scheme on the aquatic avifauna of the area based on the findings of monitoring studies described in section 12.5.3 and information on birds' habitat requirements and responses to disturbance stimuli.

The features that have been identified as being key receptors for aquatic ornithology, and therefore requiring an assessment of the potential impact of development proposals, are as follows:

Feature	Location	Conservation value
i) Little grebe	Predominantly open water of Carnsew Pool	Regional importance (possibly national during hard weather)
ii) Little egret	Distributed across the Hayle system, with concentrations in Lelant Water	Regional importance (note: National Importance threshold is not yet definitive for this species)
iii) Wildfowl feeding areas	Distributed across the Hayle system, with concentrations in Lelant Water, Lelant Saltings and Copperhouse Pool	Regional importance
iv) Wildfowl roosting areas	Distributed across the Hayle system, with concentrations in Lelant Water, Lelant Saltings and Copperhouse Pool	Regional importance
v) Wader feeding areas	Distributed across the Hayle system, with concentrations on Lelant Water, the western end of Carnsew Pool and Copperhouse Pool	Regional importance
vi) Wader roosting areas	Distributed across the Hayle system, with concentrations on Ryan's Field, Lelant Saltings, the western end of Carnsew Pool and Copperhouse Pool	Regional importance

Table 12– 8 : Key receptors relevant to ornithology (aquatic birds)

The unmitigated impacts of construction-phase works on aquatic birds are considered below on an area-basis, with reference to the itemised list of marine works described in Chapter 13, section 13.5.1.

The following operational activities have been assessed for their potential to have impacts on aquatic birds:

- sluicing to remove sediment from the harbour, implemented by closing sluice structures at the mouths of Carnsew and Copperhouse Pools to hold water in the pools at high spring tides, followed by the release of this water into the harbour on the ebb tide (c.3 hours after high tide)
- maintenance dredging of the harbour
- operation of the half-tide gate at the seaward end of Penpol Creek
- movements of pedestrians over the proposed new Copperhouse Pool bridge, bridges over the Carnsew second sluice channel, and in the region of the proposed car parking area on the Triangular Spit

Annexe 12K provides information on the response of waterfowl and shorebirds to various disturbance stimuli; this has been referenced in the following analysis. Mitigation measures are identified in section 12.6.3, and summarised in 12.7.3.1; monitoring requirements are detailed in section 12.8.3.

12.5.3.2 Construction Impacts

Harbour Wall Repairs (Works Items 17-22)

Habitat and prey loss

During the construction of Phase 1 of the development there would be temporary adverse impacts on intertidal invertebrates and seaweeds due to refurbishment of harbour walls. New and refurbished areas of harbour wall would be quickly colonised by algae (eg *Enteromorpha* spp. and *Fucus* spp.) and invertebrates (eg barnacles, limpets, mussels and periwinkles) and no impacts are likely to be visible within approximately 2 years of the repairs and renewals (see section 12.5.2.1). As such, there would be a short-term loss of habitat and prey items for an extremely limited number of birds which use this habitat. The impacts of this work are considered to be a negligible adverse impact, localised and of medium-term duration.

Full reconstruction is required on sections of wall on South Quay and East Quay, resulting in an additional 220m^2 and 155m^2 respectively, of which approximately 65% (approximately 245m^2) would be in the intertidal zone. This additional intertidal vertical habitat is estimated to be about 5% of the total wall area in the development area that is intertidal. The overall ecological impact of the reconstructions would result in a small loss of habitat and prey items for bird feeding, where slumped areas providing a none-vertical zone have previously been present; this will be a minor localised permanent impact.

Disturbance

Construction activity at the harbour walls would have the potential for some limited disturbance to occur to waterfowl on adjacent habitats. However, for the most part, works would be undertaken on the walls around the main harbour, an area of relatively low importance for waterfowl which is subject to a level of current ongoing disturbance. In this area, impacts are likely to be adverse, negligible, localised and temporary. Where works are undertaken close to Copperhouse Pool, disturbance of birds on the westernmost reach of the Pool

may occur, depending on the extent of works and methods used. Impacts here will be adverse, minor and temporary.

Lelant Water

No adverse impacts on aquatic bird species in Lelant Water are predicted during the construction phase.

Harbour

Harbour – Works Item 10 (Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN)

Habitat loss

In general, Cockle Bank is not an important site for waterfowl within the Hayle complex, although occasional feeding activity was recorded both from the 2004/5 survey programme and on *ad hoc* visits to the site. Species feeding on the area including little egret, oystercatcher and curlew; these species potentially take small polychaetes and crustaceans, as well as small fish species. The site is also used as a roost/loafing area by waterfowl on some tides, although again in relatively low numbers in the context of the wider Hayle system. As such, the physical loss of Cockle Bank is not expected to have anything more than a negligible local adverse impact on the avifauna of the estuary system.

Additional dredging work around Cockle Bank would remove sediments that contain invertebrates and sandeels (greater sandeel and lesser sandeel). The latter form an important prey component for some birds, although their composition within the prey assemblage of key bird species using the area around Cockle Bank is uncertain. However, as the harbour area is known to be important for sandeel spawning (see section 12.4.2.3) and because sandeels form an important dietary component for some species of seabird at a regional scale (Cramp *et al*, 1998), as well as prey for other fish which in turn are prey for seabirds, then methods to reduce the impacts of dredging on sandeels would be employed. While it is possible that the newly created subtidal habitat (ie beneath the existing Cockle Bank) would be suitable for sandeels, which would be a minor beneficial impact, the ecological value of this new subtidal habitat would be reduced by frequent dredging, (ie intervals of less than a few years), and as such, its benefits in terms of prey provision for waterfowl would be negligible.

Water quality

Dredging is likely to create sediment plumes with elevated concentrations of suspended solids and metals (see (Hydraulics Research, 2007, Annexe 13F). The sediment plume may cause mortality of aquatic flora and fauna, due to smothering, reduced concentrations of dissolved oxygen solids and possibly higher metals in the water column. This would have a direct minor to moderate temporary adverse impact on the invertebrate fauna of

the area, which in turn, may affect the limited feeding activity by waterfowl which currently occurs in the area, with an associated negligible to minor temporary adverse impact.

If dewatering of dredged sediments occurs on-land the metal concentrations and suspended solids in any leachate returned to the harbour may have a localised impact on flora and fauna. This is potentially a negligible to minor temporary adverse impact for avifauna (but probably greater for invertebrates and fish) depending on the contaminants.

Harbour – Works Item 12 (New fishermen's quay)

Habitat loss

Construction of the new fishermen's quay would result in the loss of intertidal sediment habitat and a gain in hard habitat on sheet pile wall quay. This area has a low diversity and invertebrate biomass due to the mobility of the sands and is of relatively low conservation interest both in terms of estuarine invertebrates and birds. As such, the loss of sandy intertidal sediment from the area would have a negligible adverse permanent impact to waterfowl, given the relatively low level of current usage. The gain in new intertidal hard habitat would have a minor beneficial permanent impact for invertebrates and fish etc, but overall would have a negligible adverse impact for avifaunal function.

Disturbance

Construction work on the new quay would have the potential to generate disturbance to waterfowl. However, the area is generally under-utilised by aquatic avifauna, and as such, any impacts would be negligible, local and temporary.

Water quality

The fishermen's quay works could affect water quality during placement of temporary bunds and dewatering of the excavation area. This is a minor adverse temporary impact for the aquatic invertebrates and fish and may also affect prey availability for birds, possibly at a slightly reduced level of impact (negligible to minor adverse temporary impact).

Harbour – Works Item 23 (Slipway and associated land works)

The sailing centre and slipway would result in the loss of a small area of intertidal sediment habitat and gain of intertidal hard substrate habitat. Avifaunal impacts are likely to be negligible given the low level of importance of this area for waterfowl.

Harbour – Works Item 13 (Excavation and dredging of i) harbour area to the north-west of fishermen's quay, and ii) sand trap)

Habitat loss and disturbance

Excavation and dredging of the harbour area to the north-west of fishermen's quay would result in a loss of biota from the dredged area. The biota here are primarily invertebrates adapted to mobile sands, eg catworm (*Nephtys cirrosa*), sand-hoppers (*Talitrus saltator*) and occasional crabs (*Pirimela denticulata*) near low water. The assemblage, together with ongoing human activity means that the waterfowl assemblage of the area is of relatively low conservation importance with the context of the Hayle system both for feeding and roosting activity. However, the ornithological survey programmes have identified this area, and in particular the intertidal sands further downstream towards the mouth of the estuary, as being important for roosting ringed plover (Appendix 12T). As such, any direct loss of habitat through removal of intertidal material would have a negligible to minor adverse medium-term impact on this species.

Dredging to create the sand-trap would remove most of the existing biota (eg invertebrates and sandeels) and affect other invertebrates and fish species that feed in this area. Although the speed of invertebrate community recovery is likely to be relatively rapid, maintenance dredging is likely to be an annual event, so there would not be a full recovery within the dredged area in terms of diversity or biomass. As such, there would be a degree of impact to waterfowl and seabirds, either on those which predate the invertebrates and sandeels of the area, or more indirectly, on birds which feed on species that prey on the invertebrate and sandeel community. The site is not particularly important for birds which predate directly on the invertebrate and fish communities, but indirect impacts from loss of species such as sandeel to seabirds at a wider, regional level, eg gannet, may occur. However, it is unlikely that any effect to seabird population levels from changes to sandeel populations in the Hayle would be measurable at such a regional scale. As such, there would be a potential negligible to minor adverse impact on seabirds, which would be permanent owing to the continuing need for dredging.

Dredging of the sand trap would produce c.10,000 m^3 of relatively uncontaminated sand that may be of sufficiently high quality for it to be used in nearby beach nourishment schemes, or for terrestrial mitigation (see section 12.6.3). Existing biomass and diversity is low and in general the intertidal area in the region of the sand-trap is not of high importance for waterfowl, either feeding or roosting, due to the depressed infaunal community and ongoing disturbance from recreational activity. Recovery of the intertidal biota is expected to occur in 6-12 months and some negligible to minor temporary adverse impacts would be expected to avifaunal usage from the dredge dumping.

Water quality

Excavation and dredging of the harbour area to the north-west of fishermen's quay may generate sediment plumes that could impact water quality at adjacent habitats. However, the sands are relatively clean and contain very little fines, so most of the sediment would settle out nearby. This is a minor adverse temporary impact for the sand/mud-dwelling invertebrate and fish of the area, which form prey items for birds. Resultant

impacts on suitability of the area for waterfowl would be expected to be negligible, given the ability of most species of soft sediment dwelling prey items to withstand periods of elevated suspended loads and deposition rates.

Dredging of the sand-trap near the entrance to the harbour would create a sediment plume that may cause sedimentation on adjacent habitats. In this area it is unlikely that contaminants would be an issue, but smothering of benthos may affect the limited feeding potential in the area for waterfowl. This would be a minor adverse temporary impact.

Harbour – Works Item 5 (Excavation of harbour at Carnsew Quay/Carnsew Wharf)

Habitat loss and disturbance

If the excavation of the harbour at Carnsew Quay/Carnsew Wharf requires a temporary bund to be installed at the north end of Carnsew Wharf, there would be major adverse temporary impacts in the area south of the bund, with most flora and fauna of intertidal and subtidal habitats expected to die. This would have some impact on feeding potential by waterfowl, although the site is not particularly important in this respect (see Appendix 12T) and impacts would thus be minor adverse, temporary and local.

Renovation of the existing South Quay harbour walls or construction of new walls would be carried out in the dry and should not have a significant detrimental impact to avifauna through habitat loss. Disturbance may have negligible to minor local temporary adverse impact, but this may be reduced further through timing of works outwith periods of bird usage.

The additional harbour walls at South Quay after excavation would provide new vertical intertidal habitat. This will be a negligible to minor beneficial permanent impact for potential niche species such as turnstone, but of little wider benefit.

Harbour – Works Item 6 (Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN)

Habitat loss and disturbance

Dredging of the basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN (-4.4m CD) would remove sediments with their associated flora and fauna. The area close to Carnsew tunnel is likely to be of moderately high ecological quality for aquatic fauna, but this area is not of importance for waterfowl as a feeding resource. A negligible to minor adverse short-term impact might be anticipated, with recolonisation within a couple of years and return of any small feeding potential for birds. It is not anticipated that the work would have a significant disturbance effect on the value of Carnsew Pool to birds.

Water quality

If wet excavation is used there is likely to be some loss of fine sediments during dredging. These are likely to be contaminated and could affect water quality in the harbour, and potentially Carnsew Pool. A moderate adverse localised impact to invertebrates is anticipated, but with *in situ* impacts to avifaunal function in the harbour considered to be zero to negligible. However, if contaminated material were to enter Carnsew Pool then a negligible to minor waterfowl impact would be expected.

Harbour – Works Item 11 (New floating pontoons for marina)

Habitat loss and disturbance

The floating pontoons for the marina would be attached to either steel piles within the marina area, or possibly a bed anchor system. During construction there is potential for polluting materials to enter the harbour. This would have negligible to minor temporary adverse impact from disturbance to avifauna.

Construction of the marina would result in the net loss of a small subtidal sediment habitat where steel piles enter the sediment or where bed anchors occur, with an associated restriction of surface feeding area for little grebe. There would be a slightly larger gain in vertical subtidal and intertidal habitat on the piles (if used), although this would be of extremely limited value to waterfowl. The loss of subtidal habitat due to piles is a minor adverse permanent impact and the gain in vertical habitat on piles is a negligible beneficial permanent impact.

Harbour – Works Item 15 (Pedestrian bridge from East Quay to North Quay)

Habitat loss and disturbance

Construction of the new pedestrian bridge from East Quay to North Quay would lead to a small loss of intertidal/subtidal sediment habitat due to construction of the bridge piers in the intertidal. The loss of sediment habitat is a minor adverse permanent impact, whilst the gain of hard substrate habitat on the piers is expected to be a minor beneficial permanent impact. Adverse and beneficial impacts are considered to be approximately in balance. Overall there would be a negligible but permanent impact on availability of bird feeding habitat. Disturbance during construction may affect birds' usage in Copperhouse Pool, a key site for waterfowl, and thus lead to a minor to major site specific short-term adverse impact. However, it is considered that the bridge is sufficiently distant from the main Pool habitats for impacts to be of a minor, site- specific, short-term adverse scale.

Water quality

Construction of the new pedestrian bridge from East Quay to North Quay may introduce contaminants into the harbour area, with consequent impacts on aquatic species. This is a minor to major site specific short-term adverse impact.

Penpol

Penpol - Works Item 7 (Lifting/swing pedestrian bridge at Penpol Creek)

The new lifting/swing pedestrian bridge at Penpol Creek would be partially supported on piers within Penpol Creek. This would result in a small loss of aquatic sedimentary habitat (all currently intertidal) and gain of a larger area of hard substrate which would be intertidal and subtidal. Overall this would be a negligible beneficial permanent impact with a small increase in potential feeding habitat for little grebe.

Penpol – Works Item 9 (Half-tide gate at entrance to Penpol Creek; part)

The Penpol Creek half-tide gate and pedestrian crossing would result in the loss of some intertidal sediment habitat and a very small amount of subtidal sediment habitat due to half-tide gate and placement of stone erosion protection "blankets" each side of the tidal gate. There would be a gain in hard substrate habitat (intertidal and subtidal) on the newly constructed faces. The creek is not of high value for waterfowl (mostly occasional waders) using the intertidal zone and of relatively low value for little grebe (subtidal). Overall the impacts would be negligible, as the gain in hard substrate habitat would be greater than the loss of sediment habitat.

Penpol – Works Item 8 (Dredged area at south end of Penpol Creek)

Dredging/excavation at south end of Penpol Creek to a depth of approximately -1.0 m ODN (-4.4m CD) would probably occur at the same time as the construction of the half tide gate at the entrance to Penpol. If so, the dredging is unlikely to adversely affect water quality in the harbour or elsewhere. Given the low importance of the area for waterfowl, any deleterious impacts would be at a local scale and affect only a very small number of birds.

Dredging/excavation at south end of Penpol Creek would remove flora and fauna in the sediments. The area to be dredged is of low conservation interest and not important for waterfowl within the Hayle complex given existing disturbance levels. There would be a minor adverse permanent impact on intertidal invertebrates and this would have a negligible adverse impact on bird usage

Carnsew Pool

Carnsew Pool - Works Items 1 and 3 (Build new Carnsew second sluice; Excavate second sluice channel)

During the construction works on the second sluice in Carnsew Pool there may be the potential for disturbance related impacts, depending on techniques and works location. It is anticipated that any impacts would be minor, localised and of a temporary nature.

While the access road onto the Triangular Spit (ie via the causeway; see Figure 3.4) is sited at the furthest distance possible from the Carnsew Pool shore, reconstruction of the road here and over the sluice channel would involve plant and personnel working close to Carnsew Pool. As such, disturbance to waterfowl using adjacent intertidal rocks and the extreme eastern end of Carnsew Pool could occur during construction. In particular, the works have the potential to affect little grebe distribution within Carnsew Pool, with disturbance leading to an effective habitat loss around the Carnsew Pool edge at this time.

Whilst there is sufficient area within the Pool for any displacement to be accommodated spatially, the eastern end of Carnsew Pool would appear to be the preferred area of the Pool by little grebe, and as such, impacts would be minor to major adverse, short-term and localised.

Carnsew Pool – Works Item 2 (New fixed pedestrian bridge at Carnsew second sluice channel)

Aquatic impacts of the construction of the new fixed pedestrian bridge at Carnsew second sluice channel will depend upon on timing. Disturbance could occur to waterfowl using adjacent intertidal rocks and eastern end of Carnsew Pool if work takes place in the winter and subsequent to (rather than concurrently with) the construction of the sluice channel and road over the causeway. Impacts would be minor adverse, temporary and site-specific.

Carnsew Pool – Works Item 4 (Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system)

Habitat loss

Refurbishment of the tunnels to Carnsew Pool and installation of the sluice gate system would result in the loss of a small area of intertidal and subtidal habitat due to construction, which may include stone erosion protection blankets to each side of tunnels. Some of these new surfaces would be colonised by marine species. However, these areas are not of particular importance for avifauna (eg little grebe) and impacts at worst would be negligible.

Disturbance

As for Work Item 2, above.

Carnsew Pool – Construction of car park on Triangular Spit

Construction of the proposed car park on the Triangular Spit would take place 5-6 years after the sluice channel and bridge works, in Phase 4 of the construction programme. This work has the potential to cause disturbance to bird usage of Carnsew Pool (eg little grebe); impacts are expected to be minor adverse localised and temporary.

Copperhouse Pool

Copperhouse Pool– Works Item 14 (New vehicular bridge by Copperhouse Gate)

Habitat loss and disturbance

Construction of the bridge piers would cause a small loss of intertidal habitat and a larger gain in vertical intertidal habitat on the piers. This would be a minor adverse permanent impact on avifauna due to the loss of a small area of habitat. This would be balanced by a minor beneficial permanent impact due to uncontaminated hard substrate on piers. An overall negligible adverse impact is anticipated in terms of habitat loss to birds.

Disturbance to waterfowl would also occur during construction, affecting in particular shelduck, and redshank usage with a moderate site specific temporary impact.

Water quality

Construction of the piers in the intertidal habitat to support the new vehicular bridge may introduce sediments and associated contaminants (eg copper, zinc and arsenic) into the water column. Very high levels of contaminants occur in Copperhouse Pool sediments (Smith, 1988), and some of the highest concentrations were found in sediments close to the proposed bridge site, eg copper maximum was 9315 ppm. Contaminant effects on waterfowl would potentially occur either through changes in the invertebrate community or via direct impact. Given existing contaminant loadings in the Pool and potential accumulations in prey items, then the additive impacts of additional contaminant resuspension are considered likely to be negligible to minor, adverse and short-term.

Copperhouse Pool– Works Item 16 (Copperhouse Pool sluice gates maintenance works)

The Copperhouse Pool sluice gates works could result in of spillages of harmful substances. As already noted this could have an associated although reduced impact to waterfowl in the area. Impacts would be negligible and temporary as works would either be carried out at low water or in the dry by installing temporary barriers at the gate housing and allowing water in and out of Copperhouse Pool through the by-pass culvert on the east side of the gate. There is likely to be minor site specific temporary disturbance to feeding and roosting waterfowl.

12.5.3.3 Operational impacts

Harbour

Some removal of contaminated material and creation of new subtidal habitats would potentially have a very limited positive impact for birds in terms of habitat creation. Activities in the harbour would potentially increase the disturbance level, and as such, direct habitat loss (in terms of available surface waters) through pontoons,

and indirect loss through new activity would also have an impact on the area's capacity to support waterfowl. In addition, there is the increased potential for contaminant release (unplanned), affecting waterfowl and their prey in the area. However, the site is currently not of particular importance for avifauna within the Hayle complex, and any additive impacts (beneficial and adverse) would be expected to be slight, with an overall negligible local permanent adverse impact.

It is possible that the newly created subtidal habitat in the harbour (ie beneath the existing Cockle Bank) would be suitable for sandeels, which are a prey species for several aquatic birds. However, the ecological value of this new subtidal habitat would be reduced by dredging (every 5-10 years) and, as such, its benefits in terms of prey provision for waterfowl would be minor.

Penpol

Penpol is the area where the greatest physical changes to habitats would occur, but it is also the least ecologically important part of the Hayle estuary complex. The main change would be a reduction in intertidal habitat and a balancing increase in the amount of subtidal habitat. In general terms this would favour subtidal invertebrates, seaweeds and fish and would reduce populations of intertidal invertebrates and seaweeds. Precise impacts on birds are difficult to predict, as they depend on the detailed management of Penpol, but densities of invertebrate prey items for waders on the upper intertidal are unlikely to be affected by the half-tide barrier, and the mid and lower intertidal zone (with fluctuating retained water levels) may see a reduction in biomass of invertebrate prey while densities of small prey items such as oligochaete worms may increase. A slight reduction in wader activity and an increase in little grebe activity might therefore be expected, with minimal change to little egret usage. Overall, the impact on the functional value of the habitat to birds would be regarded as neutral.

Carnsew Pool

Prey availability

Within Carnsew Pool there would be an additional area of high current speeds close to the proposed second sluice. This would favour those species of invertebrates, algae and fish that prefer high current speeds and reduce the densities of those species that prefer low current speeds. (eg flounder, plaice and sole). Overall this would be a minor beneficial impact on invertebrates and algae, and a minor adverse impact on many species of fish. Any impacts to bird species feeding on fish (eg little grebe) would be expected to be negligible, given the restricted extent of the altered current velocities.

Sluicing regime

At present there are no plans to sluice from Carnsew Pool during neap tides, but on spring tides the ebb would be retarded by three hours. The effective loss of intertidal area over a whole spring tidal cycle has been calculated to be c. 23% if water is retained for three hours. This extended high water period would have

impacts on invertebrates and bird usage that are difficult to predict. As already noted, Carnsew Pool is an important site for little grebe (areas of open water) but is also increasingly important at the western end for waders (feeding and roosting on the intertidal zone). The sluicing would lead to a functional loss of wader habitat, whilst providing additional potential subtidal habitat for little grebe (also possibly offsetting the slight impact to the fish population noted above). However, whilst the impoundment would lead to a functional increase in subtidal area, it is uncertain whether the effective increase in depth within Carnsew Pool over the tidal cycle would actually be of benefit for little grebe in terms of feeding function. Little grebe take both small fishes and macro-invertebrate prey items, diving to a depth of around 2m (Cramp, 1998). Based on bathymetry information for Carnsew Pool (Sea Sediments, 1983), it would appear that the main area of little grebe activity in the pool coincides with a depth of between 1m and 2m ODN. Predictions on impoundment levels in Carnsew (Buro Happold, 2007), suggest that the ebb retard would maintain levels at 3m above OD for c. 3 hours on each tide. Predictions on impoundment levels in Carnsew, suggest that the ebb retard would maintain levels at 3m above OD for approximately three hours on each tide. If this were to occur, then there may be an effective reduction in available feeding time for little grebe within the pool (if the species is taking benthic or epibenthic fauna), although this would depend on a variety of factors including prey item choice in Carnsew.

Given the bathymetry and substratum of the area of loss, it is expected that the functional intertidal loss would be greater than the possible functional subtidal gain for little grebe (see above). The changes in invertebrate assemblage composition on the intertidal area would to some extent impact on bird usage, but it might be expected that the site is at sub-carrying capacity for waders, and so impacts on birds owing to prey availability may be on the scale negligible to minor. However, the change to functional habitat usage by birds owing to a retarded ebb tide would have a greater impact than changes to prey composition. In particular, the availability of a high water roost area would be affected, with a reduced or no roosting area for c. 3 hours around high water. The Carnsew site has been seen to support quite large flocks of waders around high water, although other (possibly sub-optimal) areas on Lelant may also be available. In addition, with two sluices in operation the speed that the mudflat would be uncovered and covered by the tide would increase. This is often the period when waterfowl feeding rates are often maximised and, depending on the sluicing scenario, this may lead to an effective reduction in prey take-up, as the effective feeding time during this period would be reduced.

Overall, the change to functional habitat usage on Carnsew through a retarded ebb tide is considered to generate a minor to major adverse impact on birds. Impacts would be at least at a site specific level (ie. confined to Carnsew Pool), and for some bird species may affect estuary-system level usage. However, although they would occur throughout the lifespan of the development (permanent) they should be reversible as the sluicing regime can be amended in the light of monitoring.

Disturbance activity

The additional visitor attractions and residential housing provided by the proposed development would potentially increase footfall on public access ways around Carnsew Pool. The access road and parking on the causeway would lead to increased vehicular traffic on the eastern side of Carnsew Pool; pedestrian traffic would be directed to a new bridge located beyond the northern boundary (ie harbour-side) of the road.

Since the road and footbridge would be positioned away from the edge of the pool, it is expected that the impacts through disturbance from this source would be negligible to minor, site-specific and permanent, given the distance from the main area of waterfowl usage, the reduced disturbance sensitivity of most waterfowl to vehicles (compared to pedestrians), and habituation.

The construction of a car park on Triangular Spit would lead to additional visitor numbers on the terrestrial land adjacent to Carnsew. This would have a potential disturbance impact to waterfowl using Carnsew Pool, both on the water and in particular, on the intertidal zone at the western end of the pool. The extent to which additional visitor numbers would lead to disturbance is difficult to assess, given potential for habituation etc. It is expected that maximum visitor usage would occur outwith the key period for waterfowl on the pool (summer vs winter). However, some residual detrimental impact is anticipated, with a potential area of fringing intertidal and subtidal zone effectively subject to indirect functional habitat loss through the exclusion of waterfowl due to disturbance. This zone of impact would be dynamic on both a seasonal basis, reflecting the time of year, visitor numbers, type of activity and species composition, as well as on a daily basis incorporating tide state, waterfowl activity, visitor numbers etc. Some of these impacts can be reduced through mitigation measures, (see section 12.6.3).

Copperhouse Pool

Sluicing regime

At present there are no plans to sluice from Copperhouse Pool during neap tides, but on spring tides the ebb would be retarded by 3 hours. The effective loss of intertidal area over a whole spring tidal cycle has been calculated to be c. 26% intertidal habitat, with an effective gain of equivalent subtidal habitat. Copperhouse is an important site for little grebe (subtidal) and for shelduck and wigeon. It is also one of the key sites within the Hayle complex for waders (feeding and roosting on the intertidal area). The sluicing would lead to a functional loss of wader habitat, whilst providing additional subtidal habitat. Given the bathymetry and substratum of the area of loss, it is possible that the functional intertidal loss would be greater than the functional subtidal gain for waterfowl.

Impacts to invertebrates and algae may range from a minor to major adverse, with a minor to moderate beneficial impacts on fish, due to effective increase in the subtidal area. The changes in invertebrate assemblage composition would to some extent impact on bird usage, but it might be expected that the site is

at sub-carrying capacity and so impacts on birds owing to prey availability may be on the scale negligible to minor. However, the change to functional habitat usage by birds owing to a retarded ebb tide would cause a minor to major adverse impact. This would occur on at least at a site specific level (ie confined to Copperhouse Pool), and for some bird species may affect estuary-system level usage. However, although impacts would occur throughout the lifespan of the development (permanent) they should be reversible as the sluicing regime can be amended in the light of monitoring.

Habitat loss and disturbance

The operation of the bridge across the western end of Copperhouse Pool would have a direct impact on waterfowl usage in the vicinity of its oversailing, effectively leading to a loss of habitat for feeding and roosting in this area. In addition, the impact of traffic across the bridge would have a disturbance component to waterfowl using the western end of Copperhouse Pool, particularly pedestrian traffic. Based upon response distances by waterfowl (eg Smit & Visser, 1993, and IES, 1999), potential functional habitat loss for waterfowl from the oversailing and disturbance is anticipated to be c. 5000m^2, representing perhaps c. 3% of the habitat within Copperhouse Pool. This area of Copperhouse Pool is particularly important for mallard, mute swan, little grebe and little egret, in terms of relative usage densities around the Hayle estuary, although numbers using the area relatively small. In addition, the section of lower Copperhouse Pool can support larger numbers of waterfowl, in particular shelduck, wigeon and redshank, but with relative densities at a lower level in comparison to other sites around the estuary. Overall, the impact to waterfowl is likely to be minor to moderate, site specific and permanent.

The additional visitor attractions and residential housing provide by the proposed development would potentially increase footfall on public access ways around parts of Copperhouse Pool. However, assuming there is no increased access into the basin of Copperhouse Pool itself, it is expected that the impacts through additive disturbance would be negligible, given the existing levels of usage along the public rights of way and likely habituation.

Lelant Water

Sluicing regime

No adverse impacts are predicted for the waterfowl assemblage in Lelant Water during the operational stage of the development. There is a possible beneficial long-term impact if the predicted reduction of ingress of sand into Lelant Water occurs (see section 13.5.1.2), given the possible shift in wader feeding out of Lelant apparent from the recent survey programmes. It is believed that sand ingress into Lelant Water is reducing the suitability of the lower parts for wader prey and wading birds, so any measures that reduce sand ingress are likely to be better than the status quo. The extent of any beneficial effects to waterfowl carrying capacity in the

area, from an expected (but yet to be fully quantified) reduction in sand ingress cannot be identified in detail at present.

Disturbance activity

The new marina would generate visitor numbers and watercraft movements additional to those occurring at present. Whilst it anticipated that these would generally be confined to the harbour, outer harbour channel, estuary mouth and open sea, there remains the potential for movement of small craft into Lelant Water. This activity would have the potential to disturb feeding and roosting waterfowl in the area (eg Kirby *et al* and Hirons & Thomas, in Smit & Visser (1993)); waterfowl can be substantially more sensitive to an approach to feeding and roosting flocks made from the water rather than on land. The scope for movement of small craft into Lelant would, however, be minimised by restrictions imposed by the harbourmasters, as occurs at present.

12.6 Mitigation

12.6.1 Mitigation of impacts on terrestrial ecology

If unmitigated, the potential impacts of the proposed development on terrestrial ecology receptors range from potentially major long-term negative impacts on protected species to minor short-term impacts on local biodiversity.

With reference to construction-phase works, the duration of individual Work Items will be set out in an Outline Construction Programme (OCP). The timing of specific works identified as likely to have a significant impact on terrestrial ecology receptors (see section 12.5.1) will be determined with reference to a matrix of 'seasonal sensitivities' of ecological receptors, as shown in Annexe 12L. The periods of highest ecological sensitivity for specific species / groups will be avoided wherever possible in drawing up the OCP.

12.6.1.1 Mitigation for impacts on petalwort

Rationale

The following measures are proposed to mitigate for the potential major negative impacts that have been identified. The aim is to:

- avoid negative impact on the main petalwort population on the western side of the Triangular Spit during construction and operation
- manage the Spit to conserve the habitat for petalwort (including suitable habitat conditions for rabbits to maintain grazing levels)
- monitor the petalwort on the Spit and adjust management as necessary

- investigate translocation techniques to mitigate for loss of the small scattered populations on South Quay and on the eastern region of the Spit
- provide opportunities for field investigation of the ecology of petalwort in the wider area

Proposed mitigation method

The following measures are proposed, as a package, to mitigate for the potential negative impacts of using the eastern side of the Spit for visitor parking; Annexe 12M describes background studies conducted to date that have been used to inform this strategy. This mitigation package will be incorporated in the development proposals subject to agreement with Natural England and according to the requirements of legislative consents and the licensing regime for protected species.

1. Ensure no interference with the hydrology of the grassland areas on the Triangular Spit, during either constructional or operational phases. A construction management protocol would apply during the works to create the car park on the east side of the Spit; this would include provision of a buffer zone between the construction site and adjacent habitats to the west, and the prohibition of access to this western area. A low bund would be sited to ensure any polluted run-off from the construction site, and subsequently the operational car park, is contained so that it does not reach the petalwort colonies
2. Public use of the Triangular Spit, which is currently largely unregulated, would be managed to prevent damaging recreational effects such as extensive disturbance of grassland turf (eg from bonfires, fly-tipping, motor-biking), and to minimise dog-walking (which would result in nutrient enrichment of the habitats and disturbance of rabbits)
3. The habitat on the Triangular Spit would be managed to maintain current rabbit population levels, including areas of scrub shelter and warrens. Suitable scrub cover for rabbits would be established to replace that lost in the creation of the proposed car-parking; part of this new scrub would be used to form a landscaping screen between the car-parking and the rabbit grazing areas
4. Limiting scrub growth on the western edge of the Spit to ensure there is no obstruction to on-land movement of sands from the Hayle River
5. Negative impacts from recreational use of the spit due to lack of knowledge of the presence of petalwort would be minimised by informing the public of the importance of the site for petalwort and its statutory protection. The main colony here could be established as an official petalwort reserve
6. Any works that would affect petalwort colonies would be subject to licensed approval from Natural England
7. The six year gap between planning and development of the Triangular Spit allows a detailed translocation and monitoring programme to be established for the small populations of petalwort that would be lost from the east of the Spit. At least five years would be given to researching options for potential receptor sites for the

Spit colonies prior to any work on the Spit. In addition, the present population on the Spit would be monitored to establish whether it is stable, in decline or increasing. An investigation of the hydrology of the site would form part of this programme and the knowledge gained would be made available to the scientific community

8. A habitat management plan for the Spit, targeting the petalwort, would be drawn up before the construction phase for the Spit is begun, drawing on the information gained from the research
9. In the case of the colonies on the South Quay, a licence to translocate for the purpose of conservation of the plants in the colony would be sought as necessary. If the works are to take place before a translocation receptor site has been found, the plants could be maintained in pots, temporarily
10. An essential part of this mitigation proposal is that options for potential receptor sites would be identified, fully researched and approved by Natural England. Options to be considered include: areas of the Triangular Spit where habitat could be created, or other areas within the locality where the future management of the habitat for petalwort can be assured

Level of certainty for success

Whilst translocation of the scattered petalwort colonies from the east side of the Spit and from South Quay offers the best option for mitigation of the major permanent negative impact that is predicted from siting of the car park and built development respectively, there is no established technique for translocation of petalwort. Translocation of this species would require a licence from Natural England. However, it is already known that petalwort plants are easily maintained in cultivation (Holyoak 1998a) and the risk of excavating turfs to a depth of about 10 cm and transporting them to properly investigated appropriate habitat are not believed to be high. In addition the timing of the construction phases allows six years for research into receptor sites and habitat requirements before any translocation of petalwort colonies from the Spit would be required. Provided all aspects of the translocation (including research of soil factors) are carefully investigated, the work is carried out by an experienced ecologist under the terms of the licence, and the translocation is monitored to assess success and managed to further improve methodology over the following 5-10 years, it is probable that the translocation would be successful.

It is also known that different populations of the species in West Cornwall and elsewhere in Britain show very little if any genetic variation among or between populations (Rumsey 1999, Rumsey, Vogel & Russell 2001), so there are no grounds for concern over mixing of genetic stock during translocation.

12.6.1.2 Mitigation of impacts on bats

Rationale

Although the level of use and the importance of the site for bat populations in the locality appear to be low, the high nature conservation importance of bats makes any impact significant. Therefore mitigation is proposed (the following is based on background studies conducted to date that have been used to inform this strategy; Spalding Associates 2007b).

Proposed mitigation method

Mitigation would seek to avoid identified impacts on bat habitats and habitat use by:

- incorporation of relevant design elements to mitigate for impacts on bats and to enhance local habitats for bats (eg build roosts features in building design to mitigate any loss of roosts; siting of new landscape features such as shelterbelts and hedges to create flight line features and foraging habitat)
- wherever possible , retention of confirmed and potential natural roost and hibernation sites on the quarry and cliff face
- inclusion of bat interest in specifications for habitat restoration, creation and management proposals (see section 12.6.1.3)

The results of the additional bat surveys specified in section 12.4.1.4 will inform the mitigation requirements relevant to detailed development design elements. Since the phasing of the development proposals extends over a period of years, these follow-up detailed assessment of initial inspection surveys of buildings, the cliff and quarry face will be scheduled with reference to the timing of works to these features (as proposed in the development phasing programme). This will ensure that information on bat habitation is as up to date and as relevant to the detailed design proposals as possible.

The following mitigation has been identified to date.

Retention / creation of flight lines

The loss of flight lines would be minimised as far as possible and opportunities taken for creating new features that would link retained or created bat roosts to existing landscape features. This would be achieved by retention and creation of flight lines of semi-natural habitat at key points through the main developed area. Key sites for this comprise:

- on North Quay and the cliff top from the quarry, providing a link northwards into the adjacent landscape and more extensive semi-natural habitat
- from the electricity substation complex past the northwest and southeast ends of the proposed Towans car park into the adjacent landscape
- hedge lines on the outer boundary of the Riviere fields residential development

Habitat creation and enhancement

The development proposals include restoration of an area of dune grassland on currently low value habitat on Hayle Towans at the mouth of the estuary (sees section 12.6.1.3); this would enhance the remaining habitat available for bat foraging.

Artificial bat roosts would be designed into buildings where appropriate to their use and location, and according to the species that are using the site. In addition, where the quarry and cliff face works allow, crevice/void roost habitat could be created in stable rock faces and restoration of vegetation growth allowed.

Inclusion of bat interest in environmental management for the proposed development

During and post development, the management of construction works and landscape features would take account of the use of the site by bats and the significance of the various roost and flight line features that exist there.

Level of certainty for success

It is near certain that these mitigation measures would avoid adverse impacts on the local bat population within the proposed development site and may produce a beneficial impact through enhancement of feeding resource and improvement of flight lines. In addition dune grassland recreation and compensation (see section 12.6.1.3, below) is near certain to have a beneficial impact in enhancing the local feeding resource.

12.6.1.3 Mitigation of impacts on coastal dune grassland

Rationale

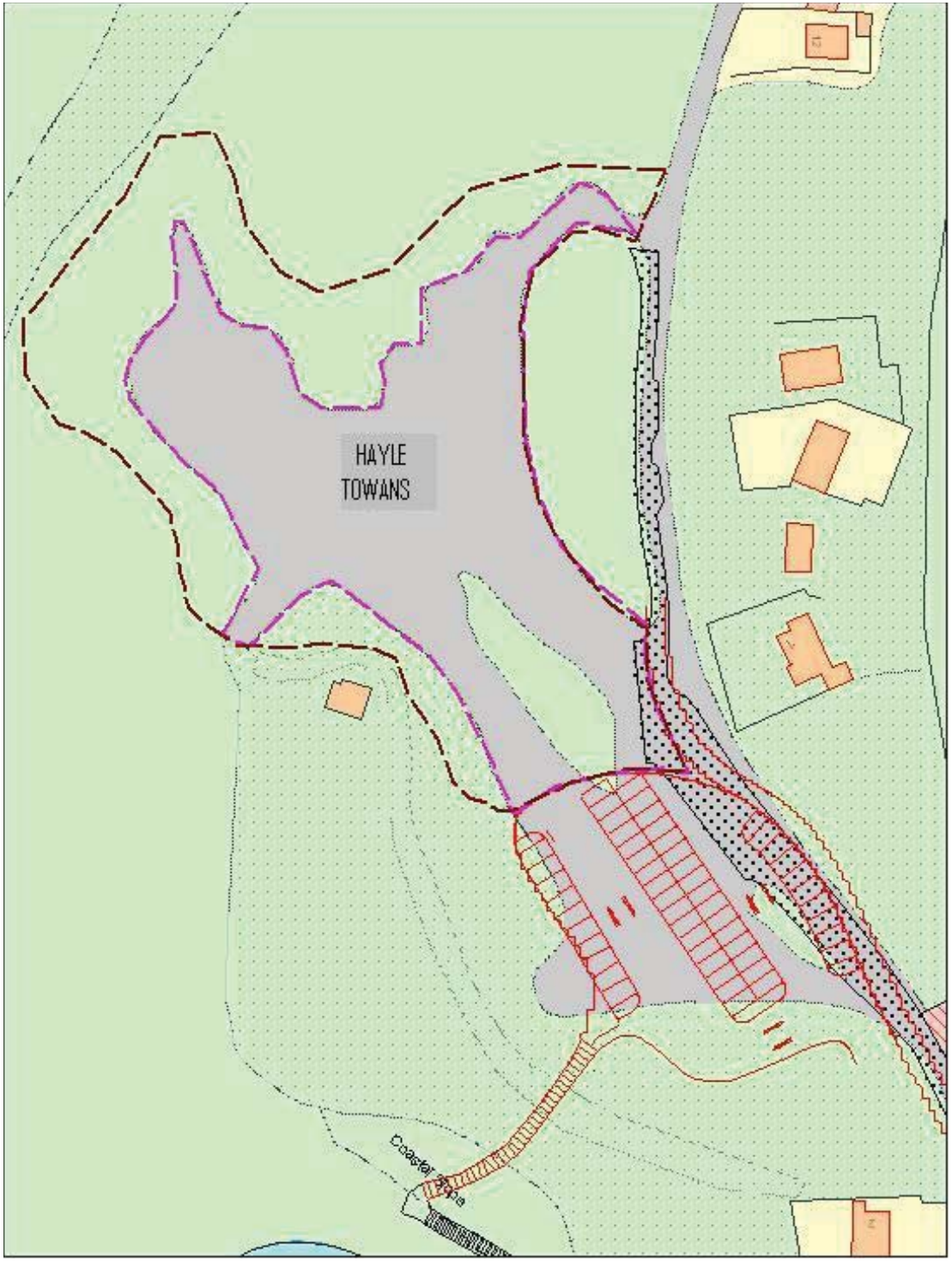
In order to mitigate for the negative impacts from loss of 3.3 hectares of dune grassland (and associated scrub) habitat to parking and residential elements at North Quay, it is proposed i) to develop and manage other undeveloped and degraded areas of dune habitat within the applicant's ownership to enhance their nature conservation value, and ii) provide compensatory habitat on nearby farmland owned by the applicant.

Proposed mitigation method

The following measures will be incorporated into the development process:

1. ***Restoration of eroded dune habitat on the outer section of the current car park at Hayle Towans (also known as Harvey's Towans), north-west of North Quay; see Figure 12 14.***

   The car park area is surfaced with an inert hard core mix that is believed to overlie waste materials deposited there after the closure of the Harvey's works. The natural onshore sand movement from the extensive sand flats in St Ives Bay is interrupted by a low cliff and the erosion of the sand on the cliff top has resulted in a loss of dune habitat. There is also localised recreational pressure on the dune habitat that has resulted in trampling erosion of the habitat. The habitat is also degraded somewhat by growth of scrub, ruderals and non-native species



DO NOT SCALE THIS DRAWING.

Hayle Harbour

Towans car park - potential areas for dune habitat creation

Figure 12.14
not to scale
print at A3
date November 2007

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Methods and licences/approvals required for dune habitat restoration will be determined in consultation with the Environment Agency, but the probable restoration strategy would be by deposition of a deep layer of clean sand over the degraded ground; the source of this sand would be surplus clean material dredged from the harbour mouth as part of the remodelling of the beach associated with the proposed sailing facility (seaward of the proposed fishermen's quay). Subsequent landscaping and planting of dune vegetation would be carried out to stabilise the sand.

The area of car park that can be directly restored, within the current masterplan and based on the OS maps of the site, is 3,323 square metres (0.3 ha); see area within solid pink line on Figure 12.14. There are also areas of degraded habitat around the car park that would increase this area to 5,374 square metres (0.54 ha), indicated by the hashed brown line.

2. ***Providing compensation habitat areas on land within the curtilage of Riviere Farm.***

   The land offered comprises part of two of the northernmost fields of the Riviere Farm landholding and would cover 2.5-3 hectares; see Figure 12.15. The criteria for identifying suitable compensation habitat were that the area should be within the ownership of the developer and that it could provide enhancement of a semi-natural habitat appropriate to the locality of Hayle and the Towans. The two fields that have been identified lie immediately adjacent to the western boundary of the Upton Towans SSSI and, subject to the results of site investigations, are believed have the potential for return to grassland habitat, either as dune grassland or herb-rich coastal grassland. The preferred option would be dependant on planning restrictions, consultations with conservation agencies, investigation of local ground conditions, and availability of surplus clean sand. The area includes potentially valuable hedge and tree line features which would be managed particularly as bat flight lines

DO NOT SCALE THIS DRAWING.

Hayle Harbour

Riviere Farm - location of proposed compensatory habitat creation area

Figure 12.15
not to scale
print at A3
date November 2007

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Improved management of the local access to Hayle beach by creation of board walks as part of the masterplan design.

This would include creation of a dedicated beach access footpath along the North Quay waterfront to create a preferred walking route and avoid access-related erosion over the wider Towans area. Additionally, the proposed pathway through dune grassland to the north-east of Riviere Fields should reduce pressure on the dune habitats by giving a direct route to Hayle town away from the Towans/beach.

Consultation with the Towans Partnership management group will take place to define preferred options for schemes 1-3 above, and to determine scope for developer input to wider dune conservation efforts on the Towans (eg access management).

It is probable that the dune restoration measures defined in 1., above, can, in the medium-term, mitigate for the loss of dune grassland at North Quay since, although the area to be restored is less than the area lost, the replacement habitat would be of particular value to this dynamic and severely pressured section of the Towans dune system. In the wider context of the Hayle dune system the habitat creation proposed at Riviere Farm (2., above) would compensate for the development-related loss of dune grassland and provide positive impacts through a gain of semi-natural coastal habitat adjacent to the Upton Towans SSSI.

Level of certainty for success

Restoration of dune habitats and reduction of pressures on dune habitats through access management are proven techniques; there is therefore a high level of certainty that the methods would be successful.

12.6.1.4 Mitigation of impacts on reptile communities

Rationale

The following mitigation methods aim to avoid, or where unavoidable, minimise, negative impacts on the reptile populations of the North Quay section of the proposed development.

The improvement of the remaining habitat areas on North Quay for the existing population and displaced individuals should provide mitigation for the anticipated direct loss of habitat for the existing reptile community. Such improvement would be achieved by:

- providing adequate feeding resource and suitable shelter for hibernaculum
- minimisation of disturbance pressure; this is partly achieved by the creation of 'favoured' pedestrian routes on the margins of (rather than through) retained semi-natural habitat above North Quay, as identified in the masterplan
- retention of adequate connectivity between habitat areas that remain, post construction, to allow animals to migrate through the landscape adjacent to the proposed development, and prevent isolation of

individual reptiles (the masterplan retains a corridor of semi-natural vegetation between the outer Hayle Towans area and the landward areas of dune grassland)

- In the long-term, the new habitats associated with the dune grassland mitigation and habitat compensation areas at Hayle Towans and Riviere Farm (defined in 12.6.1.3 above) would be expected to provide suitable conditions to support reptile communities

Level of certainty for success

It is very probable that the loss of reptile habitat would be mitigated by the measures described.

12.6.1.5 Mitigation of impacts on nesting birds

Proposed mitigation method

The predicted loss and reduction in quality of available nesting resource would be partially mitigated by development-led habitat enhancement (particularly better management of hedge structure), habitat creation (eg at Hayle Towans) and management of recreational and residential access over North Quay.

Level of certainty for success

It is probable that the measures would mitigate for the local impact of habitat loss for breeding birds in the mid to long term, although there is likely to be a time lapse in the short term before the habitat enhancement measures provide sufficiently mature habitat to be of value to terrestrial bird species.

12.6.1.6 Mitigation of impacts on BAP bird species, linnet and song thrush

Rationale

The direct loss of habitat resource for linnet and song thrush arising from the proposed development, although minor, would be mitigated by measures that enhance biodiversity value at the local level.

Proposed mitigation method

The linnet population would benefit from the inclusion in new hedgelines of thorny scrub consisting of bramble, hawthorn, blackthorn and gorse, as nesting habitat. Additionally on the retained hedge lines, it would be possible to manage the habitat to provide sections of low dense thorny growth near open grassland areas (ie at the northern boundaries of the Riviere Fields site).

Partial mitigation for the loss of linnet feeding habitat would occur from the restoration of habitat on Hayle Towans, where open weedy habitat would be a natural feature of the developing dune habitat (see section 12.6.1.3). The anticipated increased recreational use of the dune grassland habitats would be partially mitigated by management of access to the dune and beach, and the creation of access paths from the chalet parks into Hayle. In addition, the proposal to create compensatory semi-natural grassland habitat on the Riviere Farm land could provide a

valuable habitat resource for linnet, since part of the area could be managed to create areas of open weedy seed-rich growth with a significant proportion of bare ground.

Mitigation for the loss of stands of trees and shrub at North Quay, which provide feeding and nesting habitat for song thrush, would be achieved by planting of new shelterbelts on the northern margins of the Riviere Fields site.

Level of certainty for success

It is probable that the mitigation measures would partially mitigate for the local impact on the song thrush and linnet populations in the mid to long term, although there is likely to be a time lapse in the short term before the dune restoration, habitat compensation and woodland-planting measures are sufficiently developed to be of value to these species.

12.6.1.7 Mitigation of impacts on western ramping fumitory

Proposed mitigation method

To mitigate for the development-related loss of habitat for this plant, preservation and re-location of the soils in which the western ramping fumitory is occurring (on North Quay) to another site is proposed. This would have the virtue of retaining the seed-bank and the open disturbed habitat with which the species is associated. The relocation of the soils will be planned so that they are sited where occasional disturbance would retain open habitat, creating optimum conditions for vegetative growth from the seed bank, for instance arable field edges, road verges, hedge banks or other similarly cultivated habitat (suitable land areas will be considered on land owned by the applicant, eg at Riviere Fields or in the vicinity of Riviere Farm).

Level of certainty for success

There is a probable degree of certainty for success of this action.

12.6.1.8 Mitigation of impacts on purple ramping fumitory

Proposed mitigation method

To mitigate for the development-related loss of habitat for purple fumitory, preservation and re-location of the soils in which the species is occurring on the North Quay to another site would be undertaken. This would have the virtue of retaining the seed-bank and the open disturbed habitat with which the species is associated. The relocation of the soils will be planned so that they are sited onto base poor soils that are widespread on the surrounding countryside, rather than onto the base rich sandy soils of the Towans (suitable land areas will be considered on land owned by the applicant, eg in the vicinity of Riviere Farm).

The same mitigation option is available for the very small population of this fumitory which occurs on the Copperhouse saltmarsh, but the impact there is negligible and of less certainty so that mitigation is not believed to be necessary.

Level of certainty for success

There is a probable degree of certainty in this action. Other options would be the inclusion of an arable management regime targeted at purple ramping fumitory on available fields.

12.6.1.9 Mitigation of impacts on ivy broomrape

Due to the highly specialised habitat requirements of this species the most probable option for mitigating for the loss of the existing growth (on North, East and South Quays) is to translocate a well established colony and its host plant (ivy) to a suitable site where its future could be reasonably assured.

Proposed mitigation method

Translocation of the main colony on North Quay would be undertaken, providing a suitable receptor site can be identified. There is no documentation describing translocation of ivy broomrape, but broomrapes that are associated with flowering grassland plants have been translocated as part of a meadow translocation. Success is likely to require the host ivy to be carefully translocated in large masses to a suitably open habitat type.

Searches for receptor sites will focus on finding habitat with existing areas of mature ivy ground growth; where this is present in retained habitat areas on North Quay, the ground cover would be preserved wherever possible.

Level of certainty for success

There is no documentation describing translocation of ivy broomrape; there is therefore a moderate expectation of success.

12.6.1.10 Mitigation of impacts on hedges and Cornish hedge banks

Rationale

Maintenance of the hedge resource within the development proposal is of particular importance due to its intrinsic value as habitat at the landscape scale for bats, and for other valuable biodiversity features such as nesting birds and reptiles.

Proposed mitigation method

Loss of the existing hedgeline at the Riviere Fields site would be minimised as far as possible. Also, the landscape strategy for the development incorporates new, replacement hedge lengths; approximately 280 metres of hedgeline are included in the landscape design plan (85 percent of the length of hedge that will be lost). New Cornish hedges would be planted with locally appropriate native shrub such as hawthorn, blackthorn, and wild privet. The new Cornish hedges would be sited to extend existing hedgelines. These and the existing retained hedges would be managed to encourage taller shrub growth, and not clipped hard as much of the length is currently. Access gaps would be restricted (ideally to less than 10 metres), wherever possible, and tall growth

created or managed at the gaps to provide connectivity in the canopy. The potential urbanisation of the hedge lines on Riviere Fields would be minimised by education of the residents about the particular nature conservation value of the Cornish hedge habitat.

Clearance of the hedge lines would occur outside the bird nesting and reptile hibernation seasons, ie between August and October. In removing the hedge line at the centre of the fields it would be necessary to take reasonable measures to avoid harming reptiles; a combination of refuge capture and destructive searching would be appropriate at this site. The semi-natural habitat adjacent to the northern boundary hedges of the Riviere Fields site would be an appropriate receptor for the small number of individuals that can be expected from the hedge removal.

Level of certainty for success

The creation of new Cornish hedges to replace that lost would, to a large extent, mitigate for the loss of hedge, and improved management of the hedge lines to promote more diverse structure and biodiversity value would provide further mitigation; all these actions are near certain to be successful.

12.6.1.11 Mitigation of impacts on Copperhouse saltmarsh

Rationale

The proposed impoundment regime to achieve sluicing via Copperhouse Pool would increase the frequency of pool impoundment, and hence inundation of the saltmarsh habitat, compared with that which is currently experienced for recreational events, ie an average of four times per year during April-September, usually for a period of between three and six days each time. The sluicing regime would entail impoundment for c.five days twice each month, for 4.5 months (ie nine times per year), from mid-April to the end of August. This doubling in the number of prolonged inundations each year is likely to result in vegetation changes in the saltmarsh community, particularly since the impoundments take place in the summer period when the vegetation is growing.

Proposed mitigation method

Impounding only during the period of vegetation dormancy / low growth in winter would probably minimise the potential for vegetation change, but since this conflicts with the need to restrict impoundments to the summer period to mitigate effects on birds and marine inverterates (see section 12.6.2.2), this option is not acceptable.

The alternative strategy would be to monitor saltmarsh vegetation communities at least every two years in the operational phase, to detect any adverse changes that may be resulting from inundation. If growth of invasive species, eg cord grass, was detected early, it would be possible to implement control measures at an early stage, and/or propose changes to the frequency of impoundments based on perceived risks of deterioration in habitat quality.

Level of certainty for success

There are moderate levels of certainty of success with these mitigation measures.

12.6.2 Mitigation of impacts on aquatic ecology

12.6.2.1 Construction Phase Mitigation

Many of the potential impacts from the construction works on aquatic ecology are due to the possible release of contaminants (eg oil, mortar, soil) into the aquatic environment. A Construction Environmental Management Plan (CEMP) would be implemented to minimise impacts from this source during the construction phase (see Chapter 13, Water Resources, section 13.6 and Chapter 17).

The duration of individual construction Work Items would be set out in an Outline Construction Programme (OCP), and the timing of specific works identified as likely to have a significant impact on aquatic ecology receptors (see section 12.5.2) would be determined with reference to a matrix of 'seasonal sensitivities' of ecological receptors, as shown in Annexe 12L. The periods of highest ecological sensitivity for aquatic ecology would be avoided wherever possible in drawing up the OCP; the assessment of optimal timings for some particular works would need to be made in conjunction with timing requirements for ornithology, since they might not coincide (see section 12.6.3).

Harbour Wall Repairs (Work Items 17-22)

No practical mitigation can be suggested for the temporary loss of aquatic invertebrates and algae due to repairs to the harbour walls. The CEMP will describe measures to prevent spillage of any harmful substances during repairs to the harbour walls.

Harbour

Harbour – Work Item 10 (Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN)

If dredging uncovers different types of sediment that would affect the biota (eg old contaminated sediments or noticeably finer or coarser sediments) this would be mitigated by over-dredging and placement of clean dredged sand, eg from the proposed sand trap.

Sandeels are likely to be present throughout the year, therefore mitigation proposed for timing the works has aimed at avoiding the most sensitive time. The period of spawning, egg hatching and presence of larvae is probably the most sensitive time, and the main period of adults coming into the estuary to spawn, and subsequent development of the eggs, extends from August to January. The excavation of Cockle Bank would therefore be timed to avoid this period. Further minor amendments to the proposed dates would be possible if

the Environment Agency require them. It is not practical to attempt to remove sandeels, as it would have to be done immediately before dredging a particular area.

The CEMP will describe methods to reduce concentrations of sediment in the dredging plume. After mitigation there would be a negligible to minor adverse impact.

If leachate from soil washing is licensed for discharge into the harbour, control of potential pollution impacts would be achieved by monitoring for metals, suspended solids etc in relation to Environmental Quality Standards (EQS) and the discharge consent, in order that works can be stopped if pollution levels exceed these standards and remedial action (eg revision of soil washing methods) taken as necessary.

Harbour – Work Item 12 (New fishermen's quay and slipway)

The CEMP will describe methods to prevent contaminants entering the harbour.

The fishermen's quay would result in the loss of intertidal sediment habitat and a gain in hard habitat on sheet pile wall quay and slipway. No mitigation is proposed as the adverse and beneficial impacts are approximately balanced.

Harbour – Work Item 23 (Slipway and associated land works)

Construction of the sailing centre and slipway could result in contamination due to spillages of lime-based mortars, hydraulic cements or other materials. The CEMP will describe measures to prevent spillage of any harmful substances.

Harbour – Work Item 13 (Excavation and dredging of i) harbour area to the north-west of fishermen's quay, and ii) sand trap)

Excavation and dredging of the harbour area to the north-west of fishermen's quay and the sand-trap may generate plumes that could impact water quality at adjacent habitats. The CEMP will describe methods to reduce plume formation and ensure water quality and sediment concentrations in the harbour are acceptable. Some monitoring may be required. The seasonal timing of these works would be allocated to a cooler period (eg early January to late March) to reduce the potential for impacts due to the dredge plume.

Dredging would remove most of the existing biota (eg invertebrates and sandeels) and affect those species that feed near these areas, eg sandeels. Mitigation is best achieved through avoiding the most sensitive period for sandeels, which is the period of breeding, spawning and presence of larval sandeels (August to December/January); both dredging works would be timed according to this requirement. Sandeels would still be affected by the dredging, but to the minimum extent practical.

If the sand removed by dredging is of suitable quality it could be used for beach nourishment on the nearby beaches (outside the harbour). No mitigation is proposed.

Harbour – Work Item 3 (Excavation and renovation of Carnsew second sluice)

Mitigation would be achieved through the CEMP, which will describe measures to prevent spillage of harmful substances and ensure water quality of the discharge is within prescribed limits.

Harbour – Work Item 5 (Excavation of harbour at Carnsew Quay/Carnsew Wharf)

The impacts would be partially mitigated by carrying out the works in the cooler months as far as possible (eg early February to late April). Additional mitigation would involve netting to remove at least some of the fish present and relocate to a safe area such as Carnsew Pool or the harbour seaward of the bund.

Harbour – Work Item 6 (Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN)

The CEMP will describe measures to reduce contamination of the water by harmful substances and monitoring of water quality for suspended solids and selected contaminants. Further mitigation would be achieved by carrying out the works during the cooler months as far as possible (eg early February to late April).

Harbour – Work Item 11 (New floating pontoons for marina)

During construction there is potential for polluting materials to enter the harbour. The CEMP will describe measures to prevent spillage of any harmful substances into the harbour.

Harbour – Work Item 15 (Pedestrian bridge from East Quay to North Quay)

The CEMP will describe measures to prevent spillage of any harmful substances into the harbour.

There would be a small loss of intertidal/subtidal sediment habitat due to construction of the bridge piers in the intertidal. There would be a larger gain in intertidal/subtidal hard substrate habitat on the piers. No mitigation is proposed, as the adverse and beneficial impacts are approximately in balance.

Harbour – Work Item 9 (Half-tide gate at entrance to Penpol Creek; part)

Part of the new Penpol Creek half-tide gate and pedestrian crossing would be constructed behind a coffer dam extending approximately half the distance between the Penpol quayside and East Quay. Dewatering would result in a discharge to the harbour. The CEMP will describe methods to reduce suspended sediments in the water returning to the harbour after dewatering. Monitoring of contaminants and suspended solids in the water discharged to the harbour may be required.

Penpol Creek

Penpol – Work Item 7 (Lifting/swing pedestrian bridge at Penpol Creek)

The new lifting/swing pedestrian bridge at Penpol Creek would be partially supported on piers within Penpol Creek. No mitigation for this loss of habitat is required, as the piers would provide additional intertidal and subtidal hard substrates. The CEMP will describe measures for preventing spillages into Penpol Creek.

Penpol – Works Item 8 (Dredged area at south end of Penpol Creek)

Dredging/excavation at south end of Penpol Creek would remove flora and fauna in the sediments. The dredging works have been scheduled to coincide with the construction of the half-tide gate (Works Item 9). The additional impact of the dredging is a minor adverse short-term impact.

Penpol – Work Item 9 (Half-tide gate at entrance to Penpol Creek; part)

As part of the mitigation, the works to install the Penpol half-gate would be completed in the latter part of the year, so that recovery is as rapid as possible (the main breeding season for aquatic invertebrates in south-west England starts in January each year and continues until autumn). Many species have planktonic larvae that would be brought into Penpol from adjacent areas, and the aquatic biota of the impounded creek may develop relatively rapidly.

Carnsew Pool

Carnsew Pool – Works Item 2 (New fixed pedestrian bridge at Carnsew second sluice channel)

If the new fixed pedestrian bridge is constructed after the channel works the CEMP will describe measures to prevent spillage of harmful substances.

Carnsew Pool – Works Item 4 (Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system)

Timing is an important element to mitigating impacts in Carnsew Pool. The second sluice (previously called the mitre gate) would be constructed and operational before any works are carried out at the existing sluice. This would ensure that tidal exchange between the pool and the harbour is unaffected by the refurbishment of the tunnels.

It would be possible to relocate some of the boulders and associated flora and fauna from the area near the existing sluice to the new second sluice, which would be operational by that time. However, the percentage of affected habitat that could be realistically moved would be minimal and this work would only be done if required by Natural England.

The applicant will discuss ways to enhance the biodiversity of Carnsew Pool with Natural England, the Environment Agency and RSPB. This is not mitigation for any impacts, but part of the general duty of a developer to enhance biodiversity where possible. The most likely work would be clearance of contaminated slag and other man-made debris from a section of Carnsew Pool and replacement by local stone. The effectiveness of this technique would be assessed by a monitoring programme, targeting species that live on and under hard substrates.

Copperhouse Pool

Copperhouse Pool– Works Item 14 (New vehicular bridge by Copperhouse Gate)

Construction of the piers in the intertidal to support the new vehicular bridge may introduce sediments and associated contaminants (eg copper, zinc and arsenic) into the water column. Mitigation would be via the Construction Environmental Management Plan (CEMP), which will describe methods to reduce plume formation and ensure water quality and sediment concentrations are acceptable. Monitoring of water quality, especially metals, would be required.

Copperhouse Pool– Works Item 16 (Copperhouse Pool sluice gates works)

The Construction Environmental Management Plan (CEMP) will describe measures to prevent spillage of any harmful substances.

12.6.2.2 Operational Phase Mitigation

Harbour

The intensity of impacts on the aquatic ecology of the harbour will depend on the frequency of dredging of the marina, the sand trap, and the area north-west of the fishermen's quay. Dredging at intervals of less than two years would have a moderate adverse impact. This would be reduced to a minor adverse impact if the dredge intervals are 2-4 years and a negligible adverse impact if dredging occurs less frequently than every four years. The expected dredging frequencies and resultant impacts after mitigation are:

- Maintenance dredging of the marina area – The dredging frequency predicted by Buro Happold is every 5-10 years (given the sluicing regime described in section 13.6.2.4, also summarised below), which would have a negligible adverse, short-term impact since almost full recovery of biomass and diversity of aquatic flora/fauna is likely within this period. No mitigation is proposed
- Maintenance dredging of sand-trap – Annual dredging is anticipated; this would have a moderate adverse impact on sandeels. The mitigation would be to dredge only when judged necessary (based on sediment accumulation data and records of the effectiveness of sluicing), and to avoid August-January where possible, in order that the main period of sandeel spawning and egg development is avoided (the precise timings would be discussed with the Environment Agency). From an operational viewpoint, a dredge in

the spring may the most suitable period, ie towards the end of the non-sluicing period, which ends 15 April. Depending on the timing of dredging, the impacts after mitigation would be minor-moderate, adverse and short-term

- Maintenance dredging north-west of the fishermen's quay – The frequency and possible timing of dredging are unknown; there is potential for minor to moderate adverse short-term impacts on sandeels. Mitigation (if required) would be as for the sand-trap, above, and impacts are likely to be negligible to minor adverse short-term impacts

Penpol

The possibility of algal blooms in Penpol (Works Item 9) is considered to range from a negligible (if none occur) to a major adverse short-term impact. A minor adverse impact could occur if the algal bloom is of non-toxic species and does not cause any mortalities of marine life when it decays. A major adverse impact could occur if the algal bloom is toxic and/or collapse of the bloom causes mortalities due to reduced concentrations of dissolved oxygen. The need for mitigation will be clarified by further studies (see section 12.5.2.3); mitigation could be achieved by monitoring nutrients and phytoplankton (especially nuisance algal species) and allowing more regular flushing of Penpol if the results indicate that a bloom is forming. Such monitoring is relatively specialist and needs to be done during each period of neap tides during the spring and summer months.

Carnsew Pool

The unmitigated sluicing regime (ie sluicing on every high spring tide throughout the year) is considered likely to have significant adverse impacts on invertebrates, fish and birds in Carnsew Pool. The principal mitigation proposed is therefore to only sluice during the period 15 April to 30 August, in order to reduce impacts on over-wintering birds and those invertebrates that breed early in the year.

In addition, adverse impacts resulting from the increase in the predicted tidal heights due to filling Carnsew through two sluices would be avoided by using only one sluice to fill Carnsew, but both sluices used to empty it.

There would be minor to moderate adverse impact on invertebrates and algae, and negligible to minor beneficial impacts on fish during the period 15 April to 30 August, due to effective increase in the subtidal area of the pool (ie the high tide level is retained for three hours before water is released for sluicing). These impacts are reversible as the sluicing regime can be amended in the light of monitoring.

Copperhouse Pool

The unmitigated sluicing regime (ie sluicing on every high spring tide throughout the year) is considered likely to have significant adverse impacts on invertebrates, fish and birds in Copperhouse Pool. The proposed

mitigation is therefore to only sluice during the period 15 April to 30 August, in order to reduce impacts on over-wintering birds and those invertebrates that breed early in the year.

There would be minor to moderate adverse impact on invertebrates and algae, and negligible to minor beneficial impacts on fish during the period 15 April to 30 August, due to effective increase in the subtidal area of the pool (ie the high tide level is retained for three hours before water is released for sluicing). These impacts are reversible as the sluicing regime can be amended in the light of monitoring.

12.6.3 Mitigation of impacts on ornithology

If unmitigated, the potential impacts of the proposed development on aquatic birds range from a major long-term negative impact on regionally important bird interest, to minor short-term impacts on local populations.

A Construction Environmental Management Plan (CEMP; see Chapter 13, Water Resources, section 13.6) will be drawn up giving relevant construction-phase mitigation measures in detail, focusing primarily on methods to reduce disturbance. The following summarises the types of mitigation that would be implemented in order to ameliorate or negate the identified deleterious impacts to the important components of the waterfowl assemblage (and site function) of the Hayle estuary. Ornithological mitigation components to be defined in the CEMP are set out in Annexe 12N.

The duration and start/end dates of individual Work Items will be set out in an Outline Construction Programme (OCP), and the timing of specific works identified as likely to have a significant impact on ornithological receptors (see section 12.5.3) will be determined with reference to a matrix of 'seasonal sensitivities' of ecological receptors, as shown in Annexe 12L. The periods of highest ecological sensitivity for aquatic birds (ie autumn and winter) would be avoided wherever possible in drawing up the OCP; the assessment of optimal timings for some particular works would need to be made in conjunction with timing requirements for aquatic ecology, since they might not coincide (see section 12.6.2).

12.6.3.1 Mitigation of impacts on little grebe

The majority of mitigation for impacts on little grebe would centre on the key site of Carnsew Pool, where the majority of little grebe are concentrated, although the lower reach of Copperhouse Pool is also used regularly. Carnsew Pool is important in providing both a rich food supply (small fish and macro-invertebrates), as well as being an area subject to low levels of human disturbance (towards the centre of the pool). Mitigation measures would concentrate on the maintenance of good water quality, adequate food supply and low disturbance.

Construction-phase mitigation

Mitigation to reduce the extent of construction-phase disturbance to little grebe, implemented via the CEMP, would include:

- timing of works (ie second sluice, road, pedestrian bridge and car park construction at Carnsew Quay and causeway, and provision of car park on the Triangular Spit) outside the main period of sensitivity (which is October to March, see Annexe 12L); in some cases, this may need to be assessed in conjunction with timing requirements for the aquatic ecology as they might not coincide
- minimisation of visual and aural stimuli during work on the Carnsew Pool and Copperhouse Pool sluice gate systems as well as the bridge at Copperhouse (these construction activities would possibly require screening, depending on location and extent of works)
- methods to ensure no spillage of solids of liquids into Carnsew and Copperhouse Pools

Operational-phase mitigation

Measures to reduce potential sources of disturbance to little grebe at Carnsew Pool comprise:

- adoption of methods to discourage *ad hoc* access around Carnsew Pool, and in particular, along the north-western edge (whilst it is acknowledged that the northern border of Carnsew Pool is currently used for recreation (walking and dog walking), which would continue, methods to discourage additional access along the path by day visitors to the Hayle area will be considered). Restriction of public access on areas of Triangular Spit adjacent to Carnsew Pool would be assessed in conjunction with requirements for petalwort conservation on the same site (see section 12.6.1.1)
- planting of screening vegetation along the north and western borders of Carnsew Pool, using natural shrub/scrub (eg gorse (*Ulex* sp)

It could be preferable to incorporate screening on the pedestrian access route over the new Copperhouse bridge (eg to a minimum of 1.5m above path level), in order that disturbance effects on little grebe from pedestrians on the bridge (as identified in 12.5.3.3) are ameliorated. It is estimated that screening would reduce the disturbance impact to waterfowl using the western region of the Pool to c.50% of the unmitigated scenario (in terms of habitat area affected). However, the desirability of screening for ecological mitigation would need to be balanced by the competing interests of the need to preserve the view and setting of the adjacent listed structures (see section 7.5.3.5). Those issues will be considered in detail in the context of the detailed/listed building application for the bridge in consultation with both Natural England and English Heritage.

Introduction of a sluicing regime in Carnsew Pool may affect feeding potential for little grebe, primarily indirectly through changes to sediment conditions and prey availability. The principal mitigation is to only

sluice during the period 15 April to 30 August when the species is absent or near absent from the site, and only to sluice around spring tide periods for approximately five days in a row. The effects of the sluicing regime would be monitored and if deleterious impacts on waterfowl function are observed, the regime would be modified.

12.6.3.2 Mitigation of impacts on little egret

This species occurs across the Hayle site, but with concentrations in the Lelant area. The harbour area is used for feeding by a small number of birds.

Construction-phase mitigation

Standard methods to minimise sources of visual and aural disturbance that may affect little egret habitat use would be employed, using guidelines given in Annexe 12N. It is unlikely that impacts from works on the Harbour can be completely negated by mitigation. Some displacement of little egret from the area would occur, although it is questionable whether the additive effect of this displacement would have a detrimental effect on the wider population of the Hayle estuary, particularly given the extent of the potential refugia in Lelant Water, and on the carrying capacity of the system as a whole for the species.

Operational-phase mitigation

Incorporation of screening on the pedestrian access route over the new Copperhouse bridge would aid reduction of potential disturbance to little egret on the lower reaches of the Pool, but this mitigation option needs to be assessed for compatibility with visual and heritage issues at this location (see 12.6.3.1 above).

12.6.3.3 Mitigation of impacts on wildfowl feeding and roosting areas

The majority of wildfowl feeding and roosting activity is concentrated on Lelant Water (including Saltings) and in Copperhouse Pool, but with occasional activity elsewhere within the system.

It is unlikely that construction activity would have a significant effect on feeding and roosting wildfowl usage within Lelant Water, given this site's distance from the works. Similarly, any roosting activity on the western end of Carnsew would not be significantly affected by construction activity on the eastern side of the Pool and on the adjacent Triangular Spit.

Construction-phase mitigation

A zone of disturbance impact to wildfowl (perhaps 5000m^2) would be created by the construction of the new bridge at the western end of Copperhouse Pool, and mitigation to reduce the extent of this zone would include:

- timing of the works to the period outside the autumn and winter (when waterfowl usage tends to peak); this measure may need to be assessed in conjunction with timing requirements for the aquatic ecology as they might not coincide (see Annexe 12L)
- standard methods to minimise visual and aural stimuli, as per guidelines given in Annexe 12N

Where disturbance to birds on the westernmost reaches of Copperhouse could be generated by harbour wall repairs at the eastern end of North Quay, the above mitigation would also apply.

Operational-phase mitigation

Changes to the sluicing regime in Copperhouse may affect feeding potential for wildfowl, particularly shelduck, wigeon and mallard, either directly through tidal inundation and loss of feeding and roosting sites, or indirectly through changes to sediment conditions and prey/vegetation availability affecting site use in general. The principal mitigation is to only sluice during the period 15 April to 30 August when the waterfowl usage on the site is at its lowest, and only to sluice around spring tide periods for c. 5 days in a row. The effects of the sluicing regime would be monitored and if deleterious impacts are observed on wildfowl function the regime would be modified.

Incorporation of screening on the pedestrian access route over the new Copperhouse bridge would aid reduction of potential disturbance to the (relatively small-scale) wildfowl roost which occurs on the lower reaches of the Pool, but this mitigation option needs to be assessed for compatibility with visual and heritage issues at this location (see 12.6.3.1 above).

12.6.3.4 Mitigation of impacts on wader feeding and roosting areas

Wader feeding is observed across much of the Hayle Estuary, with key areas on Lelant Water, the western end of Carnsew Pool and on Copperhouse Pool. Wader roosts occur on Lelant Water/Saltings, Ryan's Field, the western end of Carnsew Pool and Copperhouse Pool, with relative usage depending on time of year and tidal height.

It is unlikely that construction activity would have a significant effect on wader feeding and roosting activity within Lelant Water, or roosting at Ryan's Field, given these sites' distance from the works. Similarly any feeding and roosting activity on the western end of Carnsew would not be significantly affected by work on the eastern end of Carnsew around the sluices, or on the adjacent Triangular Spit.

Construction-phase mitigation

Construction works around the sluice and bridge in Copperhouse Pool would have a disturbance effect on (the generally low) numbers of waders that feed or roost towards the western end of the Pool. Mitigation to reduce the extent of this zone would be as 12.6.3.3. above. Such mitigation would also apply if harbour wall repairs at the eastern end of North Quay are thought likely to generate disturbance to birds on the westernmost reaches of Copperhouse.

Operational-phase mitigation

Changes to the sluicing regime in Copperhouse may affect feeding potential for wader species, either directly through tidal inundation, or indirectly through changes to sediment conditions and prey availability. The principal mitigation is to only sluice during the period 15 April to 30 August when the waterfowl usage on the site is at its lowest, and only to sluice around spring tide periods for approximately five days in a row.

Additionally, with the second sluice available at Carnsew Pool, it is proposed to maximise potential waterfowl time feeding on the intertidal areas of the pool by operating only one sluice during the flood phase for a slow covering of the intertidal zone (at a similar rate to that currently experienced), and then both sluices during the ebb phase to uncover the mudflat as quickly as possible. The effects of the sluicing regime would be monitored and if deleterious impacts observed on wildfowl function, the regime would be modified.

Incorporation of screening on the pedestrian access route over the new Copperhouse bridge would aid reduction of potential disturbance to the (relatively small) gatherings of feeding waders which occur on the lower reaches of the Pool, but this mitigation option needs to be assessed for compatibility with visual and heritage issues at this location (see 12.6.3.1 above).

Methods to discourage *ad hoc* pedestrian access around Carnsew Pool, and in particular, along the north-western edge would be required. Whilst it is acknowledged that the northern border of Carnsew Pool is currently used for recreation (walking and dog walking) and as such, would continue, methods to discourage additional access along the path by day visitors to the Hayle area would be implemented, eg advance planting of screening vegetation along the north and western borders of Carnsew Pool and Carnsew causeway where open views are currently possible, using natural shrub/scrub such as gorse.

In order that there would be no increase in the scope for small craft to move into Lelant Water following marina development, the harbourmasters would strictly apply existing restrictions on boat movements outwith the harbour and harbour channel; further adaptive restrictions may be applied as necessary.

12.7 Residual impacts

12.7.1 Residual impacts relating to terrestrial ecology

12.7.1.1 Impact summary tables for terrestrial ecology

Receptor / Proposed activity	Construction impacts on terrestrial ecology	
	Description of unmitigated impact *Significance of impact*	**Mitigation** *Significance of residual impact*
Petalwort Construction of car park on east side of Triangular Spit	Clearance of areas of scrub and grassland resulting in loss of small proportion (<0.047%) of the population on Triangular Spit. *Moderate local permanent adverse impact on site of at least national importance for petalwort.*	Fully researched translocation of less than 0.047% of petalwort population on Triangular spit subject to licensed approval by Natural England.; early phases of the development proposals give a 6 year research window for refinement of translocation methodology. *Negligible local permanent adverse impact.*
Petalwort Construction of car park on east side of Triangular Spit	Construction activities have the potential to damage the main colony of petalwort plants, the short grassland and open habitat and disturb rabbit feeding behaviour. *Possible major permanent adverse impact on site of at least national importance for petalwort.*	The method statement for construction will include measures to avoid, and where unavoidable, minimise, potential impacts including changes in hydrology, pollution, disturbance, smothering of plants and disturbance of rabbit population. *Minor temporary adverse impact, probably reversible in response to management / monitoring.*
Petalwort Building development on South Quay	Extensive built development that will result in a direct loss of colonies of petalwort during the construction phase. *Minor permanent adverse impact within the context of the local petalwort*	Remove and temporarily maintain plants in cultivation under licence from Natural England for the purposes of research programme into translocation of more significant colonies on Triangular Spit. *Minor short to mid term adverse impact.*

Receptor / Proposed activity	Construction impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
	population.	
Bats Stripping of vegetation, removal of cliff materials and treatment of faces	Loss of potential roost habitat from stripping of vegetation, removal of cliff materials and stabilising treatment of cliff and quarry faces, though probably reverersible in long-term through re-growth of vegetation. *Probable minor, local, long-term, adverse impact on potential roost space*	Wherever possible , retention of confirmed and potential natural roost and hibernation sites on the quarry and cliff face. Bat roosts designed into development where appropriate. *Probable negligible, local, temporary adverse impact.*
Bats Clearance of ground and erection of buildings	Obstruction and loss of flight lines, loss of potential foraging habitat, (particularly where shelter trees are removed), and potential visual disturbance from security lighting. *Potential for moderate temporary short term and permanent adverse impacts at local level.*	Retention of known flight lines from confirmed roost sites during construction phases, particularly if roosts found in buildings at the centre of Riviere fields. Minimisation of security lighting. Creation and enhancement of semi-natural habitat on site. Inclusion of bat interest in specifications for habitat restoration, creation and management proposals. *Probable neutral to positive short term and permanent impacts at local level*
Dune grassland Creation of parking and residential development at North Quay	Loss of extent of dune grassland and dune scrub, comprising 3.3 hectares. *Moderate, permanent adverse impact on BAP Priority habitat*	Restoration of almost 0.6 hectare of eroded dune habitat on the outer section of the current car park at Hayle Towans providing valuable habitat continuity in semi-natural dune habitat. Provision of compensation habitat areas on land within the curtilage of Riviere Farm, comprising 2.5 - 3 hectares

Receptor / Proposed activity	Construction impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
		Minor local long-term adverse impact, partially mitigated by dune habitat creation; compensation for habitat loss would result in minor positive impact by gain in semi-natural grassland habitat.
Dune grassland Construction works on car park and residential development sites at North Quay	Minimised but unavoidable adverse impacts on the dune grassland and dune scrub habitats immediately adjacent to the construction areas *Probable minor to moderate temporary, possibly short to mid term, adverse impacts*	The extent, severity and duration are expected to be minimised by best practice construction methods. *Probably negligible temporary or short term adverse significant impacts*
Reptiles Loss of habitat to site clearance, demolition and building construction works	Probable loss of entire home range for common lizard and slow worm, and contraction of range for adders. *Potentially moderate to major permanent adverse impact on reptile community of county significance.*	Displacement and translocation programme; improvement of the remaining habitat areas for the existing population and displaced individuals; retention of adequate connectivity between habitat areas that remain, post construction, and existing landscape adjacent to the proposed development; beneficial compensating habitat creation at Riviere Farm *Potentially minor short- to mid-term adverse impact*
Nesting birds Preparation of site including clearance of	Removal of nesting habitat and disturbance of retained habitat. *Minor to moderate local temporary and*	Partial mitigation by development-led habitat enhancement (particularly better management of hedge structure), habitat creation (eg at Hayle Towans) and

Receptor / Proposed activity	Construction impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
scrub, ivy cover, buildings, at Riviere Farm, North Quay, South Quay, Triangular Spit and East Quay.	*permanent adverse impacts.*	management of recreational and residential access . *Negligible local medium-term adverse impact.*
Linnet Clearance of dune grassland at North Quay and arable land at Riviere Fields	Loss of both scrub and dune grassland habitats in the clearance of the site would reduce extent of available nesting and feeding resource for local population. *Minor to moderate permanent, local adverse impact.*	Partial mitigation for the loss of feeding habitat from dune restoration Hayle Towans, and compensatory semi-natural grassland habitat on Riviere Farm. *Minor short to mid-term, local adverse impact.*
Song thrush Clearance of dune scrub at North Quay	Loss of scrub, dune grassland and woodland edge in the clearance of the site would reduce extent of available nesting and feeding resource for local population. *Minor to moderate permanent, local adverse impact.*	Planting of new stands of trees at northern margins of Riviere Fields site, adjacent to retained stands of scrub would be of benefit to song thrush for nesting habitat. *Minor short to mid-term, adverse local impact.*
Western ramping fumitory Preparation of North Quay site, clearance of ground	Loss of known plants, and by inference the seed bank, from the clearance / construction on the North Quay area; loss of available habitat within a geographic area that is the stronghold for the species. *Minor local, long term adverse impact on plant of county significance.*	Movement of soils and seed bank to another site where occasional disturbance is ensured (such as road verge or hedge) to provide suitable habitat conditions. *Negligible long-term, local adverse impact.t*

Receptor / Proposed activity	Construction impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
Purple ramping fumitory Preparation of North Quay site, clearance of ground	Loss of known plants, and by inference the seed bank, from clearance / construction on the North Quay area; loss of available waste ground habitat within a geographic area that is the stronghold for the species. *Negligible, local, long-term adverse impact on plant of county significance.*	Movement of soils and seed bank to another site where occasional disturbance is ensured (such as arable field edge, road verge or hedge on suitable non-coastal soils) to provide suitable habitat conditions. *Negligible, local long-term adverse impact.t*
Ivy broomrape Clearance of site	Loss of colonies of plant on North Quay, South Quay and possibly East Quay. *Minor local permanent adverse impact.*	Translocation of main colony. *Negligible to minor local permanent adverse impact.*
Hedges and Cornish hedge banks Removal of hedge lengths	330 metres of hedge would be lost at the centre of Riviere Fields and short lengths would be lost to road access resulting in a direct loss of semi-natural habitat and loss of biodiversity value in remaining fragmented habitat. *Minor to moderate local permanent adverse impact.t*	280 metres of hedgeline would be planted with locally appropriate native shrub and sited to extend existing hedgelines. Hedges to be managed to encourage taller shrub growth. Access gaps restricted and tall growth managed at the gaps to provide connectivity in the canopy. *Minor local permanent adverse impact.*

Table 12– 9: Summary of construction impacts for terrestrial ecology

Receptor / Proposed activity	Operational impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
Petalwort Use of part of eastern section of Triangular Spit for car parking	Probable deterioration in quality of the main area of petalwort habitat on the west side of the Spit, due to likely reduction/loss of rabbit grazing and increase in disturbance pressures, both directly on the petalwort plants (from increased recreational pressure, nutrient enrichment and other factors) and indirectly through disturbance of rabbit grazing behaviour. *Major permanent adverse impact on protected species.*	Management of recreational activities (including access); monitoring and management of the petalwort habitat and rabbit population. Additional mitigation would be provided by the measures described in the mitigation package outlined in section 12.6.1.1. *Minor to negligible adverse impact in the mid to long term (although probably reversible through management).*
Bats Urban/street lighting	Urban lighting can affect bats adversely; species' sensitivity varies but street lighting would probably affect feeding behaviour; beneficial effects are likely for pipistrelle but adverse for long-eared bats. *Probable minor permanent local adverse impact from urban lighting.*	Type and positioning of lighting to be designed to minimise effects on bats. *Probable negligible to minor permanent adverse impacts.*
Dune grassland Increased pressures from residential and recreational users	Increase in recreational use surrounding the developments would possibly degrade areas of the adjacent dune grassland, with limited options for reversal. *Moderate, localised long term adverse impact.*	Improved management of access to Hayle beach and through dunes resulting in reduced disturbance and trampling erosion at Hayle Towans; liaison with Towans Partnership in design of dune restoration and management, and development-led contributions to access management on wider Towans area.

Receptor / Proposed activity	Operational impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
		Negligible localised long term adverse impact; possibly minor beneficial long-term impact on dune habitats district-wide, via dune habitat creation at Hayle Towans and positive management of wider Towan.s
Reptiles Increasing recreational activity within semi-natural habitats retained and adjacent to North Quay	Increased disturbance and pollution pressures on remaining reptile community . *Minor to moderate local adverse impact on reptile community of county significance.*	Improvement of the remaining habitat areas for the existing population and displaced individuals; beneficial compensating habitat creation; management of the disturbance levels on semi-natural habitat through creation of paths and through management plans *Negligible to minor adverse short-term impact .*
Nesting birds Built development and increased human activity	Loss and reduction in quality of available nesting resource . *Minor to moderate permanent local adverse impact.s*	Habitat enhancement (particularly better management of hedge structure), habitat creation and management of recreational and residential access. *Negligible-minor permanent adverse impacts.*
Linnet Recreational use of dune grassland habitats	Increased levels of disturbance from proposed residential development adjacent to retained habitat. *Possible minor permanent adverse, local impact.*	Creation of dedicated access paths from the beach into Hayle, and management of access to the dune and beach. *Negligible permanent adverse, local impact.*
Song thrush Recreational use of	Increased levels of disturbance from proposed residential development adjacent to retained habitat.	Creation of dedicated access paths from the beach into Hayle, and management of access to the dune and beach.

Receptor / Proposed activity	Operational impacts on terrestrial ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
woodland habitats	*Minor permanent adverse, local impact.*	*Negligible permanent adverse, local impact.*
Ivy broomrape Built development	Loss of available habitat. *Moderate-minor local permanent adverse impact.*	Retention of existing ivy habitat on the ground wherever possible. *Minor local permanent adverse impact.*
Hedges and Cornish hedge banks Urbanisation of hedges at proposed residential development	Minor potential for adverse impact on hedge habitats as a result of the close proximity of the residential. development and the tendency of residents to urbanise hedge habitats. (eg plant non-native species). *Minor to moderate local adverse impact; probably reversible.*	May be minimised by education about the value of hedges as a wildlife habitat. *Negligible to minor temporary local adverse impact.*
Saltmarsh Impoundment of Copperhouse Pool for sluicing, three hours on spring tides for five days, twice-monthly in period mid-April to end August	Range of effects that are unlikely to result in loss of salt marsh habitat, but may cause slight loss in extent and change in plant species and vegetation distribution in response to disturbance of the tidal and salinity regime; of concern would be the possible expansion of cord grass growth. *Potentially minor to moderate long term adverse impacts on habitat of national significance (probably reversible).*	Monitoring of changes in vegetation communities at least every two years to detect vegetation changes and adjust sluicing regime / vegetation management if significant adverse impact anticipated. *Potentially minor short to mid term adverse impacts (probably reversible).*

Table 12– 10: Summary of operational impacts for terrestrial ecology

12.7.1.2 Summary of residual impacts on terrestrial ecology

The most important residual impacts on terrestrial ecology are:

Construction phase

- There is potential for a minor temporary adverse impact on petalwort habitat in the centre of the Triangular Spit owing to car park construction activities on adjacent eastern land; the method statement for construction will include measures to minimise and avoid risks of incidental damage
- There would be a minor short-term adverse impact owing to removal of small petalwort colonies on South Quay for translocation
- Work on buildings on North Quay has potential to cause minor local temporary/short-term adverse impacts on the local bat population, at worst
- A minor local long-term adverse impact on dune grassland habitat would occur owing to habitat loss to building and car parking; partial mitigation is provided by dune habitat creation, while compensation for habitat loss is provided by gain in semi-natural grassland habitat at Riviere Farm
- There would be potentially minor short- to mid-term impacts on reptile communities at North Quay owing to habitat loss; a reptile displacement and translocation programme during construction, and habitat creation and improvement of the remaining habitat areas for the existing population and displaced individuals would prevent long-term adverse impacts
- A minor local permanent adverse impact on hedge habitats at Riviere Fields would occur owing to habitat loss to built development (the length of new hedges to be planted at this site comprises 85 percent of the total length of hedge loss)

Operational phase

- A negligible to minor adverse impact on petalwort on the Triangular Spit may occur in the mid- to long-term owing to public parking on the east side of the Spit , although this is probably reversible through management of car park use and access controls
- A possibly minor local beneficial long-term impact on dune habitats locally, via dune habitat creation at Hayle Towans and liaison with the Towans Partnership to determine development-led input to access management on wider Towans area
- A minor local permanent adverse impact on the population of ivy broomrape is expected owing to loss of colonies and habitat for this species at North Quay; mitigation through retention of existing ivy habitat may be effective, but the success of transplanting colonies is unproven

- A minor short- to mid-term adverse impact on saltmarsh vegetation at Copperhouse saltmarsh is possible, owing to summer impoundments for sluicing; this is probably reversible given it is intended to monitor the saltmarsh communities at least every two years to detect vegetation changes so allowing adjustments in the sluicing regime / vegetation management as required

12.7.2 Residual impacts relating to aquatic ecology

12.7.2.1 Impact summary tables for aquatic ecology

Proposed activity (Work Item numbers)	**Construction impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
2. New fixed pedestrian bridge at Carnsew second sluice channel.	Depends on timing. If constructed after channel works potential for aquatic contamination. *None or localised, short-term and minor adverse impact on intertidal invertebrates and seaweeds.*	If constructed after channel works, the CEMP will describe measures to prevent spillage of harmful substances. *Either none or localised, temporary negligible impact.*
3. Excavation and renovation of Carnsew second sluice.	Possible spillages of harmful substances into water. Dewatering into the harbour may introduce suspended solids and other contaminants. *Possible moderate adverse temporary impacts on regionally valuable flora and fauna in the harbour near to existing sluice*	CEMP will describe measures to prevent spillage of harmful substances and ensure water quality of the discharge is within prescribed limits. *Either none (if no spillages or incidents of poor water quality) or localised, temporary and negligible.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
4a. Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system.	Direct loss of small area of intertidal and subtidal habitat due to construction; may include stone erosion protection blankets to each side of tunnels. Some new surfaces would be colonised by marine species. *Minor adverse impact (very localised) on regionally valuable flora and fauna in the harbour near to existing sluice; offset by creation of similar habitat at second sluice.*	None proposed. *Minor adverse impact, very localised and offset by creation of similar habitat at second sluice.*
4b. Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system.	Removal of existing seaweeds and invertebrates on some lower parts of tunnel walls using pressure washing or physical removal. *Minor adverse impact on seaweeds and invertebrates on tunnel walls, with full recovery expected within 1-3 years.*	None proposed. *Minor adverse impact, with full recovery expected within 1-3 years.*
4c. Refurbishment of tunnels to Carnsew Pool and installation of sluice gate system.	Isolation of the tunnels from the harbour and Carnsew Pool would result in much lower velocities through this area. The flora and fauna in this area are regionally valuable and require high velocities. *Minor to moderate short-term local adverse impact on regionally valuable flora and fauna in the harbour near to existing sluice, ranging from reduced growth to possible death of some non mobile species.*	It would be possible to relocate some of the boulders from the area near the existing sluice and tunnels to the new second sluice, which would be operational by that time. However, the percentage of affected habitat that could be realistically moved would be minimal. *Minor to moderate short-term adverse impacts, but highly localised and not affecting mobile species such as fish.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
5a. Excavation of harbour at Carnsew Quay/Carnsew Wharf	Impacts depend on timing. If the works are carried out at same time as Carnsew second sluice and channel works a temporary bund could be installed at the north end of Carnsew Wharf. This would reduce the possibility of contaminants entering the harbour area or reaching Carnsew Pool. However, the bund would mean that aquatic intertidal and subtidal habitats south of the bund would become dry (or at best damp) whilst the work is in progress. *Major adverse temporary impacts in the area south of the temporary bund, with most intertidal and subtidal invertebrates and seaweeds expected to die.*	The impacts would be mitigated by scheduling the works to take place during the colder months (eg February to April). The Environment Agency would be asked whether some of the fish present should be netted and relocated to a safe area such as Carnsew Pool or the harbour seaward of the bund. *Moderate localised adverse temporary impact.*
5b. Excavation of harbour at Carnsew Quay/Carnsew Wharf: renovation of existing South Quay harbour walls.	The renovation of old walls or construction of new walls would be carried out in the dry. This could result in minor, localised adverse impacts, but as the surrounding area is currently terrestrial there would be only a small possibility of impacts on existing aquatic ecology. *Negligible adverse localised impact on intertidal invertebrates and seaweeds.*	The CEMP will describe measures to reduce contamination of the water by harmful substances. *Localised negligible impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
5c. Excavation of harbour at Carnsew Quay/Carnsew Wharf: renovation of existing South Quay harbour walls.	The additional harbour walls would provide new intertidal habitat. *Moderate beneficial localised permanent impact.*	None required. *Moderate beneficial, permanent, impact.*
6a. Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN.	Removal of sediments would remove flora and fauna. The area close to Carnsew tunnel is likely to be of moderately high diversity and ecological quality, due to the relatively high current speeds. Full recovery expected to take 3-4 years. *Depends on dredging method and whether site already adversely affected by bund for excavation of harbour at Carnsew Quay/Carnsew Wharf (Work Item 5). At worst a major adverse temporary impact on regionally valuable flora and fauna in the harbour near to existing sluice.*	No mitigation proposed. *Minor to major adverse temporary impact (depending on dredging method).*
6b. Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN.	If wet excavation is used there is likely to be some loss of fine sediments during dredging. These are likely to be contaminated and could affect water quality in the harbour and potentially aquatic biota in Carnsew Pool. *Moderate adverse localised impact on fish, invertebrates and seaweeds in Carnsew Pool.*	The CEMP will describe measures to reduce contamination of the water by harmful substances and monitor water quality for suspended solids and selected contaminants. *Minor adverse localised impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
7. New lifting/swing pedestrian bridge at Penpol Creek.	Piers within Penpol Creek would result in a small loss of aquatic sedimentary habitat (all currently intertidal) and gain of a larger area of hard substrate which would be intertidal and subtidal. *Overall a negligible beneficial permanent impact.*	None required, but the CEMP will describe measures for preventing spillages into Penpol Creek. *Negligible beneficial permanent impact.*
8a. Dredging / excavation at south end of Penpol Creek to a depth of approximately -1.0 m ODN.	The dredging would occur at the same time as the construction of the half tide gate at the entrance to Penpol, and so is unlikely to adversely affect water quality in the harbour or elsewhere. *Negligible impacts on water quality elsewhere, but minor temporary adverse impacts on any water remaining in Penpol.*	None proposed. *Negligible impacts on water quality elsewhere, but minor temporary adverse impacts on any water remaining in Penpol.*
8b. Dredging / excavation at south end of Penpol Creek to a depth of approximately -1.0 m ODN.	Removal of sediments would remove flora and fauna. *Minor adverse short-term impact on benthic invertebrates and seaweeds at harbour end of Penpol. No full recovery to pre-dredging conditions as Penpol Creek would have a half-tide gate that would change tidal conditions.*	None proposed. *Minor adverse short-term impact.*
9a. New Penpol Creek half-tide gate and pedestrian crossing.	Tidal flows would be maintained into Penpol during construction of the half-tide gate. *The impact on aquatic flora and fauna in Penpol would be a minor adverse short-term impact.*	None proposed. *Minor, temporary, short-term adverse impact on fauna in creek.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
9b. New Penpol Creek half-tide gate and pedestrian crossing.	The colonisation of new subtidal habitat would depend on the duration and timing of construction works. *Possible minor temporary adverse impact on aquatic biota of Penpol Creek.*	The construction period would be timed as early as possible in the year, before the main period of invertebrate and fish reproduction. This would allow the aquatic biota of the impounded creek to develop relatively rapidly. *A negligible positive impact.*
9c. New Penpol Creek half-tide gate and pedestrian crossing.	Loss of some intertidal sediment habitat and a very small amount of subtidal sediment habitat due to half-tide gate and placement of stone erosion protection "blankets" each side of the tidal gate. Gain in hard substrate habitat (intertidal and subtidal) on the newly constructed faces. *Negligible positive impact on aquatic biota of Penpol Creek., as the gain in hard substrate habitat will be greater than the loss of sediment habitat.*	None proposed, however the stone "blanket" would have recessed pointing to encourage invertebrates and algae. *Negligible temporary impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
10a. Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN.	Dredging would create sediment plumes with elevated concentrations of suspended solids and associated metals. The modelling shows that in a worse case scenario the finer material may be widely dispersed, including to areas such as lower Lelant Water, Copperhouse Pool and Carnsew. The sediment plume may cause mortality of aquatic flora and fauna, due to smothering, reduced concentrations of dissolved oxygen and possibly higher metals in the water column. *Minor to moderate temporary adverse impact on aquatic biota of lower Lelant Water, Copperhouse Pool and Carnsew.*	The CEMP will describe methods to reduce concentrations of sediment in plumes. The works would be timed to avoid the warmest months (June to September). *Negligible to minor adverse impact.*
10b. Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN.	If dewatering of dredged sediments occurs on-land the metal concentrations and suspended solids in the leachate may have a localised impact on aquatic flora and fauna. *Minor to moderate temporary adverse impact on aquatic biota of the harbour.*	Monitor leachate for metals and suspended solids and amend activities if values approach appropriate Environmental Quality Standards (EQS). *Negligible to minor temporary adverse impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
10c. Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN.	Permanent loss of intertidal (Cockle Bank) habitat and biota. Removal of subtidal biota (eg sand eels) with dredged material. Cockle Bank has a very low ecological value. Subtidal habitat adjacent to Cockle Bank is of high conservation interest for fish such as sand eels. *Intertidal biota – minor permanent adverse impact.* *Subtidal biota (including sandeels) – moderate to major adverse impact, but good recovery likely. Within 1-2 years a deeper water version of the same subtidal sand biotope will be present.*	Timing of the dredging would be scheduled in order to avoid the most sensitive time for sandeels (August to December/January). Cockle Bank is of low ecological value, apart from its role in keeping the harbour sediment-free. This would be achieved in future by sluicing and the sand-trap. *Intertidal – minor permanent adverse impact; subtidal – moderate adverse impact for 1-2 years.*
11a. New floating pontoons for marina.	Construction would involve either steel piles within the marina area, or possibly a bed anchor system. Potential for polluting materials to enter the harbour. *Negligible to minor temporary adverse impacts on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances into the harbour. *Zero to negligible temporary adverse impacts.*
11b. New floating pontoons for marina.	Minor loss of subtidal sediment habitat where steel piles enter the sediment or where bed anchors occur. Moderate gain in vertical subtidal and intertidal habitat on the piles (if used). *Loss of subtidal habitat due to piles is a negligible adverse permanent impact.* *Gain in vertical habitat on piles is a minor beneficial permanent impact.*	None required. *If piles are used there would be a minor beneficial permanent impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
12a. New fishermen's quay.	Water quality during construction of temporary bunds and dewatering of the excavation area. *Minor adverse temporary impacts on aquatic biota of excavation area.*	The CEMP will describe methods to reduce sediment leakage into the harbour. Some monitoring would also be required. *Negligible adverse temporary impacts.*
12b. New fishermen's quay.	Loss of intertidal sediment habitat and gain in hard habitat on sheet pile wall quay and concrete slipway. This area is species-poor due to the mobility of the sands and is of low conservation interest. *Minor adverse permanent impact due to loss of sandy intertidal habitat. Minor beneficial permanent impact due to creation of new intertidal hard habitat.*	None proposed. Adverse and beneficial impacts are approximately balanced. *Sediments - minor adverse permanent impact.* *Hard surfaces - minor beneficial permanent impact.*
13a. Excavation and dredging of i) harbour area to the north-west of fishermen's quay, and ii) sand-trap.	Water quality during dredging may impact on adjacent habitats. *Minor adverse temporary impact on aquatic biota in region of excavation.*	The CEMP will describe methods to reduce plume formation and ensure water quality and sediment concentrations in the harbour are acceptable. Monitoring of water quality during dredging would be carried out. *Negligible temporary impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
13b. Excavation and dredging of i) harbour area to the north-west of fishermen's quay, and ii) sand-trap.	Dredging would result in a loss of biota from dredged area. The biota here are primarily invertebrates adapted to mobile sands. Biomass and diversity are low and recovery is expected to occur within 6-12 months. Possible impact on nearby sandeels. *A minor to moderate adverse medium-term impact on invertebrates and sandeels.*	The works would be scheduled to avoid the main spawning period of sandeels, which are found nearby. *A minor adverse medium-term impact*
13c. Dredging of sand trap.	The dredged sand may be of sufficiently high quality for it to be used in nearby beach nourishment schemes. The biota on nearby sandy beaches are primarily invertebrates that are adapted to mobile sands. Biomass and diversity is low and recovery is expected to occur in 6-12 months. *A minor adverse medium-term impact on invertebrates of sandy beaches.*	None proposed. *Minor adverse medium-term impact.*
14a. New vehicular bridge by Copperhouse Gate.	Very high levels of contaminants occur in Copperhouse Pool sediments and there is a possibility that construction of the bridge piers within Copperhouse Pool would mobilise these contaminants. Water quality in Copperhouse Pool and the harbour could be affected. *A moderate adverse temporary impact on aquatic biota of Copperhouse Pool.*	The CEMP will describe methods to reduce plume formation and ensure water quality and sediment concentrations are acceptable. Monitoring of water quality, especially metals, would be required. *Negligible to minor adverse temporary impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
14b. New vehicular bridge by Copperhouse Gate.	The bridge piers would cause a small loss of intertidal sediment habitat and a larger gain in vertical intertidal habitat on the bridge piers. *Minor adverse permanent impact due to loss of small area of intertidal habitat (and fish habitat towards high water).* *Minor beneficial permanent impact due to uncontaminated hard substrate on piers that may increase the range of species that occur in Copperhouse Pool.*	None proposed. The adverse and beneficial impacts are approximately in balance. *Overall a negligible but permanent impact.*
15a. New pedestrian bridge from East Quay to North Quay.	Construction may introduce contaminants into the harbour area, with consequent impacts on aquatic species. *Minor adverse temporary impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances into the harbour. *Negligible temporary impact.*
15b. New pedestrian bridge from East Quay to North Quay.	Small loss of intertidal/subtidal sediment habitat due to bridge piers to support bridge. Larger gain in intertidal/subtidal hard substrate habitat on the piers. *Loss of sediment habitat is a minor adverse permanent impact. Gain of hard substrate habitat on the piers expected to be a minor beneficial permanent impact.*	None proposed, as the adverse and beneficial impacts are approximately in balance. *Overall a negligible, permanent impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
16. Copperhouse Pool sluice gates works.	Possibility of spillages of harmful substances. Works would either be carried out at low water or in the dry by installing temporary barriers at the gate housing and allowing water in and out of Copperhouse Pool through the by-pass culvert on the east side of the gate. *Negligible temporary adverse impact on aquatic biota of the harbour and Copperhouse Pool.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible temporary adverse impact.*
17a. North Quay wall remedial works. Total length of North Quay = 523m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
17b. North Quay wall remedial works. Total length of North Quay = 523m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing and/or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact.*
18a. North Quay (Eastern) wall remedial works. Total length of North Quay (Eastern) wall = 27m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
18b. North Quay (Eastern) wall remedial works. Total length of North Quay (Eastern) wall = 27m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact.*
19a. South Quay wall remedial works. Total length of South Quay = 626m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
19b. South Quay wall remedial works. Total length of South Quay = 626m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact.*
19c. South Quay wall remedial works. Total length of South Quay = 626m.	Full reconstruction of 220m^2 of wall would create additional intertidal hard substrate habitat for invertebrates and algae. There would be a loss of a slightly larger area of sloping intertidal boulder habitat. *Negligible, localised permanent adverse impact on aquatic biota of the harbour.*	None required. *Negligible, localised and permanent impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
20a. East Quay wall remedial works. Total length of East Quay wall = 330m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
20b. East Quay wall remedial works. Total length of East Quay wall = 330m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact.*
20c. East Quay wall remedial works. Total length of East Quay wall = 330m.	Full reconstruction of 155m^2 of wall would create additional intertidal hard substrate habitat for invertebrates and algae. There will be a loss of a slightly larger area of sloping intertidal boulder habitat. *Negligible, localised permanent adverse impact on aquatic biota of the harbour.*	None required. *Negligible, localised and permanent impact.*
21a. Carnsew Wharf wall remedial works. Total length of Carnsew Wharf wall = 160m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*

Proposed activity (Work Item numbers)	Construction impacts on aquatic ecology	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
21b. Carnsew Wharf wall remedial works. Total length of Carnsew Wharf wall = 160m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact.*
22a. Carnsew Quay wall remedial works. Total length of Carnsew Quay wall = 16.5m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
22b. Carnsew Quay wall remedial works. Total length of Carnsew Quay wall = 16.5m.	Removal of existing seaweeds and invertebrates on some lower parts of wall using pressure washing or physical removal. *Minor, localised medium-term adverse impact on aquatic biota of the harbour, with full recovery within 1-3 yrs.*	None proposed, but recessed joints would encourage recolonisation. *Minor, localised medium-term impact*
23a. Slipway and associated land works.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. *Minor, localised and temporary adverse impact on aquatic biota of the harbour.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
23b. Slipway and associated land works.	Loss of intertidal sediment habitat and gain of intertidal hard substrate habitat. *Minor, localised, permanent adverse impact on aquatic biota of the harbour.*	None proposed. *Minor, localised, permanent adverse impact.*

Table 12– 11: Summary of construction impacts for aquatic ecology

Proposed activity (Work Item numbers)	**Operational impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
1. Sluicing using Carnsew Pool.	Effective loss of 23% intertidal habitat and effective gain of equivalent subtidal habitat during sluicing (5 days of sluicing followed by 9 days of no sluicing). *Uncertain severity of adverse impacts on invertebrates and algae in Carnsew Pool, ranging from moderate to major adverse impacts. Minor beneficial impacts on fish in Carnsew Pool, due to effective increase in the subtidal area.*	The main mitigation is to only sluice on high tides during the period 15 April to 30 August (less than 10% of the year). This would reduce impacts on over-wintering birds and those invertebrates that breed early in the year. In addition, the increase in the predicted tidal heights due to filling Carnsew through two sluices is seen as an adverse impact, so only one sluice will be used to fill Carnsew, but both sluices used to empty it. Monitoring of invertebrate densities would be used to determine the actual impacts of the sluicing regime. *Minor to moderate adverse impact on invertebrates and algae. Negligible to minor beneficial impacts on fish during the period 15 April to 30 August, due to effective increase in the subtidal area. Impacts reversible as sluicing regime can be amended in the light of monitoring.*
3. Carnsew second sluice.	Additional intertidal and subtidal habitat with high current speeds created either side of sluice, adjacent to existing SSSI. *Minor beneficial permanent impact on invertebrates and algae; minor adverse impact on some fish.*	None required. *Minor beneficial permanent impact on invertebrates and algae; minor adverse impact on some fish .*

Proposed activity (Work Item numbers)	**Operational impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
5. New habitat in harbour at Carnsew Quay/ Wharf.	Additional subtidal hard substrate habitat created, close to Carnsew SSSI. Potentially good fish habitat. *Moderate beneficial permanent impact.*	None required. *Moderate beneficial permanent impact*
6. Dredged basin adjacent to Carnsew Wharf	Maintenance dredging may be required. The frequency and amounts are not known at present. *Impacts on biota in harbour range from negligible to moderate adverse short-term impacts.*	Monitoring of dredge plume and only dredging when necessary. *Impacts would range from negligible to moderate adverse short-term impacts.*
8. Dredged area at south end of Penpol Creek.	This dredged area would provide additional subtidal habitat for fish. Due to the freshwater input salinities would be lower than in Carnsew or most of Copperhouse Pool and this may favour fish normally found in the lower reaches of estuaries. *Minor beneficial permanent impacts on subtidal invertebrates, algae and fish at south end of Penpol.*	None required. *This beneficial impact on subtidal biota is balanced by a negative impact on intertidal biota at the same location during the construction phase.*
9a. Half-tide gate at entrance to Penpol Creek.	Loss of approximately half the existing intertidal habitat and gain of an equivalent area of subtidal habitat. *Minor adverse permanent impact on aquatic biota at entrance to Penpol.*	None proposed. *Minor adverse permanent impact.*

Proposed activity (Work Item numbers)	**Operational impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
9b. Half-tide gate at entrance to Penpol Creek	Possibility of algal blooms, including toxic algal blooms, during periods of neap tides with poor flushing. Further information on algal blooms is contained in Annex 12U. *Impacts uncertain at present, ranging from negligible (if no blooms occur) to major adverse short-term impact on aquatic biota of harbour (and possibly Copperhouse, Carnsew and Lelant Water) if there is a toxic bloom.*	Further surveys (water quality, phytoplankton etc) are needed prior to finalising management proposals for the half-tide gate. These may show that extra flushing is required during neap tides. *Impacts uncertain at present, ranging from negligible (if no blooms occur) to major adverse short-term impact.*
10. Maintenance dredging of marina area.	Buro Happold have estimated that maintenance dredging of the area around the marina is likely to be required approximately every 5 -10 years. This would mean that relatively mature benthic communities will develop in the dredged area, before they are removed. *Negligible adverse short-term impact on benthic fauna of marina area in the harbour.*	None required *Negligible adverse short-term impact.*
11. Operation of marina.	Potential for increased pollution incidents due to larger number of craft. Increase in antifoulants in water and sediments. *An oil spill could occur, with potential to impact the viviers (crustacean storage area in the harbour) and possibly transport into Copperhouse Pool and/or Carnsew Pool on the flood tide. Moderate, short-term adverse impact.*	Harbour Management Plan to provide detailed Emergency Response to oil spills and other events affecting water quality in the harbour. Flood tides that could carry contaminants into Copperhouse Pool or Carnsew would be prevented using the sluice gates. *Monitor anti-foulants in water and sediments occasionally. Minor short-term adverse impact.*

Proposed activity (Work Item numbers)	**Operational impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
12. Operation of fishermen's quay and slipway.	Reduction in likelihood of fuel spills due to improved facilities *Minor beneficial impact on aquatic biota of the harbour.*	None required. *Minor beneficial impact.*
13. Maintenance dredging of sand-trap.	The mitigation measures to reduce the ecological impacts of sluicing from Carnsew and Copperhouse Pools would result in more frequent dredging of the sand-trap, ie dredging would probably occur annually. The invertebrates and fish present would not reach equilibrium levels of biomass or diversity in the one-year period between dredging events. *Moderate adverse short-term impact on aquatic fauna of sand trap area.*	Dredge only when necessary. Avoid August to January if possible (timing to be agreed with the Environment Agency re- sandeels). *Minor to moderate adverse short-term impact.*
13. Maintenance dredging of harbour area to north-west of fishermens' quay	Uncertainty exists regarding amounts that may need to be dredged and frequency. *Impacts on aquatic fauna of downstream area of the harbour would range from minor to moderate adverse short-term impacts.*	Mitigation as for the sand-trap, above. *Impacts are likely to be negligible to moderate adverse short-term impacts.*

Proposed activity (Work Item numbers)	**Operational impacts on aquatic ecology**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
16. Sluicing using Copperhouse Pool.	Effective loss of 26% intertidal habitat and effective gain of equivalent subtidal habitat during sluicing (5 days of sluicing followed by 9 days of no sluicing). *Uncertain severity of adverse impacts on invertebrates and algae of Copperhouse Pool, ranging from moderate to major adverse impacts. Minor beneficial impacts on fish in Copperhouse Pool, due to effective increase in the subtidal area during sluicing periods.*	The mitigation is to only sluice during the period 15 April to 30 August. This would reduce impacts on over-wintering birds and those invertebrates that breed early in the year. Monitoring of invertebrate densities would be used to determine the actual impacts of the sluicing regime. *Minor to moderate adverse impact on invertebrates and algae. Negligible to minor beneficial impacts on fish during the period 15 April to 30 August, due to effective increase in the subtidal area. Impacts reversible as sluicing regime can be amended in the light of monitoring.*

Table 12– 12: Summary of operational impacts for aquatic ecology

12.7.2.2 Summary of residual impacts on aquatic ecology

The most important residual adverse impacts are:

Construction Phase

- Penpol half-tide gate (Work Item 9) – moderate adverse impact, with full recovery taking 2-3 years
- Removal of Cockle Bank and dredging adjacent areas (Work Item 10) - moderate adverse impact to subtidal habitats for 2-3 years
- Excavation of harbour at Carnsew Quay/Carnsew Wharf (Work Item 5) - moderate adverse impact, with full recovery expected to take 2-3 years
- Dredging of basin adjacent to Carnsew Wharf tunnel intake (Work Item 6) - minor to major adverse impact, with recovery taking 3-4 years

- Refurbishment of tunnels to Carnsew Pool and installing sluice (Work Item 4) - minor to moderate adverse impact on sessile species (ie those attached to rocks or other substrate); full recovery expected in 2-3 years

Operational Phase

- Possibility of algal blooms in Penpol (Work Item 9) - minor to major adverse temporary impact; if monitoring in Penpol indicates a significant algal bloom is likely to occur, the proposed management of water exchange into Penpol Creek could be amended
- Changed tidal regime in Carnsew Pool, April to August (Work Items 1, 3 and 4) – minor to moderate adverse impact on invertebrates and algae; impacts reversible as the sluicing regime can be amended
- Changed tidal regime in Copperhouse Pool, April to August (Work Item 16) – minor to moderate adverse impact on invertebrates and algae; impacts reversible as the sluicing regime can be amended
- Maintenance dredging of sand-trap (Work Item 13) – minor to moderate adverse impact, depending upon the timing of the dredging
- Dredging harbour area to the north-west of fishermen's quay (Work Item 13), maintenance dredging may be required (the frequency and amounts are not known at present) – impacts range from negligible to moderate adverse short-term impacts; full recovery expected 2-3 years after dredging

12.7.3 Residual impacts relating to ornithology

12.7.3.1 Impact summary tables

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
1. Build new Carnsew second sluice.	Disturbance to waterfowl (particularly little grebe) using adjacent intertidal rocks and eastern end of Carnsew Pool during construction. *Minor adverse, temporary and localised impact on waterfowl.*	The CEMP will describe measures in detail. Work undertaken outside the winter period would reduce impacts. *Negligible, adverse, temporary and localised.*
2. New fixed pedestrian bridge (and access road) at Carnsew second	Occasional disturbance to waterfowl (particularly little grebe) on Carnsew during construction. *Minor adverse, temporary site-*	Footbridge and road location shifted away from Carnsew during initial design stage to reduce impacts. Potential to undertake work during the late winter and spring period when

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
sluice channel	*specific impact.*	waterfowl usage is lower. *Impact likely to be negligible to minor, temporary and localised.*
3. Excavation & renovation of Carnsew second sluice.	Noise and activity may lead to disturbance to waterfowl, particularly on Carnsew Pool. *Possible minor adverse temporary impacts.*	Additional mitigation in terms of activity timing (outside the winter) and screening would reduce scale of impact. *Either negligible to localised, temporary and negligible. Impacts temporary.*
5a. Excavation of harbour at Carnsew Quay/Carnsew Wharf.	Impacts depend on timing. If the works are carried out at same time as Carnsew second sluice and channel works, a temporary bund could be installed at the north end of Carnsew Wharf. This would reduce the possibility of contaminants entering the harbour area or reaching Carnsew Pool. However, the bund means that aquatic intertidal and subtidal habitats south of the bund would become dry (or at best damp) whilst the work is in progress. *Minor adverse medium-term impact in the area south of the temporary bund, with a likely exclusion of waterfowl from the area and a die-off of invertebrate fauna reducing waterfowl feeding potential.l*	Timing and screening addressed in CEMP. Impact likely to be greater to aquatic ecology than to avifauna, as the area is not particularly important for waterfowl. *Minor adverse short to medium term impact in the area south of the temporary bund, with a likely exclusion of waterfowl from the area. Recovery to some extent within 3 years following completion of works.*
5b. Excavation of harbour at Carnsew Quay/Carnsew	The renovation of old walls or construction of new walls would be carried out in the dry. This could	The CEMP will describe measures to reduce direct impacts from disturbance, particularly on the relatively important Carnsew Pool, as

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
Wharf: renovation of existing South Quay harbour walls.	result in minor, localised adverse impacts to waterfowl in the area, but as the Carnsew Wharf area is relatively unimportant for waterfowl within the context of the Hayle, adverse impacts would be of limited severity. *Negligible to minor adverse localised temporary impact to site specific impact on waterfowl.*	well as indirect effects such as contamination of the water (and by association, invertebrates) by harmful substances. *Negligible localised temporary impact.*
5c. Excavation of harbour at Carnsew Quay/Carnsew Wharf: renovation of existing South Quay harbour walls.	The additional harbour walls would provide new intertidal habitat. In general however, these would not be used by many waterfowl species apart from specialist – eg potentially turnstone. *Negligible to minor beneficial localised impact on waterfowl.*	None required. *Negligible to minor beneficial permanent impact with new habitat for niche species of waterfowl. Turnstone may use as feeding resource depending on substratum / construction type.*
Access road and parking provision on Triangular Spit – to take place in Phase 4 of the construction programme.	Construction of access road and car parking on the Triangular Spit would have a disturbance impact on birds' usage of Carnsew Pool – eg little grebe. *Minor adverse localised temporary impact on waterfowl.*	Location of access road and some of the parking space provision shifted away from Carnsew edge during initial project design stage. Advance (pre-construction) planting of screening between parking and roadway and Carnsew Pool. Timing of works outside the main period of waterfowl usage on Carnsew. *Negligible adverse site-specific temporary impact.*
6a. Dredging of basin adjacent to Carnsew Wharf to a depth of	Removal of sediments would remove flora and fauna (likely to be of moderately high ecological quality). *Depends on dredging method and*	No mitigation proposed. *Negligible to minor adverse short-term impact.*

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
approximately -1.0 m ODN.	*whether site already adversely affected by bund for excavation of harbour at Carnsew Quay/Carnsew Wharf. Although a potential loss of habitat/food, area not particularly important as a wader feeding resource. Negligible to minor adverse short-term impact on waders.*	
6b. Dredging of basin adjacent to Carnsew Wharf to a depth of approximately -1.0 m ODN.	Release of fine sediments during dredging. These are likely to be contaminated and could affect water quality in the harbour and potentially Carnsew Pool. Potential impact to invertebrates and associated waterfowl predators. *Negligible to minor adverse localised impact.*	CEMP will describe measures to reduce contamination of the water by harmful substances and monitor water quality for suspended solids and selected contaminants. *None if contained, negligible to minor adverse localised impacts if release of contaminants occurs.*
7. New lifting/swing pedestrian bridge at Penpol Creek.	Piers within Penpol Creek would result in a small loss of aquatic sedimentary habitat (all currently intertidal) and gain of a larger area of hard substrate which would be intertidal and subtidal. *Overall a negligible adverse and beneficial permanent impacts on waterfowl and waders.*	None required. The CEMP will describe measures for preventing spillages into Penpol Creek. *Negligible adverse and beneficial permanent impact. Loss of intertidal soft sediment habitat used by a very small number of feeding waders. Gain of intertidal and subtidal hard substratum with new invertebrate assemblage. Potentially then used by fish and their predators leading to a very small gain in potential feeding for little grebe and little egret.*

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
8a. Dredging / excavation at south end of Penpol Creek to a depth of approximately -1.0 m ODN.	The dredging would probably occur at the same time as the construction of the half tide gate at the entrance to Penpol. *Temporary local impacts to waterfowl usage in Penpol (local exclusion).*	Avoid working during winter months. *Minor to moderate adverse temporary impacts on ecology of Penpol. Reduction in numbers of waterfowl excluded if carried out in summer – negligible to minor adverse temporary impact.*
8b. Dredging / excavation at south end of Penpol Creek to a depth of approximately -1.0 m ODN.	Removal of sediments would remove flora and fauna. The area to be dredged is of low conservation interest and not heavily used by waterfowl due to disturbance. *There will be some temporary waterfowl exclusion and local loss of prey, although area is of no particular importance for the waterfowl assemblage.*	None proposed. *Timing may reduce disturbance – negligible, local, temporary adverse impact.*
9a. New Penpol Creek half-tide gate and pedestrian crossing.	Loss of some intertidal sediment habitat and a very small amount of subtidal sediment habitat due to half-tide gate and placement of stone erosion protection "blankets" each side of the tidal gate. *Potential loss of wader foraging habitat and gain in subtidal habitat, eg for little grebe and little egret.*	None proposed. *Negligible local permanent adverse and beneficial impacts on aquatic birds through change in substratum and intertidal vs. subtidal habitat composition.*
10a. Excavation and dredging of Cockle Bank and surrounding area to	Dredging is likely to create sediment plumes with elevated concentrations of suspended solids and metals, which may cause mortality of flora	The CEMP will describe methods to reduce concentrations of sediment in plumes. *Negligible temporary adverse impact.*

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
provide Fishermen's Harbour and marina basin, to a depth of approximately -1.0 m ODN.	and fauna. Loss of invertebrates may affect usage by waterfowl; disturbance would exclude feeding and roosting activity in the area. However, area is not of high value to birds. *Negligible to minor to temporary adverse impact on waterfowl.*	
10b. Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN.	If dewatering of dredged sediments occurs on-land the metal concentrations and suspended solids in the leachate may have a localised impact on flora and fauna. This may affect waterfowl through uptake via prey. *Minor temporary adverse impact on waterfowl.*	Monitor leachate for metals and suspended solids and amend activities if values approach appropriate Environmental Quality Standards (EQS). *Negligible temporary adverse impact.*
10c. Excavation and dredging of Cockle Bank and surrounding area to provide fishermen's harbour and marina basin, to a depth of approximately -1.0 m ODN.	Permanent loss of intertidal (Cockle Bank) habitat and biota. Removal of subtidal biota (eg sand eels) with dredged material. Cockle Bank has a very low ecological value; it is of low value for feeding waterfowl, although occasionally used as a roost (eg. cormorants). Subtidal habitat adjacent to Cockle Bank is of high conservation interest for fish such as sand eels. *Intertidal – minor permanent adverse impact, with area used by occasional waterfowl and little egret for feeding*	No mitigation is proposed. *Intertidal – minor permanent adverse impact.* *Subtidal – minor adverse impact for 1-2 years.*

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
	and roosting. *Subtidal – minor adverse impact, through loss of occasional feeding resource for small number of species including little grebe and little egret. Within 1-2 years a deeper water version of the same subtidal sand biotope will be present.*	
11a. New floating pontoons for marina.	Construction would involve either steel piles within the marina area, or possibly a bed anchor system. Potential for polluting materials to enter the harbour. *Negligible to minor temporary adverse impacts to waterfowl from disturbance.*	The CEMP will describe measures to prevent spillage of any harmful substances into the aquatic environment as well as methods to reduce disturbance impacts to waterfowl. Summer timing would reduce impact, although main species present for most of year in area *Negligible temporary adverse impacts.*
11b. New floating pontoons for marina.	Minor loss of subtidal sediment habitat where steel piles enter the sediment or where bed anchors occur. Minor gain in vertical subtidal and intertidal habitat on the piles (if used). Minor loss in water surface. *Net loss of subtidal water surface may restrict feeding by species such as little grebe, although area not of key importance for the species.*	None required. *Net minor, local, permanent impact.*
13a. Excavation and dredging of harbour area to the north-west of fishermen's	Water quality during dredging may impact on adjacent habitats. Limited disturbance to waterfowl in area, primarily occasional little grebe using	The CEMP will describe methods to reduce minimise water quality impacts and disturbance to waterfowl. Some monitoring may be required.

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
quay.	area. *Minor adverse temporary impact on waterfowl.*	*Negligible temporary impact.*
13b. Excavation and dredging of harbour area to the north-west of fishermen's quay.	Dredging would result in a loss of biota from dredged area. The biota here are primarily invertebrates adapted to mobile sands. Biomass and diversity are low and recovery is expected to occur within 6-12 months. Associated impacts to prey availability for little grebe etc. *Area is not particularly important for the species so a negligible adverse medium-term impact on little grebe.*	None proposed. *A negligible adverse medium-term impact on little grebe.*
13c. Dredging of sand trap.	Dredging would remove the existing biota (eg invertebrates and sandeels) and affect those species that feed in this area. This may have an impact on waterfowl and wider seabird usage through a direct and indirect reduction in prey items although probably not measurable at a Hayle 'system-scale'. *Negligible to minor adverse short/medium term impact on birds that feed on invertebrates and sandeels, and on birds that feed on fish which predate these fauna.*	Timing of dredging amended to avoid the breeding and spawning period for sandeels. *Negligible adverse short-term impact on birds.*
14a. New vehicular bridge by	Very high levels of contaminants occur in Copperhouse Pool	The CEMP will describe methods to reduce plume formation and ensure water quality and

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
Copperhouse Gate.	sediments and there is a possibility that construction of the bridge piers within the Pool would mobilise these contaminants. This may affect waterfowl either directly through contamination or indirectly through loss of prey items. Some disturbance to waterfowl during construction. *Disturbance could affect usage in one of the more important area of the estuary (in terms of waterfowl), and in particular shelduck and redshank usage. This could be a moderate, site specific, temporary impact in the worst case.*	sediment concentrations are acceptable. Methods to reduce disturbance will be addressed by the CEMP, including types of activity, screening and timing (eg work can be timed to commence during the spring when waterfowl activity is lower in the area). *Minor, site specific temporary impact to waterfowl feeding and loafing in the area, depending on technique and mitigation.*
14b. New vehicular bridge by Copperhouse Gate.	The bridge piers would cause a small loss of intertidal sediment habitat and a larger gain in vertical intertidal habitat on the bridge piers. This would have a limited impact on prey availability for birds. *Minor adverse permanent impact due to loss of small area of bird feeding habitat (and fish habitat towards high water). Minor beneficial permanent impact to bird feeding habitat due to uncontaminated hard substrate on piers.*	None proposed. The adverse and beneficial impacts are approximately in balance. *Overall possibly a negligible, permanent, adverse impact.*
15a. New	Construction may introduce	The CEMP will describe measures to prevent

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
pedestrian bridge from East Quay to North Quay.	contaminants into the harbour area, with consequent impacts on aquatic species and by association, waterfowl. *Minor to major site specific short-term adverse impact on waterfowl.*	spillage of any harmful substances into the harbour. *Minor adverse site specific short-term impact.*
15b. New pedestrian bridge from East Quay to North Quay.	Small loss of intertidal/subtidal sediment habitat due to bridge piers to support bridge. Larger gain in intertidal/subtidal hard substrate habitat on the piers. *Loss of sediment habitat would be a minor adverse permanent impact for waterfowl. Gain of hard substrate habitat on the piers - a negligible beneficial permanent impact.*	None proposed, as the adverse and beneficial impacts are very slight and almost in balance. *Overall a negligible, permanent, adverse impact.*
16. Copperhouse Pool sluice gates works.	Possibility of spillages of harmful substances. Disturbance to waterfowl in proximity to activity. *Negligible water quality impact as works would either be carried out at low water or in the dry by installing temporary barrier. Minor site specific temporary disturbance to feeding and roosting waterfowl.*	Timed to be undertaken outside the key sensitivity period for waterfowl. The CEMP will describe measures to prevent spillage of any harmful substances and reduce disturbance to waterfowl *Negligible local temporary impact to waterfowl activity.*
17. North Quay wall remedial works; 18. North Quay (Eastern) wall remedial works;	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. Disturbance to local waterfowl. *Negligible, localised and temporary*	The CEMP will describe measures to prevent spillage of any harmful substances and reduce disturbance to waterfowl (eg. seasonal timing of works in closest proximity to Pool)

Proposed activity (Work Item numbers)	**Construction impacts on aquatic birds**	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** (CEMP to describe measures) ***Significance of residual impact***
19a. South Quay wall remedial works; 20a. East Quay wall remedial works.	*adverse impact to prey availability. Very limited disturbance due to low importance to waterfowl*	*None to negligible, localised and temporary impact.*
19b. South Quay wall remedial works. 20b. East Quay wall remedial works.	Full reconstruction of 375m^2 of wall would create additional intertidal hard substrate habitat for invertebrates and algae. There would be a loss of a slightly larger area of sloping intertidal boulder habitat. Some loss of feeding habitat for waterfowl, in particular turnstone and redshank. *Minor, localised permanent adverse impact on waterfowl feeding area.*	None required. *Minor, localised, permanent impact*
21. Carnsew Wharf wall remedial works. Total length of Carnsew Wharf wall = 160m.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. Limited disturbance to local waterfowl. *Minor, localised and temporary adverse impact on waterfowl.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*
22. Carnsew Quay wall remedial works; 23. Slipway and associated land works.	Possible contamination due to spillages of lime-based mortars, hydraulic cements or other materials. Limited disturbance to local waterfowl. *Minor, localised and temporary adverse impact.*	The CEMP will describe measures to prevent spillage of any harmful substances. *Negligible, localised and temporary impact.*

Table 12– 13: Summary of construction impacts for ornithology

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
i. Sluicing using Carnsew Pool.	Effective loss of c. 25% intertidal habitat and effective gain of equivalent subtidal habitat. Carnsew Pool is important site for little grebe (subtidal) and increasingly at the western end for waders (feeding and roosting on the intertidal). The sluicing would lead to a functional loss of wader habitat, whilst providing additional subtidal habitat. Given the bathymetry and substratum of the area of loss, it is expected that the functional intertidal loss would be greater than the functional subtidal gain for waterfowl. *Impacts to invertebrates and algae may range from a minor to major adverse impact with a minor to moderate beneficial impacts on fish, due to effective increase in the subtidal area. The changes in invertebrate assemblage composition would to some extent impact on avifaunal usage, but would be negligible to minor assuming site not at carrying capacity. However, the change to functional usage through a retarded sluicing would have a minor to major adverse impact. Impacts would be at least at a site specific level and may be at an estuary-wide level for some species. While impacts*	Sluicing only over spring tide periods between mid April and the end of August outwith the main period of waterfowl sensitivity. Monitoring of invertebrate (and bird) densities would be used to determine the actual impacts of the sluicing regime and the potential for further modification therefore exists if deleterious impacts are still identified. *Small beneficial impact for little grebe (increases in fish utilisation & subtidal area). Adverse impacts to waterfowl using intertidal area – effectively a c. 25% loss of habitat during impoundment would affect feeding and roosting activity. However, habitat loss would predominantly only occur on impoundment days (less than 10% of year) outside the main period of bird presence. Impacts would be at least local, and would probably be at a site specific level; impacts should be reversible with a return to current state if necessary by amending the sluicing regime.*

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
	would occur throughout the lifespan of the development (permanent) they should be reversible.	
ii. Carnsew second sluice.	Additional intertidal and subtidal habitat created adjacent to existing SSSI. *Moderate beneficial permanent impact for invertebrates & fish, with possible (negligible) local increase in carrying capacity for little grebe.*	None required. *Moderate beneficial permanent impact for invertebrates & fish, with possible (negligible) local increase in carrying capacity for little grebe.*
iii. Road access over Carnsew second sluice channel, onto causeway	Disturbance to waterfowl using adjacent intertidal rocks and eastern end of Carnsew Pool. *Negligible to minor adverse, permanent and site specific impact.*	Location shifted away from Carnsew during initial design stage to reduce impacts; road c. 25m from Carnsew Pool. Movement along roadbed would be partially screened from Carnsew Pool by screen-planting on the pool shore. *Negligible, adverse and localised impact*
iv. Access road and parking provision on Triangular Spit	Access road and car parking on the Triangular Spit would have a disturbance impact to usage on Carnsew Pool – eg little grebe. *Negligible to minor, adverse, localised to site specific impact.*	Location of access road and some of the parking space provision shifted away from Carnsew edge during initial project design stage. Vegetative screening between parking and roadway and Carnsew Pool. Planting design to discourage pedestrian access around Carnsew Pool. *Negligible to minor adverse localised impact. Possibly site specific depending on efficacy of visitor management around Carnsew.*
v. New habitat in harbour at	Additional subtidal hard substrate habitat created, close to Carnsew SSSI. Potentially	None required. *Negligible local beneficial permanent*

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
Carnsew Quay/Carnsew Wharf.	good fish habitat which may be used by little egret and little grebe. *Negligible local beneficial permanent impact for feeding by several bird species.*	*impact for feeding by several bird species.*
vi. Half-tide gate at entrance to Penpol Creek.	Loss of approximately half the existing intertidal habitat and gain of an equivalent area of subtidal habitat. Habitat loss for intertidal feeding species and gain for subtidal species. *The creek is not of high value for waterfowl using the intertidal (small numbers of waders use it on occasion). Similarly of low vale for little grebe etc (subtidal), so functional changes would be negligible, local and may balance out.*	None required *Changes in intertidal:subtidal habitat ratio, but as the area is not of high value for waterfowl, then impacts (beneficial and adverse) would be negligible, local and permanent. Overall, the impact on the functional value of the habitat to birds is regarded as neutral.*
vii. Maintenance dredging of marina area.	It is possible that the newly created subtidal habitat in the harbour (ie beneath the existing Cockle Bank) would be suitable for sandeels, which are a prey species for several aquatic birds. The ecological value of this new subtidal habitat would be reduced by dredging (every 5-10 years). *Benefits in terms of prey provision for waterfowl would be minor and medium-term.*	Dredge only when necessary and time activity to minimise disturbance and maximise invertebrate recruitment. *Benefits in terms of prey provision for waterfowl likely to be minor and possibly long-term.*
viii. Operation of marina.	Potential for increased pollution incidents due to larger number of craft. Increase in anti-foulants in water. Effects on invertebrates leading to changes in food	Harbour Management Plan to provide detailed emergency response to oil spills and other events affecting water quality in the harbour. Flood tides that could carry

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
	supply for waterfowl, and directly through hydrocarbon spillages. Potential for watercraft access into Lelant Water, with associated disturbance impacts to waterfowl. *Area not particularly important for waterfowl so in general effects would be of a negligible, local permanent nature.* *However, if oil spill were to move into adjacent components of system (eg Copperhouse), then of potentially major scale (depending on seasonal timing), site specific and long-term duration.* *Possible moderate, short-term localised disturbance if craft enter Lelant Water during autumn-winter.*	contaminants into Copperhouse Pool or Carnsew would be prevented by using the sluice gates. Access restrictions and educational material would prevent entry of small craft into Lelant; additional measures may be implemented within harbour management operations *Low level, negligible local permanent impacts from disturbance / functional habitat loss. Possible minor, local medium- / long-term adverse impact from spills.* *Negligible risk of disturbance to birds on Lelant Water.*
ix. Operation of fishermen's quay and slipway.	Reduction in likelihood of fuel spills due to improved facilities *Minor local beneficial impact.*	None required. *Minor local beneficial impact.*
x. Dredging of harbour area to the north-west of Fishermen's Quay.	Maintenance dredging (frequency uncertain), would lead to changes to food supply (direct and smothering or adjacent areas) as well as disturbance to waterfowl. *If maintenance dredging required, then local negligible adverse permanent impact to the limited avifauna of the area*	Timing of dredging to maximise recruitment and minimise disturbance. *Zero to negligible local permanent adverse impact.*
xi. Operation of vehicular bridge	Functional (indirect) habitat loss via disturbance to waterfowl from pedestrian	It may be possible to incorporate screening on the pool-side bridge

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
by Copperhouse Gate.	use of the bridge. *Existing bridge operation, so some habituation, but increased pedestrian traffic and change in alignment would increase disturbance and lead to an indirect loss of intertidal and subtidal habitat (c 5000m^2 in total), c.3% of habitat in the Pool. Impact to waterfowl likely to be minor to moderate, site specific and permanent.*	parapet, to reduce visibility of pedestrians to waterfowl on lower reaches of Copperhouse Pool; however, this mitigation option needs to be assessed for compatibility with visual and heritage issues. *Depending on the acceptability of screening, impact to waterfowl likely to be negligible to moderate, local to site specific and permanent (eg a screened parapet to 1.5m height could reduce functional habitat loss to c.2500m^2 (1.5% of pool habitat, ie reduction in 'footprint' of disturbance by c. 50%).*
xii. Sluicing using Copperhouse Pool.	Effective loss of c. 25% intertidal habitat and effective gain of equivalent subtidal habitat. Copperhouse is important site for little grebe (subtidal) and for shelduck and some waders (feeding and roosting on the intertidal area). The sluicing would lead to a functional loss of wader habitat, whilst providing additional subtidal habitat. Given the bathymetry and substratum of the area of loss, it is expected that the functional intertidal loss would be greater than the functional subtidal gain for waterfowl. *Impacts to invertebrates and algae may range from a minor to major adverse impact*	Sluicing only over spring tide periods between mid April and the end of August outwith the main period of waterfowl sensitivity. Monitoring of invertebrate (and bird) densities would be used to determine the actual impacts of the sluicing regime and the potential for further modification therefore exists if deleterious impacts still identified. *Small beneficial impact for little grebe (increases in fish utilisation and subtidal area). Adverse impacts to waterfowl using intertidal area –effectively a c. 25% loss of habitat during impoundment would affect*

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
	with a minor to moderate beneficial impacts on fish, due to effective increase in the subtidal area. The changes in invertebrate assemblage composition would to some extent impact on bird usage; assuming site not at carrying capacity, impacts on birds probably negligible to minor. However the change to functional usage through a retarded sluicing regime would have a minor to major adverse impact. Impacts would be at least at a site specific level and may be at a system-wide level for some species. However, although they would occur throughout the lifespan of the development (permanent) they should be reversible.	*feeding and roosting activity. However, habitat loss would predominantly only occur on impoundment days (less than 10% of year) outside the main period of bird presence. Impacts would be at least local, and would probably be at a site specific level; they should be reversible with a return to current state if necessary by amending the sluicing regime.*
xiii. Sluicing from Copperhouse Pool and Carnsew Pool	Probable reduction of ingress of sand into Lelant Water owing to sluicing; sand ingress into Lelant is probably reducing the suitability of lower parts of the mudflat for wader prey and wading birds, so any measures that reduce sand ingress are likely to be better than the status quo. *Possible beneficial long-term impact to waterfowl, but extent of any beneficial effects to wader carrying capacity in the area cannot be identified in detail at present, since quantification of sluicing*	None required.

Proposed activity (sequential numbering)	Operational impacts on aquatic birds	
	Description of unmitigated impact ***Significance of impact***	**Mitigation** ***Significance of residual impact***
	effect unavailable.	
xv. Maintenance dredging of sand trap.	Annual maintenance dredging would prevent invertebrates and fish reaching equilibrium levels of biomass of diversity. This would have a small-scale effect on waterfowl foraging activity in the area (the area has limited importance for birds). *Negligible local permanent adverse impact.*	Dredge only when necessary. Avoid August to January if possible to maximise invertebrate recruitment and avoid sandeel spawning and egg development period. *Zero to negligible local adverse impact.*

Table 12– 14 : Summary of operational impacts for ornithology

12.7.3.2 Summary of residual impacts on ornithology

Construction phase

Zones of impact adjacent to the areas of work would remain around the eastern end of Carnsew Pool and the western end of Copperhouse Pool, although the extent of impact would have been reduced by screening, and the severity of impact by timing of works outside the key period of bird presence. In general, residual impacts would be reduced substantially, assuming the CEMP is implemented fully.

The monitoring programme (see section 12.8.3) would assess the efficacy of the mitigation measures as well as the scale of and severity of any residual impacts and the findings from this will feed into the CEMP, with modification to working regimes, timings etc applied in response.

Operational phase

The ecological impacts of the new tidal regime in Carnsew Pool and Copperhouse Pool would be significantly reduced by sluicing only during 15 April to 30 August. There would be no direct impacts in the cooler winter months (September to mid April) as there would be no sluicing during that period. In the summer months the sluicing (ie retention of high water spring tides for three hours) would only occur for periods of approximately five days, followed by an interval of nine days with no sluicing. As such, impacts are expected to be negligible to minor, but would require monitoring. The results of the monitoring would then feed back into the management of harbour operations, with the sluicing regime further modified as necessary.

Disturbance impacts would occur around Carnsew Pool from visitor access along the northern bank, although screen planting and visitor management would reduce this. Similarly, the bridge over the western end of Copperhouse Pool would have an impact in terms of indirect habitat loss through over-sailing and some disturbance from pedestrian traffic, although screening along the walkway, if compatible with visual and heritage interests, could reduce this. There remains some limited potential for increased watercraft access into Lelant Water, with associated disturbance impacts to waterfowl if this occured in autumn-winter. Access restrictions and educational material would reduce this; additional measures could be implemented within harbour management operations, depending on effectiveness of current controls.

12.8 Monitoring

Ecological monitoring activities relevant to the proposed development would focus on:

- ***Effects monitoring*** – data collection to enable detection and correction of unforeseen adverse impacts of the proposed development, and to measure the success of mitigation measures
- ***Compliance monitoring*** – data collection to ensure mitigation commitments are effectively implemented to fulfil legal obligations within the planning process and under the terms of the European Protected Species (EPS) licence (for bats)

12.8.1 Monitoring relevant to terrestrial ecology

12.8.1.1 Terrestrial ecology – construction phase monitoring

The potential for adverse impacts on important ecological receptors would be reduced by the following construction-phase monitoring programmes:

Petalwort

- Triangular Spit - potentially adverse impacts of construction works on petalwort colonies adjacent to the proposed Triangular Spit car park would be monitored and controlled by ongoing recording of the site's water quality, drainage profile, and distribution and habitat use of the rabbit population
- South Quay and Triangular Spit – the colonies of petalwort due for translocation would be monitored at each site to assure their continued viability prior to translocation to receptor sites; a methodology for petalwort recording has already been established as part of the 'Species Recovery Programme' for the species (Plantlife 2006) and could logically be used in this case

Bats

- Construction work would be monitored to ensure that existing bat flight lines remain undisturbed as far as possible and that night-time construction work and lighting has no effect on bats
- Monitoring of bat mitigation measures would be carried out to fulfil the requirements of any EPS licence(s) issued by Natural England, where necessary to undertake work on buildings / site features

Reptile communities

- The North Quay construction sites would be monitored during the construction phase to ensure that no reptiles are left within the site boundaries after exclusion by disturbance and/or translocation, and that construction sites remain unattractive to reptiles
- Exclusion reptile fencing would be monitored to ensure that it remains intact and to allow replacement /repair as necessary

12.8.1.2 Terrestrial ecology – operational phase monitoring

Petalwort

- Triangular Spit – monitoring work would include ongoing annual estimates of the population size (area in m^2 and number of thalli) of petalwort on the west side of the Spit, habitat use by rabbits, relative extent of areas of scrub, and levels of use and disturbance by people and dogs
- Translocation receptor sites – translocated petalwort populations would be monitored annually for up to 10 years to ensure continued viability and to obtain results to inform future translocations

Bats

The level of use and the importance of the North Quay area for bat populations appears to be low. However, continued usage of this site by bats would be monitored as follows:

- The use by bats of new features created at North Quay and Riviere Fields as flight lines (eg hedges) and roosts would be monitored to assess whether the area continues to be used by bats. If bats are found to have deserted any areas then remedial action would be taken; in particular, any artificial roosts in buildings and the cliff and quarry faces would be monitored to ensure suitability for bats and inform remedial work
- The restored dune grassland on Hayle Towans would be monitored for bat use on an annual basis for at least five years to inform scrub planting and management activities

Reptile communities

- The suitability for reptiles of remaining habitat areas adjacent to developed sites would be monitored on an annual basis for five years to ensure that there are adequate feeding resources and suitable shelter for hibernating and that disturbance pressure is minimized
- Habitat quality of retained corridors of semi-natural vegetation, and connectivity between these areas and adjacent habitats, would be monitored on an annual basis for 5 years
- The suitability of and use by reptiles of potential translocation sites would be monitored annually for 10 years to ensure that translocations are successful and to allow remedial action to be taken as necessary

Restored coastal dune grassland at Hayle Towans and grassland creation area at Riviere Farm

- The success of planting of dune vegetation at Hayle Towans would be monitored on an annual basis for 10 years to ensure that vegetation transplants are successful and to allow for replanting as necessary
- Localised recreational pressure (which may lead to trampling erosion and increased incidence of ruderal plant species) would be monitored on an annual basis to ensure that the restoration of dune habitat is successful and to allow remedial action as required, including (as necessary) the removal of non-native species
- Compensatory semi-natural grassland establishment at Riviere Farm would be monitored on an annual basis, along with soil conditions, to ensure successful plant establishment and to allow remedial action as required
- Recreational pressure on the local access to Hayle beach (eg on new board walks) and on the proposed pathway through dune grassland to the north-east of Riviere Fields would be monitored periodically to ensure that pressure on the dune habitat in the wider Towans area is reduced

Hedges and Cornish hedge banks

- The suitability of new hedges as flight lines for bats and habitat corridors for reptiles would be monitored as these features mature

Copperhouse saltmarsh

- Saltmarsh vegetation communities would be monitored every two years to allow early detection of changes in plant species composition that may occur in response to spring high tide summer impoundments required for sluicing

12.8.2 Monitoring relevant to aquatic ecology

12.8.2.1 Aquatic ecology - construction phase monitoring

Potentially adverse impacts on aquatic ecology during the construction phase would be reduced by monitoring water quality during the following operations:

- Removal of Cockle Bank and nearby dredging
- Other dredging (Penpol, Carnsew Quay/Carnsew Wharf, sand-trap, area north-west of fishermen's harbour)

If the results show values that exceed Environmental Quality Standards (EQS), operations would need to be suspended and additional measures incorporated to prevent exceedances. Further information on the water quality monitoring during dredging is provided in Chapter 13 (Water Resources).

12.8.2.2 Aquatic ecology - operational phase monitoring

Targeted monitoring of operational impacts would be undertaken. Monitoring work related to aquatic ecology would cover:

- Surveys of fish in Carnsew Pool, Copperhouse Pool, Penpol and the harbour area. Fish surveys would need to commence prior to construction works and continue every two years for a 5 year period post-construction (a total of four surveys)
- Surveys of invertebrates in Carnsew Pool and Copperhouse Pool. Invertebrate surveys would need to commence prior to construction works and continue on an annual basis for a 5 year period post-construction (a total of six surveys)

Most of the monitoring is to assess impacts on Carnsew Pool and Copperhouse Pool. If the results showed significant alterations to the invertebrate populations, or a reduction in the quality of fish habitat, then an assessment of whether these can be mitigated by further changes to the sluicing arrangements would be undertaken. This assessment would be after consultations with the Environment Agency, Natural England and the RSPB.

The possibility of algal blooms in Penpol requires additional studies prior to construction of the half-tide gate. Water quality in Penpol, especially dissolved oxygen, metals, nutrients and chlorophyll a, would be monitored pre-and post-impoundment. Post-impoundment, surveys would be needed for at least 5 years. Data would be required on a seasonal basis, so 24 surveys would be required in total. Alternatively, automatic continuous or semi-continuous monitoring may be employed for nutrients.

Use of modern anti-foulant paints on vessels can have toxic impacts on marine life, and so occasional surveys of biocides in the marina area would be undertaken, with the first survey occurring before the marina is constructed.

If beach nourishment in St Ives Bay is planned this would require further ecological studies and perhaps a separate EIA. The only ecological data available for nearby beaches is for the intertidal immediately east of the mouth of the Hayle estuary, which was studied as part of the EIA of the proposed Wave Hub in St Ives Bay (Halcrow 2006). Issues relating to beach nourishment are likely to include the contaminant concentrations in the dredged sands compared to sands on the beaches, particle size and organic content of dredged material and receptor beaches, existing flora and fauna of the beaches and whether the new profiles are likely to be stable.

12.8.3 Monitoring relevant to ornithology

12.8.3.1 Ornithology - construction phase monitoring

As part of the Construction Environmental Management Plan (CEMP), targeted ornithological monitoring would be undertaken during the main construction phase. This would focus on the areas of particular sensitivity during the construction phase, and in particular the works adjacent to Copperhouse and Carnsew Pools. Monitoring would take the form of twice monthly surveys over the tidal cycle (eg low, mid and high water), and address behavioural responses as well as usage patterns and numbers in comparison to baseline data. Ground truthing/control data would be gathered from Lelant Water over the same period, in order to capture any estuary-wide variation in usage as well as any potential displacement.

12.8.3.2 Ornithology - operational phase monitoring

Targeted ornithological monitoring would be undertaken during the operational phase of the proposed development. This would again focus on the areas of particular sensitivity and in particular, disturbance to Copperhouse and Carnsew Pools, as well as changes in site function (in conjunction with invertebrate community analysis). Monitoring would take the form of monthly surveys over the tidal cycle (low and high water) following the baseline survey methodology, focusing on assemblage composition, numbers and activity in comparison to baseline data on a sectoral basis. The results of parts of this monitoring programme would feed into conservation management objectives for the estuary, and in particular help assess and, if necessary, revise, the sluicing regimes in Copperhouse and Carnsew Pools. As such, parts of this operational monitoring programme may be ongoing during construction of the latter parts of the proposed development. It is anticipated that a minimum of three years monitoring would be implemented from the commencement of operation of the sluicing regimes.

12.9 Conclusions

12.9.1 Terrestrial ecology

The terrestrial habitats within the proposed development site comprise sand dunes (with dune grassland and associated scrub), disused open land, derelict buildings, disused quarries (with scrub), hedgerows, plantation and agricultural land; in addition there are areas of saltmarsh within Copperhouse Pool. Both Copperhouse Pool and the Triangular Spit form part of the Hayle Estuary and Carrack Gladden SSSI.

Following detailed surveys carried out in these habitats between 2005 and 2007, key findings were:

- Land at North Quay was found to support the greatest variety of terrestrial habitats
- Three Biodiversity Action Plan (BAP) priority habitats are present in or adjacent to the proposed development site: hedgerows (at Riviere Fields), coastal sand dunes (at North Quay) and saltmarsh (at Copperhouse Pool). The hedgerows are of local nature conservation interest as wildlife corridors. The coastal dune habitat comprises dune grassland with associated scrub, and supports reptile communities (county significance), breeding birds (local significance), bats (probably local significance), several locally scarce plant species and insects; overall, the habitat is assessed as being of regional significance. The saltmarsh at Copperhouse lies within the SSSI, and includes eight semi-natural saltmarsh vegetation types
- The most important species found at the proposed development site was petalwort (*Petalophyllum ralfsii*), which is fully protected under Schedule 8 of the Wildlife & Countryside Act 1981 and listed in the EC Habitats Directive. The western region of the Triangular Spit holds the second largest population of this species in Britain, and the site hence approaches international importance for this plant. Smaller numbers of the plant are found on South Quay and on the eastern shore of Carnsew Pool

The impacts of the proposed development would be experienced during the construction and the operational phase and will affect both species and habitats:

- During the construction phase some hedges at Riviere Fields would be lost, fragmenting the habitat, reducing its biodiversity value and adversely affecting bats and reptiles. There is likely to be some adverse impact on retained and new hedges during the operational phase due the close proximity of the residential development
- Of the 8.9 hectares of dune grassland on North Quay, 3.3 hectares would be lost, comprising 1.3 hectares to car park and 2 hectares to residential development; however this loss represents only a small percentage and a peripheral part of the total Hayle dune system, of which these areas are a part. There would also be some disturbance of dune grasslands within the immediate vicinity of the construction site during the construction phase and an increase in recreational use surrounding the developments would possibly degrade areas of the remaining dune grassland

- During the operational phase there may be a slight loss in extent of saltmarsh habitat and a change in species and community distribution in response to alteration of the tidal and salinity regime owing to temporary high-tide impoundment of water in the pool during summer, for sluicing
- The main impact on species would be on petalwort, where small colonies would be lost on South Quay (to built development), and in the eastern region of the Triangular Spit (to car parking). In addition, construction activities have the potential to damage the main colony of petalwort plants on the west side of the Spit, and to disturb rabbit feeding behaviour over the open grassland habitat. During the operational phase, there is the potential for impact on the Triangular Spit petalwort populations by increased visitor pressure and a reduction in the rabbit population, leading to reduced grazing and a consequent reduced area of available short-turf grassland suitable for petalwort
- Bat activity may be affected during the construction work due to disturbance (in particular the loss of flight lines), and during operation by new urban lighting (this can disrupt feeding behaviour of some species). Loss of habitat on the quarry and cliff faces and within buildings to be demolished may reduce the availability of potential roost spaces for bats
- For reptiles, construction works will result in loss of most of the home range currently available here to adders, slow worm and common lizard. During the operational phase, reptile communities may be impacted by increased levels of recreational disturbance and a decline in quality of the adjacent dune grassland habitat

Detailed mitigation measures would be employed to minimise the severity and extent of these impacts. In particular, extensive mitigation for the loss and impact on petalwort populations would include the translocation (under licence) of populations that would be lost, and the management of the large population on the Triangular Spit. In particular, access control measures (to preclude vehicles and deter pedestrian use) and maintenance of scrub habitat would be undertaken to ensure the survival of a healthy rabbit population here.

Mitigation for the loss of dune grassland habitat at North Quay would be achieved by the following measures:

- by restoring 0.8 hectares of eroded dune habitat at Hayle Towans through deposition of surplus clean sand dredged from the harbour mouth and subsequent planting of dune vegetation
- by providing compensation herb-rich grassland habitat over 2.5-3 hectares on land within the curtilage of Riviere Farm
- by improving management of the local access to Hayle beach, to avoid access-related erosion over the wider Towans area

Mitigation of impacts on bats would involve retention of confirmed and potential natural roost and hibernation sites in the North Quay quarry and cliff face, and incorporation of bat roosts in new buildings as appropriate. Known flight lines from any confirmed roost sites would be retained during construction, and site security

lighting minimised. Bat habitat requirements would be incorporated in specifications for habitat restoration, creation and management, and the type and positioning of new urban lighting would be designed to minimise effects on bats where required.

Mitigation works for reptiles would entail improvement of remaining habitat areas on North Quay to ensure adequate feeding resource and suitable shelter for the reptile population, and maintenance of habitat corridors to adjacent dune grassland areas.

Mitigation would be informed by a detailed monitoring programme carried out over a ten year period. In addition, there would be an education programme to inform the local community about the wildlife value of the site, in particular the petalwort population on the Triangular Spit.

12.9.2 Aquatic ecology

The aquatic flora and fauna of the Hayle complex is restricted due to historical contamination of the sediments and the continued poor water quality due to mining drainage and spoil heaps in the various catchments. This makes the environmental impacts from construction and operation lower than for uncontaminated systems. The main sensitive receptors (in terms of algae, invertebrates and fish) are:

- the viviers used to hold crustaceans in the harbour (this facility requires high water quality)
- open tanks in the harbour which are supplied with a re-circulating seawater system for holding shellfish (brown crabs, spider crabs, lobsters and crawfish); the water is drawn for the deeper part of the harbour and needs to be of high quality
- fish in Carnsew and Copperhouse Pools
- fish, especially sandeels, in the harbour
- invertebrates, seaweeds and fish in the areas of high current flow above and below the Carnsew tunnels; the diverse communities here need high current speeds, low turbidity and high concentrations of dissolved oxygen
- invertebrate and algae communities in the intertidal regions of Carnsew and Copperhouse Pools and Lelant Water, which form prey for migratory and over-wintering waders and waterfowl occurring within the Hayle & Carrack Gladden SSSI

The existing high levels of metals such as copper and arsenic in invertebrates consumed by birds and fish (Annexe 12I) require a cautionary approach to mobilising additional metals (eg by dredging), as intake of copper and arsenic may already be close to acutely toxic levels.

The main residual impacts on aquatic ecology after mitigation are summarised below.

Construction Phase:

The main impacts in the construction phase would be due to dredging (Work Items 5, 6 and 10) and construction of the half-tide gate at Penpol (Work Item 9). Localised impacts in the areas immediately upstream and downstream of the Carnsew tunnels are expected during the period they are refurbished (Work Item 4).

Operational Phase:

The ecological impacts of the new tidal regimes in Carnsew and Copperhouse Pool would be significantly reduced by sluicing only during the period 15 April to 30 August each year. There would be no direct impacts in the cooler winter months (September to mid April) as there would be no sluicing during that period. In the summer months the sluicing (ie retention of high water spring tides for three hours) would only occur for periods of approximately five days, followed by an interval of nine days with no sluicing.

The main ecological impacts of the altered tidal regime in Penpol are likely to be from the possible formation and collapse of algal blooms. This issue needs further surveys and detailed assessment. Further mitigation may be possible, for example allowing a greater degree of tidal exchange during neap tides.

The operational impacts of maintenance dredging in various locations, especially the marina and sand-trap, would be important issues even after mitigation. The sand-trap is likely to require annual dredging, whilst the marina area may only require dredging at intervals of 5-10 years.

12.9.3 Ornithology

The Hayle Estuary and Carrack Gladden SSSI encompasses the Porth Kidney sand dune system west of the estuary mouth and the main inter-tidal basins of Lelant Water in the south-west of the estuary, Carnsew Pool south of the harbour, and Copperhouse Pool to the east. The primary reason for the SSSI status of the estuary lies in the populations of waterfowl and shorebirds that occur in winter and pass through on spring and autumn migration.

Ornithological survey programmes undertaken in 2000-2001 and 2004-2005 have recorded an interesting aquatic avifaunal assemblage within the Hayle estuary system. Whilst the area was not found to be of national importance for any key waterfowl species (using thresholds given in Banks *et al*, 2006), concentrations of shelduck, teal, wigeon, ringed plover, lapwing and dunlin were of regional note, as well as a number of waders being of level of local importance, including little egret, oystercatcher, ringed plover and golden plover. These species are regarded as the key ornithological receptors for the impact assessment process. Bird habitat usage was predominantly concentrated in areas of Lelant Water as well as areas of Copperhouse and Carnsew Pools, these sites supporting feeding, roosting and loafing activities by a number of species of waterfowl. Carnsew Pool was identified as being of particular interest with an area of open seawater available over the entire tidal cycle supporting little grebe at a regional (possibly national) importance level, and with an area of

intertidal habitat exposed over each tide at the western end of the pool supporting feeding and roosting waterfowl.

As such, it is considered that the Hayle Estuary, and in particular Carnsew and Copperhouse Pools, is undoubtedly of regional importance for a number of species and, during periods of hard weather, the site may take on a national importance given the relatively unique conditions present in Carnsew Pool in particular.

The proposed development of the Hayle site is extensive and complex, involving a series of phases, works in different areas of the estuarine complex and different types of construction activity. The main focus of potential construction impacts (using the receptor parameters identified above) is around Copperhouse Pool and Carnsew Pool, with some construction activities potentially causing indirect loss of habitat and associated habitat function through disturbance.

In addition, the scheme, once operational, would involve an increase in visitor numbers to the site, with car parking on the Triangular Spit and associated increased activity adjacent to Carnsew Pool, with disturbance implications and indirect loss of habitat and site function within the pool. Furthermore, the operation of the new marina would increase the use of pleasure craft in the estuary. Whilst the majority of these might be expected to use the estuary mouth and open coast, there is some potential for increased ingress into Lelant Water, a key area for feeding and roosting waterfowl.

A series of mitigation measures would be employed to reduce the severity or extent of these impacts. Such measures include the timing of key works in the vicinity of the main sites of importance to periods of lowest sensitivity (the late spring, summer and early autumn in the case of most waterfowl species using the Hayle). In addition, noise and visual stimuli from the construction work would be reduced through the use of screening where appropriate. The potential impacts from the sluicing operation would be reduced through the restriction of impoundment events to spring tides during the period mid March to the end of August. Potential disturbance from pedestrian and water-based visitors would be reduced through screening, access management and educational material about the ecological importance of the system and the legal requirements of users of the estuary.

12.10 References

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