MAYOR OF LONDON

Transport for London

Inner Thames Estuary Feasibility Study

Response to Airports Commission Call for Evidence

The Mayor of London's Submission:
Supporting technical documents

23 May 2014

Title: **Compensation and Mitigation Measures in Relation to Natura 2000 sites (2013)**

Author: **ABP Marine Environmental Research Ltd**

Purpose of paper:

To present at high level overview of possible mitigation and compensation measures that could be required and incorporates a review of compensatory policy and precedents.

Key messages:

- Produced in 2013 to support the Mayor of London's submissions to the Airports Commission: Outline proposals for long term aviation capacity.

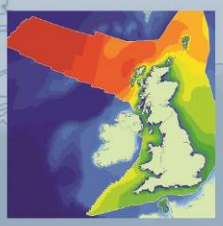
Atkins

Hub for London
Compensation and Mitigation Measures In Relation to Natura 2000 Sites

Report R.2132

September 2013

Creating sustainable solutions for the marine environment


Atkins

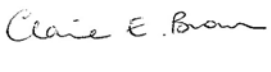
Hub for London
Compensation and Mitigation Measures
In Relation to Natura 2000 Sites

Date: September 2013

Project Ref: R/4155/1

Report No: R.2132

Version	Details of Change	Date
1.0	Draft for Comment	31.05.2013
2.0	2nd Draft for Comment	21.06.2013
3.0	Final	02.09.2013

Document Authorisation		Signature	Date
Project Manager:	N J Frost		02.09.2013
Quality Manager:	C E Brown		02.09.2013
Project Director:	S C Hull		02.09.2013

ABP Marine Environmental Research Ltd
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ

Tel: +44 (0) 23 8071 1840 Fax: +44 (0) 23 8071 1841
Web: www.abpmer.co.uk Email: enquiries@abpmer.co.uk

ABPmer is certified by:

Disclaimer:

- *Any 'Draft' issue of this report, and any information contained therein, may be subject to updates and clarifications on the basis of any review comments before 'Final' issue. All content should therefore be considered provisional, and should not be disclosed to third parties without seeking prior clarification from ABP Marine Environmental Research Ltd ("ABPmer") of the suitability of the information for the intended disclosure and should not be relied upon by the addressee or any other person.*

- *Unless previously agreed between the addressee and ABPmer, in writing, the 'Final' issue of this report can be relied on by the addressee only. ABPmer accepts no liability for the use by or reliance on this report or any of the results or methods presented in this report by any party that is not the addressee of the report. In the event the addressee discloses the report to any third party, the addressee shall make such third party aware that ABPmer shall not be liable to such third party in relation to the contents of the report and shall indemnify ABPmer in the event that ABPmer suffers any loss or damage as a result of the addressee failing to make such third party so aware.*

- *Sections of this report rely on data supplied by or drawn from third party sources. Unless previously agreed between the addressee and ABPmer, in writing, ABPmer accepts no liability for loss or damage suffered by the addressee or any third party as a result of any reliance on third party data contained in the report or on any conclusions drawn by ABPmer which are based on such third party data.*

Hub for London
Compensation and Mitigation Measures
In Relation to Natura 2000 Sites

Contents

Page

Tables

Images

Figures

1. Introduction

The Mayor of London Aviation Work Programme is currently investigating how to increase London's hub airport capacity. Transport for London (TfL) are co-ordinating this work stream which includes a review of a number of short listed options that meet the necessary requirements of a future hub airport. There are currently two short listed options that are located within the marine environment, namely the Inner Estuary and Outer Estuary options (Figure 1). A third shortlisted option, the expansion of Stansted, has not been considered further within this report as it is not located within the marine environment.

ABPmer has been contracted to undertake the following tasks as part of this programme of works:

1) Provide a baseline description of the marine ecology of the Thames Estuary;

2) Identify potential impacts that could arise in the marine environment through the introduction of a new airport;

3) The identification of possible mitigation and compensation measures that could be required for certain marine ecology receptors in relation to such a scheme to meet the requirements of the Habitats and Wild Birds Directives; and

4) A review of policy and precedents for mitigation and compensation measures under these Directives.

This report considers the possible mitigation and compensation measures that could be required, and also incorporates a review of compensatory policy and precedents. It builds on the potential marine impact pathways which have been identified and discussed in a separate report (ABPmer, 2013b) with regards to the following marine ecological receptors:

- Environmental designations;
- Intertidal and subtidal habitats and species;
- Plankton;
- Fish and Shellfish;
- Marine Mammals; and
- Marine Seabirds (wider ornithological issues are being considered by Atkins).

The difference between mitigation and compensation in relation to the Habitats and Wild Birds Directives are first outlined prior to potential mitigation options being discussed in Section 2. Compensatory policy and case law with regards to European designations are discussed in Section 3. In Section 4, compensation options are described, before their potential application to the Thames airport options with a marine component are presented in Section 5 and conclusions are provided in Section 6.

This review does not consider legal and policy requirements in relation to the protection of nationally designated sites such as Marine Conservation Zones (MCZ) designated under the Marine and coastal Access Act 2009 or Sites of Special Scientific Interest (SSSI) designated under the Wildlife and Countryside Act 1981 (as amended).

1.1 Requirements of the Habitats and Wild Birds Directives

Articles 6(3) and (4) of the EC Habitats Directive (92/43/EC) establish strict procedures for the approval of plans or projects that have the potential to affect designated features associated with sites classified as Special Protection Areas (SPAs) under the Wild Birds Directive (2009/147/EC) or as Special Areas of Conservation (SACs) under the Habitats Directive. These provisions are incorporated into English law through the Conservation of Habitats and Species Regulations 2010 and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (hereafter jointly referred to as the 'Habitats Regulations').

Under the Habitats Regulations, where a plan or project is not directly connected with, or necessary for, the management of a designated European site or European offshore marine site, including SACs and SPAs, and where the possibility of a likely significant effect (LSE) on these sites cannot be excluded, either alone or in combination with other plans or projects, an Appropriate Assessment (AA) should be undertaken in view of the site's conservation objectives by the competent authority. In addition, it is a matter of law that candidate Special Areas of Conservation (cSACs) and Sites of Community Importance (SCI) are considered in this process; furthermore, it is UK Administration policy (Planning Policy Statement 9) that sites designated under the 1971 Ramsar Convention for their internationally important wetlands (Ramsar sites) and potential Special Protection Areas (pSPAs) are considered in this process.

When evaluating the effects of a proposed development on these designated sites as part of the Habitat Regulations Assessment (HRA) process, if the competent authority cannot conclude that the plan or project will not have an adverse effect on the integrity of a European/Ramsar site (either alone or in combination with other plans or projects), the plan or project can only be adopted if it has been ascertained that there are no alternative solutions and it is necessary for Imperative Reasons of Overriding Public Interest (IROPI, including those of a social or economic nature. Where the site concerned hosts a priority natural habitat type (identified in Annex 1 of the Habitats Directive) or a priority species (identified in Annex 2 of the Habitats Directive), the grounds for IROPI are more restricted; being limited only to reasons relating to human health, public safety or beneficial consequences of primary importance to the environment or any other reasons which the competent authority, having due regard to the opinion of the European Commission, consider to be imperative reasons of overriding public interest. In circumstances where the strict tests relating to alternatives and IROPI are met, such plans or projects may only proceed once compensatory measures have been secured to ensure that the overall coherence of the network of Natura 2000 sites is maintained.

The Habitats and Wild Birds Directives have been in place for some 20 years. There is thus a relatively good understanding about how this legislation should be interpreted and implemented. This understanding has been informed by European Commission (EC) Guidance, project-specific resolutions and case-law decisions.

1.2 Mitigation and Compensation under the Directives

Many of the impacts which could potentially be incurred due to the implementation of either of the Thames airport options located in the marine environment will be both adverse and significant. It will therefore be necessary to implement measures to avoid, reduce or offset these impacts. Within the context of the Habitats and Wild Birds Directives, the nature and location of such measures are important in determining the approval procedures that need to be followed.

While the distinction between mitigation and compensation has been the subject of some legal debate (in particular at the recent Wightlink Car Ferry Public Inquiry), a clear and consistent approach has been adopted in practice in the UK and this approach was clarified/verified by the Wightlink Ferry decision (Planning Inspectorate, 2011).

By convention and case-law, mitigation relates to measures taken to ameliorate the effects of a project (or plan) which take place within the boundaries of a designated site. These are taken into account when determining whether the effects of the whole plan or project will affect the integrity of a designated site or sites under Article 6(3)) of the Habitats Directive.

Neither the Habitats and Wild Birds Directives nor the Regulations incorporating these requirements into English law make any specific mention of mitigation, but the 'Managing Natura 2000 sites' guidance (EC, 2000) does clarify that mitigation measures are 'measures aimed at minimising or even cancelling the negative impact of the plan or project, during or after its completion'. The latest EC guidance for Ports (EC, 2011) also compares the Natura 2000 conservation objectives and technical project objectives and note that 'as a general rule, damage prevention or avoidance measures should always be preferred to compensation measures'. Therefore potential mitigation measures to avoid adverse effects need to be considered first and the impacts of the project as whole (on the designated site as a whole) need to then be assessed with these measures taken into account.

By contrast, compensation is addressed only after it has been concluded that a project (with its mitigation included) will have an adverse effect on the integrity of the designated site(s) when Article 6(4) of the Habitats Directive would be applicable. Unlike mitigation, compensation measures involve habitat creation/restoration work outside the boundary of the designated site(s).

While there is a lot of clarity about how, where and when (i.e. at which point during the process of considering Articles 6(3) and 6(4) of the Habitats Directive) mitigation and compensation need to be addressed, it has also been necessary in the past to treat each project on a case-by-case. This is because of the individual and distinct issues associated with different projects or plans. Therefore there has also been an inherent variability of approach which relates to aspects such as the timing, extent, and type of habitats that are delivered through compensation when compared against the projected impacts.

2. Potential Mitigation Measures

ABPmer 2013b details the potential impact pathways which may occur in relation to the two airport options with a marine component which are being considered. Mitigation measures which could avoid or reduce the significance of an impact on the marine receptors are now discussed.

Prior to this, it is worth discussing the overlap of the two options with a marine component with European and national marine designated sites. As can be seen in Figure 2, the Inner Estuary option has a large overlap with the Thames Estuary SPA and Ramsar sites, as well as a small overlap with the Medway Estuary and Marshes SPA and Ramsar sites. As outlined in the marine ecology baseline description (see ABPmer 2013a), the habitat sub-features of the SPAs include intertidal mudflats, saltmarsh, intertidal shingle, and shallow coastal waters which support numerous waders, many of which are designated features of the SPAs. The intertidal habitats affected by the Inner Estuary option are depicted in Figure 3.

The Outer Estuary option overlaps completely with the Outer Thames Estuary SPA, and partially with the Margate and Longsands candidate SAC (cSAC)[1]. As outlined in the baseline description (see ABPmer 2013a), the Outer Thames Estuary SPA is designated for Red-throated Diver (*Gavia stellata*), and habitat sub-features 'shallow inshore waters and sandbanks'. The Margate and Longsands cSAC is designated for 'sandbanks which are slightly covered by sea water all the time' (i.e. Annex I habitat), with sub-features relating to 'dynamic sand communities' and 'gravelly muddy sand communities'. The subtidal habitats affected by the Outer Estuary option are depicted in Figure 4.

Tables 1 and 2 below detail the potential main mitigation measures for those impact pathways identified in the impact pathway report (see ABPmer 2013b). Table 1 lists those related to the construction phase, and Table 2 those related to the operational phase. The tables illustrate that a myriad of mitigation measures are available, most notably avoidance and minimisation of impact on sensitive/designated habitats and species.

Potential decommissioning impacts have not been assessed, as it is considered unlikely that the developments would be removed at the end of their operating life. Nor has the assessment considered cumulative or in-combination impacts at this stage. Given the limited information available on the possible construction requirements for either airport option with a marine component, the assessment has focused solely on the footprint of the possible airports themselves, and not the potential impacts that could be arise from any associated infrastructure (e.g. construction landing facilities, causeways, cables and tunnels). Furthermore, the impact pathways presented rely on an assessment which is very much a preliminary, high level one; thus, the key potential mitigation measures will require more detailed study both to evaluate their potential effectiveness and to assess any associated costs. The mitigation measures should therefore be seen as broadly illustrative at this stage; the individual measures may or may not be required, depending on the final scheme design and associated impacts. The potential effectiveness and confidence associated with possible mitigation measures have also not been assessed at this stage.

However, it is considered highly likely that mitigation measures will not be sufficient to avoid adverse effects on the integrity of at least some of the designated features associated with the relevant European Sites and therefore that compensatory measures are also likely to be required.

[1] NB: candidate European sites should be viewed as essentially designated.

Table 1. Potential mitigation measures – construction phase

Construction	Marine Receptors Potentially Affected	Potential Mitigation Measures
Barrier to movement	Marine mammals, marine seabirds, fish	Avoid or minimise size of barrier in estuary (i.e. estuarine footprint). Avoid sensitive sites / access routes. Avoid construction during sensitive seasons. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in habitat extent (intertidal and/or subtidal)	All	Avoid or minimise direct habitat loss, especially in areas used by sensitive species, or which are designated. Use project planning and design to ascertain whether scheme design will result in local changes to erosion/deposition patterns (undertake numerical modelling). Undertake iterative scheme design to minimise impacts/indirect losses. Sensitive intertidal areas (e.g. intertidal mudflat) subject to potential erosion could be recharged with sediment. Ecological enhancement of sub-optimal areas (e.g. creation of artificial or biogenic reefs, reduce pressure of existing human activities on relevant features; eradication of invasive non-native species). Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in habitat suitability	All	Use project planning and design to ascertain whether scheme design will result in physical regime changes (undertake numerical modelling). Undertake iterative scheme design to minimise these changes. Sensitive intertidal areas (e.g. intertidal mudflat) subject to potential erosion could be recharged with sediment. Ecological enhancement of sub-optimal areas (e.g. creation of artificial or biogenic reefs, reduce pressure of existing human activities on relevant features; eradication of invasive non-native species). Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in suspended sediment concentrations	All	Use project planning and design to ascertain whether scheme design will result in local changes to concentrations (undertake numerical modelling). Undertake iterative scheme design to minimise impacts if necessary. Monitor during construction to ensure within predictions/acceptable limits. Implementation of relevant JNCC or other relevant guidance.
Changes in water quality (salinity, temperature, dissolved oxygen, nutrients and contaminants)	Subtidal ecology, intertidal ecology, plankton, fish	Use project planning and design to ascertain whether scheme design will result in local changes to water quality (undertake numerical modelling). Undertake iterative scheme design to minimise impacts if necessary. Monitor during construction to ensure within predictions/acceptable limits. Implementation of relevant JNCC and other relevant guidance.
Collision risk (vessels)	Marine mammals, marine seabirds	Avoid traversing sensitive sites/flocks of birds. Avoid excessive vessel speeds in sensitive areas/ during sensitive periods.
Discharges and accidental spillages	All	Ensure all vessels comply with relevant codes; use vessels with a proven track record for operating in similar conditions. Ensure all marine activities occur in suitable conditions to reduce the chance of an oil spill occurring. Minimise as far as practicable the depth and diameter of foundation piles.

Construction	Marine Receptors Potentially Affected	Potential Mitigation Measures
		Use low/non toxicity compounds (e.g. compressor lubricants should be non-toxic; seawater should be used as a drilling fluid). General good housekeeping measures to avoid spillages.
Introduction of non-native species	Subtidal Ecology, Intertidal ecology, plankton	Adoption of protocol to minimise risk of the spread of non-indigenous species - including adherence to International Maritime Organisation regulations on Ballast Water Management. Monitor during construction to ensure compliance. Use antifoulants if required. Monitoring and adaptive management.
Lighting	Fish, marine mammals, marine seabirds	Minimise use of lighting as far as is practicable (particularly during sensitive periods). Minimise light pollution, e.g. install down lighting where necessary. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas). Enhancements to bird and marine mammal breeding sites.
Physical disturbance by plant and machinery	Intertidal Ecology	Avoid sensitive sites. Avoid impacts during sensitive seasons. Avoid/minimise damage through employing protective mats, bridging, etc. Restore affected areas.
Re-deposition of suspended sediment causing localised smothering	Subtidal ecology, intertidal ecology, plankton	Use project planning and design to ascertain whether scheme design will result in local changes to erosion/deposition patterns (undertake numerical modelling). Undertake iterative scheme design to minimise impacts if considered necessary. Monitor during construction to ensure suspended sediment impacts within predictions/acceptable limits.
Release of contaminants associated with the dispersion of suspended sediments	All	Undertake sampling to identify contamination levels of sediments. If required, implement contamination management through standard protocols and discuss potential disposal methods of highly contaminated seabed material.
Underwater noise/ vibration	Subtidal ecology, fish, marine mammals, marine seabirds	Minimise as far as possible significant construction operations during periods of high sensitivity, e.g. avoiding most intense periods of fish migration, seal breeding season. Consult with regulators on most appropriate times. Use less intrusive piling methods (e.g. passive gas; soft start piling) and noise screens (e.g. bubble curtains) during sensitive periods. Develop piling protocol with regulators. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas). Enhancements to bird and marine mammal breeding sites.
Visual disturbance (construction vessels)	Marine mammals, marine seabirds	Minimise vessel movements and use existing shipping routes as far as is practicable. Use 'considerate' access routes to avoid sensitive areas, flocks of rafting birds. Keep navigational lighting to a minimum. Avoid excessive vessel speed or other factors that may lead to enhanced impacts. Develop suitable monitoring strategy for marine mammals, if required (e.g. use of mammal observers and warning systems (Passive Acoustic Monitoring)).

Table 2. Potential mitigation measures – operational phase

Operation	Marine Receptors Potentially Affected	Potential Mitigation Measures
Barrier to movement	Marine mammals, marine seabirds, fish	Avoid or minimise size of barrier in estuary (i.e. estuarine footprint). Avoid sensitive sites / access routes. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Bird strike	Marine seabirds	Amendments to airport design to avoid areas of high bird activity Additional mitigation measures are being considered by Atkins (Atkins, 2013a and b).
Changes in habitat extent (intertidal and/or subtidal)	All	Avoid or minimise direct habitat loss, especially in areas used by sensitive species, or which are designated. Use project planning and design to ascertain whether scheme design will result in local changes to erosion/deposition patterns (undertake numerical modelling). Undertake iterative scheme design to minimise impacts/indirect losses. Sensitive intertidal areas (e.g. intertidal mudflat) subject to potential erosion could be recharged with sediment. Ecological enhancement of sub-optimal areas (e.g. creation of artificial or biogenic reefs, reduce pressure of existing human activities on relevant features; eradication of invasive non-native species). Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in habitat suitability	All	Avoid or minimise direct habitat loss, especially in areas used by sensitive species, or which are designated. Use project planning and design to ascertain whether scheme design will result in local changes to erosion/deposition patterns (undertake numerical modelling). Undertake iterative scheme design to minimise impacts/indirect losses. Sensitive intertidal areas (e.g. intertidal mudflat) subject to potential erosion could be recharged with sediment. Ecological enhancement of sub-optimal areas (creation of artificial or biogenic reefs, reduce pressure of existing human activities on relevant features; eradication of invasive non-native species) . Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in suspended sediment concentrations	Subtidal Ecology, Intertidal ecology, plankton, fish	Use project planning and design to ascertain whether scheme design will result in local changes to concentrations (undertake numerical modelling). Undertake iterative scheme design to minimise impacts if necessary. Monitor during construction to ensure within predictions/acceptable limits. Implementation of relevant JNCC or other relevant guidance.
Changes in the structure and function of biological assemblages (due to changes in biological interaction)	Subtidal Ecology, Intertidal ecology, plankton	Monitoring and adaptive management. Consider habitat enhancements (e.g. creation of artificial or biogenic reefs, reduce pressure of existing human activities on relevant features; eradication of invasive non-native species). Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas).
Changes in water quality	Subtidal Ecology, Intertidal ecology, plankton, fish	Use project planning and design to ascertain whether design will result in local changes to water quality (undertake numerical modelling). Undertake iterative scheme design to minimise impacts if necessary. Monitor during construction to ensure within predictions/acceptable limits.

Operation	Marine Receptors Potentially Affected	Potential Mitigation Measures
		Implementation of relevant JNCC or other guidance. Ensure discharges from airport are treated appropriately.
Discharges and accidental spillages	All	General good housekeeping measures to avoid spillages during operation.
Introduction of non-native species	Subtidal Ecology, Intertidal ecology.	Monitoring and adaptive management.
Lighting	Fish, marine mammals, marine seabirds	Minimise use of lighting as far as is practicable. Minimise light pollution, e.g. install down lighting where necessary. Install barriers if necessary. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas). Enhancements to bird, marine mammal breeding sites.
Underwater noise/ vibration	Fish, marine mammals, marine seabirds	Noise screens. Habitat enhancement in intertidal surrounding airport. Consider fish stock enhancements (reduce pressure on fish stocks, sea bed habitats, spawning or nursery areas, create new spawning/nursery areas). Enhancements to bird and marine mammal breeding sites.

3. Requirements for Compensatory Measures under the Habitats and Wild Birds Directives

3.1 Introduction

The information presented below represents the current European and UK guidance with respect to the requirements for compensatory measures under the Habitats and Wild Birds Directives. This guidance has been developed with full regard to project-specific resolutions and case-law decisions and as such the details of individual cases, which are highly case specific, have not always been included. Example projects and/ or cases have, however, been used to illustrate a number of the principles that have been described. It should also be noted that the Defra led Habitats and Wild Birds Directive Implementation Review has resulted in a series of recommended measures some of which relate to the streamlining of existing guidance. It is therefore anticipated that updated guidance will be published later this year.

If the competent authority cannot conclude that a plan or project will not have an adverse effect on the integrity of a European/Ramsar site (either alone or in combination with other plans or projects), the plan or project can only proceed if it has been ascertained that there are no alternative solutions and it is necessary for Imperative Reasons of Overriding Public Interest (IROPI). In such cases, compensatory measures must be secured before the plan or project can proceed to ensure that the overall coherence of the network of Natura 2000 sites is maintained. Given that compensatory measures can only be considered if the requirements of the alternatives and IROPI tests are met, these requirements are briefly considered below.

3.2 Alternatives and IROPI

Under the Habitats and wild Birds Directives, other 'feasible' ways of delivering the overall objective of the plan or project, which will be less damaging to the integrity of the European site affected, need to be considered. The competent authority has the duty to determine the range and type of possible alternatives that should be considered, and is to use its judgement to decide what is reasonable in any particular case. Where necessary it may consult others on potential alternative solutions. In some cases the competent authority may need to consider options that have not been identified by the applicant. Also, the 'do-nothing' option must be considered. Alternatives have to be considered objectively and broadly, and include options that could be delivered by someone other than the applicant, or at a different location, using different routes, scale, size, methods or timing. Alternatives can also involve different ways of operating a development or facility. Alternative solutions are however limited to those which would deliver the same overall objective as the original proposal (e.g. alternative solutions to a port development do not need to extend to other options for importing freight). If the competent authority determines that there are feasible alternative solutions which would have lesser effects on a European site, it cannot give consent (Defra, 2012).

Defra (2012) provides some guidance on the concept of IROPI. In particular, the grounds for IROPI depend on the nature of the site potentially affected:

- If the site hosts a priority habitat or species, the competent authority can only consider reasons relating to human health, public safety, or beneficial consequences of primary importance to the environment; or other IROPI only after having regard to the EC's opinion;

- For other sites the competent authority can consider other IROPI including those relating to social or economic benefit in addition to those of human health, public safety, or beneficial consequences of primary importance to the environment.

When identifying IROPI, a competent authority must consider whether all three elements of IROPI are met:

- Imperative: the plan or project is necessary (whether urgent or otherwise) for one or more of the reasons outlined above;

- Overriding: the interest served by the plan or project outweighs the harm to the integrity of the site as assessed in light of the weight to be given to the protection of such sites under the Directives; and

- Public Interest: a public good is delivered rather than a solely private interest.

The guidance notes that public interest can occur at national, regional or even local level, provided the other elements of the test are met.

3.3 Requirements for Compensatory Measures

One of the key guidance documents addressing the scope for compensation in order to maintain the coherence of the Natura 2000 Network is the 'Managing Natura 2000 Sites' document (EC, 2000). This was followed up by a further document on Article 6(4) of the 'Habitats Directive' (EC, 2007), which clarified the concepts of alternatives, IROPI and compensatory measures. The former document states that:

> *'In order to ensure the overall coherence of Natura 2000, the compensatory measures proposed for a project should address, in comparable proportions, the habitats and species negatively affected; concern the same biogeographical region in the same Member State; and provide functions comparable to those which had justified the selection criteria of the original site'.*

The 'Managing Natura 2000 Sites' document (EC, 2000) also indicates (Section 5.4.2) that:

> *'compensatory measures sensu stricto have to ensure the maintenance of the contribution of a site to the conservation at favourable status of one or several natural habitats 'within the biogeographical region concerned''.*

It indicates that appropriate measures could include new habitat creation or *'work to improve the biological value of an area (to be designated) or of an SPA (designated) so that the carrying capacity or the food potential are increased by a quantity corresponding to the loss on the site affected by the project'*. It further indicates that in terms of the Habitats Directive, the compensation could similarly consist of the re-creation of a comparable habitat, the biological improvement of a substandard habitat or even the addition to Natura 2000 of an existing site the proposal of which under the Directive had not been deemed essential at the time of drawing up the biogeographical list.

The follow up EC report (EC, 2007) generally confirms these requirements but also expands on some aspects, for example by providing guidance on the criteria for designing compensatory measures. The guidance states (Section 1.5.1) that:

'Compensatory measures under the Habitats Directive must be established according to reference conditions that are defined after the characterisation of the biological integrity of the site likely to be lost or deteriorated, and according to the likely significant negative effects that would remain after mitigation. Biological integrity can be defined as all those factors that contribute to the maintenance of the ecosystem including structural and functional assets. In the framework of the Habitats Directive, the biological integrity of a site is linked to the conservation objectives for which the site was designated as part of the Natura 2000 network.'

This guidance thus makes a strong link to the site's conservation objectives and aspects of structure and function affecting biological integrity. The EC 2007 guidance (Section 1.5.5) also includes a further requirement that the area selected for compensation:

'must have - or must be able to - develop the specific features attached to the ecological structure and functions, and required by the habitats and species populations. This relates to qualitative aspects like the uniqueness of the assets impaired and demands the consideration of local ecological conditions'.

However, EC (2007) also recognises (Section 1.5.3) that:

'According to current knowledge, it is highly unlikely that the ecological structure and function as well as the related habitats and species populations can be reinstated up to the status they had before the damage by a plan or project. To overcome the intrinsic difficulties standing in the way of full success for the reinstatement of ecological conditions, compensatory measures must be designed:

- *Following scientific criteria and evaluation in accordance with best scientific knowledge; and*
- *Taking into account specific requirements of the ecological features to be reinstated (e.g. soil, humidity, exposure, genetic pool, existing threats and other conditions critical to the success of reinstatement).*

The critical aspects to technical feasibility will determine the suitability of the location of compensatory measures (spatial feasibility), the appropriate timing and their required extent'.

3.3.1 Extent and Type of Compensation Against Area Affected

The spatial extent of compensatory habitat and how that compares against the area impacted varies between projects and the 2007 EC guidance indicates that:

'The extent required for the compensatory measures to be effective has a direct relationship to the quantitative and qualitative aspects inherent to the elements of integrity (i.e. including structure and functionality and their role in the overall coherence of the Natura 2000 network) likely to be impaired and to the estimated effectiveness of the measures. Consequently, compensation ratios are best set on a case-by-case basis and must be initially determined in the light of the information managed during Article 6(3) assessment and ensuring the minimum requirements to meet ecological

functionality. The ratios may then be redefined according to the results observed when monitoring the effectiveness, and the final decision on the proportion of compensation must be justified.'

The guidance further states the following in respect of the issue of 'compensation ratios' (i.e. the extent of habitat lost against habitat created or restored through compensation):

'There is wide acknowledgement that ratios should be generally well above 1:1. Thus, compensation ratios of 1:1 or below should only be considered when it is demonstrated that with such an extent, the measures will be 100% effective in reinstating structure and functionality within a short period of time (e.g. without compromising the preservation of the habitats or the populations of key species likely to be affected by the plan or project).'

In previous case-examples involving compensatory measures, a range of ratios have been applied to determine the habitat creation objectives of a particular scheme or strategy (Table 3). Based on UK implementation, these case-examples can currently be divided into two categories:

- The impacts of coastal defence planning where there can be is a need to compensate for future coastal squeeze; and

- The impacts directly associated with specific developments (mostly ports).

With regards to the coastal defence measures and the potential intertidal habitat requirements arising from coastal squeeze a ratio of 1:1 (habitat loss : habitat gain) has been applied to offset predicted losses over the next 50 years. This is the case for instance for the Humber Estuary Coastal Habitat Management Plan (CHaMP) and it is also applied in the Solent for which the large-scale Medmerry managed realignment on the Selsey Peninsula is being undertaken to offset coastal squeeze effects.

In contrast to these coastal defence strategies, a minimum ratio of at least 2:1 has more typically been applied where the required habitat gains are associated with the compensatory requirements for an identified development. This was applied first for the Cardiff Barrage compensation work (Burton, 2006), but has often been used subsequently, especially where there is a need for additional assurances that no adverse effect will occur due to differences in the type and timing of the compensatory delivery. For instance, a 2:1 ratio was applied for the compensation measure that the UK Government had to undertake for the Lappel Bank and Fagbury Flats impacts (ABPmer, 2003). This was because of the large delay between the losses in that case (arising from port developments in the 1980s and early 1990s) and the delivery of the compensation habitats (from the Allfleet's Marsh realignment on Wallasea Island (Crouch Estuary) in 2006).

To illustrate the differences in the 'compensation ratios' for different projects, Table 3 presents a summary case review. This demonstrates that each case example is different, depending on the type of loss (direct versus indirect), the time of implementation and the designation afforded the area which was lost. Generally, most EMS losses listed below would have applied to both SAC and SPA designations, as these very frequently overlap in the UK's estuaries.

Table 3. Summary of habitat creation: loss ratios from past case examples

Location of Compensation	Extent of Habitat Lost or Changed (ha)	Extent of Habitat Created (ha)	Approx. Gain:Loss Ratio	Background Details
Humber CHaMP - Coastal Squeeze	600ha	600ha	1:1	Based on 6mm SLR and upper limit of estimate of loss associated with coastal squeeze (Black & Veatch Consulting Ltd., 2004)
Humber CHaMP - losses associated with reconstruction and maintenance works	15ha	45ha	3:1	Losses associated with the implementation of the Humber Flood Defence Strategy (Black & Veatch Consulting Ltd., 2004)
Humber CHaMP - temporary losses/ disturbance	27ha	27ha	1:1	Losses associated with the implementation of the Humber Flood Defence Strategy (Black & Veatch Consulting Ltd., 2004)
Humber CHaMP - Provision of flood storage	45ha	45ha	1:1	Losses associated with the implementation of the Humber Flood Defence Strategy (Black & Veatch Consulting Ltd., 2004)
Paull Holme Strays, Humber	Not known	80ha	Not known	Predicted losses are not comparable with the area created because it formed part of the overall flood defence strategy (Environment Agency, 2006). Implemented 2004.
Brandy Hole, Crouch	12ha	12ha	1:1	Coastal squeeze. Implemented 2002.
Gwent Levels Habitat Creation, near Newport, Wales	200ha (SSSI)	438ha	2:1	To offset impacts of the Cardiff Bay barrage. Habitat types lost and gained are reportedly very different (Burton, 2006). Implemented 2000.
Allfleet's Marsh (Wallasea Island North Bank), Crouch	54ha	115ha	2:1	Habitat created many years after the losses associated with East Coast port developments (ABPmer, 2003)
Welwick, Chowder Ness and Doig's Creek; Humber	31ha	59ha	2:1	Losses associated with port development on the Humber Estuary (ABPmer, 2004). Implemented 2006.
Trimley Marsh/ Shotley Marshes enhancements; Orwell	3.93ha, plus 0.2ha annually (indirect)	24ha	not strictly applicable*	Losses associated with Trinity III Felixstowe Port Development. (Royal Haskoning, 2005). Implemented 2000.
Little Oakley, Hamford Water	72ha (69ha of direct loss)	105ha	1.5:1	Intertidal habitat to be created as a result of losses associated with port development; not yet implemented (http://www.hict.co.uk/data/downloads/incombination028-067.pdf)
London Gateway, Thames	14ha direct loss (not EMS) plus 60ha indirect, functional change (some EMS, extent unknown)	74ha	1:1	Habitat created as a result of losses associated with port development (http://www.londongateway.com/upload/environment/marine/dredging-in-the-thames/london-gateway-port-and-the-marine-environment.pdf). First site implemented 2010 (27ha); further site planned (Site 'X')

Location of Compensation	Extent of Habitat Lost or Changed (ha)	Extent of Habitat Created (ha)	Approx. Gain:Loss Ratio	Background Details
Hesketh Out Marsh, Ribble	11ha	52ha (of a 180ha site)	4:1	Loss of sandflat under footprint of breakwater (7ha) and under mitigation area (4ha) (Young Associates, 2001) compensated for by saltmarsh realignment. Implemented 2008 (ABPmer website www.abpmer.net/omreg).
Steart Habitat Creation Scheme, Bristol Channel, Somerset	113ha (33.5ha direct loss, not all EMS; rest functional/in-direct)	120ha (legal agreement), 132ha (planning application)	not strictly applicable**	Compensation for consented Bristol Deep Sea Container Terminal, realignment not yet consented itself (http://dsct.bristolport.co.uk/bristol-port-at-the-steart-peninsula)
* Due to indirect losses being expressed in annual terms ** Due to some losses not being within the EMS, and also due to large proportion of indirect/functional losses				

In a case example from Germany, compensatory ratios appear to have been highly habitat/biotope dependent, with specific ratios apparently applied to different biotopes. In practice, however, general ratios of replacement to lost habitat have been broadly similar to those in the UK (around 2:1 as a minimum). Actual implementation of compensatory measures has not always been achieved in Germany. The most prominent example relates to the provision of compensatory measures to offset the Mühlenberger Loch mudflat land claim for the Hamburg Airbus factory which occurred between 2001 and 2003. In this instance significant local opposition and NGO court action resulted in not all of the planned compensatory measures being implemented for this project (Halcrow et al., 2012).

To date, compensatory habitat has typically been provided broadly on a like-for-like basis, however, increasing consideration is now being given to moving towards a greater emphasis on ecosystem functioning. For example, the recent Government review (for England only) into the implementation of the Habitats and Wild Birds Directives in England (HM Government, 2012) makes reference to the need for greater consideration of ecosystem functioning in the future. In addition, exploratory discussions between the Department of Energy and Climate Change (DECC) and the EC in the context of a possible Severn Tidal Power scheme considered the scope for providing 'measures of equivalent value' in circumstances where it was not possible to compensate on a like-for-like basis. However, to date there are limited examples of where a (relatively) strict like-for-like principle has not been applied. One example is the compensation provided for the Cardiff Barrage. This involved the development of new wet grassland and saline lagoon habitats, as well as enhancing existing ornithological interests in the reedbeds to compensate for the enclosure of 200ha area of intertidal mudflats and saltmarsh at the mouth of the Severn Estuary (Burton, 2006).

A non like-for-like approach was also employed with respect to the Morecambe coastal defence works. This project resulted in a loss of, or changes to, around 11ha of sandflat within the Morecambe Bay SPA. Around 7ha of sandflat was lost under the footprint of the breakwaters and new sea wall while a further 4ha was changed from sandflat to skear habitat as mitigation (Young Associates, 2001). While sandflat was lost, the Hesketh Out Marsh project has created/restored a predominantly high saltmarsh habitat. The compensatory ratio was very high for this project. Lancaster City Council contributed around £900,000 to the cost of 52ha of the 180ha managed realignment at this site (RSPB, 2009). This area approximately corresponds to a 4:1 ratio and this high ratio has been attributed to the distance away from the impact (Tony Baker, RSPB Hesketh Project Manager, pers. comm.).

The concept behind ecosystem functioning involves considering the full range of benefits that the natural environment provides. The Government's Natural Environment White Paper (2011) (referenced in HM Government, 2012) sets out how an ecosystems approach will result in better informed and integrated decisions. The Government has expressed a will to support the move towards a broader ecosystems approach by inviting the newly established Natural Capital Committee to give early consideration to the following issues (HM Government, 2012):

- How an ecosystems approach can help evaluate any specific choices over mitigation or (ecological) compensation;
- The extent to which an ecosystems approach could help to identify suitable measures to help deliver Favourable Conservation Status; and
- The wider role an ecosystem approach can play in helping to make strategic choices about mitigation/compensation where a number of projects are impacting on the same area.

A recent precedent for considering the whole ecosystem in the UK is provided by the Wightlink Ferry project which was consented following Public Inquiry in December 2011. This project could have a small effect on low-shore mudflat habitat but the mitigation (NB not compensation) involves the protection of upper saltmarsh habitat. This was in recognition that the low-shore to high-shore intertidal cross-section is an ecologically-interconnected and changing/eroding system. Thus protecting the saltmarsh now will provide increased longevity not only to this upper intertidal area but also, by delaying its inevitable erosion, will increase the longevity of the mudflat habitat that it will become over time. This approach builds on an understanding of long-term habitat evolution and sustainability and represents a departure from a strict like-for-like approach.

The whole ecosystem approach appears to be more consistent with the one that has been applied in Germany where the interpretation of the Habitats Directive appears to be slightly more flexible. This approach also recognises the difficulty of predicting scheme development in the intertidal environment and the problems of setting and reviewing the fixed scheme objectives (which detail the predicted adverse impacts and the necessary compensatory and mitigation measures requirements and are often defined as part of an overall legally binding agreement).

This approach also ensures the many wider benefits that coastal habitat creation projects bring remain in view including, in terms of UK Biodiversity Action planning; improving the condition of Sites of Special Scientific Interest (SSSIs), enhancing the ecological status of waterbodies under the Water Framework Directive (WFD) and improving fisheries sustainability.

3.3.2 Timing of Compensatory Measures

The other key variable, as noted above, is the timing of compensatory measures when compared against the commencement of the impacts. In this respect, the guidance from the Office of the Deputy Prime Minister (ODPM, 2005, Paragraph 30) states that:

> *'..where new habitats are created as compensatory measures, the newly created habitats should be in place in time to provide fully the ecological functions that they are intended to compensate for'.*

The EC (2007) guidance establishes as a general principle that '*a site should not be irreversibly affected by a project before the compensation is in place*'. However, it recognises that there may be

situations where it will not be possible to fulfil this condition. It recommends that 'best efforts' should be made to assure compensation is in place beforehand. Where this is not achievable, the competent authorities should consider extra compensation for the interim losses that would occur in the meantime.

EC (2007) also (in Section 1.5.6) provides further specific guidance on the timing of compensatory measures. In particular it highlights the importance of '*the continuity of the ecological processes essential for maintaining the biological structure and functions that contribute to the overall coherence of the Natura 2000 network*'. It further requires '*a tight coordination between the implementation of the plan or project and the implementation of the measures, and relies on issues such as the time required for habitats to develop and/or for species populations to recover or establish in a given area*'. In addition, the guidance identifies that other factors and processes must also be considered:

- A site must not be irreversibly affected before compensation is in place;
- The result of compensation should be effective at the time the damage occurs on the site concerned. Under certain circumstances where this cannot be fully achieved, overcompensation would be required for the interim losses;
- Time lags might only be admissible when it is ascertained that they would not compromise the objective of 'no net losses' to the overall coherence of the Natura 2000 network;
- Time lags must not be permitted, for example, if they lead to population losses for any species protected in the site under Annex II of Directive 92/43/EEC or Annex I of Directive 79/409/EEC, requiring particularly attention when it entails priority species; and
- It may be possible to scale down in time compensatory measures according to whether the significant negative effects would presumably arise in the short, medium or long term.

The guidance emphasises that:

> *'all necessary provisions, technical, legal or financial, necessary to implement the compensatory measures must be completed before the plan or project implementation starts, so as to prevent any unforeseen delays that may hinder the effectiveness of the measures'.*

The Bristol Port Company's compensation agreement for the consented Bristol Deep Sea Container Terminal (BDSCT) constitutes the first agreement where advance timing was stipulated. The managed realignment site which is to compensate for the BDSCT is to be '*fully operational and have been subject to tidal inundation for a minimum of two winters, and 'winter' meaning the minimum period of December to February (inclusive)*' (First Corporate Shipping Ltd et al., 2008).

3.3.3 Location of Compensatory Measures

The 'Managing Natura 2000 Sites' document (EC, 2000) states that the compensatory measures proposed for a project should '*concern the same biogeographical region in the same Member State*'. EC (2001) further indicates that the compensatory provision should '*be in as close proximity as possible to the habitat that has been adversely affected by the project or plan*'. The EC 2007 guidance repeats the requirements for compensation measures to be within the same biogeographic region (for Habitat Directive sites) or within the same range, migration route or wintering area for bird species (site designated under the Birds Directive) in the Member State concerned.

In addition, there is general agreement that the local conditions necessary to reinstate the ecological assets at stake are found 'as close as possible to the area affected by the plan or project'. Therefore, locating compensation near to the Natura 2000 site concerned in a location showing suitable conditions for the measures to be successful seems the most preferred option. However, this is not always possible and it is necessary to set a range of priorities to be applied when searching locations that meet the requirements of the Habitats Directive. EC guidance states the priorities as:

- Compensation within the Natura 2000 site provided the necessary elements to ensure ecological coherence and network functionality exist within the site;

- Compensation outside the Natura 2000 site concerned, but within a common topographical or landscape unit, provided the same contribution to the ecological structure and/or network function is feasible. The new location can be another site designated as Natura 2000 or a non-designated location. In the latter case, the area must be designated as Natura 2000 site itself in due course and be subject to all the requirements of the 'nature' directives; and

- Compensation outside the Natura 2000 site, in a different topographical or landscape unit. The new location can be another site designated as Natura 2000. If compensation takes place on a non-designated location, the area must be designated as Natura 2000 site itself in due course and be subject to all the requirements of the 'nature' directives.

For some projects such as the Immingham Outer Harbour development in the Humber Estuary, the relevant compensatory measures (realignments at Welwick and Chowder Ness) were delivered within the Humber. Indeed, on the Humber the typical policy has been to seek to deliver compensation according to the particular location within the estuary system (inner-middle-outer) that the impacts occur (Halcrow *et al.*, 2012). For other projects there is a need, for reasons of practicality, to search for compensation site(s) further afield from the location of impact. The Government's compensation for impacts at Lappel Bank and Fagbury Flats was located between the areas where these losses occurred (see Image 1; ca. 22km and 50km away). However, the search for the best site covered the whole of the Greater Thames area from north Kent to southern Suffolk (ABPmer, 2003).

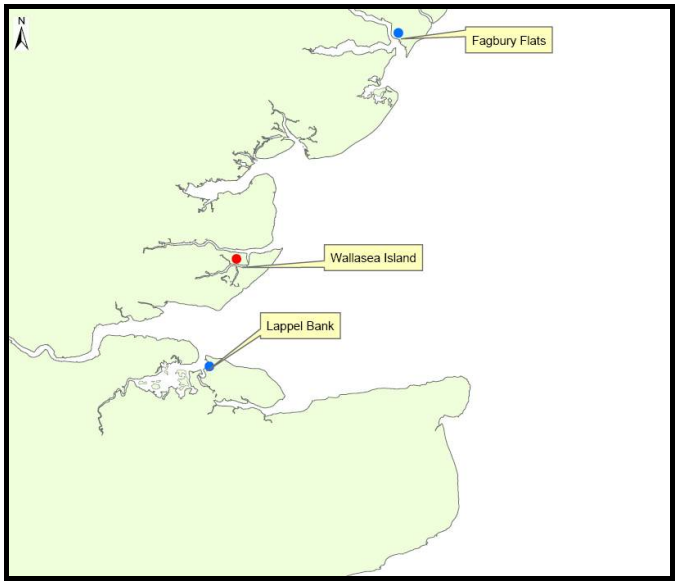


Image 1. Location of Wallasea and Port Developments at Lappel Bank and Fagbury Flats

The Bristol Port Company's Steart Habitat Creation scheme is located in the Bristol Channel, whereas the BDSCT impacts will occur at Avonmouth in the inner Severn Estuary, some 43km from the Steart site. The compensatory measures for the coastal defence works at Morecambe were also located 40km to the south of the zone of impact. For this project, no appropriate compensation site could be identified in the vicinity of the Morecambe Bay SPA itself and as such the Hesketh Out Marsh site on the Ribble Estuary was selected. The distance between the compensatory site and the location of the impacts was the main reason for the high 4:1 compensation ratio being adopted (see Table 3).

3.3.4 Objective Setting, Monitoring and Legal Agreements to Ensure Success

One of the defining principles associated with the implementation of a compensation measure is the need to have the requisite certainty that there will be no adverse effect on integrity. This can be brought about by the timing and the ratio (as described above) but it is also achieved through the setting of appropriate objectives and then the implementation of monitoring and management programmes in which the impacts of a development and the benefits of a compensation measure are monitored for a period and compared against each other over time.

There are a number of examples of such an environmental management planning approach being undertaken and underpinned by a legal agreement which in turn has allowed the Statutory Nature Conservation Body to have the confidence needed to withdraw an objection. Past projects include:

- Immingham Outer Harbour Environment Monitoring and Management Plan on the Humber;
- Seaforth River Terminal Monitoring and Mitigation Plan on the Mersey;
- Ipswich Ro-Ro berth;
- Harwich Channel Deepening since 1998/2000;
- Poole Channel Deepening (2006/2007);
- Trinity Terminal extension at Felixstowe (2003); and
- London Gateway Port (construction ongoing).

Another very recent example is The Bristol Port Company's (TBPC) Steart Habitat Creation Scheme which is being undertaken to create new mudflat and saltmarsh habitats in compensation for the loss and impacts on designated mudflats resulting from the proposed construction of a new deep water container terminal at Avonmouth (near Bristol). In summary, TBPC will carry out the compensation scheme so far as reasonably practicable to meet the following objectives:

- Deliver the required compensatory habitat (particularly 120ha of intertidal habitat, including at least 20ha of longer-term mudflat) in advance of the predicted damage to the designated habitats at Avonmouth during the construction of the BDSCT;
- Support around 3,000 water birds in the winter (together with the Avonmouth intertidal area);
- Be of sufficient quality to qualify for designation as an extension to the Severn Estuary European Marine Sites within ten years of becoming fully functional; and
- Require minimum future intervention and should be sustainable in the long term.

The securing of adaptive processes within legal agreements has therefore been increasingly used for large-scale projects.

These legal agreements are generally accompanied by objectives for habitat delivery or for the specific numbers of target species being accommodated (typically invertebrates and birds). These objectives are then generally regularly reviewed through monitoring. For most UK compensatory sites with specific compensation objectives it is however uncertain how these sites will be signed off and the habitat deemed as acceptable compensation for that which was lost. For all sites reviewed no official sign off procedure was in place from the outset and thus in practice there is no certainty about what will happen at the sites at the end of the defined review period.

With regard to the managed realignment sites on the Humber Estuary, which were undertaken to offset impacts of multiple Associated British Ports' developments, data is collected each year and reviewed against objectives at six monthly Environmental Steering Committee (ESC) meetings. It is assumed that this ongoing review process will be concluded at the end of the original ten-year monitoring period and a sign-off procedure agreed. Similarly at Defra's Allfleet's Marsh site at Wallasea, a Technical Advisory Panel will meet and review the data after the original five year monitoring period. They will then re-assess what monitoring needs to be taken forward into the future.

At the Trimley Marsh Managed Realignment, changes to monitoring that have occurred over the years have been agreed at meetings with the regulator group and recorded in the meeting minutes. This regulator group also agreed the final sign off of the site at the end of the monitoring period. Trimley Marsh was incorporated into the SPA a few years ago which is an added confirmation that the site has met its objectives and that the regulators are happy with the site. The potential for the boundaries of designated sites to be extended to include the managed realignment sites on the Humber Estuary has also been discussed at the six monthly review meetings. Natural England has advised, however, that the mechanism by which this is achieved is relatively complex and can take several years. It may therefore be more appropriate to agree that the sites are of sufficient quality to be included within the designated sites as part of the official sign off procedure and for Natural England to revise site boundaries during their ongoing review processes.

In Germany, the compensatory measures are written into the planning conditions for the respective damaging project. These plans are typically very long and complex documents. Site objectives though appear to be slightly less specific and more flexible in Germany than in the UK, particularly for more recent schemes. For example, for the recent Bremenports measures in the Weser Estuary, the objectives were purposely kept relatively general, and avoided stipulating biotope areas or bird numbers (in agreement with the regulators). This recognises the difficulty of predicting scheme development in the intertidal environment, and experience gained from earlier schemes.

However, some German sites have had specific bird numbers attached, most notably the Hahnöfer Sand measure in the Elbe Estuary, which has so far failed to attract the required roosting Shoveler numbers by a factor of 20 (some 50 pairs as opposed to the 1,000 anticipated). However, no corrective action has been requested by the regulators, as they had been involved in the design of the measure and had initially signed it off as apparently appropriate. Another German scheme in the Weser Estuary (Kleinensieler Plate) also failed to meet its objectives within a few years of implementation; here, the implementers felt a moral obligation to undertake corrective measures. These included dredging a lagoon which had accreted too rapidly and the adjustment of the cill levels (breach depth/invert levels) to reduce inundation frequencies. The implementers had to initially convince the regulators of the appropriateness of these corrective actions. Due to their success however, regulators have now expressed a desire to include corrective dredging in plans for similar upcoming managed realignments in Germany (Halcrow *et al.*, 2012).

None of the German sites have yet been officially signed off, and all the sites whose monitoring period will soon come to an end are anticipated to be maintained by the implementers into the foreseeable future. Monitoring timescales tend to be longer-term in Germany, especially for more recent schemes, averaging 15 years. However, monitoring frequencies appear to be lower (every two to three years in general) and aspects monitored very site specific (vegetation and birds at most sites). Sign off is envisaged at the end of the monitoring periods.

Finally, it should be noted that the increased consideration of overall ecosystem functioning (as described above) may bring with it different approaches to setting objectives; this has however yet to be implemented in practice.

3.4 Summary

In summary compensatory measures are required to maintain the coherence of the Natura 2000 network and should be of a comparable size and type to the habitats being lost or affected. However, this is not always achievable due to:

- The practicalities of identifying specific sites for habitat creation or enhancement measures within or near any given designated site; and

- Many compensatory habitats once created typically have evolving habitats rather than fixed sustainable features.

To address these considerations it is important to identify the best scientific understanding about the specific ecological requirements of the affected features and consider the flexibilities of extent, timing and location to provide requisite assurances of no adverse effect on integrity. In this respect there are precedents for considering not just like-for-like delivery but wider ecosystem functioning and how the offsetting measures compare against the losses in the context of the long-term projected evolution of a coastal ecosystem.

The key consideration is to ensure that the overall integrity of designated sites will be protected and there are valuable precedents which show that this can be achieved though the adaptive implementation of an integrated and iterative package of measures underpinned and informed by comparative monitoring of the ecological gains (from compensation) against the losses (from the plan or project). Based on these principles, the following Section reviews the possible compensation measures that could be applicable if one of the current Thames airport options were to be implemented, recognising that any such development would need to meet the requirements of the alternatives and IROPI tests before such measures could be considered.

4. Potential Compensation Measures

There are a number of options that could be used to compensate for the likely impacts of a Thames airport on European designated sites. These can include:

- Intertidal and subtidal habitat creation (Section 4.1);

- Identification of additional sites / areas for SAC designation (Section 4.2); and

- Enhancement opportunities (existing habitats/populations in designated sites not affected by the proposed developments) (Section 4.3).

4.1 Inter and Subtidal Habitat Creation Through Managed Realignment and Sediment Recharge

In order to create intertidal or subtidal habitats, two main techniques are theoretically feasible including:

- Managed realignment (including regulated tidal exchange); and
- Sediment reprofiling (either directly or indirectly).

4.1.1 Managed Realignment

Managed realignment is generally viewed as the main option for the creation of intertidal habitat, but it can also be used to create subtidal habitat in low lying areas, or in combination with sediment reprofiling. It involves the deliberate breaching, or removal, of existing seawalls, embankments or dikes in order to allow the waters of adjacent coasts, estuaries or rivers to inundate the land behind.

There are essentially three different managed realignment methods which can be applied:

- Managed breaching (or breach realignment);
- Defence removal (or bank realignment); and
- Regulated tidal exchange (RTE).

These techniques can be defined as follows.

Managed breaching

Breaching a site in one or more locations and thus leaving the old defence line mostly in place can provide more sheltered conditions for sediment accretion and vegetation establishment, and breach realignment is normally the cheaper solution (Leggett et al., 2004; Townend, 2006). Of the circa 110 managed realignment/RTE schemes implemented in Northern Europe to date, some 57 have been breach realignments compared to 26 which have been bank realignments (ABPmer, 2013). Image 2 shows an aerial image of a breach realignment (Allfleet's Marsh, Crouch Estuary, Essex).

Image 2. The Managed Realignment Along the North Bank Of Wallasea Island (At High Tide) – Bing Maps Derived Aerial View

Bank realignment

Undertaking bank realignment by removing a defence completely means that the created area becomes an integral part of the estuary/system. This can however lead to more wave activity due to a more exposed situation of the restored area, and consequently to lower accretion and vegetation establishment rates (which can be desirable where mudflat is the target habitat). Bank removal is generally considerably more expensive and more difficult to implement than breach managed realignment (Leggett et al., 2004; Townend, 2006; Pontee et al., 2006). Image 3 shows an aerial image of a bank realignment (Chowder Ness, Humber Estuary, Lincolnshire).

Image 3. The Managed Realignment at Chowder Ness - Google Earth Derived Aerial View

Regulated tidal exchange (RTE)

RTE is a form of managed realignment / intertidal habitat creation that allows the controlled inundation of defended land by saline water through the use of weirs, sluices, culverts and/or pipes inserted into a flood protection embankment. RTE differs from managed realignment in that the sea wall remains intact. Furthermore, through the use of tidal exchange mediums such as sluices and culverts a high degree of control is retained, the tidal flow and water exchange volumes are restricted and the existing defence line tends to require continued maintenance. To date a large number of small-scale RTE projects (19) have been undertaken in the UK, with the largest measuring around 20ha. Larger-scale projects have, however, been implemented overseas, including in the Netherlands, Germany and the United States, with the largest European scheme measuring almost 900ha at Beltringarder Koog, Germany. In the United States, at Batiquitos Lagoon (California), a 65ha coastal inlet which had been cut off from the sea was re-connected in 1994 as a compensatory measure (creating both subtidal and intertidal habitat) (Azevedo, 2000). There has been considerable technique variation amongst RTE schemes; from simple solutions whereby existing outfall sluice gates are manually opened, to sophisticated approaches employing Self Regulated Tide gates (SRTs) or a high inlet/low outlet RTE approach (termed 'Controlled Reduced Tide' in Belgium). Those utilising pipes or culverts have to date been more popular than those employing other exchange structures. Many recent schemes have been employing SRTs for exchange regulation (Halcrow et al., 2012). Images 4a and b show a SRT gate at a RTE scheme, while an example of a high inlet sluice gate is shown in Image 5.

(Source: RSPB)

Image 4a. The SRT Gate at Goosemoor River Clyst, Devon) at Low Tide

(Source: RSPB)

Image 4b. The SRT Gate Floating on a Rising Tide

(Source: O. Beauchard, Antwerp University)

Image 5. The Lippenbroek (Scheldt Estuary, Belgium) Inlet Structure at High Tide

4.1.1.1 Review of experience

As indicated above, numerous managed realignment sites have been implemented to date, and the technique has been proven as largely successful. Managed realignment can be especially valuable for saltmarsh creation, though functional equivalency with adjacent mature marshes can take many years if not decades to achieve (e.g. Brown *et al.*, 2007). Mudflat creation has also been successfully achieved in many cases, though, as previously mentioned, in estuaries with a high sediment load, such as the Humber and the Severn, rapid accretion has occurred, elevating significant proportions of managed realignment sites out of the mudflat range after a few years (Halcrow *et al.*, 2012). However, in estuaries with lower sediment loads, accretion rates over mudflats tend to be significantly lower, and mudflat can thus be expected to be maintained for several decades. This is, for example, the case at Allfleet's Marsh (Crouch, Essex), where some 10cm have accreted over the mudflats over the course of five years (ABPmer, 2012).

With regards to subtidal habitat creation, this has to date not been pursued on a large scale in the UK, although there are examples in mainland Europe and the United States (as previously mentioned), and small scale lagoons are frequently incorporated into UK managed realignment design (e.g. Welwick, Humber; Abbotts Hall, Blackwater). As managed realignment sites are typically fairly sheltered, a 'settling tank' effect is often observed and subtidal/lagoon features in managed realignment sites tend to accrete/fill in fairly rapidly, even in estuaries with lower sediment loads (e.g. Hagge et al., 1998; ABPmer, 2012). This effect is generally particularly pronounced in RTE sites, where the hydrodynamic

environment tends to be fairly un-dynamic, with often long slack periods, due to the restricted size of the water exchange medium(s). In Germany, the Kleinensieler Plate RTE scheme which aimed to create a subtidal lagoon required dredging only five years post implementation (as well as other measures aimed at reducing future sedimentation), due to rapid filling in (Schirmer et al., 2003).

4.1.2 Sediment Reprofiling

Sediment reprofiling (either the deposition of sediment or removal of sediment) can be used to manipulate existing habitats. Intertidal recharge is a process by which dredged sediments are placed over or around intertidal mudflats and saltmarshes to either restore them or to protect them from ongoing erosion (Nottage and Robertson, 2005; Cefas, 2009). Recharge can also be utilised to create intertidal habitat on what was previously subtidal habitat. An example recharge scheme at Lymington, on the south coast of England, is shown in Image 6.

(Source: ABPmer)

Image 6. The Wightlink Lymington Recharge Scheme

This approach is especially valuable for protecting habitats that are perhaps sediment starved and where the introduction of dredge arisings will allow the habitat to cope with and respond to sea level rise.

Recharge projects can differ greatly in terms of their scale (i.e. the area of deposition or the volume of sediment used) and on the basis of the number of structures, if any, that might be put in place to retain sediments once they are deposited (Colenutt, 1999 and 2001). However, the ethos is usually that the sediments are allowed to integrate benignly into the local environment with the whole process being viewed very much as a 'sacrificial' one (i.e. the expectation is that the deposited sediment will eventually dissipate over time and contribute to the local sediment supply). While dissipation is likely to occur, the rates vary depending upon the local conditions and the type and volume of the sediment deposited, the recharge materials often stays at the site of deposition for months/years and can also be topped up during regular maintenance dredge campaigns. Therefore this process can be a cost-effective, adaptable and a sustainable way to delay the erosion of habitats at the deposition/recharge site. This method has also been adopted as a valuable way of retaining sediments within an estuarine system (as opposed to exporting them to an offshore site for deposition). Most schemes use fine sediment from the navigational dredging of ports and harbours and, in doing so, provide a ‘beneficial’ use for this material. However, other sediment sources have also been considered. Typically this kind

of work is undertaken as mitigation (as opposed to compensation) for port activities and to date at least 20 such schemes have been undertaken in the UK (ABPmer internal database).

Removal of sediment has been used in some locations (often in conjunction with managed realignment) to create intertidal habitat. It could also be used to create subtidal habitat, but this has rarely if ever been undertaken for nature conservation reasons as the ecological value of intertidal areas is generally greater than subtidal areas.

Sediment reprofiling could also be achieved indirectly by manipulating patterns of erosion or deposition through engineering interventions, but there are few examples of where this has been undertaken for nature conservation benefit.

4.1.3 Costs Incurred for Past Intertidal Habitat Creation/Enhancement Measures

Research, led by ABPmer, into the costs of managed realignment schemes has revealed that the average unit cost for all schemes that have been implemented up to and including 2011 is about £34,000 per hectare. Costs have, however, increased significantly (almost six fold) since managed realignments were first implemented. Average unit costs for schemes implemented since 2000 are £ 47,090 per hectare. Compensatory schemes tend to be most expensive, costing on average £ 75,000 per hectare. There appears to be little evidence of larger managed realignment schemes having economies of scale. This is illustrated in Image 7, which also demonstrates that schemes implemented after 2000 had higher unit costs. With regards to component costs, site preparation and landward defence construction on average account for over 60% of the cost of a realignment. The next biggest cost tends to be pre-implementation costs (i.e. planning, assessing, consulting) accounting for just over 20% of overall scheme costs, followed by land purchase (accounting for ca. 11%). Post-scheme management and monitoring tend to account for around 5% of the overall cost.

Table 4 lists the total and per unit costs of schemes which have been implemented to date, as well as anticipated costs of two which are expected to be breached in 2013 (based on 2011 prices, and a survey undertaken in 2011). The following are compensatory schemes (main purpose): Allfleet's Marsh, Chowder Ness, Paull Holme Strays, Trimley, Welwick.

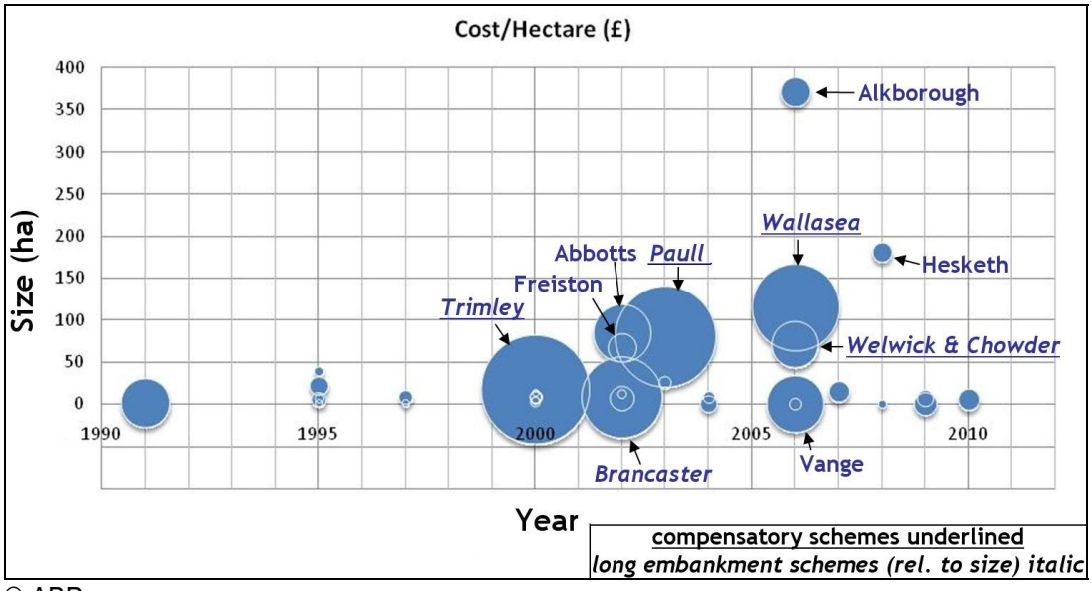


Image 7. Unit Costs Of Implemented Realignments Plotted Against Size And Year

Table 4. Costs of Managed Realignment schemes in the UK

Scheme	Location	Type	Year	Area (ha)	Total Cost - 2011	Unit (Per Hectare) Cost – 2011
Abbott's Hall	Blackwater	breach	2002	85	£5,350,800	£62,951
Alkborough	Humber	sill breach	2006	370	£11,689,200	£31,592
Allfleet's Marsh (Wallasea)	Crouch/Roach	breach	2006	115	£10,657,800	£92,677
Alnmouth 1 + 2	Alne	breach	2006	28	£58,446	£2,087
Annery Kiln	Taw/Torridge	breach	2000	3.8	£2,682	£706
Barking Creek	Thames	bank realignment	2006	1.04	£1,008,480	£969,692
Black Devon Wetlands	Firth of Forth	regulated tidal exchange	2000	7	£120,690	£17,241
Black Hole Marsh	Axe	regulated tidal exchange	2009	6	£106,500	£17,750
Brancaster West Marsh	Norfolk Coast	breach	2002	7.5	£764,400	£101,920
Brandy Hole	Crouch/Roach	breach	2002	12	£114,660	£9,555
Clapper Marshes	Camel	regulated tidal exchange	2011	10	£257,000	£25,700
Devereux Farm	Hamford Water	breach	2010	15	£258,750	£17,250
Donna Nook[1]	Humber	breach	2013	137	£6,500,000	£47,445
Freiston	The Wash	breach	2002	66	£2,063,880	£31,271
Glasson	Conder	regulated tidal exchange	2002	6.4	£171,480	£26,794
Goosemoor	Clyst	regulated tidal exchange	2004	6	£130,200	£21,700
Goswick/Beal	south Low River	regulated tidal exchange	2010	4.5	£98,325	£21,850
Havergate Island	Ore	breach	2000	8.1	£100,575	£12,417
Horsey Island	Hamford Water	regulated tidal exchange	1995	1.2	£2,714	£2,262
Lantern Marsh	Ore	breach	1999	29	£20,355	£702
Lepe / Darkwater	Lepe	regulated tidal exchange	2005	5	£142,074	£28,415
Man Sands	Dorset coast	groyne removal	2004	3	£24,100	£8,033
Medmerry[2]	West Sussex coast	breach	2013	263	£15,000,000	£57,034
Nigg Bay	Cromarty Firth	breach	2003	25	£123,600	£4,944
Northey Island	Blackwater	breach	1991	0.8	£36,938	£46,173
Orplands	Blackwater	breach	1995	38	£180,960	£4,762
Paull Holme Strays	Humber	breach	2003	75	£9,270,000	£123,600
Pillmouth	Taw/Torridge	breach	2000	12.9	£14,751	£1,143
Ryan's Field	Hayle	regulated tidal exchange	1995	6.23	£24,731	£3,970
Saltram	Plym	regulated tidal exchange	1995	4.2	£55,796	£13,285
Seal Sands	Tees	regulated tidal exchange	1993	9.08	£707,850	£77,957
South Efford Marsh	Avon	regulated tidal exchange	2011	17	£330,000	£19,412
Thorness Bay	Solent	breach	2004	7	£89,773	£12,825
Thornham Point	Chichester Harbour	breach	1997	6.9	£70,800	£10,261
Tollesbury	Blackwater	breach	1995	21	£452,400	£21,543
Treraven Marsh	Camel	regulated tidal exchange	2007	14	£233,730	£16,695
Trimley Marsh	Orwell	breach & land raising	2000	16.5	£1,810,350	£109,718
Vange Marsh	Thames	regulated tidal exchange	2006	1	£51,570	£51,570
Walborough	Axe	regulated tidal exchange	2004	4.5	£48,200	£10,711
Warkworth	Coquet	breach	2009	0.4	£51,120	£127,800
Watertown Farm	Taw/Torridge	breach	2000	1.5	£2,682	£1,788
Welwick / Chowder Ness	Humber	breach	2006	69	£3,438,000	£49,826

[1] Not yet breached; anticipated costs in 2011, will have increased; [2] not yet breached; anticipated costs in 2011 (have increased)

Cost information is available for a small recent recharge scheme in Lymington Harbour (Hampshire), whereby some 0.5 hectares (ha) of saltmarsh was improved by adding sediment. The costs for the first phase of the replenishment works and monitoring cost were £74,000 in 2012, and a further £36,000 is envisaged for another round of replenishments in 2013, during which a further ca. 1,500 tonnes of sediment are to be added and some of the detainment structures improved (Lymington Harbour Commissioners, 2013). A project of a similar scale and extent (details of which cannot be provided) cost almost £500,000 in total, including planning, modelling and implementation.

4.2 Identification of Additional Sites/Areas for SAC Designation

Theoretically, it could be possible to designate additional locations as SACs in order to compensate for losses to existing sites. However, based on current research there appears to be no precedent for this in the UK or Europe more widely.

Potential locations for additional designations would need to be evaluated against the site selection criteria laid down in the Habitats Directive and in relation to the potential contribution they might make in compensating for impacts of airport development in the Thames Estuary. Areas of search for new SAC site designations would need to focus on areas supporting potentially qualifying features. This could include features within areas currently classified as SPAs but which were not already protected by the SPA designation. Habitat enhancement may be required in order to ensure that areas are of a sufficient quality to be designated.

It would not be possible to designate additional areas as SPAs. Under Article 4 of the Birds Directive, Member States are already required to classify all suitable territories as SPAs.

4.3 Enhancement Opportunities (existing habitats/populations)

A wide range of enhancement measures could be implemented as compensatory measures. These include any of the mitigation measures identified in Table 2 where these are implemented:

- In designated sites that are not affected by a possible airport development (or where the benefits of the measures help to protect features associated with designated sites that are not affected by a possible airport development); and
- Where they are not already required to support achievement of the conservation objectives for those features in the relevant sites.

For example, improvements to the quality of existing habitats could be achieved by reducing existing pressures from human activities, for example reductions in the intensity and spatial extent of towed fishing gear impacts on sea bed habitats or reductions in areas subject to marine aggregate dredging or dredged material disposal. Similarly, improvements to the spawning and nursery habitats of fish could contribute to an overall package of compensation (where they benefit fish or bird species using the affected designated sites).

5. Potential Options/Requirements for Compensation

The following section provides a high level review of potential compensation opportunities which could be applied to the Thames airport options that are currently under investigation. In contemplating possible compensation options, it is recognised that this could suggest that assumptions have been made about the need for the project, alternative solutions and IROPI. However, this exploration of

possible measures is not intended to bypass these requirements but simply to look at what might be possible, should these other tests be satisfied.

5.1 Inner Estuary Option

5.1.1 Possible Impact Footprint

The Inner Thames option in its current location would result in a direct loss of approximately 1,830 ha of intertidal and subtidal habitat. The extent of overlap with internationally designated sites is summarised in Table 5 and includes overlap with terrestrial as well as intertidal and subtidal habitats. There are also likely to be indirect changes in intertidal habitat extent as a result of changes in the hydrodynamic (water levels) and sedimentary regimes (changes in patterns of sediment erosion and deposition) (ABPmer, 2013). These indirect losses have not been quantified at this stage. Impacts to wading birds are being considered separately by Atkins (Atkins, 2013a, b and c).

Table 5. Area of overlap of Inner Thames option with designated sites

Designation	Site	Area of Overlap (ha)	Percentage of Total Designated Site (%)
SPA	Thames Estuary and Marshes	2220	46
	Medway Estuary and Marshes	171	4
Ramsar	Thames Estuary and Marshes	2220	40
	Medway Estuary and Marshes	171	4

5.1.2 Compensatory Opportunities

It is considered that a compensatory package for this option would mostly consist of intertidal and subtidal habitat creation, but it is possible that additional measures would be required for migratory fish, waders and sea birds.

It is envisaged, based on previous experience (see Section 3), that the ratio of intertidal habitat provision to intertidal habitat loss would be at least 2:1. It is possible that lower compensation ratios could be acceptable for indirect losses, and losses occurring outside of the boundaries of the European designated sites. Managed realignment schemes themselves will invariably lead to physical processes changes in the estuaries they are undertaken in (or along the coasts they are undertaken on), so mitigation/compensation for such impacts would have to be considered, and the area required for compensation would be likely to increase.

Thus, it is considered that there would be a requirement for the creation of a considerable extent of intertidal habitat According to current guidance the required habitat creation would be expected to be on a like-for-like basis (i.e. will likely be required to deliver predominantly mudflat, with some saltmarsh and subtidal habitat). It is worth highlighting that existing measures have to date mainly focused on intertidal habitats and to the best of ABPmer's knowledge, a large-scale subtidal compensatory habitat scheme has yet to be implemented in the UK, although European and American case examples do exist (see Section 4.1.1).

The replacement habitat would not necessarily need to be provided at a single location. It would be considered preferable, however, if the replacement habitat was as close to the airport option as possible. In this context site selection exercises have already been undertaken in the Thames Estuary and elsewhere along the Anglian and South-East coasts. These exercises were mostly led by the Environment Agency in projects including the Thames Estuary 2100 (TE2100) flood risk management

strategy, the Greater Thames Coastal Habitat Management Plan (CHaMP), and in the South-East and Anglian Regional Coastal Habitat Creation Programmes. In reality, given the scale of habitat requirement, the area of search would be necessarily large and could be extended to include the entire biogeographical region. The extent of this region would very much depend on the feeding ranges and migration routes of the birds for which the overlapping SPAs are designated.

Regardless of the area of search applied, implementing such a large scale intertidal habitat creation project would be challenging. To put this into perspective, over the past 25 years, just over 1,500ha of intertidal habitat has been created in the UK through the implementation of over 55 schemes (ABPmer, 2013c). The largest UK managed realignment site to date, at Alkborough on the Humber, measures 370 ha. Finding enough land for such a large scale habitat creation scheme will be challenging. Much of the land that would potentially be suitable for intertidal habitat creation along the South-East and East coasts is either densely populated, highly valuable (e.g. for food production and industrial use) or already designated. Furthermore managed realignment can face public opposition, particularly those schemes which are of a larger-scale. Costs can also be significant, and have largely been increasing over time, with relatively limited economies of scale generally being delivered (see Section 4.1.3 for more detail on costs).

The timescale for delivery in relation to the predicted losses would also need to be agreed with regulators. Such a large scale habitat creation programme would be likely to take many years to implement. Based on experience with larger scale UK projects (100 to 300ha), it is estimated that it would take at least two years to find suitable site(s). The land purchase, design and assessment/ consenting phases of such schemes would also be expected to be fairly protracted due to the size of area involved. Construction would then probably take at least two to three years. There is however, the possibility that some of these phases could overlap to some extent. Overall, we suggest that the process is likely to take several years to secure planning permission and complete construction works.

5.2 Outer Estuary Option

5.2.1 Possible Impact Footprint

The Outer Thames option in its current location would result in a direct loss of approximately 5,530 ha of subtidal habitat including shallow inshore waters and subtidal sandbanks. The loss of subtidal habitat will also affect the extent of available foraging habitat for Red Throated Diver. The extent of overlap with designated sites is summarised in Table 6. There are also likely to be indirect changes in subtidal habitat composition as a result of changes in flow speeds and sedimentary regimes (changes in patterns of sediment erosion and deposition) (ABPmer, 2013). These indirect losses have not been quantified at this stage. Impacts to wading birds, for example, as a result of bird strike, are being considered separately by Atkins (Atkins, 2013a, b and c).

Table 6. Area of overlap of Outer Thames option with designated sites

Designation	Site	Area of Overlap (ha)	Percentage of Total Designated Site (%)
SPA	Outer Thames Estuary	5227	1
cSAC	Margate and Long Sands	1954	3

5.2.2 Compensatory Opportunities

It is considered that delivering a like for like compensation package for the Outer Thames option would be very challenging. This is primarily due to the scale of the direct losses of subtidal habitat and the

difficulty in replacing such habitat. While the construction of saline lagoons or a new coastal inlet is theoretically possible, this would not create truly like-for-like subtidal habitat, as the sediment properties, depth and openness of the current habitat could not be achieved. In particular, it is unlikely to be possible to create subtidal sandbank habitat through this means.

Depending on the extent to which impacts to Red Throated Diver can be mitigated within the Outer Thames SPA (for example through enhancement of herring stocks or reductions in disturbance), it may be necessary to deliver additional compensatory measures for this species. This could require similar measures to be applied in other SPAs supporting Red Throated Diver.

Due to the difficulties associated with subtidal sandbank habitat creation to offset losses within the Margate and Long Sands cSAC and the limited opportunities for habitat enhancement, the designation of currently undesignated habitat could be considered. It should be noted (as described in Section 4.2) that based on current research there appears to be no precedent for this in the UK or Europe more widely. To compensate for the SAC losses, it is assumed that at least 1,954ha (assuming a 1:1 ratio) of non-designated, high value, areas of subtidal sandbank would need to be located, and accepted by regulators.

In addition, a number of additional enhancement measures could be implemented to seek to ensure that the overall coherence of the Natura 2000 network is maintained. These might include intertidal habitat creation, reductions in pressure from other human activity or specific forms of biodiversity enhancement. While some of these measures would not deliver like-for-like benefits, they could be considered in terms of their contribution to overall ecosystem function and in delivering 'measures of equivalent value'. However, in pursuing this route, it would be necessary to demonstrate to the satisfaction of the EC that such measures sufficiently contributed to the maintenance of the Natura 2000 network.

6. Summary

In conclusion, mitigation and compensation for impacts to designated sites are complex issues, and requirements are likely to be very extensive for either airport option. As neither option has been subject to detailed environmental impact assessment as yet, the scale of impacts and the degree to which they could be mitigated is not certain. Similarly, the exploration of potential compensatory measures is at a very initial stage and it would therefore be inappropriate to draw firm conclusions about the extent to which either of the Thames airport options considered may or may not be able to comply with the requirements of the Habitats Regulations. Given the current uncertainties surrounding impacts, the evaluation provided in this report only covers the potentially affected features at a high level. Furthermore, it is recognised that consideration of compensatory measures for any project affecting a Natura 2000 site can only be entertained once the requirements of the alternatives and IROPI tests have been met.

With regard to the two options, achieving mitigation and like-for-like compensation requirements for the Inner Estuary option may be more feasible than for the Outer Estuary option, though this would still present significant challenges. Extensive mitigation and compensation would be required to make either option legally complaint. A more rigorous evaluation of potential measures is recommended as part of the next phase of option development, including the identification of sites that could be suitable for habitat creation or considered for SAC designation, as well as a more detailed review of possible ecological enhancements.

7. References

ABPmer, 2003. Lappel Bank and Fagbury Flats Compensatory Measures: Phase 1 Site Selection Revisited. ABP Marine Environmental Research Ltd, Report No. R.956.

ABPmer, 2012. Allfleet's Marsh Managed Realignment Results of Monitoring from 2006 to 2012. ABP Marine Environmental Research Ltd, Report No. R.1967 (Draft).

ABPmer, 2013a. Thames Estuary - Marine Environmental Baseline. ABP Marine Environmental Research Ltd, Report No. R. 2130.

ABPmer, 2013b. Thames Estuary - Airport Impact Appraisal. ABP Marine Environmental Research Ltd, Report No. R.2131.

ABPmer, 2013c. The Online Managed Realignment Guide. Website content available at: http://www.abpmer.net/omreg/ [last accessed May 2013]

Atkins, 2013a. Hub for London. Wlidlife Hazards Good Practice – Technical Note.

Atkins, 2013b. Hub for London. Potential Bird Strike Risk – Technical Note.

Atkins, 2013c. Hub for London – Impact Appraisal – Part A: Terrestrial Ecology – Technical Note.

Azevedo, M., 2000. Wetlands mitigation – reflections on a hazardous road. California Coast and Ocean, Winter 1999-2000, 19-32.

Black and Veatch Consulting Ltd., 2004. Humber Draft CHaMP. Prepared on behalf of the Environment Agency.

Brown, S.L., Pinder, A., Scott, L., Bass, J., Rispin, E., Brown, S., Garbutt, A., Thomson, A., Spencer, T., Moller, I. and Brooks, S.M., 2007. Wash Banks Flood Defence Scheme - Freiston Environmental Monitoring 2002-2006. Centre for Ecology and Hydrology, Dorchester, 374p.

Burton, N.H.K., 2006. The impact of the Cardiff Bay barrage on wintering waterbirds. Waterbirds around the world. Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh. p805.

Cefas, 2009. Dredged marine sediments. Website content available at: http://www.cefas.defra.gov.uk/our-science/assessing-human-impacts/dredged-marine-sediments.aspx?RedirectMessage=true [last accessed May 2013]

Colenutt, 1999. Evaluation of Inter-Tidal Recharge Techniques: A Discussion. New Forest District Council, Lymington, 16p. Report available at: http://www.nfdc.gov.uk/index.cfm?articleid=3810&articleaction=dispmedia&mediaid=2610 [last accessed February 2012]

Colenutt, 2001. Saltmarsh Management Techniques - A Review New Forest District Council Coast Protection Group October 2001. New Forest District Council, Lymington, 29p. Report available at: http://www.nfdc.gov.uk/index.cfm?articleid=2544&articleaction=dispmedia&mediaid=2311 [last accessed May 2013]

Department for Environment, Food and Rural Affairs (Defra), 2012. Habitats Directive: guidance on the application of article 6(4) - Alternative solutions, imperative reasons of overriding public interest (IROPI) and compensatory measures. Defra, London, 10p.

Environment Agency (EA), 2005. Humber Estuary Flood Defence Strategy, Paull Holme Strays Environmental Monitoring Report. Environment Agency, Leeds, 51p.

European Commission (EC), 2000. Managing Natura 2000 Sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.

European Commission (EC), 2001. Assessment of plans and projects significantly affecting Natura 2000 sites Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC November 2011.

European Commission (EC), 2007. Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC Clarification of the concepts of: alternative solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall coherence, opinion of the commission. January 2007.

European Commission (EC), 2011. The implementations of the Birds and Habitats Directives in estuaries and coastal zones with particular attention to port development and dredging. EC January 2011.

First Corporate Shipping Ltd, Natural England, the Environment Agency and the RSPB, 2008. Mitigation, Compensation and Monitoring Agreement Relating To The Bristol Deep Sea Container Terminal. First Corporate Shipping Ltd (trading as The Bristol Port Company), Bristol, 39p (excl. appendices).

Hagge, A., Thiel, H., Peters, C.P., Lüdemann, K.L., 1998. Hydrobiologische Untersuchungen im Beltringharder Koog und in den vorgelagerten Wattgebieten - Abschlussbericht 1987-1997 - Teil 3: Salzwasserlagune. Universität Hamburg, Hamburg. 156p.

Halcrow, ABPmer and Institute of Estuarine and Coastal Studies, 2012. Humber Estuary Managed Realignments: Lessons for the Future - Volume 1: Review Document. Halcrow, Leeds, 259p.

HM Government, 2012. Report of the Habitats and Wild Birds Directive Implementation Review HM Government, London, 52p.

Institute of Environmental Management and Assessment (IEMA), 2012. Considering alternatives during the EIA. IEMA, London, 4p.

Institute of Environmental Management and Assessment (IEMA), 2013. Position Statement Revising Directive 2011/92/EU - The Environmental Impact Assessment (EIA) Directive. IEMA, London, 15p.

Lowe, S., 2012. 'Lymington Harbour habitat replenishment scheme: Summary of works'. The Crown Estate, London, 18p.

Lymington Harbour Commissioners, 2013. Harbour News - Habitat Replenishment. Website content available at: http://www.lymingtonharbour.co.uk/News/habitat.htm [last accessed May 2013]

Natural England and Joint Nature Conservation Committee, 2010. Departmental Brief: Outer Thames Estuary Special Protection Area. Natural England and Joint Nature Conservation Committee, Peterborough, 21p.

Nottage, A. and Robertson, P., 2005. The saltmarsh creation handbook: a project manager's guide to the creation of saltmarsh and intertidal mudflat. RSPB, Sandy. 128p.

Office of the Deputy Prime Minister (ODPM), 2005. Circular 06/05: Biodiversity and Geological Conservation - Statutory Obligations and Their Impact Within the Planning System 16 August 2005.

Royal Haskoning, 2005. Saltmarsh Management Manual. Royal Haskoning, Peterborough, 253p.

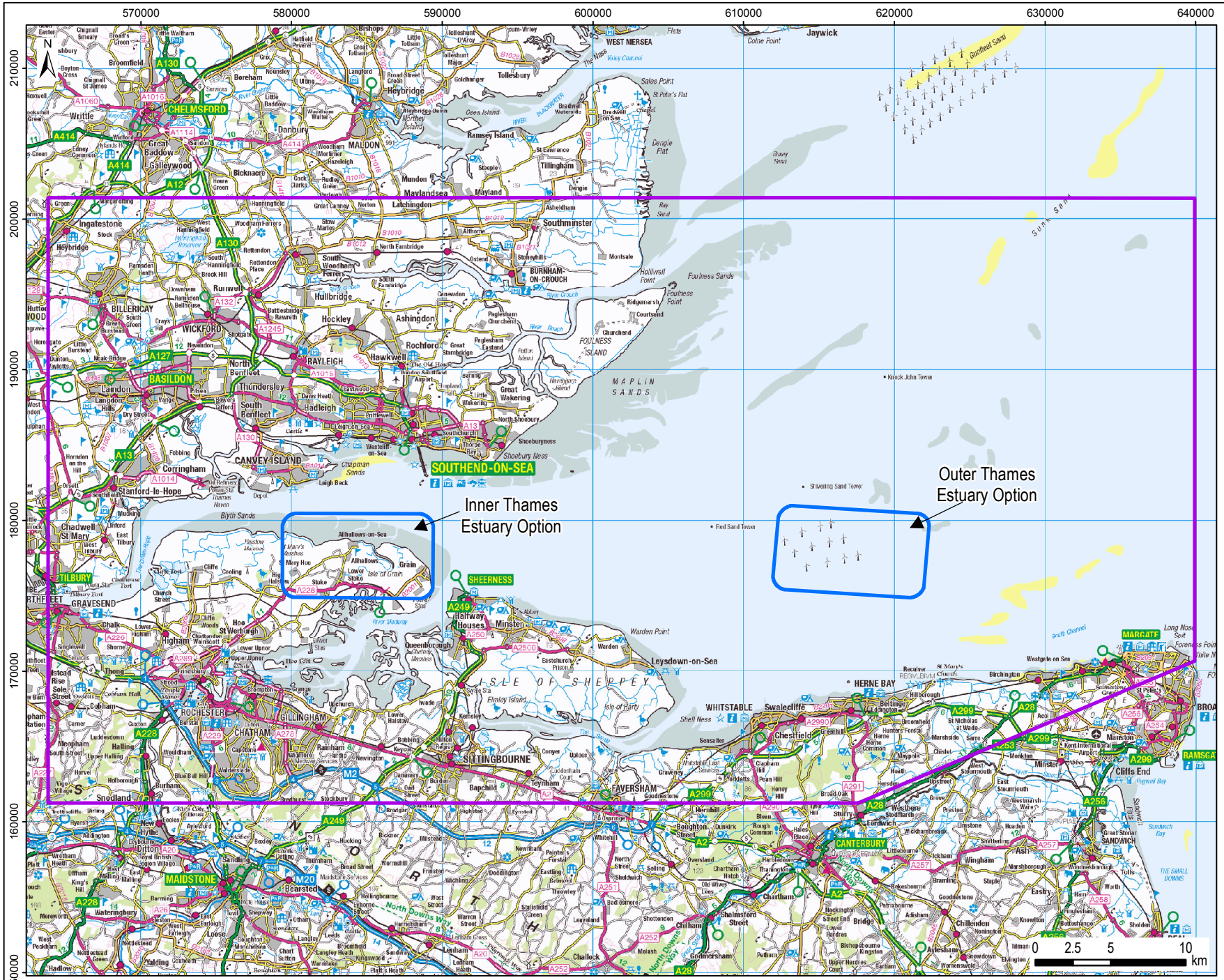
Royal Haskoning, 2005. Saltmarsh Management Manual. Royal Haskoning, Peterborough, 253p.

Schirmer, M. and Lange, J., 2003. Aquatische Fauna Flachwasserzone 'Kleinensieler Plate'. Wasser- und Schifffahrtsamt Bremerhaven Fachseminar "14m-Ausbau – Auswirkungen auf die Umwelt'.

The Planning Inspectorate, 2011. Appeal Decisions - Appeal A: APP/B1740/A/11/2152093, Appeal B: APP/B9506/A/11/2152094. The Planning Inspectorate, Bristol, 59p.

Young Associates, 2001. Morecambe Phase V11 Coastal Defences Proposal Environmental Statement and Appropriate Assessment Final Report A2106 November 2001.

Figures



Study Area

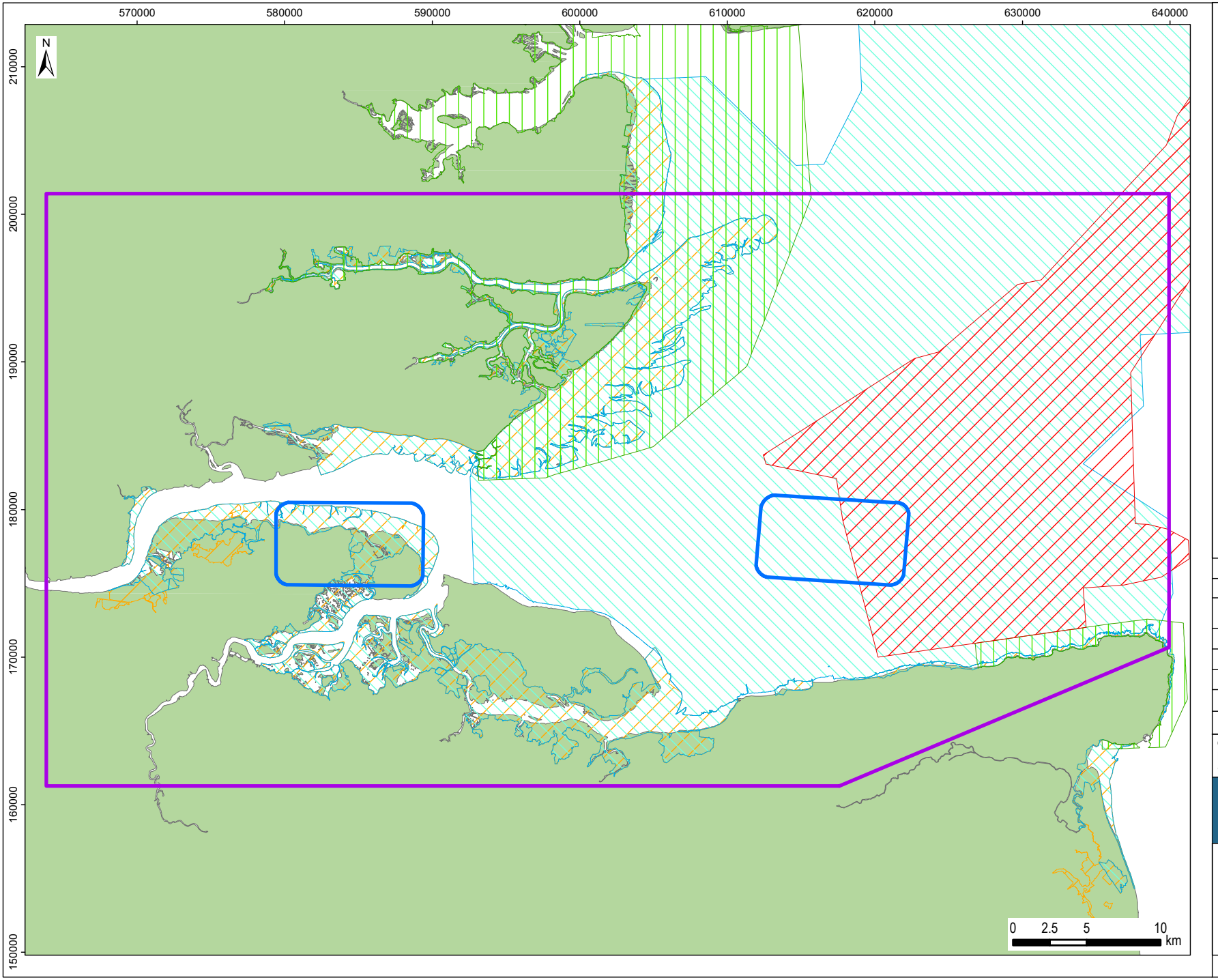
Possible Airport Options

Date	By	Size	Version
May 13	NMW	A4	1
Coordinate System		British National Grid	
Projection		Transverse Mercator	
Scale		1:350,000	
QA		FMM	
Fig1_Study_Area.mxd			
Produced by ABPmer			

ABP mer
marine environmental research

Study Area and Possible Airport Locations

Figure 1



Study Area

Possible Airport Options

Candidate Special Area of Conservation

Special Area of Conservation

Special Protection Area with Marine Components

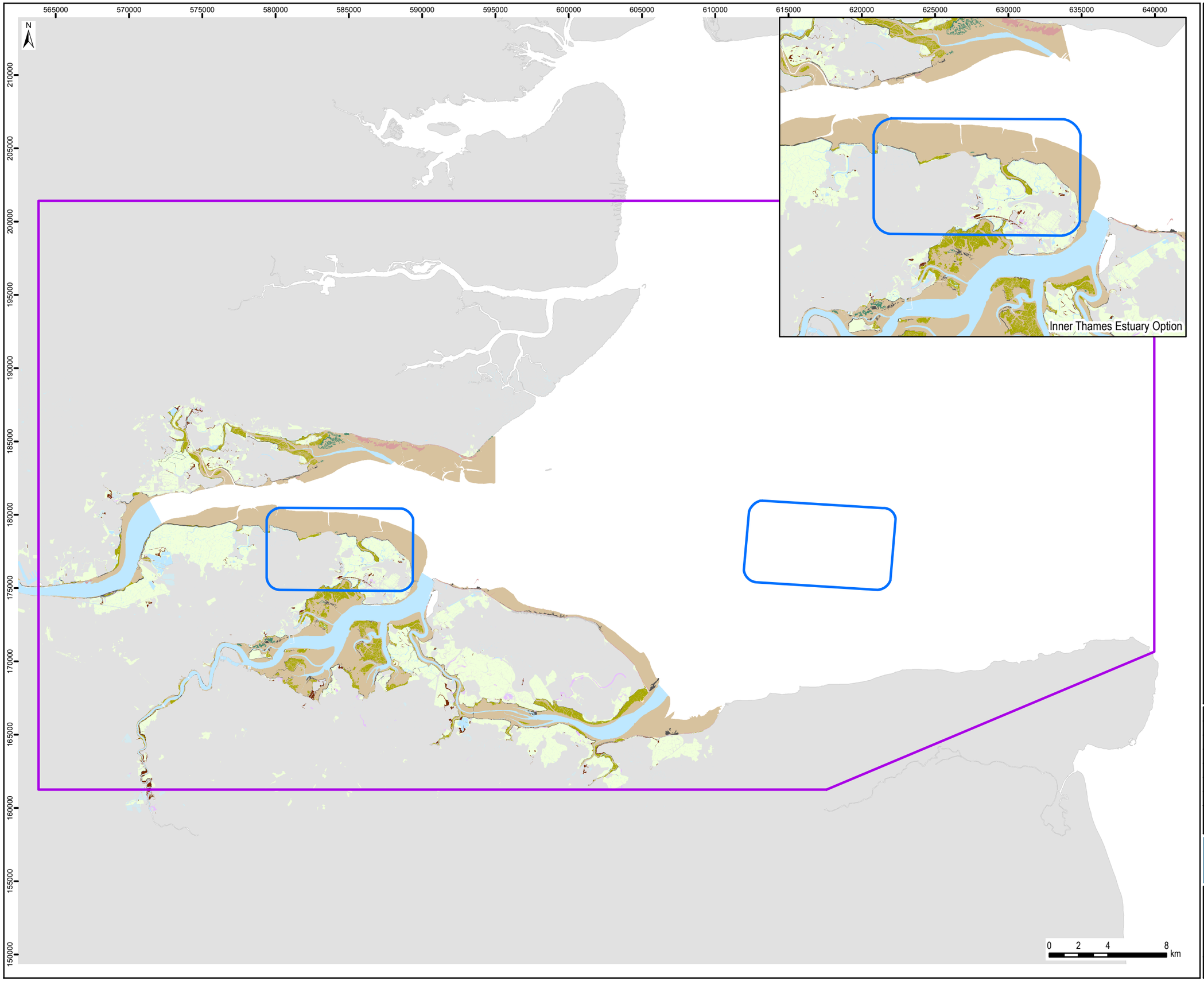
Ramsar

Date	By	Size	Version
Jun 13	NMW	A4	1
Coordinate System		British National Grid	
Projection		Transverse Mercator	
Scale		1:350,000	
QA		FMM	
Fig2_MitComp_Int_Designations.mxd			
Produced by ABPmer			

ABP mer
marine environmental research

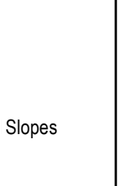
International Designations

Figure 2



Study Area
Possible Airport Options
Fresh Water
Estuarine Water
Intertidal Mud, Sand, Sediment
Sea Grass
Intertidal Gravel and Shingle
Reedbeds
Marsh/Swamp Vegetation
Saltmarsh
Sand Dunes
Grazing Marsh
Sea Wall/Rock
Marine Cliffs and Slopes

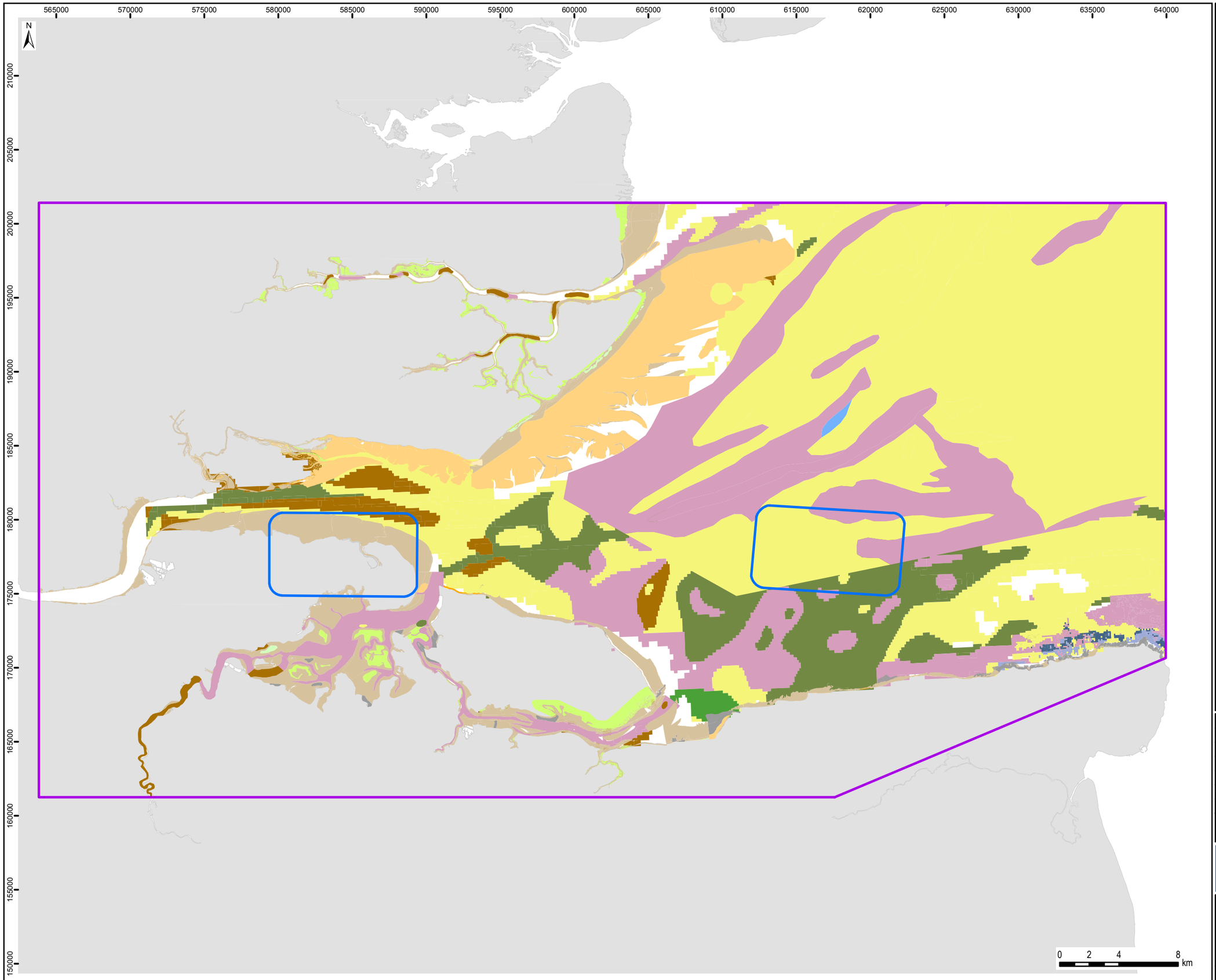
Date	By	Size	Version
May 13	NMW	A3	1
Projection		OSGB 1936	
Scale		1:240,000	
QA		FMM	
4155 - Fig3_MitComp_Int_Habitats.mxd			
Produced by ABPmer			



ABP mer
marine environmental research

Intertidal Habitat Map

Figure 3



Study Area

Possible Airport Options

Habitats

- A1.1 - A1.4 Intertidal Rock
- A2.1 Intertidal Coarse Sediment
- A2.2 Intertidal Sand & Muddy Sand
- A2.3 Intertidal Mud
- A2.4 Intertidal Mixed Sediment
- A2.5 Saltmarsh
- A2.6 Eelgrass
- A3.2 Infralittoral Rock
- A4.2 Circalittoral Rock
- A5.1 Subtidal Coarse Sediment
- A5.2 Subtidal Sand
- A5.3 Subtidal Mud
- A5.4 Subtidal Mixed Sediment
- A5.6 Subtidal Biogenic Reefs

Date	By	Size	Version
May 13	NMW	A3	1
Projection		OSGB 1936	
Scale		1:240,000	
QA		FMM	
4155 - Fig4_MitComp_Subtidal_Habitats.mxd			
Produced by ABPmer			

ABP mer marine environmental research

Subtidal Habitat Map (EUSeaMap and MESH)

Figure 4