INNER THAMES HUB ESTUARY

Feasibility Studies

May 2014

Contents

Acronyms and Abbreviations

AQMA	Air Quality Management Area
ATC	Air Traffic Control
ATM	Air Traffic Movement
BA	British Airways
BHS	Baggage Handling System
CAA	Civil Aviation Authority
CHaMP	Coastal Habitat Management Plan
CHP	Combined Heat and Power
dB	Decibels
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EU	European Union
FDI	Foreign Direct Investment
GSE	Ground Support Equipment
HS1	High Speed 1
HS2	High Speed 2
HVDC	High Voltage Direct Current
ICAO	International Civil Aviation Authority
IROPI	Imperative Reasons of Overriding Public Interest
LDA	Landing Distance Available
LNG	Liquefied Natural Gas
MARS	Multi-Aircraft Ramp System
MR	Managed Realignment
MTOW	Maximum Take Off Weight
NE	Natural England
ODN	Ordnance Datum Newlyn
ODPM	Office of the Deputy Prime Minister
OLS	Obstacle Limitation Surface
OMREG	Online Managed Realignment database
PSZ	Public Safety Zone
Ramsar	Wetlands of international importance designated under the Ramsar Convention
RESA	Runway Extension Safety Area
RET	Rapid Exit Taxiway
RSPB	Royal Society for the Protection of Birds
RTE	Regulated Tidal Exchange
SERAS	South East of England Regional Air Services Study
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STP	Severn Tidal Power
TE2100	Thames Estuary 2100 Plan
TfL	Transport for London
WeBS	Wetland Bird Survey

Executive Summary

Thames Hub response, May 2014 – introduction to technical report

Foster + Partners is pleased to submit evidence in response to the Airports Commission's Terms of Reference for the Inner Thames Estuary Feasibility Studies. We have addressed each of the questions raised in the Terms of Reference and, where appropriate, illustrate how they relate to our proposals. We have also taken the opportunity to further develop our technical proposals for the airport to better illustrate what might be achieved on our proposed site.

We welcome the Airports Commission's recognition of the potential that an inner estuary location could bring, both in terms of noise and risk reduction, and the key role it could play in the growth of London and the South East. As time passes, the noise argument becomes ever more compelling and the challenges to accommodating growth more serious.

It is essential to develop an airport proposal that is both a credible answer to London's needs and national economic requirements. The inevitable timescale for any solution means that there is no hope of a short-term fix. For the immediate future, there are only better ways of managing what we have – adding to what we have is a short-term solution and out of step with our wider needs. There has never been a better time to embrace a new airport and to direct its transformative powers to the benefit of the whole country, not just the South East. It is the only credible solution to longer-term capacity needs, both in aviation and economic development.

In the time the Airports Commission has been gathering evidence, a new breed of global hubs has started to emerge – we have seen decisions on Beijing South Airport, accelerated investment in Dubai World Central and the award of the concession for New Istanbul. These, and the recent competition for Mexico City International Airport, show how the stature of hub airports has grown and Britain's relative status will be measured.

If Britain is to maintain its status as an aviation hub, we need to measure our capabilities against our true future competitors. This is not a question of vanity, but one of lasting future ability. Hamstringing our capabilities by under-investing in capacity is a decision that will hinder us for generations to come.

As we continue to evolve our development capabilities, we look forward to continuing to work with the Commission and very much appreciate the dialogue and meetings so far.

Foster + Partners

Study 1: Environmental/Natura 2000 impacts

1-1 Background

Following consultation by the Airports Commission on the proposed terms of reference[1] for the Inner Thames Estuary Feasibility Studies this report has been produced as part of the call for evidence. This report considers Study 1 in the Terms of Reference, Environmental/Natura 2000 impacts, which requires a review of the impacts on the Natura 2000 sites of constructing and operating a new airport in the Inner Thames Estuary location, and the feasibility of meeting the legal test for such development.

The Thames Estuary and adjacent areas provide habitats for a diverse range of species, including waterbird populations (overwintering, passage and breeding), fish, aquatic mammals and marine invertebrates as well as the intrinsic value of the habitats; however, this report will only provide a response to the Airports Commission terms of reference Study 1 and will not include wider issues of other ecological impacts and their potential mitigation and compensation.

The Thames Hub proposed site is within the eastern end of the Thames Estuary and Marshes Special Protection Area (SPA) and Ramsar site, adjacent to the Medway Estuary and Marshes SPA, Ramsar site, and only 5 km south across the Thames from Benfleet and Southend Marshes SPA. In addition, the western boundary of the newly designated marine SPA of the Outer Thames Estuary is situated approximately 5 km east at Sheerness.

In complying with the Ramsar Convention, the UK Government treats listed Ramsar sites as if they are Natura 2000 sites, as a matter of national planning policy, and the legislation to protect Natura 2000 sites is therefore equally applied to the Ramsar listing.

1 Airports Commission, March 2014, Terms of Reference: Inner Thames Estuary Feasibility Studies. Airports Commission. London.

1-2 The Natura 2000 Legal Tests

Under Article 6(3) of the EU Habitats Directive, an “appropriate assessment” is required where any plan or project, either alone or in combination with other plans or projects, could have an adverse effect on the integrity[2] of a site designated under the EU Habitats Directive or the EU Birds Directive (known collectively as Natura 2000 sites). This requirement is implemented in England and Wales through the Conservation of Habitats and Species Regulations 2010[3] (the “Habitats Regulations”), and in the Habitat Regulations, Natura 2000 sites are referred to as European sites.

The two pillars of Natura 2000 sites are the establishment of a coherent European ecological network of protected areas, and protecting animal and plant species to maintain or restore the species at a favourable conservation status. Compensatory measures are required to protect the coherence of the Natura 2000 network (Article 6(4) Habitats Directive) if a project has an adverse effect on the integrity of a Natura 2000 site and a project must be carried out for imperative reasons of overriding public interest and there are no alternative solutions. Adverse effect on integrity is assessed in relation to the conservation objectives that have been identified for the site.

Competent authorities cannot consent to projects they determine may have an “adverse effect on the integrity of a European site” following such appropriate assessment. The Habitats Directive provides a derogation under article 6(4) which allows such projects to be approved provided three sequential tests are met (Defra, 2012):

1. ***There are no feasible alternative solutions to the project which are less damaging to the affected European site(s).***
2. ***There must be “imperative reasons of overriding public interest” (IROPI) for the project to proceed.***
3. ***All necessary compensatory measures must be secured to ensure that the overall coherence of the network of European sites is protected***

1-2-1 Test 1: No Alternative Solutions

The purpose of the alternative solutions test is to determine whether there are any other feasible ways to deliver the overall objective of the plan or project which will be less damaging to the integrity of the European site(s) affected. For the test to be passed it must be objectively demonstrated that there is an absence of feasible alternative solutions.

In considering alternative solutions to the proposed Thames Hub it would normally be expected to only need consider alternative airport developments. Alternative solutions to an airport development would normally be limited to other ways of delivering airport capacity, and not alternative transport options. Alternative solutions could include options at a different location, using different routes, scale, size, methods, means or timing. The “do-nothing” option should be included as part of the consideration of alternatives.

---

2 The integrity of a site is the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.
3 Which implement in England and Wales the 1992 EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive) and replace the Conservation (Natural Habitats, &c) Regulations 1994.

1-2-2 Test 2: IROPI

Once established that there are no feasible alternative solutions, it is necessary to demonstrate that there are “imperative reasons of overriding public interest” (IROPI) that justify the project despite the environmental damage it will cause.

A breakdown of what the different elements of this term is (Defra, 2012[4]):

- **Imperative:** it must be essential (whether urgent or otherwise), weighed in the context of the other elements below, that the project proceeds;
- **Overriding:** the interest served by the project outweighs the harm (or risk of harm) to the integrity of the site(s) as identified in the appropriate assessment;
- **Public Interest:** a public benefit must be delivered rather than a solely private interest. Projects which enact or are consistent with national strategic plans or policies (e.g. covered by or consistent with a National Policy Statement or identified within the National Infrastructure Plan) are more likely to show a high level of public interest.

1-2-3 Test 3: Coherence of the Network of Sites

If harm to a site in the Natura 2000 network is to be allowed (because there are no alternatives and IROPI can be shown) the Directive requires that all necessary compensatory measures are taken to ensure the overall coherence of the network of European sites as a whole is protected.

Suitable compensatory measures can include, among other things:

- The creation or re-creation of a comparable habitat which can in time be designated as a European site
- The creation or re-creation of a comparable habitat as an extension to an existing European site

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

1-3 Review of Natura 2000 Habitats and Species Affected

1-3-1 Natura 2000 Sites

It is estimated that the Thames Hub footprint will be a total area of around 35 km2. It is estimated that possibly 18 km2 of this area is designated as a Natura 2000 site.

The Natura 2000 site which will be primarily directly affected is the Thames Estuary and Marshes SPA and Ramsar, with some intertidal habitat and grazing marsh within the Medway Estuary and Marshes SPA, also affected. A summary description of each site is as follows.

- The Thames Estuary and Marshes: The proposed Thames Hub spans the eastern end of the Thames Estuary and Marshes SPA and Ramsar site. The SPA/Ramsar site comprises up to 5,286 ha of coastal grazing marsh, intertidal mudflats, salt-marsh and lagoons, and supports over 75,000[5] wintering waterfowl. The marshes extend for about 15 km along the south side of the Thames Estuary and also includes intertidal areas on the north side of the estuary. The saltmarsh and grazing marsh are of international importance for their diverse assemblages of wetland plants and invertebrates and supports one endangered plant species and at least 14 nationally scarce plants of wetland habitats. It holds nationally and internationally important wintering and migratory populations of several waterfowl species.
- The Medway Estuary and Marshes: The proposed Thames Hub is adjacent to the northern end of the Medway Estuary and Marshes SPA, Ramsar site, with potential for some direct impacts. It feeds into and lies on the south side of the outer Thames Estuary and forms a single tidal system with the Swale. It comprises 4,684 ha of coastal grazing marsh, intertidal mudflats and saltmarsh. The saltmarsh and grazing marsh are of international importance for their diverse assemblages of wetland plants and invertebrates. The complex of coastal habitats supports nationally and internationally important wintering and migratory populations of several waterfowl species.

The proposed Thames Hub would also be likely to result in indirect effects to nearby Natura 2000 sites (as well as to the Thames Estuary and Marshes and Medway Estuary and Marshes). Those considered with potential to be affected are the Benfleet to Southend Marshes SPA and Ramsar and the Outer Thames Estuary Marine SPA.

- Benfleet to Southend Marshes: Located on the north shore of the outer Thames Estuary and comprise an extensive series of saltmarshes, cockle shell banks, mudflats, and grassland, which support a diverse flora and fauna, including internationally important numbers of wintering waterfowl.
- Outer Thames Estuary: is formed by a line between Sheerness and Shoeburyness, approximately 3 km east of the proposed Thames Hub, which stretches northwards along the coast of Essex and Suffolk and eastwards to Margate and hosts a wintering population of over 6,000 red-throated divers.

5 Five year peak mean 1993/4 to 1997/8, as stated on Natura 2000 Standard Data Form for the SPA.

1-3-2 Habitats

Table 1.1 identifies habitats (using the Site of Special Scientific Interest (SSSI) Management Units) likely to be directly affected within Natura 2000 sites.

Natura 2000 Site	Habitat Directly Affected
Thames Estuary and Marshes	Management Unit 103 Large areas of tidal mudflat. Management Unit 101 Several small areas of saltmarsh scattered along the coast between the mudflats and the sea wall, unfavourable declining condition due to coastal squeeze. Management Unit 31, 34, 35,36, 37 and 39 Grassland, with areas of ephemeral standing water and more permanent water in the ditches and larger water bodies which support emergent vegetation. Management Unit 32 Uneven area of grassland generally short with areas of taller tussocks. Management Unit 38 Large (> 10m) margins of common reed bordering areas of open standing water. Adjacent grassland generally short with areas of taller tussocks. Management Unit 64 Close grazed grass bank and level strip between sea wall and main carrier.
Medway Estuary and Marshes	Management Unit 74 Neutral grassland.
Benfleet and Southend Marshes	None
Outer Thames Estuary	None

Table 1-1 Natura 2000 Sites Habitats (from SSSI Management Unit information, http://magic.defra.gov.uk accessed 02/05/14)

1-3-3 Birds

Thames Estuary and Marshes, the Medway Estuary and Marshes and Benfleet and Southend Marshes habitats support internationally important numbers of wintering waterfowl and also rare wetland birds breeding in important numbers. The Outer Thames Estuary Marine is important for its wintering population of red-throated diver. The qualifying features for the SPA and Ramsar designations for these sites are detailed within Tables 1.2, with Table 1.3 detailing bird species which are qualifying species.

1-3-4 Priority Habitats and Species

Priority habitats and species as identified within Annexes I and II of the Habitats Directive are currently considered not to be impacted by the proposed Thames Hub.

Natura 2000 Site	Qualifying Features
Thames Estuary and Marshes SPA	Article 4.1[6]: Hen harrier and avocet Article 4.2[7]: Wintering: dunlin, knot, black-tailed godwit, grey plover and redshank. Passage: ringed plover. Internationally important assemblage of wintering waterfowl.
Thames Estuary and Marshes Ramsar	Criterion 2[8]: 14 nationally scarce plants of wetland habitats and more than 20 British Red Data Book invertebrates. Criterion 5[9]: Wintering waterfowl of international importance. Criterion 6[10]: Spring /Autumn ringed plover and black-tailed godwit. Wintering grey plover, red knot, dunlin and redshank.
Medway Estuary and Marshes SPA	Article 4.1 breeding: common tern, little tern, avocet. Overwinter: Bewick's swan and avocet. Article 4.2 wintering: dark-bellied brent goose, dunlin, pintail, shoveler, teal, wigeon, turnstone, oystercatcher, knot, ringed plover, black-tailed godwit, curlew, grey plover, shelduck, greenshank and redshank. Internationally important assemblage breeding and wintering.
Medway Estuary and Marshes Ramsar	Ramsar criterion 2: The site The site holds several nationally scarce plants and at least twelve British Red Data Book species of wetland invertebrates. Ramsar criterion 5: Assemblages of international importance: Ramsar criterion 6: Species with peak counts in spring/autumn: Grey plover and redshank. Species with peak counts in winter: dark-bellied brent goose, shelduck, pintail, ringed plover, red knot and dunlin. Species/populations identified subsequent to designation for possible future consideration under criterion 6: Species with peak counts in spring/autumn: Black-tailed godwit
Benfleet and Southend Marshes SPA	Article 4.2 wintering: dark-bellied brent goose, dunlin, red knot, ringed plover and grey plover. Internationally important wintering assemblage.
Benfleet and Southend Marshes Ramsar	Ramsar criterion 5: Assemblages of international importance. Ramsar criterion 6: Species with peak counts in spring/autumn: Dark-bellied brent goose. Species with peak counts in winter: Grey plover and red knot. Species/populations identified subsequent to designation for possible future consideration under criterion 6: Species with peak counts in winter: Dunlin.
Outer Thames Estuary Marine SPA	Article 4.1 Wintering red-throated diver.

Table 1-2

6 Article 4.1 qualification is for rare and vulnerable species.
7 Article 4.2 qualification is for regularly occurring migratory species.
8 Criterion 2: A wetland which supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
9 Criterion 5: A wetland which regularly supports 20,000 or more waterbirds.
10 Criterion 6: A wetland which supports 1% of the individuals in a population of one species or subspecies of waterbird.

Species	Thames Estuary & Marshes SPA	Medway Estuary & Marshes SPA	Benfleet & Southend Marshes SPA	Outer Thames Estuary Marine SPA
Hen harrier	*	>		
Avocet	* -	/*-		
Dunlin	* -	* -	* -	
Knot	* -	* -	* -	
Black-tailed Godwit	* -	* -		
Grey Plover	* -	* -	* -	
Redshank	* -	* -		
Ringed Plover	* -	* -	* -	
Common Tern		/		
Little Tern		/		
Berwick's Swan		* -		
Dark-bellied Brent Goose		* -	* -	
Pintail		* -		
Shoveler		* -		
Teal		* -		
Wigeon		* -		
Turnstone		* -		
Oystercatcher		* -		
Curlew		* -		
Shelduck		* -		
Greenshank		* -		
Red-throated diver		> -		*
Kingfisher		>		
Mallard		> -		
Short-eared owl		>		
Pochard		> -		
Merlin		>		
Cormorant		> -		
Lapwing		> -		

Table 1-3 Natura 2000 Qualifying Birds (from SPA and Ramsar datasheets JNCC website accessed 11/04/14)

* over winter
+ passage
- over winter assemblage
/ breeding
> breeding assemblage

1-4 Impacts, Issues and Risks to Natura 2000 Features

We are acutely aware and sensitive to the high ecological value of the habitats and species present in the locality of the proposed Thames Hub. Through detailed design, the use of the current scientific database, case study and innovation the proposed Thames Hub would be able to incorporate appropriate mitigation for many of the potential impacts, issues and risks and, where this is not possible to provide compensatory measures. These would be subject to and, detailed within, an Appropriate Assessment as part of a Habitat Regulations Assessment.

- Generic potential impacts to Natura 2000 habitats and species are[11]:
- Changes in habitat extent
- Changes in habitat suitability
- Changes in water quality
- Changes in suspended sediment concentrations
- Discharges and accidental spillages
- Changes on structure and function of the biological assemblages as a result of changes in biological interaction; and
- Introduction of non-native species

Particular potential impacts to waterbirds are:

- Changes in habitat extent
- Changes in habitat suitability
- Noise/vibration disturbance
- Visual disturbance
- Barrier to movement
- Bird strike; and
- Discharges and accidental spillages

Based upon the above, this section identifies those potential impacts and issues and outlines mitigation or compensatory approaches.

1-4-1 Potential Direct Habitat Loss

An estimate of the projected size of the current proposal for the Thames Hub shows a total development footprint of approximately 35 km^2, with an estimated direct impact (loss) to Natura 2000 sites at approximately 18 km^2. The estimated direct loss of habitat (intertidal and grazing marsh) as a percentage of the designated areas is shown in Table 1.4.

Natura 2000 site	% of site lost	% of intertidal lost	% of grazing marsh lost
Thames Estuary and Marshes SPA	37	37	34
Medway Estuary and Marshes SPA	<1	<1	1.5

Table 1-4

Compensation measures for loss of Natura 2000 habitat is detailed below.

11 ABPMer, 2013, Hub for London Impact Appraisal – Part B: Marine and Coastal. Unpublished report for Transport for London.

1-4-2 Habitat Loss and Birds

The greatest number of waterbirds occurs during the winter and during spring and autumn migration periods, although there are breeding populations of some species that nest on the salt-marshes, grazing marshes and lagoons associated with both the Thames and Medway estuaries. Most of the non-breeding populations feed at low tide on the intertidal mudflats, and roost at high tide on the upper shore, salt-marshes and the fields and marshes landward of the flood embankment.

Intertidal birds are distributed over the mudflats all along the coast of the Hoo Peninsula, and from Egypt Bay eastwards towards the proposed Thames Hub it is used by grey plover, lapwing, knot, brent goose, shelduck, wigeon, oystercatcher, black-tailed godwit, curlew and redshank[12,13]. The intertidal flats on the east coast of the Isle of Grain, in the mouth of the Medway estuary, host mainly oystercatcher, ringed plover, grey plover, dunlin, curlew and redshank[14]. At high tide there are roost sites at Yantlet Creek and, to the west of the proposed Thames Hub, at St. Mary's Bay, Egypt Bay and Cliffe Lagoons[15].

Mean peak counts[16] for some of the Natura 2000 qualifying species for the Thames SPA indicates the following, with regard to potential effects to individual species:

- Avocet: main populations are in the Medway and Swale with low numbers around the Isle of Grain and only low numbers of the local population likely to be affected.
- Ringed plover: main populations are in the Swale, although significant numbers are present on intertidal habitats on the Hoo peninsula.
- Grey plover: the main densities are south of the Isle of Grain in the Medway and in the Swale. A low proportion of the local population may be affected.
- Knot: A significant area for the species around Allhallows and also in the Medway and Swale. A fairly low proportion of the local population may be affected.
- Dunlin: high densities in the Medway and Swale, with significant numbers on intertidal habitat in the north of the Hoo peninsula. A fairly low proportion of the local population may be affected.
- Black-tailed godwit: A significant area for the species around Allhallows and also in the Medway and Swale. A fairly low proportion of the local population may be affected.
- Redshank: main densities in the Medway and the Swale, with significant numbers using the intertidal of the Isle of Grain to Egypt Bay. A fairly low proportion of the local population may be affected.

---

12 Musgrove, A., Langston, R., Baker, H. & Ward, R. (Eds.) (2003) Estuarine Waterbirds at Low Tide: The WeBS Low Tide Counts 1992-93 to 1998-99. International Wader Studies 16. WSG/BTO/RSPB/JNCC, Thetford. pp105-109.

13 Bell, J.C., Walls, R., Allan, J.R., Watola, G., Burton, N.H.K., Musgrove, A.J. & Rehfisch, M.M. (2003) Study on the potential safety risks from birds at and around a potential new airport at Cliffe Marshes and measures for mitigating those risks. Central Science Laboratory, York, and British Trust for Ornithology, Thetford. 229pp.

14 Musgrove et al. (2003) Op.cit.

15 Bell et al. (2003) Op.cit.

16 Liley, D. 2011. What do we know about the birds and habitats of the North Kent Marshes?: Baseline data collation and analysis. Natural England Commissioned Reports, Number 082.

1-4-3 Bird Strike

The International Civil Aviation Authority has imposed a series of Standards And Recommended Practices that relate to bird strike prevention, which includes that *'When a bird strike hazard is identified at an aerodrome, the appropriate authority shall take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures to discourage their presence on, or in the vicinity of, an aerodrome.'* The UK government has established an 8 nautical mile (13 km) radius safeguarded zone around major civil aerodromes[17].

When it comes to assessing the impact of a new airport it is not simply a case of estimating the numbers and species of birds likely to be a bird strike risk, but also of assessing their likely behaviour. A bird sitting on a wetland poses no risk to an aircraft, but there is a risk of collision when birds cross an airfield or its approaches at an altitude that would bring birds into conflict with aircraft.

Estimating the frequency with which birds will move to and from a wetland depends on the ecology of the species involved and the distance and resource value of other exploitable sites in the local area[18]. Predicting, the numbers, frequency and altitude of movements of birds to and from wetlands is difficult to do with precision. However, recent studies have investigated this is some detail[19], resulting in a statistical approach combining bird count data to the characterisation of environmental conditions (including natural habitat areas, water quality parameter and indicators of anthropogenic disturbance) in multivariate analysis and species-habitat regression models to identify a series of habitat requirements for different bird species[20]. The UK CAA guidance[21] on the subject suggests an approach based on an assessment of habitat type, numbers of birds likely to be attracted, their likely behaviour, other sites in the area to and from which they might move, and the proximity of these movements to the aerodrome or its approaches.

The proposed Thames Hub would maximise the use of such studies and statistical analysis, incorporated within detailed design to minimise the risk of bird strike and consequently the management measures necessary to control that risk.

Oakervee (2009)[22] provides information on bird flight movements within the Thames Estuary, which indicates the following:

- East-west on the northern fringe of the estuary, between the River Crouch estuary and the Canvey Island and East Tilbury area of the Thames
- East-west on the southern side of the Hoo peninsula, from the Medway and Swale estuaries to the west end of the Hoo peninsula at Cliffe; and
- North-south from the River Crouch estuary and Maplin Sands to the east end of the Isle of Sheppey and eastwards along the north Kent coast

The above indicates that the proposed Thames Hub is located in an area that is not a major flight path for birds and that interactions with major movements of large numbers of birds could be avoided and potential mitigation measures included to minimise effects (e.g. stipulations of aircraft take-off and landing trajectories).

17 ODPM (2003) Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction. Office of the Deputy Prime Minister Circular 1/2003.
18 Allan, J. (undated). Taking Account of Aviation Hazards in the Development of a Wetland Vision for England. Central Science Laboratory, Sand Hutton, York
19 Franco, A., Thomson, S. &. Cutts N.D.,2013. Determinants of bird habitat use in TIDE estuaries. Institute of Estuarine and Coastal Studies (IECS), University of Hull, UK.
20 Franco, A.,2013. TIDE Tool: Guidelines for the waterbird habitat analysis methodology. IECS, University of Hull, UK.
21 Civil Aviation Authority (2007) CAP 772 Birdstrike Risk Management For Aerodromes. Civil Aviation Authority, London.
22 Oakervee, D.E. (2009) Thames Estuary Airport Feasibility Review. P46-47

1-4-4 Noise

There is potential for an impact on bird populations as a result of increased noise levels particularly from the aircraft themselves. A study[23] on the Humber estuary concluded that birds become habituated to regular noise below 70dB; the noise contour map produced for a proposed Isle of Grain airport[24] (annual average day noise contours, 55-75 dB L_{den}) shows the of 70dB contour more or less being confined within the airport footprint, with some extension to the east of the Isle of Grain; the 65dB contour extends a few km east of the Isle of Grain and westwards just beyond the airport footprint. Only the 60dB contour extends eastwards across to the north coast of the Isle of Sheppey and west across the Hoo peninsula to the Cliffe Marshes. Benfleet and Southend Marshes SPA and the majority of the Medway Estuary and Marshes SPA would be subject to noise levels of less than 55dB and, therefore, noise impacts to bird populations may not be significant.

Sensitivity to disturbance varies between bird species and also dependent upon other factors, including, bird activity at the time of disturbance, frequency of disturbance, distance from the disturbance source, visual disturbance levels and seasonality. As an example one study[25] found that brent geese were among those species which react most strongly to aircraft noise, together with curlew and redshank, with shelduck and bar-tailed godwit reacting less often. The study also found that civil aircraft flying at an altitude of >300 m disturbed flocks on 8% of occasions, those flying at 150-300m in 66% and those flying <150 m in 70% of the cases.

However, irregular, infrequent disturbances can be more disturbing to bird activity than regular noise or visual stimuli (i.e. that which would result from the proposed Thames Hub). For example, construction or personnel activity on a mudflat can be considered a high level of disturbance, whereas a regular noise above 70dB can be considered as moderate[26]. A summary of disturbance potential for some bird species, which are qualifying features of the SPAs, are shown in Table 1.5, (taken from, and using the examples within, Cutts *et al.*, 2013), which shows that species will be affected by noise (and other disturbance stimuli) to different degrees.

Table 1.5 demonstrates that many of the Thames and Medway SPA qualifying species have low or moderate sensitivity to disturbance and will habituate to regular disturbance. Where more sensitive species are likely to be affected (e.g. knot within the Thames Estuary SPA) then the detailed design of the Thames Hub and mitigation measures could be implemented to minimise exposure to noise.

23 IECS, (2008). Construction and waterfowl: Defining sensitivity, response, impacts and guidance. University of Hull Institute of Estuarine and Coastal Studies report to Humber INCA.
24 Civil Aviation Authority Environmental Research and Consultancy Department, 2013. Noise Analysis: Isle of Grain.
25 Smit,C .J. & Visser,G .J.M. 1993. Effects of disturbance on shorebirds a: summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bull. 68: 6-19.
26 Cutts, N., Hemingway, K. & Spencer, J., 2013. Waterbird Disturbance Mitigation Toolkit Informing Estuarine Planning & Construction Projects. University of Hull.

		Qualifying Feature		
Species	**Disturbance Potential**	**Thames SPA**	**Medway SPA**	**Benfleet SPA**
Brent goose	High Sensitivity - highly sensitive to noise disturbance and they react in a variable manner to visual disturbance. They have been found to react to up to 92% of aircraft passes although this declined to 64% with habituation.	No	Yes	Yes
Shelduck	High Sensitivity - generally highly sensitive to visual disturbance. However, the species is subject to a high degree of habituation and further exposure can lead to no response to stimuli.	No	Yes	No
Mallard	Moderate Sensitivity - relatively tolerant species that will habituate rapidly to activity. There is very little information on the effects of noise disturbance, but there was no observed response to loafing and foraging birds in a moderately 'noisy' tidal freshwater site on a busy navigation.	No	Yes	No
Oystercatcher	Moderate Sensitivity - relatively tolerant of disturbance and will habituate rapidly to ongoing activity. There is little information on the effects of noise disturbance, but direct observation at a highly disturbed site saw a reaction to only 9% of events with a degree of habituation assumed.	No	Yes	No
Ringed plover	Low Sensitivity; extremely tolerant with habituation - an extremely tolerant species that habituates to anthropogenic activities rapidly. Their reaction to noise or construction works is likely that again they have a high threshold given their general high tolerance.	Yes	Yes	Yes
Grey plover	Moderate Sensitivity - Limited data suggest that they are a relatively disturbance tolerant species, although their ability to habituate to works is unknown. It is also largely unclear how tolerant they are to noise disturbance.	Yes	Yes	Yes
Lapwing	Moderate Sensitivity - There is very little research to disturbance in their wintering areas, either in response to noise or visual stimuli. Ad hoc observations suggest that Lapwing do not react particularly strongly to disturbance when at roost.	No	Yes	Yes
Knot	High Sensitivity to Noise Disturbance; Tolerant of Visual Disturbance - appear to be a relatively tolerant species that habituates to works rapidly and are also surprisingly tolerant of people. Despite this tolerance of visual disturbance, they are highly disturbed by overflying aircraft which combine visual stimuli with noise and a resemblance to raptors (predators). Knot would also seem to be highly sensitive to noise disturbance.	Yes	Yes	Yes
Dunlin	Low Sensitivity - a relatively tolerant species that habituates to various stimuli. Despite a general tolerance of visual disturbance they can be disturbed by overflying aircraft which combine visual stimuli with noise and have a resemblance to raptor predators.	Yes	Yes	Yes
Black-tailed-godwit	Moderate Sensitivity - an under-studied species, but suggested that the species is tolerant of disturbance.	Yes	Yes	No
Curlew	Moderate Sensitivity - evidence indicates that they are an extremely wary species that does not habituate to stimuli rapidly. Considered to be highly reactive to aircraft, although some observations have shown no reactions to machinery operation or aircraft passing overhead.	No	Yes	No
Redshank	High Sensitivity to Noise Disturbance; Tolerant of Visual Disturbance - relatively tolerant species that habituates to works rapidly. Despite a tolerance of visual disturbance, they are highly disturbed by overflying aircraft which have a resemblance to raptors. Redshank were seen to react to aircraft overhead at noise levels of 72dB (heads-up) and 88dB (flushed).	Yes	Yes	No
Turnstone	Low Sensitivity; extremely tolerant with habituation - thought to be an extremely tolerant species that habituates rapidly. There is no published evidence with regard their reaction to noise, but it is likely that again they have a high threshold.	No	Yes	No

Table 1-5

1-5 Overall Stability of the Ecosystem

1-5-1 Estuarine Hydrology and Geomorphology

The construction of the Thames Hub would reduce the width of the estuary and have a 'throttling effect', potentially reducing the tidal range upstream and immediately downstream of the proposed airport, although a 75% constriction of the estuary width would be needed before significant changes in water level were achieved, which is far greater than would result from the proposed Thames Hub. The potential cumulative effects of additional infrastructure and other development would need consideration.

Local accretion may occur in the lee of the platform required within the mudflats and the Thames Estuary, producing new mudflats and saltmarsh, but there is also a risk of erosion of mudflats owing to changed tidal flows and wave climate. The potential areas at greatest risk of erosion are those around Southend-on-Sea and the mouth of the Medway[27]. Such geomorphological changes may lead to loss or change of estuarine habitats and the intertidal feeding grounds of waterfowl, however, change associated with current coastal processes and management are likely to have similar effects.

The surface freshwater flow on grazing marshes, saltmarshes and/or mudflat areas could potentially decrease as a result of diversion, or increase as a result of additional surface water collection and discharge. There may also be increases in salinity as a result of tide level changes[28], with plant growth in estuarine saltmarsh communities stimulated by freshwater inflow[29]. In addition, water quality could be affected by discharge and drainage from the proposed Thames Hub. However, modelling of water inputs and flow and would be incorporated within the detailed design to develop mitigatory measures to minimise such impacts. All discharges would be fully compliant with legal requirements and in accordance with best practice and guidance from the Environment Agency.

1-5-2 Potential New Infrastructure Impacts

The surface access required for the proposed Thames Hub will include new rail and road links, which will have additional impacts to Natura 2000 sites (i.e. the Thames and Medway Estuary and Marshes SPAs). These are considered below based upon infrastructure proposals without a lower Thames crossing. However, these indicative proposals would be developed through detailed design and the sensitive siting of new infrastructure would be a major consideration and, therefore, it is considered that indirect impacts are manageable, with any additional loss of habitat incorporated within the consideration for habitat compensation measures.

1-5-2-1 Rail Links

The rail links (refer to Surface Access submission) have the potential to affect Natura 2000 sites, either directly as a result of the route passing through the site, or indirectly (e.g. hydrological change or noise). The sites and associated issues are as follows:

- Thames Estuary and Marshes SPA/Ramsar: the proposed alignment of the rail route directly impacts on Allhallows Marshes component of the SPA (approximately 900m length) and potential effects to Higham Marshes.
- Medway Estuary and Marshes SPA/Ramsar: the proposed alignment of the rail route directly effects a narrow fringe on northern extents of Stoke Saltings for approximately 3 km.

1-5-2-2 Road Links

The road links (refer to Surface Access submission) will not directly affect any Natura 2000 sites, but would be within a short distance of Stoke Saltings, within the Medway Estuary and Marshes SPA/Ramsar, with potential for indirect effects.

---

27 Pontee, N. (2011). Initial assessment of the impacts of the Thames Airport reclamation and barrage on flood erosion risk. Halcrow, Swindon.
28 Perkins, M. (2011). Thames Integrated Hub: Groundwater and surface water issues. Halcrow Technical Note. Halcrow, Swindon.
29 Longley, W.L. (1994). Freshwater inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs. Texas Water Development Board and Texas Parks and Wildlife Department, Austin, Texas. 386pp http://repositories.lib.utexas.edu/handle/2152/6728

1-6 Case Studies

1-6-1 Background

In the UK the largest intertidal habitat creation schemes have been implemented as managed re-alignment (MR) (as compensation for predicted losses to Natura 2000 intertidal habitat from flood defence schemes and climate change) and have been applied to relatively small areas, with the total area of all schemes being less than 2000ha[30].

A 2001 study in the UK on the success of intertidal habitat creation and restoration was produced[31], which considered that the science of coastal habitat creation and restoration was poorly understood at that time. However, since that time there has been considerable advancement in terms of numbers and scale of coastal habitat creation and restoration in the UK, Europe and globally that have contributed to the scientific database. In the UK particular examples of large-scale intertidal habitat creation are those on the Humber Estuary (Alkborough Flats and Paull Holme Strays), the Steart Peninsula and Wallasea Island.

The experiences from the schemes, detailed below, show that there is a precedent for large scale intertidal, coastal and wetland habitat creation, with global examples. Although every scheme and the aims and objectives of the compensation are different, the examples below, together highlight overriding themes which are:

- That large-scale habitat compensation schemes can be effectively implemented to compensate for major infrastructure development or other habitat loss;
- There is a precedent for successful large-scale intertidal habitat creation, supported by a range of creation and restoration techniques, which are applied depending upon target habitat and local circumstances; and
- Large-scale intertidal habitat creation has been successfully agreed and implemented in accordance with the legal requirement for compensatory measures for significant effects to Natura 2000 sites under Article 6(4) of the Habitats Directive.

1-6-2 UK Case Studies

1-6-2-1 Wallasea Island

Wallasea Island, on the Crouch Estuary, is the largest habitat creation scheme of its type in Europe, which is a managed realignment project designed initially to compensate for intertidal habitat losses at Lappel Bank on the Medway estuary and Fagbury Flats on the Orwell estuary from flood defences and climate change impacts. Wallasea Island is being transformed from farmland into a 670-hectare (1,500-acre) wetland using 4.5 million tonnes of earth excavated from the Crossrail project to raise soil levels to be suitable for intertidal habitat creation (the island is currently below sea level). The first phase of the scheme, covering an area of 115ha, is already operational and managed by the RSPB, but they also have plans for 740 ha of adjacent land on Wallasea Island, including 620 ha of arable farmland[32, 33]. The RSPB reserve is due to be completed by 2020, and will cost about £50m in total (approximately £75,000 per ha).

1-6-2-2 Steart Peninsula Habitat Creation, Severn Estuary, Somerset

The Environment Agency is currently undertaking a major habitat creation project with the Steart Coastal Management Project to create new intertidal habitat on the Steart Peninsula. The Project will create a major new wetland (totalling over 400 ha), including some 194 ha of intertidal habitat, 67 ha of transitional brackish habitat, 106 ha of coastal grazing marsh, 17 ha of brackish and saline lagoons, 8 ha of freshwater lagoon, 12 ha of reedbed and numerous ponds and ditches. This will offset losses of intertidal habitat that are occurring elsewhere in the Severn Estuary as a result of rising sea levels

30 Department of Energy and Climate Change, 2010. Severn Tidal Power: Potential for Compensatory Measures. DECC, London.

31 Atkinson, P.W., Crooks, S.,Grant, A. and Rehfisch, M.M.2001.English Nature Research Reports, Number 425,The success of creation and restoration schemes in producing intertidal habitat suitable for waterbirds. English Nature. Peterborough.

32 RSPB (2011) Wallasea Island Wild Coast Project. http://www.rspb.org.uk/wallasea

33 Eftec (2008) Wallasea Island Economic Benefits Study. Final report submitted to East of England Development Agency. Eftec, London. www.eftec.co.uk/eftec.../wallasea-island-economic-benefits-study

as over the next 100 years, it is estimated that between 1500 to 3500 hectares of inter-tidal habitat will be lost due to coastal squeeze within the Severn Estuary, depending on the rate of sea level rise.

The Severn Estuary and North Devon and Somerset Shoreline Management Plans identified a number of sites in the estuary where realignment of existing flood banks is the preferred option. The Environment Agency's draft Severn Estuary Flood Risk Management Strategy Plan (2011) further investigated how these sites could be realigned and a likely timescale for implementation. The potential sites were selected using a range of criteria:

- Absence of existing major development or infrastructure
- Absence of known landfill or contaminated land
- Whether or not existing land levels would provide the types of intertidal habitat needed
- Whether or not the sites still retained the topography from that time in the past, before they were reclaimed, when they supported salt marsh
- Whether or not habitat creation on the sites was likely to be sustainable in the long term which has been based on an estimate of tidal energy in different parts of the estuary
- Proximity to existing high water roost sites
- Proximity to the sites where salt marsh is being lost or considered to be vulnerable to erosion
- Whether or not the site already forms part of an EU designated site and thus would require further compensation for the loss of existing nature conservation interest features
- Absence of freshwater SSSIs that might be impacted by realignment; and
- Whether there may be additional social benefits that could be obtained from the proposed works in terms of opportunities for new or improved access or for recreation

Costs of approximately £50,000 per ha.

In association with this The Bristol Port Company is proposing a habitat creation scheme on adjacent land as compensation for increased container terminal capacity necessary for the future demand for container ships at Bristol Port. Constructing this new container terminal will involve some reclamation of the foreshore on the Severn Estuary on which birds currently feed and roost. To compensate for that loss, the Port proposes to create at least 120 ha of new 'compensatory' habitat for wetland birds and other wildlife.

1-6-2-3 Alkborough Flats[34]

Location: Humber, North Lincolnshire

Implementation date: 2006

Area (ha): 370

Type: Managed breach

Main Reasons: Improved flood defence, compensation, habitat creation

Cost: £10,200,000 (approximately £28,0000 per ha)

Habitats created/expected (ha): 170 mud flats/saltmarsh, 50 freshwater reedbed, 100 wet grassland

Components (incl. dimensions) 1 breach: 20m; defence lowering over 1,500 m

Tidal Range (m): 5.9.

Summary lessons learned: (1) Funding and approval requirements are very complex, so need to allow lots of time. (2) Consideration about how to involve stakeholders.

34 Online Managed Realignment Guide (OMReG) http://www.abpmer.net/omreg/. Accessed April 2014.

1-6-3 European Case Studies

On the Online Managed Realignment (OMREG) database (www.abpmer.net/omreg) there are two MR schemes in Germany of comparable size to that which may be required for the Thames Hub (i.e. over 500ha), namely Beltringharder Koog and Anklamer Stadtbruch. However, the Rotterdam Mainport Development has provided compensatory habitat of over 750ha, plus an extensive area of sub-tidal habitat compensation. The case studies are presented below.

1-6-3-1 Rotterdam Mainport Development Project[35]

The development is situated in the Voordelta, a protected nature reserve off the Dutch coast. The proposed expansion of the Port of Rotterdam (the 'Rotterdam Mainport Development Project' required the reclamation of some 2,000 hectares of land, with likely negative impacts on habitats and species in the surrounding Natura 2000 sites. An adverse effect on priority habitats was unavoidable, so a comprehensive package of compensation measures, including establishing a marine reserve and creating dunes and wetlands, was developed in close co-operation with stakeholders. These measures were approved by the Commission in accordance with Article 6 (4).

Mitigation: In order to minimise or mitigate significant adverse effects as might arise from construction and operation of the harbour, mitigation measures were taken into account though the entire construction phase (design, use of substrate, transportation of goods) and in the spatial planning of the new harbour itself.

The development would have an adverse impact on:

- Habitat - Sandbanks slightly covered with low tide
- Feeding ground for sandwich tern and common tern; and
- Habitat for velvet scoter

Compensation comprises:

- Creation of three new nature and recreation areas on the edge of Rotterdam, totalling 750 ha
- A 25,000 ha large sea bed protection area will be established in the Voordelta. The sea bed will remain undisturbed in this area, in compensation for the loss of marine nature. Any form of fishing that disrupts life on the sea bed will be prohibited in this area
- Five smaller areas within the 25,000 ha area will be set up as bird resting areas
- New dune area of 35 ha will be developed along the coast.

The results of the environmental compensation are being closely monitored by the European Commission. Should the environmental effects of the land reclamation turn out to be greater than expected, then more environmental compensation will be needed.

1-6-3-2 Beltringharder Koog, North Friesland, Northern Germany[36]

A regulated tidal exchange (RTE) scheme was created in 1988 as in situ compensation for advancing the defence line into the Nordstrand Bay in 1987 (land-claiming 3,350 ha of mudflats, sandflats and saltmarshes in the process). Before the embankment, the Nordstrand Bay had been one of the largest unfragmented saltmarsh areas and one of the most important feeding areas for wetland birds migrating along the East Atlantic Flyway on the northern German Wadden Sea coast.

The 853ha RTE scheme forms part of a compensation package undertaken in the newly created polder. Whilst the main habitat created is a saline lagoon, approximately 380 ha of intertidal habitats are also included (166 ha tidal flats, 214 ha saltmarsh). There are also some 95 ha of transitional habitat. The remainder of the 3,350 ha Koog (i.e. polder) was converted into a number of terrestrial/freshwater habitats for nature conservation purposes, including reedbeds, marshes and transitional grassland.

35 Institute for Infrastructure, Environment and Innovation, 2005. Paralia Nature Report Phase II. Institute for Infrastructure, Environment and Innovation, Belgium.
36 http://riverwiki.restorerivers.eu/wiki/index.php?title=Case_study%3ABeltringharder_Koog_Regulated_Tidal_Exchange_Scheme Accessed April 2014

The whole polder was declared a nature reserve in 1992; and is now highly designated, forming part of the following Wadden Sea sites: Ramsar, Special Protection Area, and Special Area of Conservation. The RTE site is open to tidal influence through two culverts in the new sea dike.

By 2000 the newly developed saltmarshes became a habitat for endangered halophytes and an important resting area for wetland birds during high tides[37].

Cost: Unknown

1-6-3-3 Anklamer Stadtbruch[38]

A managed breach scheme at Oderhaff, Mecklenburg Vorpommern (North East Germany) implemented in 2004

Area (ha): 1750

Type: Managed breach

Previous land use: Unknown

Main Reasons: Reduced flood defence costs, habitat creation

Cost: Unknown

Habitats created/expected (ha): 1000 lagoon (salinity <10%); 750 forest

1-6-3-4 Mühlenberger Loch, Hamburg, Germany[39]

The freshwater mudflat Mühlenberger Loch is located next to the Port of Hamburg. It is protected by national law, is a Ramsar convention area and it has been designated in the framework of the European Birds and Habitats Directives. Impacts associated with land reclamation in the Mühlenberger Loch is loss of:

- 151 ha freshwater mudflats
- 18 ha of shallow waters
- 0.8 ha of alluvial forest
- 169 ha of breeding area for fish in shallow waters and on tidal flats
- Seedbank of Oenanthe conioides (endemic plant); and
- Resting place for migratory birds

For the purpose of mitigation a hydro-numerical mathematical model calculated the most efficient shape of the extension area of the Mühlenberger Loch, which provided some ecological mitigation. The compensation measures were:

- Restoring of tidal areas of a former tributary of the Elbe (Haseldorfer Marsh) to enlarge the estuarine habitat areas by about 220 ha. In this instance NGOs went to court and stopped the compensation measure at Haseldorfer Marsch.
- The Hörner Au developed into a wetland to provide a resting place for regular migratory bird populations (100 ha).
- Creation of 99 ha freshwater mudflats by taking back the main flood protection line and by removing topsoil at the Elbe island of Hahnöversand, as compensation for the loss of resting and feeding functions for migratory water birds.

Costs of the compensation are unknown.

37 Wolfram, Ch.*, Hörcher, U., Lorenzen, D., Neuhaus, R., Aegerter, E. & Dierßen, K., 2000. Vegetation succession in a salt-water lagoon in the polder Beltringharder Koog, German Wadden Sea. Proceedings IAVS Symposium, pp. 43-46, 2000.
38 http://www.abpmer.net/omreg/. Accessed April 2014.
39 Institute for Infrastructure, Environment and Innovation, 2005. Op. Cit.

1-6-3-5 Port of Antwerp, Belgium[40]

A project to compensate for habitat impacts from the building a new tidal container dock, the Deurganck dock, on the left bank of the Scheldt.

Compensation:

- Mudflat and saltmarsh – 51ha
- Coastal bird habitat – 204ha
- Reedbeds and marshes – 218ha
- Open water – 117ha
- Wet meadows – 123ha

The development attempted to find a balance between meeting ecological objectives, offering guarantees for long-term viability of local communities and safeguarding long term port development. Which included:

- Robust natural structures around the port area and focusing on the conservation objectives; and
- Network of Ecological Infrastructure within the port area focusing on species conservation

Development conclusions:

- Integrated planning and proactive approach
- Favourable state of conservation of SPA will be restored/maintained in network of nature areas around the port area
- Favourable state of conservation of protected species will be restored/maintained in network of ecological structure within the port area; and
- Further development/exploitation of port and industry will be possible without significant impact on favourable state of conservation

Costs of the compensation were approximately £20.5 million (25 million Euros) or £30,000 per ha.

1-6-4 Other Case Studies

1-6-4-1 South Bay Salt Pond Restoration Project, San Francisco Bay

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast of America. Although not a habitat compensation project it is intended to restore and enhance wetlands in South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation and demonstrates the feasibility of large-scale habitat creation/restoration in an urban area.

When complete, the project will restore 15,100 acres (approximately 6,100 ha) of industrial salt ponds to a rich mosaic of tidal wetlands and other habitats. This represents the largest single acquisition in a larger campaign to restore 40,000 acres (approximately 16,000 ha) of lost tidal wetlands in San Francisco Bay.

The goals of the project are to:

- Create, restore, or enhance habitats of sufficient size, function, and appropriate structure to:
  - Promote restoration of native special-status plants and animals that depend on South San Francisco Bay habitat for all or part of their life cycles
  - Maintain current migratory bird species that utilise existing salt ponds and associated structures such as levees
  - Support increased abundance and diversity of native species in various South San Francisco Bay aquatic and terrestrial ecosystem components, including plants, invertebrates, fish, mammals, birds, reptiles and amphibians

40 De Craene, K., 2013. Implementation of Birds and Habitats Directives in the Port of Antwerp. Presentation, Sydney, Australia, September 2013.

- Maintain or improve existing levels of flood protection in the South Bay Area
- Provide public access and recreational opportunities compatible with wildlife and habitat goals
- Protect or improve existing levels of water and sediment quality in the South Bay, and take into account ecological risks caused by restoration
- Implement design and management measures to maintain or improve current levels of vector management, control predation on special status species, and manage the spread of non-native invasive species
- Protect the services provided by existing infrastructure (e.g., power lines, railroads)

This major restoration effort, in the middle of a major urban centre, will transform the landscape into a thriving wetland ecosystem and also providing a critical natural buffer against the effects of global climate change and sea level rise.

The Project will help create, enhance, and conserve a variety of wetland habitat types, with the predominant wetland being shallow sub-tidal areas, tidal mudflats, tidal marsh, salt ponds, muted tidal/managed ponds, and seasonal wetlands. In the Bay, restricted tidal exchange, limited sediment supply, and internally generated wind waves were described as the three most important physical process which can retard or prevent the ideal physical evolution of a realignment site (in combination, or isolation)[41].

There is a recognised similarity between Californian and British coastal systems (i.e. comparable meso-tidal setting, similar marsh inundation and colonisation patterns) and Crooks and Sharp (2007)[42] concluded that lessons from the San Francisco Bay restoration experience would be valuable to British practitioners. During peak annual migration periods, hundreds of thousands of birds migrating along the Pacific Flyway use the Californian coastal wetlands for refuge and food and San Francisco Bay/Estuary is a 158,711 ha Ramsar wetland site. Overall, in the San Francisco Bay area has either completed or in the progress of constructing over 11,300 ha of wetland restoration with another 12,500 ha planned.

1-6-4-2 Los Machos Mangrove Restoration, Puerto Rico

The project was for the restoration of hydrology to a 500 ha mangrove basin at the U.S. Naval Facility, Puerto Rico and designed and managed by CH2M HILL and provides an example of large-scale intertidal habitat restoration, supported by complex modelling to achieve the desired result.

Historically, the Basin had three primary tidal connections but these have become severely impacted through incremental development since the 1940s. The hydrological restoration was accomplished through enhancements to maximise tidal sea water flushing potential. The concepts were modelled using a two-dimensional, depth-averaged hydrodynamic model, and to predict the tidal mixing between the Los Machos mangrove wetland and the adjacent near-shore area. Results of hydrodynamic modelling were used to quantify the flushing characteristics of the site both before and after dredging of a second inlet channel. Vegetative and water quality monitoring are ongoing to track the success of the restoration process.

41 ABP Marine Environmental Research Ltd, 2010. Severn Tidal Power: Feasibility of Large Scale Managed Realignment. Report for the Department of Energy and Climate Change. London.

42 Crooks, S. and Sharpe, J., 2007. California Dreamin' - lessons in coastal marsh restoration from San Francisco Bay. Defra 42nd Flood and Coastal Management Conference, 03.1.1-03.1.12.

1-6-5 Unsuccessful Case Studies

1-6-5-1 Dibden Bay, Southampton Water[43,44]

In 2000 Associated British Ports (ABP) sought permission for an extension of the port of Southampton with a deep water container quay comprising a 1.85 km long six berth deep quay covering around 240 ha at Dibden Bay. The terminal would for the most part have occupied land that had been reclaimed with dredged material. The proposal was highly controversial at the time, with a Planning Inspectorate decision made in 2003. The plans would take around 76 ha of intertidal foreshore, some it being a Natura 2000 designated site. The environmental impact of the project on the surrounding areas would have been significant. There are nearby sites classified as SPA (Solent) and SAC (New Forest).

The outcome of the public inquiry, was a refusal to grant the permit on recommendations from the Inquiry Inspector. The arguments considered that:

- Although there is a need for additional container capacity, this need could also be fulfilled by other expansion programmes foreseen on the British east coast.
- The project confuses mitigation and compensation; in other words, the project needs large scale compensation, but many of these measures were presented as mitigation.
- Although there were economic considerations, the Inspector did not believe that the IROPI test could be met.

The application was refused despite the national need for additional container port capacity to meet future economic demand. The impact on the Natura 2000 site was an important factor in the decision to refuse as the environmental value of the site could not be overruled when there were alternative sites for port expansion which had not yet been fully explored.

Dibden Bay was an unsuccessful major development proposal with likely significant effects to a Natura 2000 site as it failed the ‘alternative solutions’ test.

1-6-5-2 Western Scheldt Container Terminal[45]

The Port of Flushing developed plans to extend the port with a Container Terminal. The proposed development area included part of a Natura 2000 site. The project developers had proposed compensation in the form of a newly created estuarine area outside the dykes and a wet saline nature reserve inside the dykes, totalling an area that was larger than the area to be occupied by the development.

The Court concluded that the proposed compensation measures were adequate, however it was found that the project could not be justified and the proposals were refused as:

- The IROPI criterion was not met
- The project did not consider sufficiently the available alternatives
- The effects of additional employment and the economic benefits had not been weighed adequately against the nature protection objectives

The failure of the above schemes would not apply to the proposed Thames Hub, as there is an extensive and robust argument that there are no alternative solutions and that there is a case of overriding public interest. The following outlines the potential for satisfying the compensatory measures test.

43 http://www.planningresource.co.uk/article/433296/dibden-bay-port-terminal-plan-rejected
44 Mink, F.J., 2007. Maritime Infrastructure and Marine Coastal Zones: Issues with the Habitats Directive. European Dredging Association.
45 Mink, F.J., 2007. Ibid.

1-6-6 The Legal Process

The Natura 2000 legal tests set out previously would need to be proven as part of a Habitat Regulations Assessment for the proposed Thames Hub. These are:

- No feasible alternative solutions;
- IROPI; and
- All necessary compensatory measures.

1-6-6-1 No alternative solutions

The main alternative solutions of expansion of either Heathrow, Gatwick or Stansted have a number of environmental and practical issues which would not resolve the requirement for additional airport capacity. Heathrow is now full and, aside from the use of larger aircraft, it cannot be expanded, largely because of the level of aircraft noise and air quality impacts that Heathrow inflicts on Londoners and the scale of its surrounding urban development. A new Gatwick runway would do nothing to maintain the UK's hub aviation status and there is insufficient space to add further runways and convert it into a hub airport.

The Thames Hub Airport would remove aircraft noise from around 750,000 people in net terms, which would only be exacerbated by an additional runway at Heathrow. Given the increasingly crowded nature of the South East and scale of land required, the only environmentally and commercially feasible option is to build a new four runway hub airport on a platform on the Isle of Grain in Kent.

1-6-6-2 IROPI

As well as the significant public health benefits stated above, the case of overriding public interest would be served by the unquestionable national economic benefits of the Thames Hub. The airport's proximity to High Speed 1 would provide it with world class high speed rail connections to Central London, Kent and continental Europe. This connectivity could be supplemented by extending Crossrail to the airport. It would secure major investment in environmental mitigation and enhancement measures. It would also kick-start the regeneration of the Thames Gateway, providing jobs for hundreds of thousands of people in the only area able to accommodate the 1 million growth in London's population by 2030.

The reasons for the failure of comparable major development Case Studies presented above would not apply to the proposed Thames Hub. There is an extensive and robust argument that there are no feasible alternative solutions that provide the same benefits as the Thames Hub proposal and that there is a case of overriding public interest. The following outlines the potential for satisfying the compensatory measures test.

1-7 Compensation

1-7-1 European Commission Guidance

In order to ensure the overall coherence of Natura 2000, the compensatory measures should: a) address, in comparable proportions, the habitats and species negatively affected; b) provide functions comparable to those which had justified the selection criteria of the original site, particularly regarding the adequate geographical distribution[46]. The distance between the original site and the place of the compensatory measures is not necessarily an obstacle as long as it does not affect the functionality of the site, its role in the geographical distribution and the reasons for its initial selection.

In principle, compensatory measures must be implemented before the occurrence of adverse effects. In outstanding circumstances, some exceptions from the general principle are allowed, such as in situations, in which obtaining the full functionality of compensation requires a long time.

Compensatory measures appropriate or necessary to minimise the adverse effects on Natura 2000 sites can consist of:

- Restoration or Enhancement in existing sites: restoring the habitat to ensure the maintenance of its conservation value and compliance with the conservation objectives of the site or improving the remaining habitat in proportion to the loss due to the plan or project on a Natura 2000 site; and/or
- Habitat Re-creation: re-creating a habitat on a new or enlarged site, to be incorporated into Natura 2000

Compensation will comprise the creation of replacement habitat to accommodate the bird populations displaced, either directly or indirectly, by the project. The criteria published by the European Commission for designing compensatory measures are, briefly, as follows:

- Targeted compensation: the compensation measures must specifically address the effects of the project on the integrity of the site and be designed to offset the damage caused and restore the habitat functions and species to favourable conservation status.
- Effective compensation: the measures must be feasible and operational in reinstating the necessary ecological conditions.
- Technical feasibility: the measures must be designed using best scientific knowledge and the specific requirements of the ecological features to be reinstated.
- Extent of compensation: must be such as to ensure the minimum requirements to meet ecological functionality, and should generally be well above 1:1.
- Location of compensatory measures: the area selected must be within the same range, migration route or wintering area for the bird species affected in the Member State concerned, and it is generally accepted that it should be as close as possible to the area affected by the plan or project.
- Timing of compensation: the measures must be in place and effective at the time the damage occurs.
- Long term implementation: the necessary means must be secured to maintain the measures in the long term.

46 European Commission, 2007/2012. Op.Cit.

1-7-2 Existing Policies and Plans

1-7-2-1 Habitat Compensation in the Thames Estuary 2100 Plan[47] and Greater Thames Estuary Coastal Habitat Management Plan[48]

The Thames Estuary (TE) 2100 Plan presents a risk-based flood management plan for London and the Thames Estuary. The Plan addresses the issues in the context of a changing climate and varying socio-economic conditions that may develop over the next 100 years (commencing 2010).

The Greater Thames Coastal Habitat Management Plan (CHaMP) provides a high level framework to advise the management decisions that may affect sites within the estuary designated under the Habitats and Bird Directives and the Ramsar Convention. The CHaMP: (i) acts as an accounting system to record and predict losses and/or gains to habitat; and (ii) sets high level direction for habitat conservation measures to address net losses. The CHaMP was produced for the Thames Estuary Partnership to support TE2100 to inform decisions on proposed flood and coastal erosion risk management activities and provide a strategic picture of habitat replacement requirements in the Greater Thames area. The CHaMP study areas extends from Gravesend/Tilbury in the west to Herne Bay in Kent and Foulness Point in Essex, where it meets the southern North Sea, and thus fully encompasses both the proposed location for Thames Hub and all parts of the estuary that might be suitable for its habitat compensation.

The CHaMP assesses how future morphological and hydrodynamic changes will affect habitats within the study area, based on a number of criteria including historic evolution, present distribution of habitats, their responses to present processes, and modelling of estuarine processes (including Defra-advised future rate of sea level rise). The study identifies six “habitat behaviour units” (HBU) according to broad geomorphological character plus habitat interconnectivity and behaviour. The northern shore of the Isle of Grain and the Hoo peninsula is in HBU5 (Thames Estuary). The CHaMP predicts:

- Approximately 500 ha loss in the overall extent of intertidal mudflat and sand flat over the next 100 years (commencing 2006);
- A continuing historic trend of saltmarsh loss, approximately 150 ha in the first 50 years rising to 350 ha after 100 years; and
- Net loss of transitional grassland, 20 ha after 50 years increasing to 80 ha after 100 years.

These losses are largely related to “coastal squeeze” as rising sea levels erode habitats on the seaward side but fixed coastal defences prevent habitat from “migrating” landward.

The CHaMP also identifies broadly suitable locations for delivering habitat through shoreline realignment based on suitable elevation relative to tidal levels and the absence of obvious infrastructure. The total area of such sites identified by this process was 14,211 ha. Much of the northern part of the Hoo peninsula is identified as potentially suitable for realignment. One managed realignment site is already being progressed here as compensation for the London Gateway Port. The Environment Agency has identified a further three sites on the north-east of the Hoo peninsula (St. Mary’s, Allhallows and Grain sites) of its five priority sites in the estuary to meet its compensatory habitat requirements for coastal flood and erosion management.

The Environment Agency has a legal requirement to deliver 876 ha of compensatory intertidal habitat within the lifetime of the TE2100 Plan as well as 779 ha of compensatory freshwater grazing marsh habitat. The Intertidal habitat requirement is the more urgent, and is programmed to be delivered over three epochs (and to exceed the 876 ha requirement):

- 2006-2026 – 314 ha
- 2026-2056 – 264 ha; and
- 2056-2106 – 398 ha

47 Environment Agency, 2012. Thames Estuary 2100, Managing flood risk through London and the Thames estuary: TE2100 Plan. Environment Agency. London.
48 Environment Agency, 2008.Thames Estuary 2100. Greater Thames CHaMP. Summary Document. Environment Agency, London.

The first phase of delivery of TE2100 is required to provide at least 84 ha of intertidal habitat by 2020, with a high probability that at least one or the priority sites on the Isle of Grain will contribute towards this.

Candidate locations for delivering freshwater grazing marsh to meet TE2100's legal requirements are not yet identified beyond broadly suitable areas based on elevation and absence of development. The broad areas to the south of the Thames are on the Hoo Peninsula, The Swale, and the Medway valley between Rochester and New Hythe. The Greater Thames Nature Improvement Area consortium is undertaking studies to better define candidate locations, but we are not aware of any programme for reporting on this.

Implications for Habitat Compensation for the Thames Hub

1 Any assessment of habitat compensation requirements for Thames Hub will need to be set in the context of an updated Greater Thames CHaMP. This is likely to require new modelling to account for effects of the Thames Hub on physical processes within the estuary.

2 The CHaMP update will require a re-assessment of potential habitat compensation sites, to exclude those within the footprint of the Thames Hub footprint.

3 The demand for habitat compensation sites around the Greater Thames CHaMP study area has been identified for some years and, therefore, some of the highest opportunity sites, i.e. those with fewest obvious constraints, have already been progressed by some parties. Therefore some re-appraisal of locations may be necessary and consideration given to all options for habitat creation, such as intertidal recharge.

4 Thames Hub's requirements for freshwater compensation will be addressed by identifying suitable sites for grazing marsh creation or reinstatement.

5 There may be some synergies between the habitat compensation needs of the Thames Hub and those of other parties, in particular the Environment Agency, as larger sites which combine needs can theoretically provide a more cost effective option, per hectare, than a series of smaller sites.

6 The TEP Plan recommends that a Thames estuary land strategy is developed in partnership with decision makers, land owners and managers to safeguard land for future flood risk management and to bring together the various strategic plans and vision statements from across the estuary, and the development of the Thames Hub would be integrated into this partnership.

1-7-2-2 TE2100 Plan's for Coastal Defence Management and Implications for Thames Hub

The TE2100 Plan proposes a flood risk management policy for each of the 23 policy units in the Plan area. These policies set the standard for flood risk management in each policy unit and direct the implementation of actions and future flood management investment, and they provide a common foundation from which all parties can plan their short-, medium-, and long-term activities. The Thames Hub primarily overlaps the Isle of Grain component of "*Action Zone 7 – lower estuary, urban/industrial and marshland*". The related policy is to "*take further action to keep up with climate and land use change so that flood risk does not increase*", which is wholly compatible with the Thames Hub's requirements for coastal flood defence. To the west of Action Zone 7 are marshes which do not justify the current level of tidal flood protection along the Thames and Yantlet Creek and TE2100 identifies habitat creation opportunities here.

The extreme western elements of Thames Hub will extend into "*Action Zone 6 – lower estuary marshes*". The related policy is to "*continue to maintain flood defences at their current level, accepting that the likelihood and/or consequences of a flood will increase because of climate change*". The TE2100 vision is to conserve and enhance this important marine and freshwater environment, in cooperation with local stakeholders. The main changes are likely to be caused by the need to create replacement intertidal habitat as the sea level rises and to enhance existing freshwater and grazing marsh habitats as potential compensation for loss of designated habitat. There are potential synergies with Thames Hub related to habitat compensation.

Therefore, the Thames Hub would work with the EA and other TE2100 stakeholders in the early identification and development of habitat creation / restoration sites to contribute to both the TE2100 coastal management objectives and those of intertidal habitat compensation required for the Thames

Hub. There is potential for the coastal management requirements of the Thames Estuary and the national requirement for airport capacity to be incorporated within a National Policy Statement, to ensure an integrated approach to sustainable development and that it has been integrated with other Government policies.

Wetland Vision

The England Wetland Vision partnership consists of statutory organisations and leading conservation bodies comprising English Heritage, the Environment Agency, Natural England, the Royal Society for the Protection of Birds and The Wildlife Trusts and sets out a 50-year Vision for freshwater wetlands in England. The aims of the Wetland Vision are to[49]:

- *"Place existing wetlands at the heart of our vision; enabling them to adapt in the face of climate change by linking new and existing wetlands across the landscape.*
- *Restore degraded wetlands in the uplands and lowlands, so that, in functioning more naturally, they can provide enhanced benefits to society.*
- *Significantly extend, and in some cases double, many lowland wetland habitats such as reedbed, ponds and grazing marsh.*
- *Preserve the unique and fragile record of our historic environment by keeping the most important former wetland sites wet.*
- *Create and restore wetlands wherever they can support wildlife, reduce run-off and pollution, and provide wildlife-rich green spaces for people to enjoy.*
- *Make wetlands more relevant to people's lives by better understanding and harnessing the benefits provided by naturally-functioning rivers and wetlands – that can slow and store flood waters, protect water quality, recharge groundwaters and store carbon – and then communicating these benefits widely throughout society."*

Although, the Thames Hub compensation will primarily be concerned with intertidal habitat creation, there will also be a need and an opportunity to contribute to the Wetland Vision aims of freshwater habitat creation and restoration (e.g. grazing marsh). Wetland Vision has produced a series of maps indicating priority areas for wetland creation/restoration, including priority areas for the historic environment.

1-7-3 Affected Species Requirements

In planning for compensation, it will be necessary to give close attention to the habitat preferences of, particularly the Natura 2000 qualifying species, in order to ensure, as far as possible, that the compensatory habitat matches their requirements. Consideration in this case will need to be given to compensating particularly for the loss of intertidal mudflats, saltmarshes and grazing marshes.

Creation of suitable habitat for estuarine birds requires the establishment or re-instatement of controlling ecological processes on what is, in most cases, agricultural land (although beneficial recharge uses dredged material for the creation or maintenance of coastal or estuarine habitats). Consequently, detailed design of a proposed site would address the main factors of hydrology, geomorphology, sediment dynamics, and both biological and biogeochemical processes[50]. The physical characteristics of a site that are most likely to affect its colonisation by birds are elevation relative to the tides, sediment type and the degree of exposure to waves and currents. These will determine the saltmarsh-mudflat balance and the benthic invertebrate communities on which the birds will depend[51,52].

The key habitat preferences or requirements of some of the potentially affected species are summarised in Table 1.6, as an indication of the habitat components necessary for the target species.

---

49 Hume, C. 2008. Wetland Vision Technical Document: overview and reporting of project philosophy and technical approach. The Wetland Vision Partnership

50 Atkinson, P.W., Crooks, S., Grant, A. & Rehfisch, M.M. (2001) The success of creation and restoration schemes in producing intertidal habitat suitable for waterbirds. English Nature Research Report No. 425. English Nature, Peterborough. p93

51 ABP Southampton (1998), Review of Coastal Habitat Creation, Restoration and Recharge Schemes. Report No. R 909. ABP Research & Consultancy Ltd., Southampton. P85-86.

52 Nottage, A. & Robinson, P. (2005). The saltmarsh creation handbook: a project manager's guide to the creation of saltmarsh and intertidal mudflat. RSPB, Sandy and CIWEM, London. Pp29-30.

Species	Habitat	
	Foraging	Roosting
Shelduck	Soft intertidal mud; mud covered by shallow water; linear borrow pits.	Roost on saltmarshes, upper mudflats and fields.
Teal	Creeks and saltmarshes; fringe zone between open shallow water and marginal vegetation; fine mud covered by a thin layer of water; linear borrow pits.	Similar fringe habitats with, preferably, a gently sloping (<1/1000), south facing shore.
Mallard	As for teal. Also waters edge along narrow intertidal shores.	Along the upper shore, on open water and on inland water bodies.
Lapwing	Extensive upper/mid shore mudflat with good visibility; grassy (short) and bare arable fields close to estuary.	
Black-tailed godwit	Soft fine intertidal mud; areas of shallow permanent water over fine mud; artificially created lagoons.	On saltmarshes, on the shore along the high tide line, in fields and lagoons (natural and artificial).
Knot	Extensive areas of muddy sand or sandy mud.	Upper shore and saltmarshes.

Table 1-6

1-7-4 Compensation Ratio

The Habitats Directive sets out the requirement to protect coherence of the Natura 2000 network. Guidance states that measures should:

- Address in comparable proportions the habitats and species negatively affected; and
- Provide functions comparable to those which had justified the selection of the original site, particularly regarding the adequate geographical distribution of the features concerned

However, there should not be a requirement for more compensation than is needed to ensure that the integrity of the network of European sites is maintained[53].

The extent of impact and therefore the required level of compensation can only accurately be derived through Appropriate Assessment as part of the Habitats Regulations Assessment. The compensation ratio required to maintain overall coherence of the Natura 2000 network should generally be substantially more than 1:1. Guidance[54] states that compensation ratios are applied on a case-by-case basis and ratios of 1:1 or below should only be considered where the measures will be 100% effective within a short period of time.

In consideration of uncertainty, with regards to the quality of habitat that will be created, a compensatory habitat ratio of approximately 2:1 was required in light of the predicted impact due to the Bathside Bay container terminal project in the Stour and Orwell estuaries. This contrasts with the Weser, Bremen, Germany (expansion of a container terminal) where the compensation measures (habitat creation) were progressed on a 1:1 basis[55].

In the determination of the compensation ratio consideration is needed for existing habitat value and distinctiveness, uncertainty, spatial risk, correlated success/failure, and years to target condition, with

53 Department of Environment, Food and Rural Resources, 2012. Habitats and Wild Birds Directives: guidance on the application of article 6(4) Alternative solutions, imperative reasons of overriding public interest (IROPI) and compensatory measures. Defra. London.
54 European Commission, 92/43/EEC. 2007. Guidance document on Article 6(4) of the 'Habitats Directive'. Luxembourg: Office for Official Publication of the European Communities.
55 Royal HaskoningDHV, October 2012, Environmental Impact Assessment (EIA) and Appropriate Assessment (AA) Evaluation of assessment tools and methods. Lot 2: Analysis of case studies of port development projects in European estuaries. Commissioned by the Antwerp Port Authority

allowance for the risk that the compensation may be unfavourable in the long-term[56,57]. The Biodiversity Offsetting Pilot scheme for England recognises that where there are real risks around the methods and certainty of restoration or creation then a high compensation ratio may be required; but for other situations (e.g. where restoration techniques are tried and tested), lower ratios can be used.

Should there be indirect impacts that cannot be fully mitigated, consideration may need to be given to the delivery of sufficient habitat area to accommodate fragmentation effects, in addition to direct losses[58]. With regards to compensation these can only be considered with any certainty following the completion of detailed studies.

Background study into potential habitat compensation ratios for a potential Severn Tidal Power (STP)[59] considered that a likely compensation ratio for intertidal features will depend upon the following factors:

- Efficacy of measure
- Scale of delivery
- Tranches
- Proximity
- Timing
- Resource equivalence
- Ecological productivity
- Habitat development and a dynamic approach to targets and ratios

There is difficulty in establishing a clear rationale for the selection of suitable compensation multipliers. In the context of the Directives a guaranteed outcome is required and it is necessary to reduce risk of net loss to acceptable levels[60]. Precedent is a useful guide as it shows what ratios have been considered to be effective in protecting coherence. The Environment Agency applies a compensation ratio approaching 1:1 when considering the future requirement for compensation to offset the coastal squeeze effect, which is justified as the measures are planned to be in place and ecologically functioning well in advance of flood risk management actions being felt. Case studies show that compensation ratios have ranged from 1:1 for schemes located adjacent to the impact site to ratios of 4:1 (e.g. Harwich Harbour Authority, where the ratio was required to compensate for accelerated intertidal erosion over the five years taken provide the compensation).

The STP studies recognised that compensation ratios for supporting habitat creation for SPA birds would be based on an assessment of the functionality of the habitat that has been lost and the likely functionality of the replacement habitat. This might justify a lower compensation ratio for supporting habitat for birds than that used for SAC habitat creation. Larger sites may achieve greater functionality, be more sustainable and be less vulnerable to edge effects.

Therefore, it is expected that a compensation ratio in the range of >1:1 to 4:1 (considering potential for indirect effects) would be likely to be required. Consequently, it is estimated that 2,000-7,000 ha of replacement habitat will be needed to compensate for the proposed Thames Hub.

---

56 Moilanen, A., van Teeffelen, A.J.A., Ben-Haim., Y. and Ferrier, S., 2009. How Much Compensation is Enough? A Framework for Incorporating Uncertainty and Time Discounting When Calculating Offset Ratios for Impacted Habitat. Restoration Ecology, Volume 17, Issue 4, pp470-478.

57 DEFRA, 2012. Biodiversity Offsetting Pilots Technical Paper: the metric for the biodiversity offsetting pilot in England. DEFRA, London.

58 Franco, A., Thomson, S. & N.D. Cutts, 2013. Determinants of bird habitat use in TIDE estuaries. Institute of Estuarine and Coastal Studies (IECS), University of Hull, UK.

59 Department of Energy and Climate Change, 2010. Severn Tidal Power Report on Possible Compensatory Measures under Article 6(4) Habitats Directive. Annex C Severn Tidal Power Feasibility Study Working Paper: Compensatory Measures – Application of Compensation Ratios under Article 6 (4). DECC. London.

60 Department of Energy and Climate Change, 2010. Severn Tidal Power: Potential for Compensatory Measures. DECC, London.

1-7-5 Location

European Commission guidance sets out priorities for the location of compensatory measures which are in order:

1. Compensation within the Natura 2000 site
2. 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
3. Compensation outside the Natura 2000 site in a different topographical or landscape unit

Taking into account that the area of compensatory habitat required is likely to be above 2,000 ha, the area for potential intertidal habitat creation in Britain has been identified as over 33,000 ha[61], with a concentration of potential locations on the north Kent and Essex coastlines. This RSPB study showed that within the south-east of England there is a total of 34 potential sites, averaging over 200 ha (largest site of over 2000 ha), with East Anglia having 100 sites averaging 138.9 ha (largest site of 799 ha).

In addition, the STP studies identified that the area of relatively unconstrained coastal floodplain in England and Wales within which managed realignment might be undertaken as 110,000 ha[62]. Wetland Vision[63] have indicated potential wetland creation locations within England, which show significant potential in north Kent around the Isle of Sheppey, the Swale and Isle of Thanet, with other significant areas on the coast of Essex, Suffolk and Norfolk, which also coincide with those areas at highest risk of coastal erosion.

The ideal compensatory habitat would be contiguous with the Thames/ Medway estuary. However, should there be insufficient suitable land adjacent to the estuary, then the search boundaries for compensation land will be sequentially extended whilst ensuring that potential sites are within the same range, migration route or wintering area for the bird and, where relevant, other species populations affected. Habitat on the flyway of displaced migratory bird species might also be considered. The Thames Estuary is part of the ecosystem around the North Sea, which includes the coastal lowlands of the Continent and the East of England and there is potential to extend the potential compensation sites/s location to a wider geographic area, if necessary (e.g. widened to the level of the Atlantic Bio-geographic region).

---

61 Pilcher, R. Burston, P. Kindleysides, D. and Davis, R (2002). Seas of Change, the Potential for Intertidal Habitat Creation around the Coast of Mainland Britain. RSPB Report October 2002 35pp.
62 Department of Energy and Climate Change, 2010. Severn Tidal Power: Potential for Compensatory Measures. DECC, London.
63 http://www.wetlandvision.org.uk, accessed April 2014)

1-7-6 Compensatory Habitat Specifications

A sequential process of determining potential sites within an identified search area boundary is proposed below. The flow diagram in Figure 1 shows how these activities might slot together.

Primary Criteria (essential):

- Elevation suitable for desired habitat creation
- Geomorphology is suitable for proposed habitat creation

Data to be obtained using LiDAR data.

Secondary Criteria (highly desirable):

- Old estuaries or coastal wetlands which could be restored to full functionality
- No cultural heritage features
- No property or infrastructure
- No contamination
- No aquifers

Tertiary Criteria (nice to have):

- No valuable habitats on site
- No public footpaths or other recreational areas on site
- Low grade agricultural land
- Ease of access

1-7-7 Technical Feasibility

Intertidal habitats pose particular problems for creation/restoration because (i) they are topographically and ecologically complex, (ii) they support many species of animals, some of which require specific habitats and linkages to other terrestrial or marine habitats, and (iii) they exist and evolve within dynamic coastal settings, subject to changing tidal levels, salinities and long term forcing factors associated with sea-level rise and climate change[64]. However, estuary birds are highly mobile, particularly outside the breeding season, and will readily use newly created habitats within an estuarine system provided the conditions are suitable.

This has been demonstrated, for example, by existing schemes on the Humber, where colonisation of the Paull Holme Strays realignment site by birds began in the same autumn season that breaching occurred[65]. However, invertebrate populations often take 5 years to fully establish themselves[66], so that bird populations may not stabilise during that period.

The technical feasibility of such large-scale habitat creation/restoration schemes has increased significantly over recent years as similar schemes have been implemented, the results of monitoring collated and remedial measures taken. Research findings have contributed to intertidal habitat creation and models developed to help design and implement such schemes (e.g. development of a model of wetland (re-creation which can be used as a template to plan new projects, based upon an Ecosystems Services approach[67]).

The STP studies found that there are no technical barriers to “large scale” managed realignment (MR) (beyond those already encountered in completed schemes) and that MR in excess of 1,500 ha appears technically feasible, with scaling up adding relatively few new technical issues. The study also identified that modelling has shown that it is possible to find large sites that could be breached and creek networks excavated sufficiently to allow regular inundation of water such that mudflat and saltmarsh could be created.

---

64 Atkinson, P.W., Crooks, S., Grant, A. & Rehfisch, M.M. 2001. The success of creation and restoration schemes in producing intertidal habitat suitable for waterbirds. English Nature Research Report 425. English Nature. Peterborough.
65 Mander, L., Cutts, N.D., Allen, J. & Mazik, K. (2007) Assessing the development of newly created habitat for wintering estuarine birds. Estuarine, Coastal and Shelf Science 75 (2007), 163-174.
66 Atkinson et al. (2001), pp90-91.
67 ELP. 2008. Creating New Wetland: Key Principles and a Project Model. Report on behalf of the Broads Authority and Natural England

The approach to compensation provision could be a ‘small sites approach’, which would require a high number of sites, but might allow for more flexibility in terms of site selection and programming, or a ‘large sites approach’, or potentially a use of the two approaches. There would be a number of variables to consider to determine which approach is most appropriate, which would need to be considered as part of a detailed compensation delivery strategy.

Habitat compensation solutions are likely to necessitate an approach which may include a mix of MR of coastal defences, habitat restoration of degraded intertidal habitats and the creation of new intertidal habitat areas. There is evidence to show that there is a massive potential to replace lost areas of intertidal habitat and create new habitat for waterbirds[68], which the Thames Hub compensation would contribute to.

1-7-8 Delivery Timelines

Compensation will need to be available and in operation prior to operations which are likely to significantly affect the integrity of Natura 2000 sites. The delivery timelines for the practical delivery of the compensatory measures for the Thames Hub would not be under-estimated. A detailed compensation delivery strategy would be an early priority due to the potentially long lead-in period for compensation site identification, procurement, design, consents, construction requirements and period for development of the required habitat types.

Delivery timescale could be positively influenced if it was possible to buy into pre-existing or pre-planned habitat creation projects, which could be adopted and developed as part of the Thames Hub compensation (a form of habitat banking, which is considered below).

1-7-9 Costs

The approximate per ha cost of major MR schemes between 2004 and 2010 indicates a significant cost implication based upon scale, with a site of <100 ha costing up to £100,000 per ha and larger schemes >100 ha costing in the range of £50-70,000 per ha.

On this basis and that between 2,000 - 7,000 ha of habitat compensation creation/restoration would be required for the Thames Hub, it can be calculated that the total approximate cost would be in the region of £100 million to £500 million[69].

1-7-10 Habitat Banking

Habitat Banking could be considered as part of the solution to the need for compensatory habitat. Habitat Banking is an established approach in some parts of the world and is an economic strategy which allows conservation actions such as creation, restoration or enhancements, intended to compensate and mitigate for the unavoidable impact to biodiversity caused by development projects, to ensure no net loss of biodiversity. This is being progressed with Defra in the UK to enable developments to yield substantial gains for the natural environment. By brokering arrangements between developers, landowners and planning authorities in appropriate locations, it is possible to assimilate large funds for the creation and management of habitats at a large landscape scale. A key feature of the habitat banking scheme is the pooling of credits from a range of development schemes to provide added value by provisioning large landscape-scale initiatives. Furthermore the strategic approach employed enables in perpetuity agreements to monitor and manage the mitigation and compensation of habitats within a long-term framework. If “credits” are purchased during construction, it may also be possible to sell credits once any newly created habitat is in favourable condition.

68 Atkinson, P.W. 2003, Can we recreate or restore intertidal habitats for shorebirds? Wader Study Group Bull. 100: 67-72.
69 Not including inflationary rise since 2010.

1-8 Conclusions

The first two Natura 2000 legal tests regarding ‘alternative solutions’ and IROPI are covered in detail within 1.2 and 1.6.6. This report has provided a comprehensive response to Study 1 - Environmental/ Natura 2000 impacts and an initial response to the test to ‘ensure that the overall coherence of the network of European sites’.

Although there is a great deal of detailed study and assessment required to determine fully the likely significant effects to Natura 2000 habitats and species, it is accepted that there would be direct and indirect effects. However, this report demonstrates that there is precedent from a number of case studies, allied to an existing scientific database to demonstrate that an appropriate degree of habitat creation and/or restoration is feasible to enable the likely significant effects to be compensated to a level where the ‘overall coherence of the network’ is maintained. There are sufficient intertidal habitat creation opportunities in the north Kent area or further afield within Essex and the south and east of England. Ideally compensation locations will have comparable conditions to those at the Thames Hub site (e.g. salinity, hydrodynamics) to maximise the likelihood of successful compensation provision. In order to create an area of suitable habitat substantial enough to compensate for the loss it may be necessary to utilise a number of methods at a number of different sites.

Case studies have shown that defining the ecological requirements of a species or habitat is only part of the equation and equally important is the process of working with stakeholders to find ways of implementing these provisions in order to achieve sustainable long-term results. Development of the UK ports industry is seen as a good example of how economic development and Natura 2000 interests have been mediated and their model would be used to guide dialogue and agreement over the scope and analysis of impact assessment, mitigation, compensation and monitoring.

1-9 Landscape, Historical and Archaeological Impacts

1-9-1 Introduction

The proposed airport and surface access routes are located in the Greater Thames Estuary National Character Area (NCA) 81 and the North Kent Plain NCA 113[70].

The Greater Thames NCA lies around the northern and southern shores of the Thames valley east of London. The NCA is described as “predominantly a remote and tranquil landscape of shallow creeks, drowned estuaries, lowlying islands, mudflats and broad tracks of tidal salt marsh and reclaimed grazing marsh that lies between the North Sea and the rising ground inland” (Natural England).

The area is scarcely populated with scattered hamlets and small villages. Towards London, the landscape is industrial and urban, with new port developments, waste disposal sites, housing regeneration, power stations, and other activities. These urban landscapes are visible from the low lying marshes.

The historic landscape is characterised by the reclaimed marshes with the network of ditches and dykes dug to drain them, traditional unimproved wet pasture for sheep and cattle, the pattern of hamlets and small villages on higher land above the marshes reflecting their medieval original and coastal economy together with their Saxon Churches, sea defences, and the evidence of coastal military history with Napoleonic defences, forts and 20th century pillboxes.

The marshes along the southern shore of the Thames have very strong literary associations with Charles Dickens’ Great Expectations and recent adaptations for television and film, with a brooding sense of wildness and danger in the flat empty landscape. Dickens purchased Gadshill Place, Higham near Rochester in 1856 and lived there until his death. Higham also has a literary association with the character Falstaff who attempts robbery in the woods at Gad’s Hill in Shakespeare’s Henry IV Part I.

There are no areas designated for their landscape value, although there are international, European and nationally designated ecological sites, which have been discussed in the previous sections.

Drivers of change identified by Natural England include climate change causing sea level rise, loss of coastal habitats, changes in estuary morphology and coastal process. Other drivers of change include ongoing industrialisation and associated infrastructure such as Thames Gateway, housing provision, ports, as well as opportunities for landscape improvement from the restoration of brownfield sites.

The North Kent Plain (NCA 113) extends in a belt from the coast around Margate, encircling the Medway estuary, and south of the Greater Thames Estuary NCA, westwards towards Croydon. Parts of the proposed airport and surface access routes would like within the North Kent Plain. This landscape type is characterised by open, gently undulating countryside, with areas of ancient woodland and farming based on traditional orchards, soft fruits and horticulture. There are several large towns, including Rochester, Chatham and Gillingham on the Medway. There is a rich cultural heritage, with scheduled (ancient) monuments, listed buildings, registered parks and gardens associated with country houses and estates, and military remains along the coast.

A small part of the NCA extends into the North Downs Area of Outstanding Natural Beauty (AONB) in the west. There are international, European and national ecological designations within the NCA, including the coast and marshes of the Medway estuary.

Drivers of change include climate change, which may lead to changes in woodland composition, deterioration of wetlands due to summer drought, effects on traditional orchards, summer water shortages, and rising sea levels which in turn could lead to accelerated loss of marshes, changes in patterns of erosion and deposition, and changing composition of flora and fauna. Other pressures on the landscape character are pressure for housing, food production, and proposals for a Lower Thames Crossing. Opportunities include restoration of brownfield sites.

70 Natural England has published profiles of the NCAs available from www.naturalengland.org.uk.

1-9-2 Impacts and Mitigation

The sensitivity of the low-lying landscapes of the Greater Thames Estuary to change are considered to vary between very high in the East Thames marshes to moderate in the Hoo Peninsula and the Medway marshes. The large scale and nature of the Thames Hub will have significant impacts on the existing landscape character of the area. The large terminals and operational buildings, offices, roads and car parks will interrupt the broad open scale of the marsh landscape. The network of ditches and creeks will be destroyed under the footprint of the airport. The settings of historic buildings and structures adjacent to the airport will be dramatically changed, assuming that they are not removed. The low hills of the Hoo Peninsula rising out of the surrounding marshland will be lost entirely. The existing open views out over the Estuary will be lost and replaced by terminal buildings, aircraft hangers and extensive areas of paving.

The likely visual receptors of the proposed development would be residents of properties within the Hoo Peninsula and the Isle of Grain, and along the surface access routes, tourists, birdwatchers and workers.

The scope for landscape and visual mitigation to alleviate the obstruction of views and landscape character will be limited due to the sheer scale of the development. However, much can be done through master planning and architectural design to create a coherent, visually attractive airport, through the massing of structures with open space and runways, the form and finish of buildings, land contouring, and planting.

For its size, there are relatively few significant archaeological features on the Hoo Peninsula. The proposed Hub airport would directly affect five cultural heritage assets, a grade I listed church, a listed public house, listed WWII shoreline defences, scheduled Coastal Artillery Defences, and the listed Grain Tower which lies within them. The impact of the development on the fabric and setting of these features would be permanent and irreversible. However, through sensitive design and mitigation measures, the potential adverse impacts could be reduced. Such measures may include the relocation of structures, incorporation of the features into the design of the airport, preservation by record prior to demolition, and landscaping to screen and soften the impact of the airport on the setting of the cultural heritage feature. Material changes in the setting or fabric of listed buildings would be assessed as part of the environmental impact studies and reviewed during the planning process. It would be necessary to obtain Listed Building consent prior to alterations or demolition of any listed buildings.

In addition to the five listed features, there are also non-designated cultural heritage features, including buried and extant archaeology, historic structures notable for their local architectural or historic value, palaeo-environmental deposits and marine archaeology, including two offshore wrecks. These features are afforded protection under the planning process through the National Planning Policy Framework and local planning policies. Detailed studies and surveys to assess the risk of finding archaeological remains include non-intrusive measures, such as walk over surveys and geophysical surveys, and intrusive measures such as trial trenching. During construction, further measures to be implemented would include a watching brief during soil stripping and excavations, recording of finds, and the archiving and exhibition of finds in museums.

The costs associated with mitigation of cultural heritage features will vary depending on the amount of mitigation required, and it is difficult to put a cost against them before developing a schedule of mitigation needs, and for a development as extensive as the Thames airport. The following examples indicate the potential costs that could build up for a large scale development such as the Thames Hub:

- A city centre excavation of a medieval and post medieval settlement could cost £300,000.
- The log boats found in Newport were a huge cost given the long term conservation issues. Any remains found in the intertidal zone could cost £100,000 per item to excavate and long term storage commitments.
- The costs for handling the Crossrail plague pits were in the order of £250,000.

The cost of mitigating heritage features could be in the order of six to seven figures, which although substantial, would be small compared to the capital cost of the airport and surface access routes.

1-9-3 Conclusions

While there are no statutory protected landscapes in the study area, the open and wild countryside of the Thames marshes has a strong emotional appeal to many people resulting in the high likelihood of objections on landscape and heritage grounds. A holistic and comprehensive landscape and heritage mitigation strategy would be developed for the airport, its surrounds, and surface access routes, to ameliorate the impacts on landscape, views and heritage assets, while providing a fitting gateway to the UK.

Figures

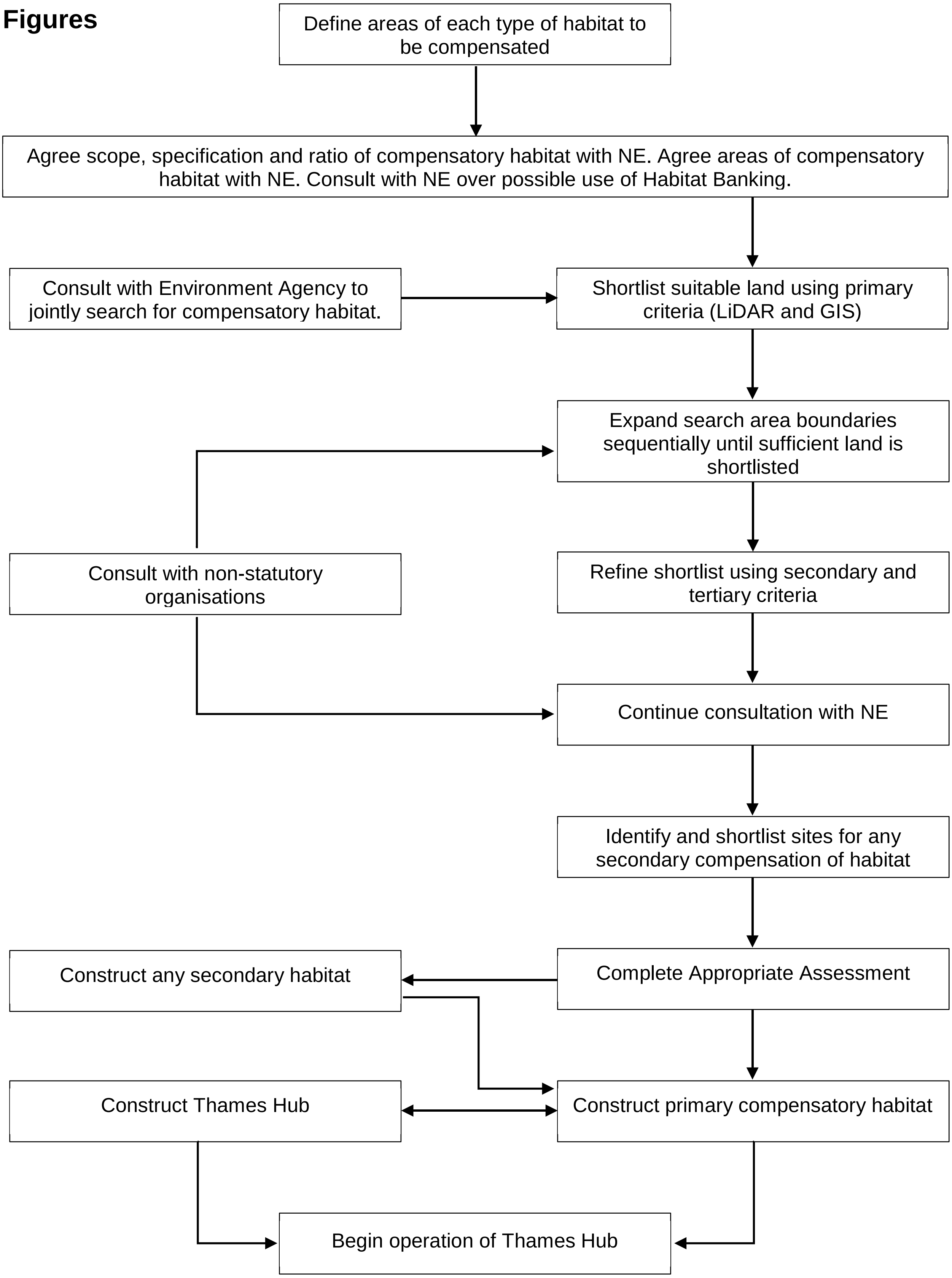

Figure 1-1 Outline work flow for acquiring compensatory habitat

Study 2: Operational Feasibility and Attitudes to Moving to a New Airport

2-1 Operational Feasibility

2-1-1 Risk of Flooding on Operations

2-1-1-1 Introduction

The Thames Hub is proposed to be located on the north east corner of the Isle of Grain, in the Inner Thames Estuary. The footprint covers Yantlet Flats and Grain Split, which are exposed at low tide, but covered at high tide. Yantlet Flats and Grain Split currently provide protection to the shoreline by causing large waves to break before reaching the shoreline.

The placement and compaction of suitable fill material will be required to create a stable surface to support the airport infrastructure and facilities. The final airport platform would be approximately 8.7 km long and 4.2 km wide, with an assumed height of around +7mODN. The +7mODN value has been based on a desktop benchmarking exercise taking into account the local meteorological conditions at the proposed site and the latest predictions for sea level rise (SLR).

The final platform level will have to adequately protect the platform from tidal flooding, wave action, sea level rise, provide sufficient falls for surface water drainage and means to shed water from the site, and allow for anticipated settlements within the existing ground and reclamation fill.

According to the Thames Estuary 2100 project (Environmental Agency), the tidal flood risk is increasing in the Thames estuary, due to; climate change and sea level rise; ageing of the current flood defence infrastructure; and more people living and working in the defended floodplain.

2-1-1-2 Current Situation

The Thames floodplain area is approximately 350 km^2 and includes important parts of central London. There are over 500,000 properties and about 1.25 million residents, amongst other commercial, industrial and government properties.

The main flooding threat to the proposed site would be flooding from the tidal River Thames. Other sources are tributaries, local drainage, surface water and ground water.

In order to prevent flooding of the new Thames Hub operations, a sufficient platform level should be provided. An analysis of the critical extreme water level scenarios that the Isle of Grain might encounter, both currently and in the future, has been assessed against the proposed platform height, as follows:

- Scenario 1: Current situation of high/low tides
- Scenario 2: Current situation with a possible replica of the 1953 storm surge
- Scenario 3: Current situation with maximum wave heights on a replica of the 1953 storm surge
- Scenario 4: Year 2100 Mean Sea Level
- Scenario 5: Year 2100 situation of high/low tides
- Scenario 6: Year 2100 situation with a possible replica of the 1953 storm surge
- Scenario 7: Year 2100 situation with maximum wave heights on a replica of the 1953 storm surge

2-1-1-3 Tide Levels

Tides in the study area are affected by the Atlantic tidal wave which enters the region through the Dover Strait and to a lesser extent via the North Sea. The times and heights of these high and low waters are periodically measured at several locations along the River Thames by the PLA (Port of London Authority). The table below indicates the expected highest and lowest tides for the Isle of Grain site from the Admiralty Tide Tables for Sheerness.

Tide at Sheerness		Water Level (mODN)
Highest Astronomical Tide	HAT	+3.4mODN
Mean High Water Springs	MHWS	+2.9mODN
Mean Sea Level	MSL	+0.2mODN
Mean Low Water Springs	MLWS	-2.3mODN

Table 2-1

2-1-1-4 Extreme Water Levels

The following extreme water level predictions are taken from the Environment Agency report: 'Coastal Flood Boundary Conditions for UK Mainland and Islands - Practical Guidance Design Sea Levels' (2011).

Return Period (years)	Probability of occurrence in any given year (% chance)	Extreme Water Level (mODN)
1	1.0 (100%)	3.6mODN
5	0.2 (20%)	3.9mODN
10	0.1 (10%)	4.0mODN

Table 2-2

1953 Storm Surge Event

Data published by the Environment Agency, suggests that during the 1953 surge event, water levels peaked at +4.60mODN at Southend. At Southend, this would equate to approximately a 1:500 year return period event today. If the same return period is assumed for Sheerness, the corresponding extreme water level at Sheerness would be around + 4.9mODN.

2-1-1-5 Wave Assumptions

In the Outer Thames Estuary dominant waves approach from the east-northeast to southeast. According to the draft SMP (Royal Haskoning, 2010), the extensive offshore bank and channel system located to the east of Southend protects much of the estuary from these southern North Sea storm waves. Hence, wave activity in the Thames Estuary west of these banks is generally from locally-generated wind waves. Various studies suggest that extreme 1 in 100 year wave heights in this location can reach a significant wave height of 1.5 m.

Combining the 1 in 100 year extreme wave height with a 1 in 500 year water level as assumed above is extremely conservative. The probability of such a combination of extreme wave height and extreme water level occurring jointly, is extremely low - possibly in excess of a 1 in 2000 year return period event, which is an order of magnitude greater than a typical design criteria value.

In the most extreme conditions, a +7mODN platform would not be sufficient to avoid disruption of operations due to flooding. However, as noted above, the scenario of combining a 1 in 100 year wave height with a 1 in 500 year water level is extremely conservative, and well in excess of a 1 in 100 year event as typically required as design criteria. Also, in addition to crest height, the degree of wave run-up and overtopping is very sensitive to the slope and roughness of the slope protection applied to the reclamation, and also the water depth at the toe of the structure. If we assume that the required design criteria is to limit overtopping from a 1 in 100 year joint probability (wave and water level) event, then during subsequent design, it is anticipated that the required reclamation level may be reduced from the currently assumed +7mODN to closer to +6mODN (although this would need to be confirmed during design and will be dependent on factors including those mentioned above, which are unknown at this stage).

This analysis has not taken into account the effect of the reclamation on the cross section of the river and hence in the tidal prism, nor the possible wave mitigation measures that could be implemented downstream to protect the airport. These factors could further reduce the required height for the platform.

2-1-1-6 Reclamation Impacts

In general terms, the installation of a large reclamation extending across the estuary has the potential to cause a number of impacts in relation to flood risk.

Tidal Range - The magnitude of the impact will be dependent on the degree to which the reclamation decreases the cross sectional area of the estuary and creates a throttling effect. The effect will be that the volume of water passing upstream decreases and thus the high water levels. Water levels might raise in the downstream vicinity of the reclamation, but in a less extent. On the ebb tide the reclamation could restrict the seaward flow of water and this could raise water levels. Any throttling effect could also produce a reduction in the peak tide and surge levels upstream of the reclamation.

The net impact of these changes would need to be assessed using a hydrodynamic model. Several modelling investigations undertaken as part of the Thames Estuary 2100 project (using ISIS and TELEMAC) show that, to produce significant reductions in upstream water levels, the reclamation would need to constrict the estuary channel by greater than 75%.

The airport would be in the reclaimed area, which implies that it will receive both the upstream and downstream impacts described above.

Tidal Flows - The reclamation has the potential to increase adjacent tidal flows due to the restriction of the estuary cross sectional area. These increased flows would in turn have the potential to cause erosion of intertidal areas which could threaten the integrity of existing defences and reclamation protection.

Wave Climate - The reclamation may reduce waves generated in the outer estuary from propagating upstream. Around the reclamation there may be changes in local wave patterns due to changes in fetch lengths and wave reflections from the new structure (depending on the nature of the reclamation edge treatment). Such changes would have the potential to alter erosion/accretion patterns on the intertidal areas which could influence the exposure of the flood defences.

2-1-1-7 Mitigation

The following measures can mitigate the potential flood risk and aforementioned impacts. They could contribute in the reduction of the extreme water level the future airport platform may encounter. Therefore, the currently assumed +7mODN platform height could be reduced after further design and consideration of the following:

- The construction of a rock revetment along the full perimeter of the airport platform would provide protection for the airport platform from the erosive effects of waves and tidal currents. The roughness of the rock revetment would also help reduce wave overtopping.
- A raised concrete wave wall at the top of the bund.
- Locating the platform as far into the supra-tidal (landward) as possible.
- Reducing the size of the intertidal/subtidal reclamation.
- Avoiding channels and creek systems.
- Engineering the interface of the platform and the estuary with a hydrodynamically smooth transition zone to mitigate or eliminate potential erosive effects on the existing coastline
- Design the edge of the airport platform to be less reflective (e.g. use of sloping rock revetment protection rather than vertical sheet piles).
- Maintenance dredging of any banks that might form due to the scheme or by undertaking improvements to the defences themselves.

2-1-2 Risk of Fog on Operations

We have undertaken an assessment of incidence of fog and restricted visibility conditions for an airport in the Thames Estuary, with regard to how fog occurrence may impact operations.

Consideration has been given to recent meteorological data registered from 2004 to 2013. The following table presents the annual number of fog events (hours) observed at Shoeburyness, spanning a 10 year period, and categorised by visibility range and the type of approach required.

Visibility range*	**<1000 m**	**<600 m**	**<400 m**	**<200 m**
Approach	*Non precision*	*CAT I (<550 m)*	*CAT II (<370 m)*	*CAT III (<210 m)*
Airport / Year	**Thames Estuary**			
2004	96	73	54	23
2005	131	97	80	49
2006	128	100	78	38
2007	114	83	68	39
2008	105	84	71	44
2009	143	113	88	37
2010	193	146	120	60
2011	173	122	99	41
2012	172	136	92	28
2013	127	103	83	47

*Table 2-3 * Visibility range information was only available in hundreds.*

The worst period of fog occurred in 2010, where fog conditions were observed for 2% of the total annual hours recorded. The most affected period of the day was early morning, from 0400 to 0600.

Occurrences of fog at airports are addressed by using navigational aids and managing movement slot throughout the day.

Aircraft at the Thames Hub Airport would operate under Instrument Flight Rules and would be equipped with state-of-the-art navigational systems, operating to ICAO CAT II/III standards. This would ensure unimpeded aircraft movements and safety. In addition, ongoing developments in precision, all-weather aircraft landing systems will provide even greater safety in the future, potentially even in zero-visibility conditions.

During periods of fog conditions, air traffic controllers increase the airspace separation between aircraft to ensure that there is more time to react to any problems. This may impact on the capacity of a runway system. However, with consideration of an average runway utilisation of 85%, as proposed for the Thames Hub airport, which will allow for a peaky distribution of flights throughout the day, the Thames Hub runway system would have resilience to cope with fog delays by reallocating flights to the 'trough' periods.

2-1-2-1 Impact on Operations: Case Study

The following is an example of how the risk of fog incidence, on airport operations, would be managed.

To assess the impact of fog on future operations for the Thames Hub, a daily operations peak profile has been developed to simulate how delayed operations would be managed. This profile includes around 2,900 ATMs distributed in peaks and troughs throughout the day, which is a typical procedure to provide the runway system with resilience in case of unforeseen events such as fog. The normal operation of the runway system is recommended to be at 85% of its capacity, as shown in the profile chart below. The peaks correspond to 95% usage of the runways.

During periods of fog, air traffic controllers may increase separation between aircraft in airspace from 60 seconds to 90 seconds. This change in time-separation, would reduce runway capacity from an average of 85% utilisation to 66% utilisation, during periods of fog.

Assuming a 3 hour period of fog conditions occurring when the runway system is operating at its peak of 95% utilisation (0500 to 0800), the below graph highlights movements that would not be able to be accommodated during the peak. Due to the peaky profile, the movements in our example could be delayed, rather than cancelled, and shifted to later time slots when the runway system experiences a trough in utilisation (dotted bars).

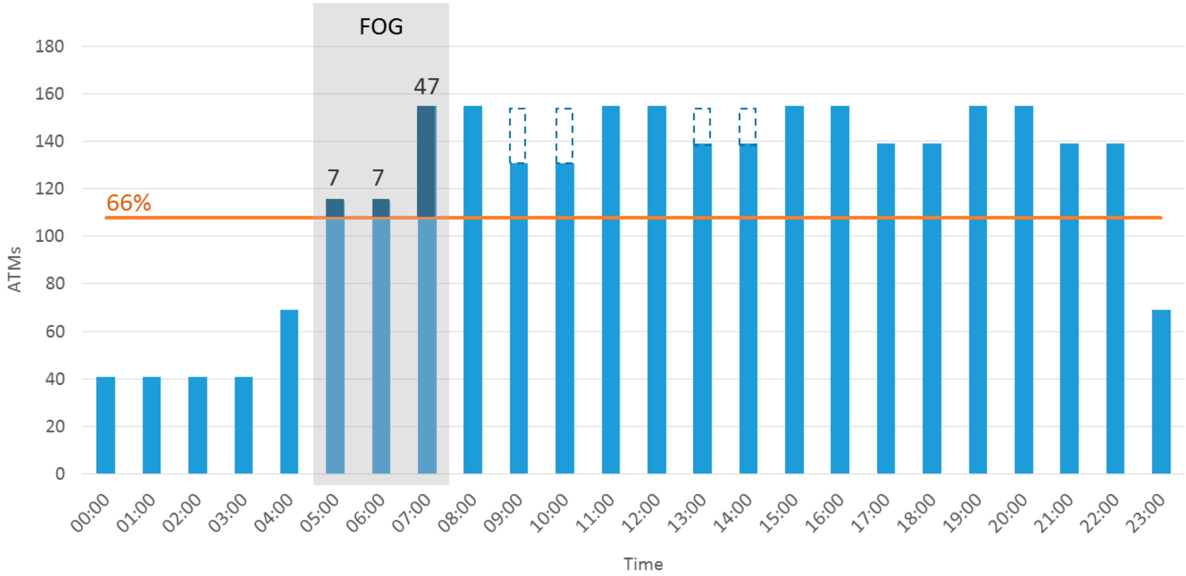

Figure 2-1

2-1-3 Risk of Wind on Operations

Wind is not considered as an operational risk factor for the proposed Thames Hub Airport.

ICAO Annex 14 requires runways or runway systems to have a usability factor of 95%, which represents the percentage of time the runway system is not restricted due to any crosswind component. The maximum permissible crosswind component is 20 knots. Higher crosswind components imply preclusion of any landing or take-off, even for the heaviest and more stable commercial aircraft.

The selected orientation of the 4 parallel runways of the Thames Hub is East-West (090°-270°). This takes into account the prevailing wind direction in the Thames Estuary area, in order to optimise the usability factor of the runway system.

Previous meteorological studies[71] prepared as inputs to the SERAS concluded that, considering the prevailing West to South East wind direction, a runway alignment ranging between 210° and 280° is recommended for an airport located in the Thames Estuary. This accords with the proposed Thames Hub runway system orientation.

The following shows the usability factor for crosswind components of 20, 30 and 40 knots with a runway alignment of 090-270°, as detailed in the SERAS, which confirms achieving the 95% usability factor.

Proportion of time with cross wind component 0-19.9 Knots: 97.8%

- Proportion of time with cross wind component 0-24.9 Knots: 99.4%
- Proportion of time with cross wind component 0-29.9 Knots: 99.7%

2-1-4 Risk of Bird Strike on operations

2-1-4-1 SERAS Strike Risk Report 2003

As part of the SERAS, a detailed bird strike study of the Hoo Peninsula was carried out for the proposed airport at Cliffe, by a team of scientists from the former government Central Science Laboratory Birdstrike Avoidance Team and from the British Trust for Ornithology. As the proposed Thames Hub site extends approximate 1 km east of the position of the Cliffe site, it is considered that this report can usefully inform the issues at Thames Hub.

The study concluded that an airport on the Hoo Peninsula would require a ‘comprehensive and aggressive bird management programme in place, incorporating careful and considered airport design, appropriate habitat management and active bird control. The study also included a case study assessment, considering bird strike risks at coastal airports. The case study assessment illustrates that the rates of bird strike vary between coastal airports depending on the particular characteristics of the airport and their location.

2-1-4-2 Bird Strikes at Existing UK Airports

Bird strikes are a risk at the majority of airports all over the world and all of London’s existing airports suffer from bird strike. Between 1998 and 2002, Heathrow had 268 bird strikes, Gatwick 201 and Stansted 109. None were recorded at London City Airport despite its location on the River Thames.

The number of reported bird strike incidents at UK airport doubled in the last six years. More stringent bird control managements plans will be needed whether a new hub airport is provided at an existing, or a new, airport and irrespective of whether that airport capacity is located inland or at a coastal or estuarine location.

---

71 The Department of the Environment, Transport and the Regions undertook a meteorological study in January 2001 as part of the “South East of England Regional Air Services Study (SERAS)”.

2-1-4-3 Management of Bird Populations to Manage Risk on Operations

Bird strike management forms an integral part of an airport's Safety Management System (SMS).

The SEARS report suggested that some of the risks to aircraft could be managed and mitigated by a number of measures.

In Section 8.2.1 of our Thames Hub Airport submission (July 2013), we have set out some high level approaches to the management of bird strike risk, including habitat management and establishing an active bird control management plan.

2-1-4-4 Habitat Management Plan

Habitat management would aim to minimise the attractiveness of the airport and its vicinity to birds, by removing attractive features such as food, security, and breeding grounds, and effectively denying access for the birds.

As part of the habitat management plan the location and density of the existing bird population will be managed in a considered manner during the development of the airport and its supporting infrastructure by removing or re-engineering some existing sites and creating compensatory habitats elsewhere. The aim of this would be to encourage bird populations to relocate to strategically located sites away from the airport. This will enable the position of bird flight lines to be influenced, reducing the potential for conflict with aircraft operations and for the impact of active management measures to be more accurately predicted.

2-1-4-5 Active Bird Control Management System

The bird control management system would be based on methods of deterring birds that are least damaging in the context of the surroundings and bird population densities and would involve the early detection of birds within the vicinity of the airport and the employment of effective dispersal tactics, such as visual, acoustic or lethal methods and the use of mobile patrols.

The density of the existing bird population in the area around the Thames Hub Airport creates the potential for consequential or 'knock on' bird movements arising out of active bird management activities. It will be necessary to try to manage the number of individual bird populations through initial habitat management so that the impact of the active management measures can be more accurately predicted.

All such measures would be undertaken following advice of recognised industry experts and in consultation with relevant bodies such as the RSPB, Environment Agency and English Nature.

2-1-4-6 Next Steps

An in-depth study would be undertaken as part of the detailed planning for the proposed airport, to determine the scale of the bird-strike risks, the additional impact of the management and bird control measures on the bird populations of the SPA/Ramsar sites, and the additional mitigation and compensatory measures that may be needed. This study should consider risk associated with a 4-runway estuary/coastal hub airport, located at Isle of Grain as well as a risk comparison exercise between other like airports, such as hubs, 4-runway airports, and estuary/coastal airports. We believe that lessons can be learnt from comparable airports to help develop an effective bird management programme that manages and mitigates the risk of bird strike for the Thames Hub Airport.

We have already met, and propose to work closely with, the Environment Agency and other stakeholders, such as the RSPB, to consider a range of options for providing compensatory habitats for birds to address the bird strike risk. We would seek to provide a significant area of attractive new habitat that will encourage large numbers of birds to roost and feed away from the airport.

2-1-5 Risk of the impact on the SS Montgomery of the location of a new airport, including assessment on the need for disposal and any costs associated with it.

The hull of the SS Montgomery is located about three miles to the east of the Thames Hub site.

It lies close to one of Europe's busiest shipping lanes, about 15 metres under water and contains around 1,400 tons of high explosives. If this ordinance is still viable this poses a significant threat to the local community, to shipping in both the Medway and Thames Estuaries and to London. The wreck site is designated a prohibited area under section 2 of the Protections of Wrecks Act 1973 and is constantly monitored by Medway Ports and the Maritime and Coastguard Agency (MCA).

The latest MCA report, dated September 2011 and publicly released in 2013, states:

1. Regular surveys have shown that the hull is reasonably stable if left undisturbed, although the hull and the explosives themselves are degrading and eventual collapse is inevitable;
2. Although there are many unknowns, expert opinion has suggested that whilst any significant structural collapse does not appear to be imminent, the prospect of structural collapse and/or loss of munitions is becoming a more realistic possibility in the medium term; and.
3. It has always been recognised that there may come a point when the risks associated with the non-intervention will become greater than the risks associated with a carefully planning intervention operation.

We have consulted with munitions experts and have been advised that, irrespective of whether or not the Thames Hub Airport is built, the wreck will have to be dealt with.

During our wider consultations we spoke with London Gateway who confirmed they had considered the ship during construction of the port from the point of view of potential bow wave impacts from dredge ships. It was determined this was no more onerous than impacts from current large vessel usage or the ongoing dredging activities to maintain existing channels.

While we do not believe construction of the Thames Hub Airport, with a physical separation from SS Montgomery of 3 miles, will have any impact on the wreck, we recognise its perceived threat to the proposed airport and local communities.

We recommend that further studies are undertaken, led by the Government, to determine what interventions should be considered and when they should be carried out.

2-1-6 Potential Impacts of Related Energy Facilities on the Isle of Grain and Assessment of the Feasibility of Doing So

2-1-6-1 Current Power Generation and Gas Storage on the Isle of Grain

There is currently one active Power Station on the Isle of Grain peninsular, this power station is a Combined Heat and Power (CHP) facility that opened in 2010. The power station has an electrical generating capacity of 1,2750 MW and supplies 350 MW of heat to the LNG facility that is also located on the Isle of Grain. The CHP power station went live in 2010 when the first of the three gas turbines was brought on line. The CHP power station has three chimneys with an approximate height of 100 m.

In addition to the CHP facility, there is a 950,000 cubic metre Liquefied Natural Gas (LNG) storage facility that supplies 20% of the UK's natural gas.

The Isle of Grain is also the landing point for the UK-Holland subsea power cable a 1,000 MW high voltage direct current (HVDC) link between the British and Dutch transmission systems. The HVDC link between Britain and the Netherlands opened in March 2011.

Finally, there are two decommissioned Power Stations on the Isle of Grain, both of which, as of April 2014, are being demolished. The old Isle of Grain Power Station was UK's 4th tallest building with a chimney height of 244 m, while the Kingsnorth chimney is 198 m tall and it is anticipated that demolition works will be complete by late 2014.

All three operating facilities are of significant national importance with the CHP facility providing electricity for approximately 1,000,000 homes, the LNG facility providing 20% of UK gas supply, and the HVDC cable forming part of a wider European energy transmission network.

2-1-6-2 Risk associated with Neighbouring Land Uses

If the CHP chimneys are still in operation when the Thames Hub Airport opens, it is anticipated that the chimneys would have some minor impact on the airport's Obstacle Limitation Surface (OLS) – the area of airspace used by aircraft around the airport. However, any such obstacle impact can be mitigated by way of clearly marking the facilities in relevant navigation charts. As the chimneys are laterally separated from the runways (situated directly south of the southern-most runway), they would not impact on approach and climb surfaces, or normal aircraft operations. Any impact on navigational aids caused by the height of the chimney, would be mitigated in consultation with NATS.

The Thames Hub Airport will impinge on National Grid's Liquefied Natural Gas (LNG) facility at Grain.

An airport located near an LNG plant would not be exposed to any greater hazard from that plant than would any other commercial or industrial land use, and there have not been any incidents at an LNG plant that have affected UK airports. However, the LNG facility has been identified as risk to life if an incident, similar to the 2005 Buncefield incident, were to occur at the Isle of Grain LNG facility.

Conversely, the LNG plant would, in principle, be exposed to the risk of an aircraft impacting on the facility.

Following initial meetings with the HSE it is recommended as part of detailed planning, an assessment be undertaken of this risk for the Thames Hub, based on HSE relevant guidance. However based on past experience of Public Safety Zone assessments, which follow similar principles, the risk of such an incident occurring appears likely to be very small.

With regard to the BritNed cable, it is recommended that as part of detailed planning it needs to be accurately located to determine the exact impact of the construction of the reclamation, platform and airport facilities on the HVDC cable and land based facilities.

2-1-6-3 Facility Relocation

From the team's discussions with National Grid, it is understood that the LNG plant will be life expired by the time the airport opens in 2029. Therefore an option exists for the LNG facility to be relocated to an alternative location, suitable for the type of operation required and fitting the requirements of the HSE and COMAH. The replacement cost of the facilities could be offset by the residual value of the assets and their net worth to the business, combined with the value of the land released.

2-1-7 Potential airspace implications of operating a new hub airport, including the rationale for closures and impacts on UK and European air space

We have met with NATS to seek their advice on the feasibility of an airport at the proposed Thames Hub location. NATS confirmed that, in terms of air traffic management, a Thames Hub Airport could be included in a London airspace development programme and that operational procedures and airspace changes could be developed to accommodate a new hub airport in the Thames Estuary, and mitigate operational impacts on other UK airports. This would include developing sufficient approach path distances for a multiple runway airport.

A major restructuring of London and South East airspace is currently under consideration by NATS, with a view to increasing capacity and enhancing the safety and efficiency of air operations serving the existing airports. Should a new airport be built in the estuary, it would dictate region-wide changes to the structure and use of this airspace and its management. An airport on the scale contemplated would be likely to have airspace implications beyond the immediate region, into the rest of the UK and across the North Sea to the Netherlands.

In addition, it should be borne in mind that technological developments, such as the planned introduction of 4D navigation systems within the next 10 years, will enable significant improvements in the use of airspace near airports and will make airspace capacity much less of a constraint on airport capacity as well as improve operational efficiency and help meet wider EU emission targets..

It is also worth noting that the SESAR programme has clearly shown, aviation capacity is a European issue. SESAR is concerned with providing sufficient airspace capacity to enable Europe to connect to the World and vice versa, recognising the pivotal role of London’s hub airport in the European aviation system.

We recommend that further consultation and studies, including fast time simulations (following NATS advice on airspace-NATS support to the airports Commission, Issue 1, 25 Nov 2013), are undertaken, led by the NATS, in order to inform definitive recommendations.

Any potential airspace impacts would be mitigated in consultation with NATS and other European bodies. This would be considered as part of the next stage of feasibility studies.

2-1-8 Plans for transitioning to a new hub airport, including phasing, delivery, risks and barriers

The key issues which will need to be addresses in planning the transition are the size of the incremental moves and how staff are managed. Clearly many businesses will see this as unwelcome disruption so the priority will be to manage their risks and reduce the potential impact on their business to a minimum.

2-1-8-1 Incremental vs Large Moves

There is a dilemma which faces every airport which opens significant new facilities, or in the opening of a new airport. Because of the nature of the operation and particularly the importance of transfers between flights the ideal moving strategy would be to move all flights at once, offering all the same operational efficiencies and transfer opportunities at once. However this would be such a significant logistical exercise and overwhelming risk in terms of bringing the infrastructure into full use that it is not a strategy that could be adopted.

However the more the moves are staged the more challenging operationally it will be in terms of managing the resulting inefficiencies. Similarly there would be far fewer transfers being facilitated which would have a significant commercial impact on the airlines, particularly those which move first and last. The period of transition would also be confusing for passengers, knowing which flights are leaving from where.

2-1-8-2 Staff

One of the key factors will be the availability of trained staff to manage both airports simultaneously, and with the right incentives to deliver the right experience and efficiency that passengers expect and airlines require. There is likely to be a significant number of current workers at Heathrow who will not want or be able to transfer to the new airport so this will in part mitigate this issue. However this will not be a perfect fit and this will need to be carefully managed.

2-1-8-3 Striking the Right Balance

All the time that both airports are operating simultaneously will be sub-optimal for the airlines, operators and potentially passengers. The transition should therefore be managed over as short a time as possible.

Our proposal is to aim to complete the Transition in four moves. British Airways and their oneworld partners constitute about half of Heathrow’s traffic. The Star Alliance represents around 25% and Sky Team and the non-aligned airlines a further 25%. The vast majority of transfers happen within the British Airways/oneworld group or between them and another airline. That suggests that the British Airways/oneworld grouping should be neither first nor last to move. We therefore propose that the Sky Team/non-aligned airlines move first, probably staged in airline groups a week apart from each other, moving on midweek when the schedule is under the least pressure. The second group would be part of British airways and all their oneworld partners, the third the remainder of British Airways and the final group the Star Alliance. Each of the last three groups would also be staged over week intervals.

In the 57 airline moves which happened at Heathrow after the opening of Terminal 5 there was a significant body of knowledge and processes built up around how to make moves successful and these processes would inform the transition to a new airport. Clearly the logistics of moving equipment across London is a larger challenge the across a runway but in many ways not significantly so. This process is going to be repeated during this year in the opening of Terminal 2 and again there will be significant lessons learnt, particularly around multiple airlines moving into a new Terminal.

2-2 Attitudes to Moving to a New Airport

2-2-1 Assessment of Qualitative Reactions of Stakeholders – Operators & Airport Users

The key issues for airlines currently at Heathrow will be resolving their commercial interests and making sure their passengers are fully protected. These will essential to gain their full support. The airline map is however changing and there are a number of emerging and future airlines for whom the estuary is their opportunity to access the UK. They are currently a silent voice because they are not here but shouldn't be forgotten.

2-2-1-1 Airline Commercial Interests

Every airline at Heathrow will have capital invested in facilities to support their operation. These facilities will include lounges, offices, maintenance facilities, etc. These facilities will generally be leased from the airport but in some instances, where these facilities are not on airport, they will be leased from landowners.

2-2-1-2 Airline Leases

When the airlines move to a new Estuary Airport these leases will need to be surrendered and any financial liabilities relating to them resolved. At the new airport airlines will have to arrange new leases for replacement facilities, and these may need to be bigger to reflect the potential for growth. The element associated with growth should be a commercial decision for the airlines but the replacement of like for like will be a liability the airlines will seek to be covered. Ultimately this issue is a financial liability which will need to be funded.

2-2-1-3 Invested Capital in Facility Fit Out

The airline's current facilities will have been fitted out and there will be un-depreciated capital on that investment within their accounts. As the facilities will need to be re-provided at the new airport there is a financial liability for the fit-out of those facilities. Whilst there will be a negotiation about how much the like for like replacement should be and the benefit of new facilities the airlines will be looking to have no financial impact as a result of the move. Similarly to the leases any expenditure associated with growth will be the airlines decision and funding.

2-2-1-4 Property

Some airlines, and particularly British Airways, have freehold property at Heathrow in which case this will need to be bought and added to the redevelopment. A proportional stake in any profit generated by the development would be an added incentive.

2-2-1-5 Conclusions

Most if not all of these issues come down to protecting the financial position of the airlines and for them to move willingly this will need to be covered as part of the funding for the project. The airlines are unlikely to accept that they are incurring costs in exchange for the opportunity to grow which reflects the financial and competitive pressures they operate under. We have therefore allowed a significant figure within our estimates to cover these costs.

2-2-2 Passenger Interests

2-2-2-1 Getting to the Airport

On the last day of operating at Heathrow to the first day of operating at the new airport for all airlines will be one day apart, and they will be serving the same passengers. The airlines are therefore extremely concerned that those passengers can get to the new airport with little or no extra inconvenience or time that they can to Heathrow, or the airlines will be concerned they will take a short hop to another European hub to connect to their long haul flight.

We have therefore put together a surface access proposal which reaches out to the west of London and offers parkway solutions to make the airport experience, and the predictability of travel times more accessible across the capital. This has been fully covered elsewhere in the submission

2-2-2-2 Preserving the Experience at Heathrow

There will be a temptation to under invest in Heathrow if the airport is closing but it is essential that the passenger service levels are maintained right up to the last day of operation and this will require appropriate funding levels to be continued.

Within our preliminary funding models we included continued investment for preserving the passenger experience including during the last quinquennia of operation.

2-2-3 Gaining Airline Agreement and Support

2-2-3-1 Closing Heathrow

Willie Walsh has publically said that he wants both early additional capacity to meet British Airways's (BA) short term needs but that the long term requirements of BA needs a new hub of the appropriate capacity to serve their, and the UK's, needs. However he has also been clear the closing Heathrow as a hub airport will be essential. Interaction with other airline groups has re-confirmed this stance and airlines point to the examples around the world where the decision has not been taken to close the existing airport and the new development has failed as a result.

2-2-3-2 Managing the Commercial Impact

The airlines will not support the move unless their commercial impacts are fully recognised and covered. The airline industry is very competitive and the profit margins are very tight. The promise of future growth will not be enough to support significant costs in the short term.

2-2-3-3 Minimising the Impact on the Passengers

The airlines often position passengers as their customers rather than those of the airport, and this is true in the transactional sense. However managing the passengers successfully through this transition will be vital for the airlines and they will need absolute reassurance that this is properly managed.

2-2-3-4 Smooth Transition

All the measures set out above will need to be planned in conjunction, the plan will need to jointly owned with the airlines and they will take the lead in many of the processes. This will only be the case is all the other conditions set out are met.

Study 3: Economic and Social Impacts

3-1 Introduction

The development of the Thames Hub Airport would result in a range of national, regional and local socio-economic impacts and these impacts would need to be assessed against a base case scenario of no increase in the capacity of the UK's hub airport. The new airport would require the closure of, and transfer of air traffic from, Heathrow. Therefore a full economic assessment of these impacts would require complex macro-economic modelling to fully capture the net economic impacts. In the absence of such modelling, the section identifies the main gross economic impacts which are:

National Impacts

- Increased connectivity with UK regions and globally
- Service quality improvements
- Efficiency benefits
- Surface access impacts; and
- Taxation impacts

Regional impacts

- Employment and economic activity impacts; and
- Wider regional impacts

Local socio-economic impacts

- Impacts on other airport
- Local environmental impacts

3-2 National Impacts

3-2-1 Connectivity

The Thames Hub Airport - with four runways and an estuarial location that allows 24 hour operation compared with two runways operating 18 hours a day at Heathrow today - would provide greater connectivity with both UK regional airports and the rest of the World. There is a high level of demand by airlines to provide services at Heathrow, but the lack of runway capacity acts as a constraint on that demand and has pushed up the price of airport slots (which often trade for tens of millions of pounds) and landing charges (the second highest in the World). As a result many airlines are unable to provide domestic and international services to and from Heathrow. In addition the number of destinations served by Heathrow has reduced in recent years to focus on more profitable ‘thick' routes, thereby reducing its ability to act as a global hub airport.

The combination of larger passenger and freight operating capacities and 24 hour operations means that the Thames Hub Airport is able to accommodate more inbound and outbound flights benefitting both passengers and freight users. The increased number of flights would include higher frequency services on existing routes and the provision of new services which would increase the number of destinations served by the UK's hub airport. In addition, 24 hour operation means that the timing of services, particularly long haul flights, can be optimised to better reflect the needs of passengers and freight users and would enhance the global competitiveness of the UK's hub airport.

All of these impacts would boost inward and outward trade, investment and tourism. The greater number of flights would also boost the output of the UK aviation industry.

For businesses an increase in air connectivity enables firms to more efficiently conduct their business operations. This efficiency is reflected by a rise in Total Factor Productivity which in turn increases GDP. Econometric modelling by Oxford Economics suggests that a 10% increase in business related connectivity would increase GDP by 0.5% over the long run. This suggests that improved connectivity provided by Thames Hub Airport could contribute a cumulative £73 billion to the UK economy to 2050[72].

Leisure trips account for 70% of journeys at Heathrow and in 2013 inbound and outbound tourism contributed £127 billion to the UK economy[73]. The ability of the Thames Hub Airport to connect to more destinations would encourage more tourism and provide a boost to UK GDP.

As well as providing better air connectivity, a Thames Hub Airport, would be easily accessible to people in North West Europe by high speed rail services through the Channel Tunnel. As a result it is ideally located to capture excess air passenger demand from this region particularly as airports in France, Belgium the Netherlands begin to reach capacity. Eurocontrol estimate that there will be 12% unmet demand by 2035[74]. This demand could not be served by an expanded Heathrow.

72 Calculation based on Oxford Economics' modelling cited in Ramboll; Oxford Economics (2013): Impacts on the UK Economy through the Provision of International Connectivity

73 Visit Britain http://www.visitbritain.org/insightsandstatistics/visitoreconomyfacts/

74 Eurocontrol (2013): Challenges of Growth 2013 Task 4: European Air Traffic in 2035; (EUROCONTROL 20-year Forecast of Annual Number of IFR Flights (2012 -2035)

3-2-2 Quality of Service

The very high level of runway utilisation at Heathrow (98.5%) means that passengers regularly experience poor service quality due to two issues:

1. Air traffic congestion at Heathrow today means that departing and arriving passengers routinely suffer delays. Departing aircraft are delayed in leaving stands as well as in taxiing to the runway, and arriving aircraft are held in stacks. These delays further add to airlines' operational costs, result in more emissions of aircraft pollutants and increased carbon emissions.
2. Heathrow also suffers from poor operational resilience when incidents occur, such as aircraft-related incidents or bad weather. The lack of capacity means that when an incident occurs there is virtually no ability to implement contingency measures to alleviate the inevitable disruption to the airport's flight schedule. For example, it is easier to accommodate the impact on flights from closing one runway when there are three alternative runways compared to just one.

The additional capacity provided at a Thames Hub Airport would result in an improvement in service quality in these two areas.

3-2-3 Aviation Economic Efficiency

There is a range of ways in which the Thames Hub Airport can deliver improvements in aviation-related economic efficiency that will benefit passengers and freight users. Surface Access impacts are considered separately in study 4. The precise impact of these efficiencies on aviation costs for users will be determined by a combination of:

a) The extent to which the additional runway capacity at Thames Hub Airport leads to an increase in the number of flights which, on its own, would put downward pressure on slots and airline charges and thus reduce air fares and freight charges. This impact of the provision of four runways operable 24 hours a day would be greater than that from three runways operating only 17.5 hours a day.

b) Increased airline competition. British Airways operates over 50% of flights at Heathrow. The ability of Thames Hub Airport to accommodate more airlines would mean that the share of flights operated by British Airways is likely to fall and greater airline competition would result in a reduction in air fares and freight charges. A consequence of this would be that the value of BA's slots on its balance sheet would fall.

c) The improved operating and resource efficiency of the Thames Hub airport which will reduce airlines' operating costs. Unlike Heathrow today (and even if it is expanded), the Thames Hub Airport would be optimally designed to minimise airport and airline operational costs

d) The capital costs of the new infrastructure and the extent to which non users can be required to contribute towards these costs. There are three factors here:

- As a purpose built new facility, the four runway Thames Hub Airport can provide long term capital costs savings by providing the long term level of hub capacity needed by the UK in one core facility development phase as opposed to piecemeal expansion at Heathrow which would be more costly.
- The unit costs of building an airport on a greenfield site would be lower than those at highly utilised operational airport which would impose restrictions on construction activities; and
- Heathrow Airport Limited is unable to capture any of the value that accrues to businesses, such as hotels, that locate around and benefit from the airport. A Special Economic Zone can be created around the Thames Hub Airport such that businesses locating within the zone can be required to contribute towards the capital and operating costs of the airport.

e) Reductions in air travel time as a result of passengers and freight users having more opportunities to fly direct to and from the UK rather than hubbing through other airports. The level of these benefits would depend on the pattern of flights provided at the Thames Hub Airport.

3-2-4 Surface Access Impacts

Significant benefits are expected to accrue to non-airport travel from use of spare capacity on many of the rail services (and, to a lesser extent, bus services) that are intended primarily to carry air passengers and airport employees. In particular:

- The extension of Crossrail via Dartford and Gravesend will bring improved connectivity at North Kent line stations, with direct connections to the Royal Docks, Canary Wharf and the Crossrail core, avoiding the need for interchange at Abbey Wood; increased frequency (particularly on the section between Dartford and Gravesend where there is the likelihood of significant brownfield re-development, e.g. Ebbsfleet (new town) and increased train capacity.
- The Waterloo express will offer an alternative central London destination at Bromley, with increased frequency and capacity. Swanley Parkway, while focused on Airport Park & Fly travellers using the M25, will be co-locational with Farningham Road station, with the potential to become a new rail-head if new Thames Gateway developments extend into the area.
- The Milton Keynes regional service, while routing round central London, will offer new direct connections between key demand generators to the north west (Milton Keynes, Hemel Hempstead, Watford), the east (Stratford) and international services at Ebbsfleet.
- The Reading regional service, while routing round central London, will offer new direct connections between key demand generators to the west (Reading, Slough, HS2 at Old Oak) and the south east (Bromley);
- Local services in mid and east Kent will provide higher frequencies and new journey opportunities
- Reduced commuting demand for trips to London, coupled with increased rail capacity might actually add to capacity available for central London commuting, especially through Bromley South and in the Gravesend-Dartford-Abbey Wood axis.

The potential to add a rail tunnel to a future Lower Thames Crossing for improved Airport access would bring further benefits to non-airport users and communities, with:

- Increased frequencies and higher capacity trains on Airport access trains on the Barking-Rainham-Grays-Airport axis, passing through the planned Barking Riverside development area.
- The potential for new, non-airport rail services linking established and development areas in the Lower Thames Gateway on both banks of the river, e.g. Barking-Chatham, Southend-Dartford; and
- An effective London rail-freight bypass serving the industrial Midlands and North via Wembley and an electrified Gospel Oak-Barking line, Tilbury container terminal, London Gateway Port, Thamesport container terminal, the Channel Tunnel and the cargo centre at the Airport itself, which, with good air, water, road and rail links would become a major logistics hub.

Airport travel is expected to be impacted as follows:

- Analysis of expected trip ends shows that with Heathrow being closer to central London than the Thames Hub, the average distance to the airport will increase. However, distance is not the only determinant of travel time. The level of transport services will influence generalized journey time.
- The Thames Hub Airport itself will alter access time for some travellers. Increased capacity will allow domestic feeder flights from more UK airports.
- 24-hour operation at the Thames Hub Airport would allow for staggered work shifts and this will smooth out airport staff commuting peaks, reducing congestion in and out of the airport.
- Very high speed access via St Pancras will result in shorter journey times for the Thames Hub Airport than for Heathrow from much of central London, in particular the rapidly growing international business district around Canary Wharf.

A key point to consider is that surface access journey time is not simply the time taken between airport and UK destinations, but rather significant components of surface access journey time, for both passengers and freight, are:

a) The time taken between arrival at the airport and the time the aircraft leaves the runway; and

b) The time taken by the arriving aircraft to complete its final descent from when it enters a stack.

The increased capacity at the Thames Hub airport should reduce airport related delays on the ground and in the air, providing travel time benefits for passengers.

3-2-5 Tax Receipts

The greater levels of employment, economic activity and flights at Thames Hub Airport and economic activity at the redeveloped Heathrow site would provide a boost to the Government's tax receipts through greater levels of income tax, corporation tax, VAT and air passenger duty.

3-2-6 Foreign Direct Investment

There is likely to be an impact on the level and location of Foreign Direct Investment (FDI) into the UK. Results of London First's survey[75] showed that 90% of foreign-owned businesses stated that international air links are critical to their business.

According to a study by Deloittes[76], FDI accounts for 220,000 jobs in the surrounding areas of Heathrow. The scale of FDI around Heathrow provides strong evidence of the impact of FDI on the local areas in close proximity to an airport.

75 As cited in Greater London Authority, 2011: A new airport for London part one, as cited within Ramboll; Oxford Economics (2013): Impacts of New Hub Options on Business Locations, FDI and Alignment with Strategies.
76 Deloitte, 2007: The Heathrow Phenomenon. Economic Impact Analysis.

3-3 Regional Impacts

3-3-1 Employment at Thames Hub Airport and Regional Airports

The construction of the Thames Hub Airport and enhanced surface access links is expected to provide a net average of 26,400[77] local direct, indirect and induced jobs annually over a ten year period. This employment is likely to contribute £8.2 billion in gross value added to the UK economy over the construction period.

A four runway Thames Hub Airport operating at full capacity would create annual direct, indirect and induced employment for around 134,000[78] people. This level of employment reflects recent trends in airport employment efficiency at optimally designed airports. However this level of employment is still higher than the level of employment at a three runway Heathrow which would not benefit from the same level of employment efficiencies. The cumulative value of this increased employment is estimated to reach £107 billion by 2050[79].

The increased number of flights at Thames Hub Airport would also boost employment levels at regional airports and in UK based airlines as airlines are able to expand domestic air services to the UK's hub airport.

- The Thames Hub Airport would become the largest centre of employment in Kent with well over 110,000 direct jobs and thousands more indirect jobs and additional induced employment. The income from these jobs would help reduce North Kent's high levels of social deprivation. This would be much greater than the level of additional employment at Heathrow.
- The provision of such a large piece of infrastructure would stimulate further investment in the east of London, further adding to the employment impacts.

The regeneration potential of such an airport on east London north Kent and Essex and the south and east of England.

3-3-2 Regional Connectivity

Thames Hub Airport would improve connectivity between UK cities and regional airports, with an anticipated cumulative impact of £19 billion by 2050[80].

3-3-3 Redevelopment of Heathrow

The redevelopment of the Heathrow site provides opportunities to create a new economic centre for the West London economy. Redeveloping the airport site as an urban residential and commercial centre has the potential to provide both 90,000 jobs and 80,000 dwellings for around 190,000 new residents, potentially adding £30 billion to the UK economy by 2050[81] from the remediation and redevelopment of the site.

Using the Heathrow site for residential development to address London's acute housing shortage is the most efficient use of this prime area. Using this brown field site with its existing transport infrastructure is far more productive than a developing a green field site with no transport access for residential purposes.

The redevelopment of the Heathrow site would provide the largest development site within the M25 to date. A new urban city, with a mix of commercial and residential land uses, could be developed providing a new focal point for economic activity in West London.

77 Calculation partially based on Oxford Economics' input-output modelling cited in: Ramboll; Oxford Economics (2013): Impacts Upon the Local and National Economy

78 Ibid.

79 Net present value, expressed in 2013 prices. Calculation partially based on Oxford Economics' input-output modelling cited in: Ramboll; Oxford Economics (2013): Impacts Upon the Local and National Economy

80 Expressed in net present value terms, calculation based on TfL estimates of regional connectivity impacts.

81 Expressed in net present value terms, calculation based on TfL estimates which are based on: Jones Lang LaSalle and Peter Brett Associates (March 2014): "Heathrow Redevelopment Scenarios"

3-3-4 Relocation from Heathrow

The closure and relocation from Heathrow would have both negative and positive impacts on the local area. Initially the closure of the airport would result in job losses for those workers at the airport that did not relocate to the Thames Hub Airport. However those job losses would not happen for 15 years, allowing time for the Heathrow labour market to adjust. For example many of those people who would be concerned about losing their jobs when the airport closes would have time to find alternative employment and be replaced by others who will have factored the closure into their careers plans. The experience of other sectors that have declined over similar time periods, such as the ports industry, is that London's economy is large enough to accommodate this change. However employment, training and community support programmes will need to be provided prior to, and immediately after, the airport's closure to ensure that workers who lose their jobs have the best opportunities to find new work.

- The time taken to plan and build a new airport would allow airport employees and businesses to plan for the transition to the new airport. Aside from those high skilled jobs at Heathrow which would transfer to the new airport, a Public/Private Development Corporation could be established to redevelop the site, co-ordinate employment training courses and help employees find alternative employment. The Old Oak Common/Park Royal site – which is 60% of Heathrow's size – is an example of a similar redevelopment.
- Over time the development of the Heathrow site would provide new job opportunities, most of which would provide higher skilled jobs than those at Heathrow today.

A decision to develop the Thames Hub Airport has the potential to support the growth of London's economy and drive change in the economic geography of London towards the east. The closure and transfer of air services from Heathrow to the Thames Hub Airport would:

- Relieve surface access congestion in West London that will reduce costs for businesses and other transport users.
- Stimulate investment to the East of London that would help deliver the eastwards growth of London. For example, DfT's plans for a Lower Thames Crossing would need to take account of the new Thames Hub Airport.
- Provide the level of demand needed to justify extending Crossrail and which could serve the airport.
- Complement TfL's plans for transport infrastructure to serve East London such as that proposed between Waterloo and Barking Riverside.

The location of the Thames Hub Airport, close to HS1 with access to European markets, would complement recent port investments in the Estuary, such as London Gateway, providing freight companies with a greater range of shipping options and enhancing the Estuary's role as the UK's leading freight centre.

Furthermore, the Thames Hub Airport will bring urgently needed regeneration to North Kent, providing essential jobs to one of the most deprived areas of England. It would help unlock planned housing developments and revitalise the stalled Thames Gateway vision.

3-4 Local Socio-economic Impacts

3-4-1 Local Airports

London City Airport is located closer to Heathrow than the Thames Hub Airport and we do not see any operational impact on the airport from the development of the Thames Hub Airport. London City serves a niche business market to European destinations for Canary Wharf and the City and we do not anticipate a significant impact on the airport. We are therefore not of the opinion that London City airport has to close, nonetheless, we are aware that if it were to do so studies by Nef suggest that there will be a net benefit to this[82].

Similarly we do not think there will be a significant impact on Southend Airport. It primarily serves a local market for low-cost leisure travel for Essex and such travellers are unlikely to use the Thames Hub Airport. The runway lies 5 miles to the north of, and parallel to, the Thames Hub Airport. However there may be a need to adjust approach and departure profiles for these airports.

3-4-2 Noise

The latest evidence from TfL shows Thames Hub Airport would remove aircraft noise from around 1,000,000 people in net terms compared to a third runway at Heathrow. The socio-economic benefits of this would include reductions in: noise nuisance; sleep deprivation; stress; lost productivity; and poor educational performance.

3-4-3 Air Quality

Aircraft emissions at Heathrow contribute to London's poor air quality and health related impacts and are directly responsible for around 100 premature air pollution related deaths per annum. That number would increase if a third runway was built. In contrast nearly all of the emissions from the Thames Hub Airport would disperse to the east of London over water.

3-4-4 Safety

The removal of aircraft overflying Central London would provide safety benefits for five million people living in London and significantly reduce aircraft-related terrorist threats.

82 Nef (2013): Royal Docks revival: Replacing London City Airport

3-5 Preliminary Estimates of Impacts

The preliminary, high-level estimates of the net present value of the combined, cumulative gross national impacts of the Thames Hub, an integrated infrastructure concept is £322 billion. The basis for the estimate is as follows:

- Cumulative national employment impacts to 2050 of both construction and (24 hour) operation of the Thames Hub Airport are estimated to be £309 billion[83], expressed in 2013 prices.
- Cumulative international connectivity impacts to 2050 are estimated at £43 billion in 2013 prices[84]
- Cumulative regional connectivity impacts to 2050 are estimated at £19 billion in 2013 prices[85];
- Cumulative impacts from the redevelopment of the Heathrow site to 2050 are estimated at £30 billion[86];
- The net relief from aircraft noise for 1,000,000 people around Heathrow is valued at approximately £1.3 billion, based on DfT noise values;
- MIT/Cambridge estimated that Heathrow is prematurely killing 100 people per year in terms of air pollution, whilst pollution from Thames Hub would largely disperse over water. Using DfT value of life figures, this equates to a positive impact of approximately £4 billion.
- From the above we deduct the impacts of relocation from Heathrow to Thames Hub, estimated at £84 billion

83 Calculation partially based on Oxford Economics' input-output modelling cited in: Ramboll; Oxford Economics (2013): Impacts Upon the Local and National Economy

84 Calculation based on Oxford Economics' modelling cited in Ramboll; Oxford Economics (2013): Impacts on the UK Economy through the Provision of International Connectivity

85 Calculation based on TfL estimates of regional connectivity impacts

86 Calculation based on TfL estimates which are based on: Jones Lang LaSalle and Peter Brett Associates (March 2014): "Heathrow Redevelopment Scenarios"

Study 4: Surface Access Impacts

4-1 Introduction

The optimal location for a new airport in the Thames Estuary, some 65 km east of London and 15 km from existing strategic road and rail links, presents an airport access challenge but offers an opportunity to plan and design efficient, effective airport access facilities relatively unconstrained by existing infrastructure.

From the outset a target of high public transport use by both air passengers and employees has been adopted, focussing on the provision of high quality rail services to the main areas of demand generation from the day the airport opens. Options have been identified for adding to the surface access provision as the airport grows, ultimately allowing the airport to serve as a transport and logistics hub for the UK and near Europe.

In this section we describe the road and rail links selected to connect the airport to London and the wider strategic transport network, a possible set of rail passenger services at the airport on opening and after further development, the potential financial consequences of those links and services and the environmental impact of airport surface access.

4-2 Operations

4-2-1 New infrastructure required to support inner Thames Estuary proposals and the deliverability of said infrastructure

New high quality, high capacity rail and road links are proposed to link the Thames Estuary Airport to the strategic transport network in the vicinity of the airport. Further away from the airport a number of upgrades to existing transport infrastructure will be needed to allow the optimum benefit to be gained from these new links. Indicative alignments for these links are shown in Figure 4.1

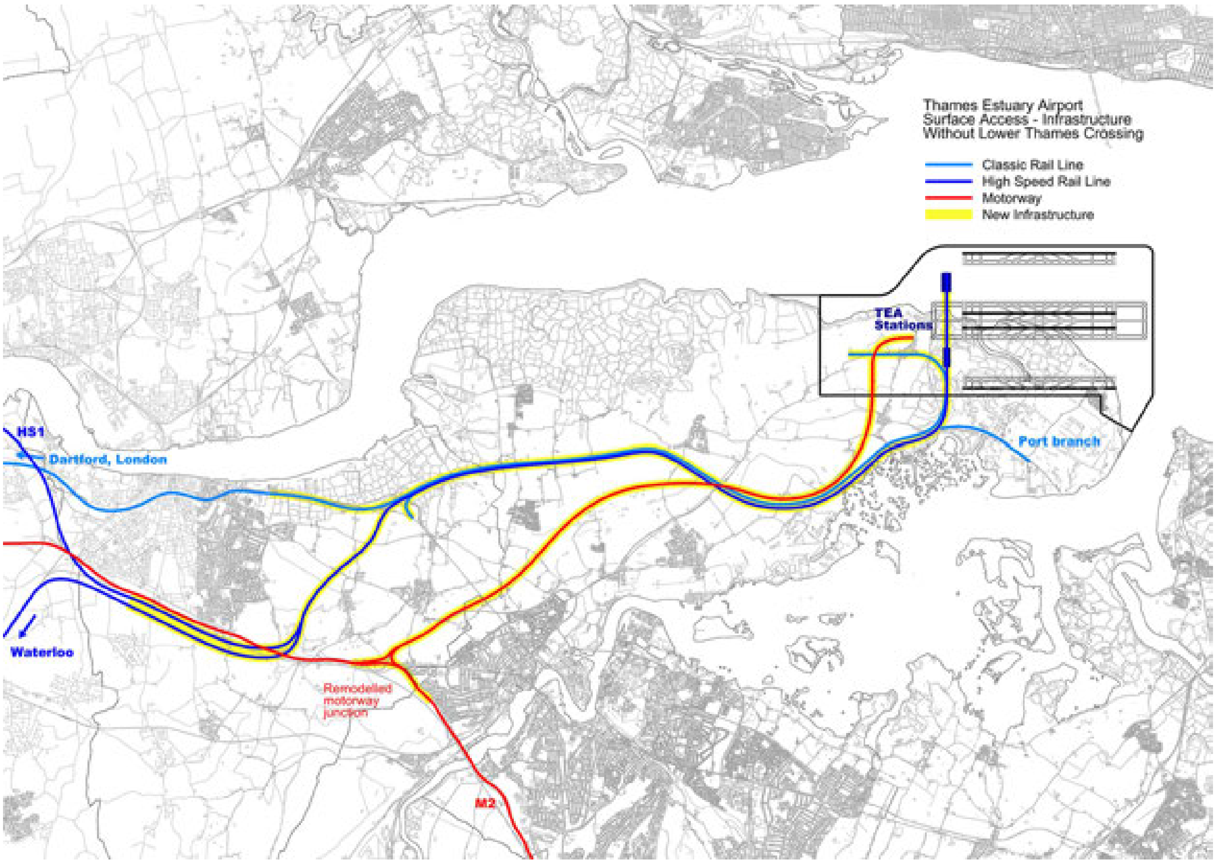

Figure 4-1 New surface access links at Airport opening

4-2-1-1 Rail

Two, parallel rail links are proposed, following the alignment of the existing Grain freight branch from just south of the airport to Hoo Junction. Here the 'classic' (160 km/h) line joins the North Kent line, with links towards both Gravesend and Strood while the high speed line (225 km/h) passes over Hoo Junction, continuing to a junction with HS1 near Singlewell, south-east of Gravesend. The southern section of this route would be in tunnel under Shorne Wood Country Park.

It is envisaged that there will be a total of 5 tracks north east of Hoo Junction: 2 high speed; 2 new 'classic'; and the existing freight line (upgraded). This arrangement gives both the capacity for frequent trains to serve peak demand and the flexibility to run a 24 hour service while undertaking overnight maintenance.

These links would need to be in place at the airport opening.

4-2-1-2 Highway

A high level analysis of the level of highway demand has been undertaken, summing: residual air passenger trips; airport employees; air freight deliveries and collection and airport operations (maintenance, supplies etc.). While further analysis will be required during the detailed planning stage, a strategic spine connection of D4 Motorway standard between the airport and the A2/M2 corridor is indicated, together with upgrade of the existing A2/M2 junction 1.

In addition, the A228, currently used for vehicle access to the Thamesport container terminal, the east end of the Grain peninsula and local communities, will be upgraded to D2AP throughout to provide enhanced access to the airport and Airport City from the Medway Towns via the Medway Tunnel.

These links would need to be in place at the airport opening.

Away from the immediate vicinity of the airport selective widening of trunk roads will be needed to accommodate Airport traffic while maintaining an acceptable level of service for non-airport trips. Links likely to need widening at an early stage include:

- A2 between M25 junction 2 and M2 junction 1 (from 4 to 5 lanes)
- M25 between junction and junction 3 (from 4 to 5 lanes)
- M25 between junction 3 and junction 6 (from 3 to 4 lanes); and
- M25 between junction 30 and junction 27 (from 4 to 5 lanes)

Further analysis as airport design is developed will indicate the optimal timing for these interventions and whether any would ultimately be needed in a no-airport (do-minimum) scenario.

4-2-1-3 Deliverability

No significant engineering issues regarding the deliverability of the key airport access infrastructure are foreseen. With the exception of the tunneled section of high speed line, all links are at-grade with no major waterways to cross or earthworks required.

Potential threats to deliverability that will need to be considered at the design and planning stage include: compulsory purchase of land; environmental considerations (see Section 4.4); and availability of skilled staff (particularly railway signal engineers) during the construction phase of HS2 and possibly Crossrail 2.

4-2-1-4 Rail Services

The high level analysis of access demand also identified the target number of air passenger and airport employee trips to be accommodated on rail. The rail links outlined above allow the operation of a range of airport services tailored to the needs of air passengers and airport employees, while allowing continued rail freight access to Thamesport and rail freight access to the airport.

While the actual services to be operated will be confirmed at the detailed design stage (when there will be a clearer understanding of airport employee access demand) an indicative set of routes is shown in Figure 4.2.

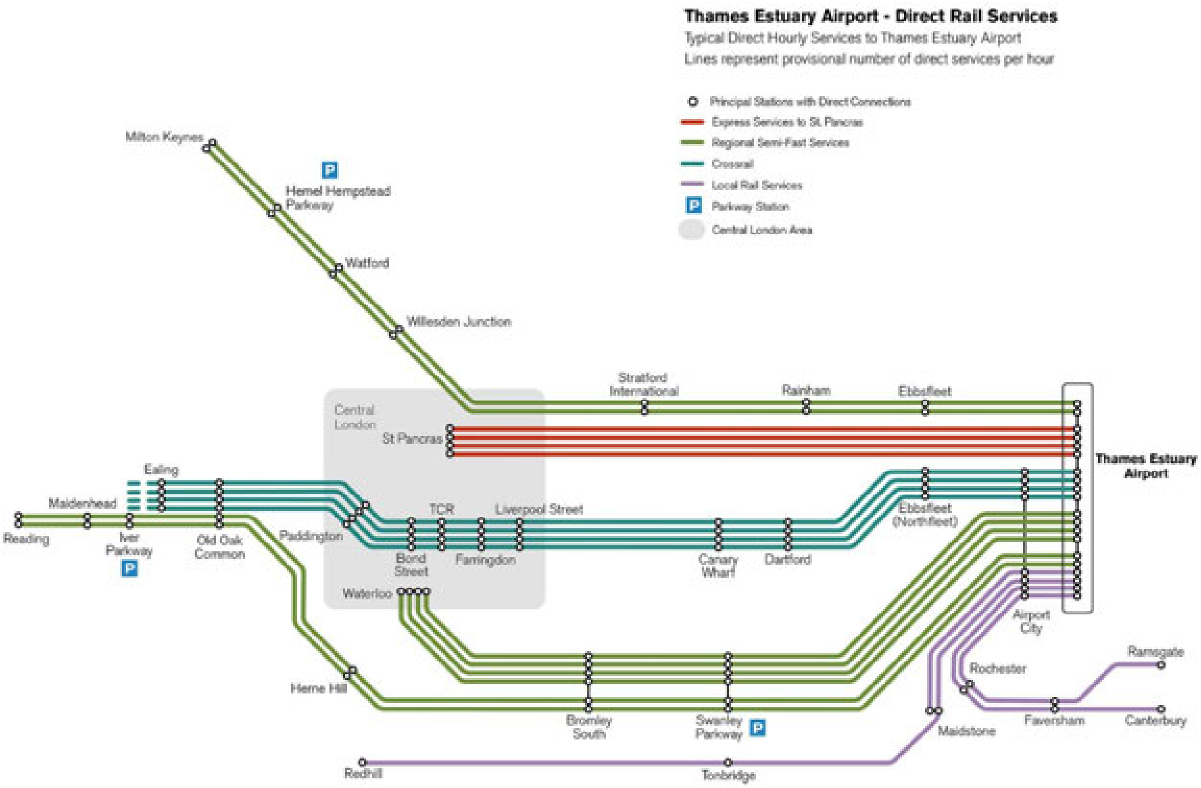

Figure 4-2 Potential airport rail services at Airport opening

Some of these services require additional infrastructure internventions at locations away from the airport. The services and their infrastructure needs are summarised below.

The principle air passenger route will run to St Pancras International via the new line to HS1. As this route is wholly over lines which are (or can be) built to Continental loading gauge, double-deck trains are feasible. Existing European double-deck express trains have seating densities above 4/m of train length. A 300 m train could have both 1,200 seats and adequate space for air passengers' luggage. A 15-minute headway service could offer around 5,000 seats per hour each way, with an estimated journey time of 26 minutes.

These trains can be accommodated within the existing HS1 infrastructure (see 4.2.2) but would require additional platform capacity at St Pancras (see 4.2.3).

A secondary 15-minute headway express route could run to Waterloo via the new HS1 link and the former Eurostar route between HS1 and Waterloo. A new station is proposed at 'Swanley Parkway', close to the point at which the route crosses the M25, close to the existing Farningham Road station. Trains would also call at Bromley South. Indicative journey times from the Airport are shown in Table 4.1.

Station Call	Time from Airport
Swanley Parkway	14
Bromley South	25
Waterloo	42

Table 4-1 Indicative journey times on Waterloo service

This route uses the existing Chatham Main line, part of the classic network, restricting trains to the UK loading gauge. Without platform lengthening at Bromley South, trains will be limited to 240 m in length and a capacity of 600-700 per train, around 2,500 seats per hour each way.

In addition to the new parkway station, 1 mile of additional tracks either side of HS1, linking the existing 4-track section at Singlewell to Southfleet Jn., would avoid these trains needing to mix with Ashford-Ebbsfleet services on the main HS1 tracks.

Infrastructure capacity issues are covered in greater detail in sections 4.2.2 and 4.2.3.

Figure 4.2 also shows two Regional Express routes, to Milton Keynes and to Reading.

The Milton Keynes service would use the new high speed link but join the North Kent line at Hoo Jn., running via Gravesend to join HS1 at Ebbslfleet. North of St Pancras trains would run via the HS1-North London Line chord to Primrose Hill and the West Coast Main Line. Station calls could include Gravesend, Ebbsfleet, Rainham Parkway, Stratford International, Willesden Junction, Watford Junction, Hemel Hempstead Parkway, Bletchley and Milton Keynes. Indicative travel times are shown in Table 4.2.

Station Call	Time from Airport
Gravesend	11
Ebbsfleet	15
Stratford	26
Willesden Junction	39
Hemel Hempstead Parkway	57
Milton Keynes	82

Table 4-2 Indicative journet times on Milton Keynes service

West of Camden this route runs on the classic network, restricting trains to the UK loading gauge. Using trains similar to the ‘Javelin’ Class 395 a capacity of 600-700 per train is feasible. Limited capacity on HS1 may restrict this service to 2 trains per hour, probably running instead of current peak ‘Javelin’ services from Maidstone or Ebbsfleet, providing around 1,300 seats per hour each way.

In addition to the new stations (including reinstating platform faces on the West Coast slow line at Willesden Junction) the operability of this service would benefit from doubling-tracking the HS1-North London Line chord (the viaduct is wide enough for 2 tracks) to limit potential disruption to HS1 by late-running trains.

The Reading service follows the Waterloo route to Wandsworth Road, then runs via the West London line to join the Great Western at North Pole (former Eurostar depot). Station calls could include Swanley Parkway, Bromley South, one or more interchange nodes between Bromley and Old Oak, Old Oak HS2 Interchange, Iver Parkway, Slough, Maidenhead and Reading. Indicative journey times are shown in Table 4.3.

Station Call	Time from Airport
Swanley Parkway	14
Bromley South	25
(Herne Hill)	35
Old Oak	49
Iver Parkway	61
Reading	81

Table 4-3 Indicative journey times on Reading service

Much of this route is on the classic network, restricting trains to the UK loading gauge. Trains similar to ‘Javelin’ Class 395 could be used but would be limited to 160 m at some potential station calls. A capacity of around 500 per train is feasible. Limited peak capacity between Herne Hill and Old Oak may restrict this service to 2 trains per hour and a capacity of around 1,000 seats per hour each way.

Infrastructure capacity issues are covered in greater detail in section 4.2.2.

In addition to parkway stations this service requires a West London–Great Western link through North Pole depot - under consideration as part of proposed North and West London platforms at Old Oak Interchange.

Crossrail (Abbey Wood branch) could be extended to the Airport, running via Dartford, Gravesend and the new classic link (including a station call at Airport City for airport employees). Indicative journey times from the Airport are shown in Table 4.4.

Station Call	Time from Airport
Gravesend	15
Dartford	27
Abbey Wood	39
Isle of Dogs	49
Liverpool Street	56
Paddington	65

Table 4-4 Indicative journey timeson the Crossrail service

Air passengers may use this service but the main use is expected to come from airport employees and use of standard Crossrail trains, adapted for dual-voltage operation, is envisaged. With only 450 seats per train the extensive standing areas will provide space for luggage. At 4 trains per hour to the Airport there would be 1,800 seats per hour each way. A possible western terminus for these trains could be Heathrow, providing a direct link from the re-developed site to the new Airport for employees moving employment location but not residential relocation.

A number of employee-focused local services could also run. Indicative routes shown in Figure 4.2 are to the Medway Valley line (Maidstone West, possibly extending to Tonbridge or Redhill) and to East Kent (Medway Towns, Faversham, Ramsgate, Dover). All trains would call at Airport City and Strood.

A frequency of 2 trains per hour on each route is envisaged, operating as part of the South Eastern franchise and using standard rolling stock (already equipped for dual-voltage operation).

These links will give a 1-change rail journey between the Airport and many parts of both London and the UK, as detailed in section 4.2.4 below, with capacity of around 13,000 seats per hour.

4-2-2 Implications of an inner Thames Estuary Airport on the utilisation of current strategic and local road and rail infrastructure, including the availability of rail paths for commuter and intercity services, the availability of capacity on HS1 and levels of road congestion, and impacts on local transport networks

4-2-2-1 Rail

In assessing the future capacity of the rail system to cope with airport traffic, consideration has been given to the potential for change in non-airport commuting patterns given the scale of airport employment compared to the current level of commuting. At present the total AM peak capacity on offer to London from the towns nearest to the Airport is just 23,500, some of which used by passengers at stations nearer London.

A new employment opportunity in North Kent almost three times as large as the current rail commuting market may alter journey-to-work travel patterns in the Medway Valley and west Kent, impacting on the future level and direction of travel of non-airport peak traffic (on both rail and road). Notwithstanding projected increases in commuting demand, some peak period extra trains may not be needed in a with-airport future. Nevertheless, in assessing the impact of airport demand and services it has been conservatively assumed that all current services continue to run or are extended into the airport.

The routes shown in Figure 4.2 give rise to two particular capacity concerns: on HS1; and at Herne Hill.

The HS1 working timetable indicates peak flows of between 10 and 13 trains per hour on the busiest section (between St Pancras and Stratford International) compared to a theoretical capacity of 20 trains per hour and a practical capacity of 16. Assuming a future peak service level of 8 'Javelin' services (as now) and 4 international trains (a 33% increase), there will be capacity to run an Airport Express.

Adding the Milton Keynes regional service requires either 18 trains in the peak hours or, preferably for the Milton Keynes service to replace peak-period Javelin services, some currently servicing Maidstone West. With a forecast eastward move of both population and jobs to the east, the importance of commuter access to a central London destination will be reduced and a Milton Keynes service calling at Gravesend, Ebbsfleet and Stratford International covers much of the commuter function of the trains it replaces. Interchange for St Pancras services will be possible at Stratford.

At Herne Hill Thameslink services between Tulse Hill and Elephant and Castle cross the Chatham Main line. In the peak this junction is close to capacity - some trains divert via Catford to avoid this pinch point. The Thameslink Sutton/Wimbledon-Luton route runs all day but Brighton-Bedford trains normally run via London Bridge, diverting via Herne Hill as there is insufficient peak capacity west of London Bridge for SouthEastern and Thameslink trains.

Following completion of the Thameslink Project (2018) Bedford-Brighton trains will run via London Bridge all day, releasing sufficient capacity at Herne Hill for the Waterloo Airport Express service. Off-peak there will also be capacity for the Reading service to run via Herne Hill but in the peaks these trains (or some Waterloo expreses) may need to run via Catford.

4-2-2-2 Highway

Detailed modeling of changes in highway utilization and congestion on the wider network in the 'with airport' scenario will be undertaken as the design and definition of the airport and its access infrastructure progresses. It is expected that the proposed upgrades to the existing network will maintain volume: capacity ratios and thus the level of congestion to be roughly the same as in the 'no airport' scenario.

The two road links into the airport are intended to keep airport traffic off local roads on the Grain Peninsula. It is likely that there will be an increase in all-day traffic in the (unmodified) Medway Tunnel with airport employee trips but airport shift patterns may see these flows concentrated outside the non-airport peak.

4-2-3 Availability of London rail terminal capacity and the ability to relieve constraints in this area (for example via outer-London interchanges)

Only two of the rail services described in section 4.2.1 will terminate in central London:

- The main Airport Express service to St Pancras; and
- The secondary Airport Express service to Waterloo.

At St Pancras an additional platform face (14) and track will be added on the east side of the HS1 Domestic station, cantilevering over the kerbside on Pancras Road and requiring re-configuration of the train shed side screen and roof supports in the way of the additional track and platform face. Platforms 13 and 14 will be dedicated to airport trains, with domestic services using platforms 11 and 12.

A dedicated Airport Express Taxi rank would be created on Pancras Road below platform 14, along with a new ticket hall and airline baggage check-in facility below platforms 13 and 14 and dedicated vertical circulation from the Airport Express ticket hall and check-in facility to platforms 13/14. A goods lift from the baggage check in facility to platforms 13/14 to allow transfer of checked-in baggage in sealed containers to dedicated baggage compartment on train.

There would also be access to platforms 13/14 from the existing SouthEastern barrier at the south end of the platforms, helping to more evenly distribute passengers along the length of the train and avoiding excessive demand at the existing escalators.

There would thus be a pair of platforms for 4 airport services per hour. With a projected journey time of 26 minutes trains would arrive 4 minutes before the next departure and have a 19 minute layover at each end of the route, i.e. a train would always be waiting in the platform for passengers to board. For domestic services layover time would be limited to around 10 minutes if the current 8 trains per peak hour is to be accommodated but 2 of these may be diverted to Milton Keynes, easing pressure on platform capacity at St Pancras.

At Waterloo the cessation of international services and increasing domestic demand for South Western services has led to proposals to bring the ‘international’ platforms (20-24) back into domestic use. However, capacity constraints elsewhere on the South Western network limits the number of additional services to take advantage of the extra platform capacity. There is a short-term need to bring the platforms into use while platforms 1-4 are closed for lengthening, following which longer-term domestic use of some ‘international’ platforms could continue, easing congestion on the east side of the station. Alternatively, an airport service could use 2 of the ‘international’ platforms without any significant loss of resilience for South Western services.

A dedicated pair of platforms is desirable for an airport service (e.g. Heathrow, Gatwick and Stansted expresses currently), allowing scheduling so that there is always a train in the platform for departing passengers to board. While peripheral to the rest of the station, platforms 23 and 24 offer the possibility of a dedicated entrance from the main station concourse or the disused Eurostar lounges below, which could be adapted for use by passengers using the airport service, with a dedicated ticket hall and baggage check in. A taxi rank could be located on York Road.

The rail services shown in Figure 4.2 are designed to minimise demand for airport services at central London stations by providing a number of opportunities to access Airport services without the need to use a central London station:

- On the Waterloo service at Bromley South and Swanley Parkway
- On the Milton Keynes service at Milton Keynes, Bletchley, Hemel Hempstead Parkway, Watford Junction, Willesden Junction, Rainham and Ebbsfleet
- On the Reading service at Reading, Iver Parkway and Old Oak, with the potential for additional interchange nodes between Old Oak and Bromley – possible calls are at Shepherds Bush, West Brompton, Herne Hill and Beckenham Junction

Parkway stations are proposed where rail lines with a direct service to the airport abut links on the strategic highway network, providing locations at which passengers can change mode between coach, bus, car or taxi and dedicated rail. As at motorway services, slip roads would only give access to the station car park, preventing their use as a new junction (local access to a separate car park may be provided). A pro-active car park pricing strategy will be adopted, with:

- A (free) short-stay parking area for pick-up and drop-off
- Taxi rank
- A long-stay car park for air travellers with a minimum charge to dissuade use of airport-user facilities by commuters; and
- At parkways nearer to the airport (Swanley, Rainham), medium-stay parking for airport employees

Demand for each of the parkways will be influenced by the level of rail service on offer at each station, the proportion of airport demand that could pass close to the station if using highway modes to access the airport and the quality of the public transport alternative to those highway journeys.

4-2-4 Implications of an inner Thames Estuary Airport for travel times to a hub airport for users beginning or ending their journey outside of the London area

A consequence of re-locating the UK's main airport is that some air travel demand generating areas will be further from the Thames Estuary site than from Heathrow, but other demand generating areas will, necessarily be nearer. Trips with an O/D west of London, possibly passing close to Heathrow on a Thames Estuary access trip will have a longer journey while for those with to the east the distance will be shorter. The impact on trips from north or south of London is less clear, with an expectation that Heathrow would be closer for highway trips as the airport is adjacent to the M25 whereas the Thames Estuary is a 25 km from Dartford.

Analysis of expected trip ends at a Thames Estuary Airport undertaken for the Mayor of London's submission to the Airports Commission indicated: 52% of demand arises in London, 21% to the west, 9% to the east and 18% to the north or south. Within London 22% arises in the centre, 15% to the east and 15% to the west. On balance, with Heathrow being closer to central London than the Thames Estuary, the average distance to the airport will increase.

However, distance is not the only determinant of travel time. The level of transport services will influence generalised journey time. In this respect the nature of the Thames Estuary Airport itself will alter access time for some travellers. Increased ATM capacity at a 4-runway airport will allow domestic feeder flights from more UK airports, allowing some longer-distance access by air. This will include areas 'closer' to Heathrow – Cardiff, Plymouth, Exeter – as well as 'neutral' areas – Newcastle, Yorkshire.

Thames Estuary surface access time will benefit from high-speed rail services via HS1, supported by a range of secondary services, illustrated in Figure 4.2, contributing to a high PT mode share at the Thames Estuary. These links will give rapid access from central and suburban London and 1-change rail journeys between the airport and many parts of both London and the UK:

The Airport Express itself will connect at St Pancras with:

- East Coast Main Line
- Midland Main Line
- International services not calling at Ebbsfleet
- Thameslink (Cambridge/Peterborough/Bedford)
- Thameslink (Croydon-Gatwick-Brighton/Surrey)
- Circle, Metropolitan, Northern, Piccadilly and Victoria Lines;
- Proposed Crossrail 2; and,
- (With an inter-station link to Euston) HS2 and West Coast Main Line

The Waterloo Airport Express will connect at Waterloo with:

- South Western Main Line (Portsmouth/Southampton/Salisbury)
- South Western suburban
- Bakerloo, Jubilee and Waterloo and City Lines

At Bromley South with:

- Thameslink (Catford-Swanley-Sevenoaks)
- SouthEastern (south east London, Orpington)

The Milton Keynes regional service will connect:

- At Milton Keynes with London Midland (Coventry, Northampton)
- At Bletchley with the planned east-west rail
- At Watford Junction with St Albans and the Metropolitan Line
- At Willesden Junction with London Overground and the Bakerloo Line
- At Stratford International with DLR and (via inter-station link to Stratford Regional) Great Eastern services, Central and Jubilee Lines; and
- At Ebbsfleet with high speed domestic services and some International services

The Reading regional service will connect:

- At Reading with all Great Western radial services
- At Old Oak Interchange with HS2 and London Overground
- Will also call at Bromley South; and
- May make additional calls at Shepherds Bush (Central Line), West Brompton (District Line), Herne Hill (Thameslink local services) or Beckenham Junction (Croydon Tramlink)

The Crossrail service will intersect with:

- Most Underground Lines; and
- SouthEastern local services at Abbey Wood and Dartford

In addition to the resulting wide range of direct and one-change destinations, very high speed access via St Pancras will result in shorter journey times for a Thames Estuary Airport than for Heathrow from much of central London, in particular the rapidly growing international business district around Canary Wharf.

4-2-5 Resilience of surface transport links to an inner Thames Estuary Airport against forecast growth in non-airport demand on road and rail networks

The specification of transport infrastructure interventions, together with potential services to use the rail links, has been undertaken against a background of expected growth in travel demand. While further demand modeling work will be undertaken as Airport design progresses the infrastructure proposed in 4.2.1 is considered compatible with expected demand growth.

As noted, it is likely that the Airport itself will impact on the volume, direction and timing of traffic flows in the areas of greatest overlap between Airport and non-airport travel.

4-2-5-1 Rail

As indicated, the scale of employment at the airport could lead to a lowering of forecast growth in demand on routes and services between North Kent and London, possibly even a reduction in demand. Coupled with increased frequency on some routes, notably through Bromley South and in the Gravesend-Dartford-Abbey Wood axis, airport services will add to the capacity available for central London commuting.

While the introduction of airport services means that HS1 will be at capacity in the peak hours, all peak period trains will be able to run with the maximum 12 cars, resulting in increases in capacity at Ebbsfleet and Stratford International.

Off-peak, demand on Kent and south east London rail services is significantly lower than peak-period demand, with no crowding or performance issues foreseen.

4-2-5-2 Road

A similar situation is expected on roads, with changes in the pattern of traffic associated with the airport and increases in capacity on trunk roads designed to maintain volume: capacity ratios at non-airport levels. Inter-alia, the improvement in the public transport offer in many areas where there will be an overlap between airport and background traffic could lead to modal shift, making use of spare contra-peak and off-peak capacity on public transport and reducing demand pressure on highways.

4-2-6 Whether these forecasts remain realistic alongside any development opportunities that might reasonably be expected to accompany an inner Thames Estuary Airport

There are likely to be a number of residential and commercial developments in the Lower Thames Gateway over the next 15-20 years even if a Thames Estuary Airport is not constructed. Ebbsfleet Garden City has already been announced but will be relatively small-scale, adding only 15,000 homes at a time when planners and politicians are calling for 200,000 new homes a year at a national level and housing provision equivalent to Ebbsfleet every three months in London and the South East. Further development, on both sides of the Thames, is likely.

The impact of such developments on transport capacity is difficult to assess at an early stage in the airport access planning process, Ebbsfleet and Barking Riverside are the only proposals to date with a location identified. Transport demand will be influenced by the extent to which developments are self-sufficient communities or dormitory towns creating additional commuting to central London.

With a Thames Estuary Airport the need for Thames Gateway developments will increase, both as residential locations for airport employees and as an industrial/commercial base for airport support activities. By allowing the new developments to be more self-contained a combination of airport and new developments may lead to a reduction in travel (particularly peak period commuting) between the Lower Thames Gateway and London, with business and journey-to-work trips re-focused towards the airport.

With airport employee and operations traffic already included in the expected level of transport demand underlying the infrastructure proposals outlined above, it is not considered that Thames Gateway developments will materially alter forecasts of transport system adequacy.

4-2-7 The relationship between any surface transport infrastructure required for an inner Thames Estuary Airport and other planned major infrastructure works such as Crossrail, HS2 and lower Thames crossing

The transport infrastructure proposed above to serve the needs of the Thames Estuary Airport is not dependent on any other transport infrastructure currently at the construction, planning or concept development stage. However, the rail services proposed at 4.2.1 are scoped assuming a number of planned infrastructure works are implemented.

Crossrail

Crossrail forms an essential part of the rail package at the airport, with a service every 15 minutes proposed between the airport and the Crossrail core. While travel times to central London will be longer than on Airport Expresses Crossrail will offer a direct service to key destinations and interchanges less easily accessed by the main Express services. The Crossrail extension will also provide airport journey-to-work opportunities over a wide area of south east London but without a Crossrail extension the airport could be linked to these areas by extending SouthEastern inner suburban trains via Dartford and Gravesend.

HS2

It is not proposed that any airport services use HS2 infrastructure but in planning the Milton Keynes regional service it has been assumed that HS2 will free up capacity on the West Coast Main Line.

The expected concentration of travel between London and the North on HS2 has both benefits and dis-benefits for airport access. By concentrating longer distance trips onto a single corridor HS2 feeds airport services at Old Oak Interchange or (via Euston and a travelator to King's Cross) St-Pancras. However, without HS2 some trips would use East Coast Main Line or Midland Main Line services with a more convenient interchange.

An HS2-HS1 rail link could adversely affect airport access. With the London end of HS1 at capacity in the peaks any through trains between HS2 and HS1 would need to run instead of, rather than in addition to, the services assumed above. Such services could run: to the airport (e.g. from Birmingham or Manchester), replacing planned airport trains; to Europe (replacing International trains; or to other destinations in Kent (replacing high-speed domestic trains) but would shift the central London locus away from the established nodes of Euston and King's Cross-St Pancras.

Thameslink

While the main focus of the Thameslink Project is north-south, this scheme has two main benefits for airport rail access: reduction of congestion at Herne Hill, discussed in 4.2.3; and drawing north-south regional travel into the Thameslink core, intersecting with airport services at St Pancras and Farringdon (Crossrail). This brings 1-change airport rail access to wide areas of Sussex, Surrey and south London not served by direct airport routes.

Crossrail 2

While the detailed alignment and nature of this project are still out to consultation, the proposed route via Tottenham Court Road and Euston/King's Cross would offer access route to airport services and aid dispersal of demand at the airport Express terminal at St-Pancras.

Lower Thames Crossing

Lower Thames Crossing Option C would be the most useful for airport access, allowing highway trips to avoid the congested Dartford crossings and relieve the A2 between M25 Junction 2 and M2 Junction 1. A multi-modal crossing would be optimal, facilitating airport rail access from south Essex and east London, widening the airport's employment catchment area and increasing the potential workforce by 25-33%.

For the 'ultimate', 150 mppa airport at Lower Thames Crossing would become part of the airport surface access package. An indicative layout of road and rail links (including those which would be part of the Lower Thames Crossing in a no-airport scenario) is shown in Figure 4.3

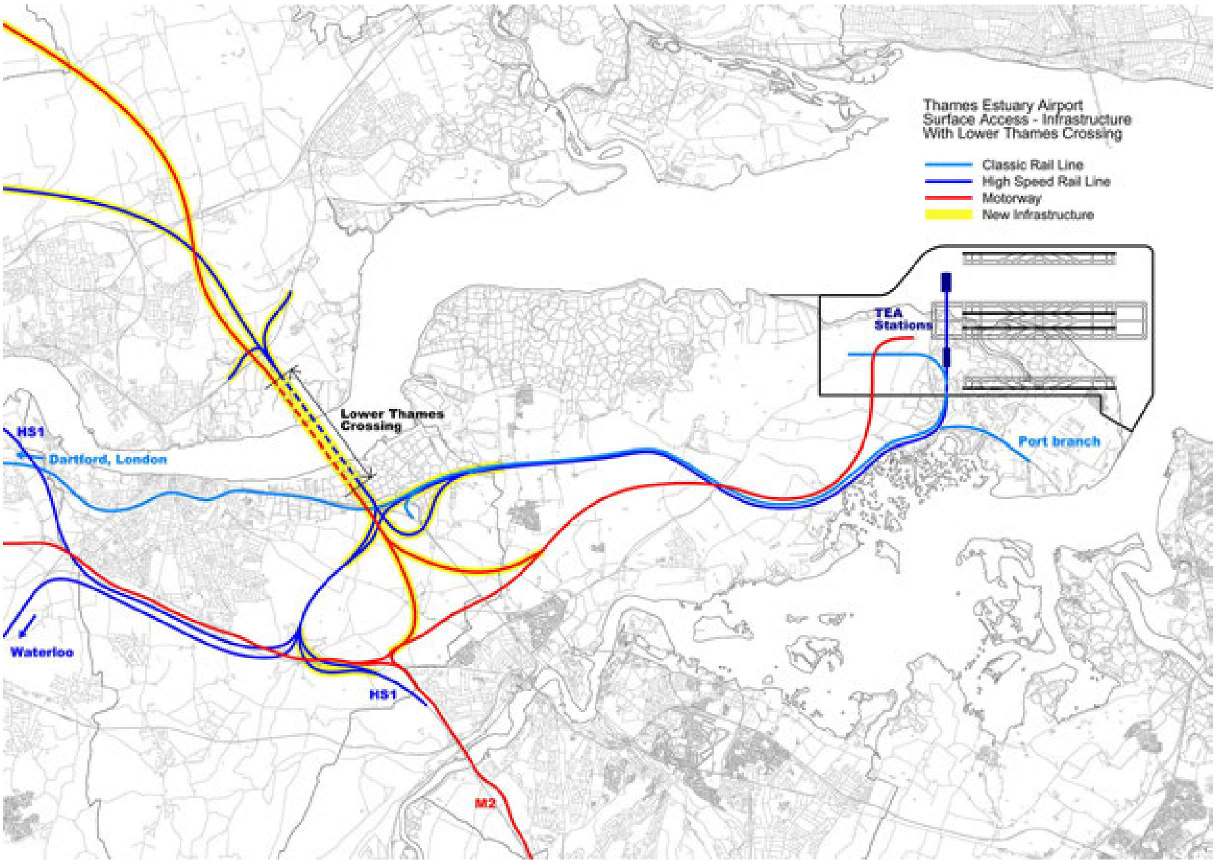

Figure 4-3 Surface access links for the mature Airport

High speed rail could be routed through the Crossing, connecting to HS1 near Wennington, reducing distance and time to central London. Local, employee-focused services could be introduced, possibly diverting some Shenfield Crossrail trains to run via Barking, Riverside, Rainham and a new South Essex Parkway station where the new line crosses the M25 and classic rail Grays-Upminster line.

A possible network of rail services at a 150 mppa airport with a multi-modal Lower Thames Crossing is shown in Figure 4.4.

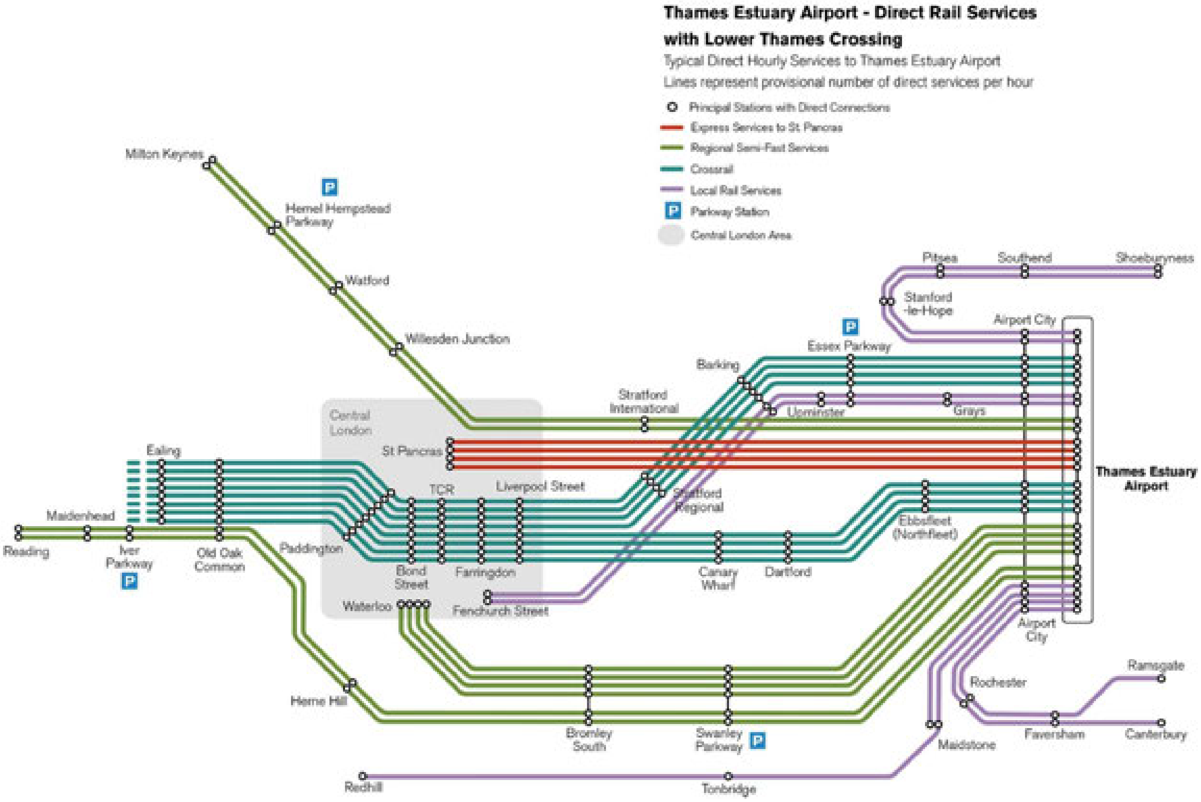

Figure 4-4 Potential airport rail services at the mature Airport

A rail-served Lower Thames Crossing would also facilitate a freight hub adjacent to the airport, with direct rail access to: the airport cargo centre; Thamesport container terminal; London Gateway container terminal; Wembley/West Coast Main Line; and Eurotunnel.

With higher levels of both rail and road access further widening may be needed on the strategic highway network:

- A2 between M25 junction 2 and M2 junction 1 (from 5 to 6 lanes)
- M25 between junction 2 and junction 3 (from 5 to 6 lanes)
- M25 between junction 3 and junction 6 (from 4 to 5 lanes)
- M25 between junction 6 and junction 7 (from 4 to 6 lanes)
- M25 between junction 7 and junction 9 (from 4 to 5 lanes)
- M25 between junction 7 and junction 9 (from 4 to 5 lanes)
- M25 between junction 29 and junction 27 (from 5 to 6 lanes); and
- M25 between junction 27 and junction 21 (from 4 to 5 lanes)

Further analysis as airport design is developed will indicate the optimal timing for these interventions and the extent to which widening would be needed in a no-airport scenario to accommodate Lower Thames Crossing traffic.

4-3 Costs

4-3-1 Cost of constructing new surface transport infrastructure

We have now had the benefit of understanding the Commission's methodology on cost and have had the opportunity for detailed discussion with TfL. This has led to significant allowances for risk and contingency which should fit with the appraisal process being used on the short listed schemes.

The specifics of the proposed surface access infrastructure outlined in 4.2.1 will be developed as Airport planning progresses, with changes in scale, scope and alignment (to minimise the environmental impact indicated in Section 4.4 below). Costs are therefore presented at a high level of aggregation and include a mark-up of between 50% and 80%, depending on scheme for risk, contingency and optimism bias.

Costs for the initial phase of access infrastructure construction (required at, or shortly after Airport opening) are summarised in Table 4.5.

	Base infrastructure cost	**Risk and contingency**	**Total**
Rail			
Classic rail link	680	400	1,080
High speed link to HS1	1,370	1,090	2,460
Additions to existing network	660	420	1,080
Rail total	**2,710**	**1,910**	**4,620**
Highway			
Motorway link to A2/M2	300	170	470
Local roads	85	45	130
Trunk road widening	730	380	1,110
Highway total	**1,115**	**595**	**1,710**
Surface Access Total	**3,825**	**2,505**	**6.330**

Table 4-5 'Opening Day' surface access infrastructure, £m current prices

Costs for the later phases of infrastructure construction, increasing the capacity and scope of access infrastructure as shown in Figure 4.3 in line with growth in Airport throughput, are summarised in Table 4.6. A conservative approach has been taken in estimating the highway costs, some of which may need to be incurred in a future with-LTC, without-Airport scenario.

	Base infrastructure cost	**Risk and contingency**	**Total**
Rail			
Lower Thames Crossing link	600	480	1,080
New link to HS1	930	730	1,660
Rail total	**1,530**	**1,210**	**2,740**
Highway			
Lower Thames Crossing upgrade	250	150	400
Further Trunk road widening	750	375	1,125
Highway total	**1,000**	**525**	**1,525**
Surface Access Total	**2,530**	**1,735**	**4,265**

Table 4-6 Additional infrastructure for the 'Ultimate' Airport, £m current prices

4-3-2 Level of any potential charging required to support the ongoing operation of surface transport links to Airport

Long-term rail and public transport financial viability is reviewed in 4.3.3.

It is possible that, by the time the airport opens there will be a national road user charging scheme that would generate a per-vkm revenue stream from airport traffic which could contribute to ongoing highway maintenance. In the absence of, or in addition to, road user charging the airport-M2/Lower Thames Crossing link could operate as a tolled facility, either as a national road or as a private sector business. As on the Severn or Dartford crossings, traffic would only be charged in one direction, ideally towards the airport.

Further analysis will be required to evolve a charging regime which would to leave local access to the airport (via the Medway Tunnel and A228) and other communities on the Grain peninsula untolled. Alternatively a charge to enter the airport could be applied, with the proceeds being used (as is proposed at Heathrow) to both fund highway maintenance and subsidise local public transport services to the airport. This would avoid an airport-related charge on non-airport traffic on the Grain peninsula.

An access charge, combined with medium/long term parking charges within the airport would incentivise air passengers and employees to use public transport. It would also encourage air freight and airport operations delivery traffic to consolidate loads, reducing highway demand both at the airport and on the wider network. Conversely, it is desirable to make access to the main national airport as cheap and convenient as possible.

A charge level similar to the Dartford Crossing (average £2.50) would raise around £50-70 m a year, depending on the number of local resident/essential user waivers issued. Airport employees could be offered reduced rates, possibly subsidised by employers or the Airport.

4-3-3 Implications of an inner Thames Estuary Airport for wider Government revenues and subsidies to transport sectors, for example rail franchising, bus funding, local funding and any other

Government income and expenditure in the transport sector could be affected in a number of ways by a Thames Estuary Airport, with the potential for increased demand for funding from both road and rail but the prospect of increased income (reduced subsidy). The full impact is difficult to assess in advance of decisions on ownership/operation arrangements, in particular for Airport Express rail services.

4-3-3-1 Rail

The net cost to Government could be influenced by the ownership structure adopted for the links from Singlewell and Hoo Junction. These could be built by Network Rail, becoming part of its Regulatory Asset Base, with costs recovered through access charges, or by a subsidiary of the airport (which would itself levy access charges) with arrangements similar to Heathrow, where HAL has ownership and responsibility for the infrastructure between Airport Junction and T5.

Similarly rail services could be operated by a separate train operating company (as Heathrow Express is and Gatwick Express has been), as an add-on to existing franchises (high-speed domestic services operate largely on HS1 but are part of the SouthEastern franchise) or a combination of these approaches with multiple rail operators - AirportExpressCo, Crossrail, SouthEastern, c2c – serving the airport.

Regardless of ownership, a high-level comparison of potential operating cost and revenue indicates that the St Pancras and Waterloo routes will generate an operating surplus, allowing contributions to the cost of operating the rail infrastructure. The Milton Keynes and Reading services are unlikely to cover full operating cost from air passenger traffic. With additional revenue for these routes from non-airport, cross-London, trips and employee use financial viability is achievable, with revenue growing over time as the airport expands.

For Crossrail air passenger revenue alone is expected to cover the marginal operating cost of extending trains to the airport, with significant additional income (some abstracted from existing SouthEastern services) from non-airport and employee users.

As a package, these to/through London routes, which will carry the bulk of air passenger demand should comfortably exceed direct operating cost, making contributions to the costs of running the wider railway, helping pay for the rail infrastructure investment and reducing subsidy.

Local rail services will add to the number of vehicle km run by SouthEastern (and, with a Lower Thames Crossing, Essex Thameside) and thus to the cost of running the railway, offset by increased revenue form air passenger and, particularly, employee trips. Traffic on these franchises is currently dominated by London-focused commuting, with inter-peak demand less than 1/4 of peak flows. Airport employment may tilt the balance of commuter flows, with airport-related demand carried on trains otherwise running lightly loaded or empty. In addition, shift patterns for airport related employment, may result in peak-spreading, generating additional revenue but negligible costs.

Overall the financial impact of the airport on classic rail services is expected to be neutral – no net cost to Government – and that air-passenger focused services should more than cover operating costs, potentially (depending on ownership structure) making a contribution to Government funds.

4-3-3-2 Highways

Long-distance coach services to the airport (e.g. National Express) would be run on a commercial basis, placing no operating cost demands on public funds but making a small net contribution via vehicle excise duty, fuel duty etc.

To achieve the target public transport mode share for employee travel local bus services linking the airport and Airport City with communities not easily linked by rail will be needed, as will extended hours of operation of feeder bus services at key stations on the employee-focused rail network, to enable shift workers to access their local station. New routes (e.g. Chatham-Wainscott-Hoo-Airport) imply additional vehicles but extended operating hours for rail feeder services will incur only marginal costs. The increase in bus operating costs may be only partially covered by farebox revenue, leading to an increase in the subsidy need for these services. Cost attribution models will be developed during the detailed design and planning stage. It is possible that the extra cost of bus services could be covered by the airport operator or employers, along the lines of BAA's 'freeflow Heathrow' intiative. Monies raised from an airport access charge for road vehicles could be used to fund this.

4-3-4 Balance between those costs that might be privately financed and those which would require taxpayer support, with clear view as to the balance between users getting to and from the airport and to and from other locations on any new infrastructure

Decisions on the financing and ownership or management of the main rail and road links to the airport will be made later in the project development process. These links could be privately funded or undertaken by public sector bodies (Network Rail, Highways Agency).

It is, however, expected that a 'user pays' approach will be adopted, with charges levied not only for use of the rail lines but also the motorway link. It is expected that air passenger rail services will be premium priced, generating a surplus over direct operating costs. Applying the surplus to track access charges to an infrastructure owner, rail links to the airport could be privately financed, as could infrastructure improvements at locations away from the airport (St Pancras, Willesden Junction, Parkway stations).

Similarly, an airport access charge levied on users of the motorway link would allow this facility to be privately funded.

Other highway costs – A228, trunk road widening – would initially be funded by the Highways agency, with any private sector contribution to be determined.

The level of non-airport use of infrastructure primarily provided to facilitate airport access is likely to vary by mode, location and stage of airport development;

- There will be few non-airport trips on the road and rail links between the A2/M2, HS1 or the North Kent line, or on trains at the airport, at any level of airport development (Thamesport and local community traffic will use the upgraded A228)
- Non-airport trips are expected to comprise the bulk of traffic on the widened motorways and trunk roads, a national road user charging scheme would see this traffic make some contribution to the cost of the upgrades

- Non-airport trips are expected on all airport rail services except the St Pancras express as there is no expectation that these will be restricted to airport traffic only at intermediate stations. These passengers will pay fares which will contribute to the surplus over direct operating costs and thus to any infrastructure access charge
- With a multi-modal Lower Thames Crossing non-airport rail services – Thames Gateway passenger services, domestic and international freight - will be able to use the rail link that is proposed to enhance airport access and will contribute to the costs of the rail link via access charges

4-3-5 Wider benefits that might accrue from surface transport investments for example in east London and north Kent

The location of the airport at the east end of the Isle of Grain limits the potential for wider benefit from non-airport use of the airport links outlined in 4.2.1 as these almost exclusively serve the airport. Accessibility for the east end of the Grain peninsula would be enhanced, as would Thamesport container terminal.

Extensive widening of the trunk road network away from the airport is intended to maintain the status quo, i.e. there would be no benefit but no cost to non-airport traffic and economic activity.

However, significant benefits are expected to accrue to non-airport travel from use of spare capacity on many of the rail services (and, to a lesser extent, bus services) that are intended primarily to carry air passengers and airport employees. In particular:

- Extension of Crossrail via Dartford and Gravesend improves connectivity for communities on the North Kent line, with direct links to the Royal Docks, Canary Wharf and the Crossrail core and increased frequency, particularly east of Dartford where there is the probability of significant development, e.g. Ebbsfleet new town
- The Waterloo express will offer an alternative central London destination at Bromley, with increased frequency and capacity. Swanley Parkway, while focused on airport park & Fly travellers, will be co-locational with Farningham Road station, with the potential to become a new rail-head if new Thames Gateway developments extend into the area
- The Milton Keynes service, while routing round central London, offers direct connections between key demand generators to the north west (Milton Keynes, Hemel Hempstead, Watford), the east (Stratford) and international services at Ebbsfleet
- The Reading service, while routing round central London, offers direct connections between key demand generators to the west (Reading, Slough, HS2 at Old Oak) and the south east (Bromley); and
- Local services in mid and east Kent will provide higher frequencies and new journey opportunities.

The airport-related addition of rail to a Lower Thames Crossing would bring significant benefits to non-airport users and communities, with:

- Increased frequencies and higher capacity trains on airport access trains on the Barking-Rainham-Grays-Airport axis, passing through the planned Barking Riverside development area
- The potential for new, non-airport rail services linking established and development areas in the Lower Thames Gateway on both banks of the river, e.g. Barking-Chatham, Southend-Dartford; and
- An effective London rail-freight bypass serving the industrial Midlands and North via Wembley and an electrified Gospel Oak-Barking line, Tilbury container terminal, London Gateway Port, Thamesport container terminal, the Channel Tunnel and the cargo centre at the airport itself, which, with good air, water, road and rail links would become a major logistics hub.

4-4 Environment

4-4-1 Likely impact of new surface transport infrastructure requirements on protected sites, habitats and landscape and whether these raise any particular legal problems

Figure 4.5 superimposes the main rail and highway corridors to the proposed airport location on the main environmental constraints in the area between Gravesend, the Isle of Grain and Rochester. There is an existing rail link between the Isle of Grain and Gravesend.

A new high speed railway would be run parallel to the existing, creating a railway corridor about 40m wide. A new D4 airport link road is planned by 2029 and the existing A228 would be widened from D1 to D2 by 2050. The A2/M2 junction would be remodelled. Further improvements may be required, such as widening the M25 further west and a new Lower Thames Crossing, but these schemes are not considered here.

The main environmental constraints identified in Figure 4.5 and listed in Table 4.5 include sites designated for their ecological, landscape, and heritage features. The designations vary in the level of legal protection afforded to them, from sites designated at the European level under EU Directives, to national legislation, and non-statutory sites which are usually afforded protection under the local plan framework.

Special Protection Areas (SPAs), Special Areas of Conservation (SAC) and Ramsar sites are treated as sites protected under European legislation and forming part of the Natura 2000 network. Under Article 6(3) of the EU Habitats Directive an appropriate assessment is required where a project could have an adverse effect on the integrity of Natura 2000 sites. This requirement has been transposed into English law under the Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations, which set out the assessment process (Habitats Regulation Assessment, HRA).

Much of the coastal waters and marshes along the southern shore of the Thames estuary and the Medway estuary are SPAs and Ramsar sites. The proposed railway route would cross a short section of the Thames Estuary and Marshes SPA to the east of Gavesend. The land-take would have to be mitigated through the provision of compensatory habitat. The proposed new highway link skirts the Medway Estuary and Marshes SPA and Ramsar sites, which would be mitigated by modifying the alignment to lie outside the designated site. The legal issues around development on these sites are covered extensively in relation to the airport itself in Study 1 and is not discussed further here.

The proposal to provide further railway capacity by following the existing railway route seeks to contain the additional impacts on the environment along an existing transport corridor. The western end runs through the South Thames Estuary and Marshes SSSI before reaching Gravesend. This would result in land-take, loss of habitat and fauna, and increased severance of the SSSI lying to the south of the railway line from the rest of the site. These impacts would need to be mitigated and could be dealt with as part of the approach to compensatory habitats under the HRA. The existing railway passes close to a number of listed buildings. During project development consideration would be given to assessing vibration impacts and developing measures to mitigate the impact of the additional railway on the setting of heritage features, for example by landscaping. The need to demolish a listed building would be avoided as far as possible, but if needed would require Listed Building consent.

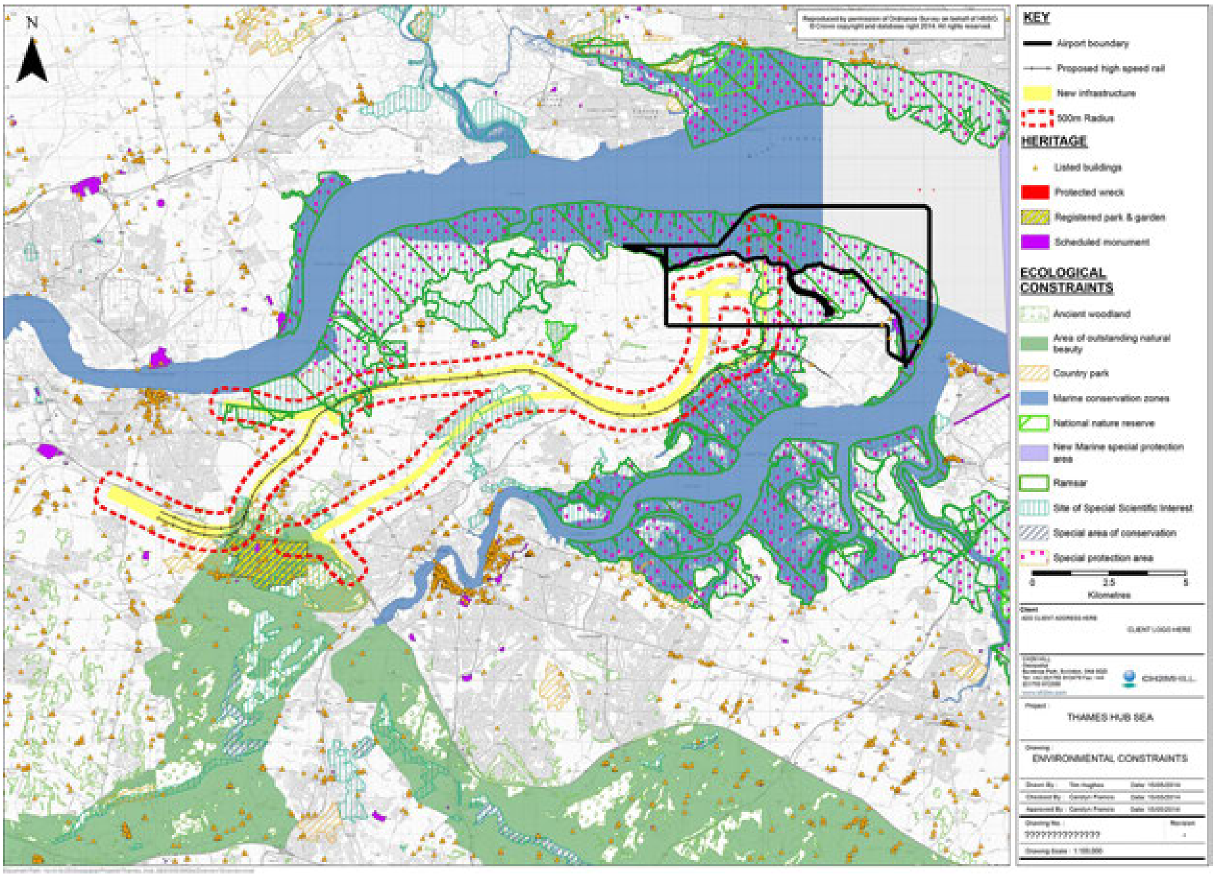
N
KEY
Airport boundary
Proposed high speed rail
New infrastructure
500m Radius
HERITAGE
Listed buildings
Protected wreck
Registered park & garden
Scheduled monument
ECOLOGICAL CONSTRAINTS
Ancient woodland
Area of outstanding natural beauty
Country park
Marine conservation zones
National nature reserve
New Marine special protection area
Ramsar
Site of Special Scientific Interest
Special area of conservation
Special protection area
0
2.5
5
Kilometres
THAMES HUB SEA
ENVIRONMENTAL CONSTRAINTS
??????????????

Figure 4-5

Name	Reason for designation	Legislation	Conservation Value	Affected by
Chattenden Woods and Lodge Hill SSSI	Ancient woodland, population of nightingale, and lowland species-rich grassland	Countryside and Wildlife Act 1981	High	Airport link road crosses SSSI
Great Crabbles Wood SSSI	Mixed coppice woodland under oak with sweet chestnut dominant.	Countryside and Wildlife Act 1981	High	Airport link road on / near boundary of SSSI
Shorne and Ashenbank Woods SSSI	Representative woodland including scarse species of flora.	Countryside and Wildlife Act 1981	High	HS rail link in tunnel
Cobham Woods SSSI	Woodland and old parkland, including one very rare and specially protected plant species, and breeding birds	Countryside and Wildlife Act 1981	High	Remodelled junction on A1(T)/M2 on/near boundary
Cobham Registered Park and Garden	Grade II* listed 16th century deer park with 18th and 19th century alterations.	Non-statutory site. Presumption against development under planning policy.	High	Remodelled junction on A1(T)/M2 on / near boundary
Several listed buildings associated with Cobham Park	Cobham Hall, Grade I, red brick manor house built in Elizabethan, Jacobean, Carolean, and 18th century styles. Currently a school.	Planning Act (Listed Buildings and Conservation Areas) 1990	High	Remodelled junction on A1(T)/M2 nearby
Various	Grade II* and Grade II listed structures	Planning Act (Listed Buildings and Conservation Areas) 1990	Moderate - Low	Various listed buildings within 300m of the surface access routes
Bowl Barrow Ashenbank Wood Schedule Monument in Cobham Park	Bowl barrows, the most numerous form of round barrow, are funerary monuments dating from the Late Neolithic period to the Late Bronze Age. Despite the limited damage caused to the Ashenbank Wood monument by partial excavation in 1895, the barrow is considered to retain considerable potential because the majority of the mound, the underlying ground surface, the burials placed on or below the ground surface and the surrounding ditch all survive.	Ancient Monuments and Archaeological Areas Act 1979	High	Remodelled junction on A1(T)/M2 nearby

Name	Reason for designation	Legislation	Conservation Value	Affected by
Jeskyns Country Park	Recreation	Countryside Act 1968	Moderate	HS rail link crosses northern part of Park
Shorne Wood Country Park	Recreation	Countryside Act 1968	Moderate	HS rail link crosses park in tunnel
Ranscombe Farm Country Park and SSSI	Recreation	Countryside Act 1968		
Countryside and Wildlife Act 1981	High	Remodelled junction on A1(T)/M2 on / near boundary		
Ancient woodland	Existing or sites of ancient woodland.	Non-statutory site. Presumption against development under planning policy	Moderate	Within 300m of surface access routes including designated SSSIs
Chattenden Woods and Lodge Hill SSSI	Ancient woodland, population of nightingale, and lowland species-rich grassland	Countryside and Wildlife Act 1981	High	Airport link road crosses SSSI

Table 4-7 Summary of sites of conservation value

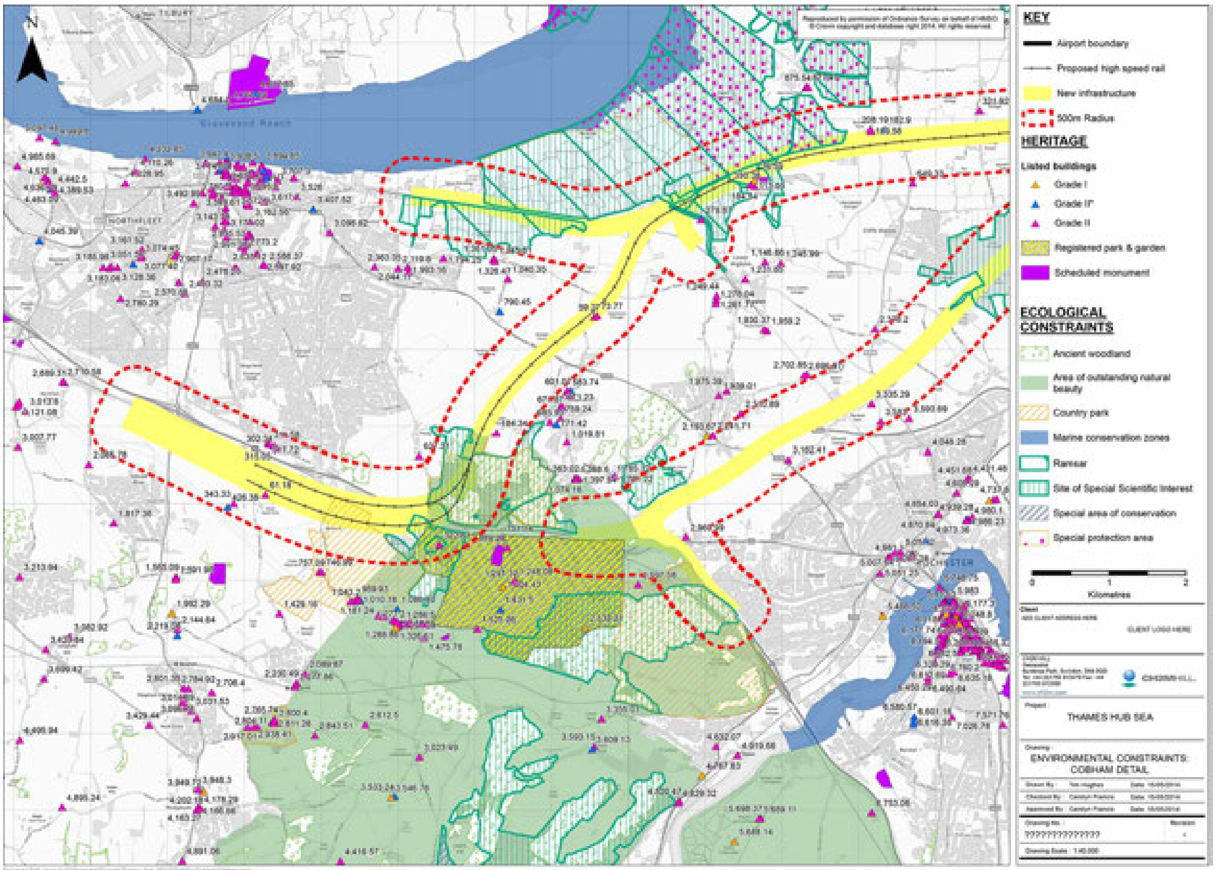

Figure 4-6 Environmental constraints in the Gravesend-Rochester area

The proposed highway improvements include a remodelled Junction and widening of the A289. The existing junction lies in the North Downs AONB and close to Cobham Registered Park and Garden with its listed buildings and scheduled monument. The Cobham Woods SSSI and Ranscombe Farm Country Park and SSSI border the M2 south of Junction 1. Options to remodel the junction to minimise direct impacts on these designated sites would be undertaken and consideration given to landscaping to reduce the ecological, visual and landscape impacts.

The A289/A228 passes the Crabbles Wood SSSI and Chattenden Wood SSSI and close to a number of listed buildings. Minor adjustments to widening, such as symmetrical and asymmetrical widening, and off line widening would be examined to reduce the direct impact of land-take on designated features.

The proposed new highway takes an alignment across open countryside. This route crosses the Chattenden Wood SSSI, which was designated as recently as November 2013, following our original submission to the Airports Commission. An alignment of a D4 highway along the length of this designated site would cause very significant impacts and loss of integrity of the site. In view of this, we would consider options to change the highway alignment, possibly following the railway corridor further before crossing to Junction 1 on the A2/M2.

4-4-2 Any significant local environmental issues (such as air quality, carbon, noise) arising from new surface transport links to an Inner Thames Estuary airport and whether these can be overcome.

The proposals for new surface transport links to the Inner Thames Estuary airport will introduce adverse impacts due to emissions of vehicle exhausts and noise, the use of embodied carbon in construction materials and carbon in vehicle emissions, and vibration from construction activities and the movement of traffic.

Poor air quality and noise affects the quality of people's lives, while nitrogen deposition can damage some sensitive habitats and noise disturbs wildlife. These impacts can be overcome, following the mitigation hierarchy avoid, reduce, remediate and compensate. Figure 4-7 shows that the proposed surface access routes avoid the main built up areas. The impacts of air quality and noise decrease with distance from the source. Air quality generally decreases to ambient levels within 200m, and road noise decreases to acceptable levels within 300m in urban areas and 600m in rural areas, depending on attenuating features such as topography.

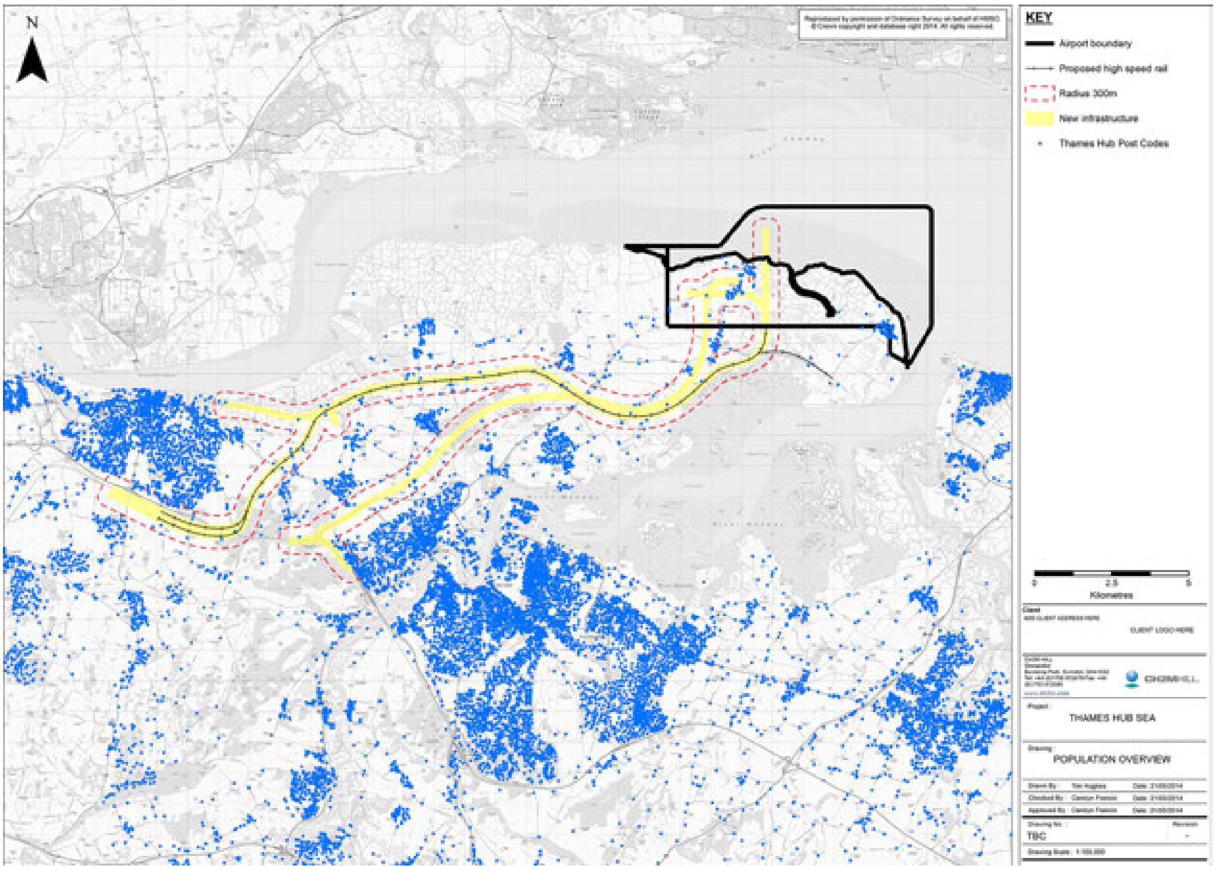

Figure 4-7 Population areas based on postcodes

4-4-2-1 Air Quality

The EU limit value for nitrogen dioxide is currently widely exceeded across the UK, including alongside several hundred kilometers of the strategic road network. The limits should have been achieved in 2010, and the European Commission has begun legal proceedings against the UK government for failed compliance. Currently the UK government is not able to promote highway schemes which have a significant impact on air quality (i.e. lead to or worsen non-compliance with EU limit values set for the traffic pollutants nitrogen dioxide and fine particulate matter). For example, in 2013 the prospect of worsening breaches of the nitrogen dioxide limit in Manchester led to the Highways Agency re-designing and pushing back the implementation of the M60 Managed Motorway scheme.

There are existing Air Quality Management Areas[87] covering roads in north Kent, including the A2(T) and the A289 in Chatham and Rochester, where air quality limit values are exceeded. The proposals to construct a new D4 highway from the A2(T)/M2 Junction 1 and widening the A228 would potentially draw more traffic onto the network. Even if the proposed new roads do not present significant air quality issues with respect to breaching the EU limit values, knock-on effects on parts of the network where there are existing breaches could potentially prevent the scheme from being delivered in the short term.

However, the scheme is not intended to be delivered in the short term, and it will be many years before the surface access routes are in place. Although there has been little improvement in air quality over the last decade, mainly due to the failure of older vehicles to meet emission standards under urban driving conditions, modern cleaner Euro 6/VI vehicles are expected to meet emissions standards on urban roads, delivering air quality benefits across the road network. There are therefore expected to be future improvements in air quality as these vehicles become increasingly common in the national vehicle fleet. London is expected to be the last area of the country to achieve compliance with EU

The new D4 airport link road and the widening of the A228 are currently programmed for opening in 2029 in time for the airport. Given these timescales, there is an opportunity for improvements in technology to result in local improvements in air quality, and the later the planned development of the surface access routes, the lower the risk of the schemes being held up due to poor air quality. At present, an estimated approximate 4,050 people live within 300m of the new airport link road who, under present conditions, could be affected by reduced air quality. Further study would be required to forecast whether the reduced air quality would result in exceedance of the air quality standards by year of opening and later years.

The introduction of new rail links are not likely to give rise to significant air quality impacts in terms of legal compliance, particularly if the lines are electrified.

Figure 4-8 AQMAs declared in North Kent, Source: Defra website

87 Local authorities are responsible for designating Air Quality Management Areas where air pollutants exceed the air quality limit values and for preparing and implementing Air Quality Action Plans to address the air quality problems.

4-4-2-2 Carbon

In terms of carbon, surface access designs will affect the overall carbon footprint, but the legal framework is not such that it would present a significant impediment to the deliverability of the scheme.

4-4-2-3 Noise and vibration

Significant noise impacts are possible if any of the new infrastructure is constructed close to sensitive receptors, especially if there are no existing major noise sources in the area. Potential impacts along the new surface access routes could be made worse due to the 24-hour operation of the Airport contributing to higher night-time movements on the surface access routes and ambient noise levels. An estimated approximate 4,800 people live within 300m of the proposed new high speed rail links and airport link road.

If identified at an early stage, these potential noise impacts can be either reduced or eliminated during the design process. There is some scope for altering the route alignment and cuttings and land contouring could be used to attenuate noise. Mitigation measures could include the use of noise barriers or tunnels for both rail and road. Specifically for roads, further mitigation could be the use of low noise surfaces and speed restrictions. Noise insulation would be available for qualifying properties. For rail, the use of train and track is critical to the noise generation and measures taken during design to reduce noise.

Vibration tends to be a problem where frail structures are located very close to the source. Preventative measures can be taken to avoid impacts, such as minor changes in horizontal alignment and the selection of less intrusive construction methods. The level of vibration can be monitored during construction, and further mitigation taken reactively to reduce vibration at source and strengthen the affected structure. Vibration is often scoped out of the impact assessment of transport schemes and is not considered to have a determining influence on the selection of the Thames Estuary airport and surface access routes.

Study 5: Master Plan

5-1 Introduction

Establishing a new airport in the Thames Estuary offers the once-in-a-lifetime opportunity to plan and design an airport in the UK that is convenient for its passengers, operationally efficient, flexible in terms of use, easy to expand in phases, and resilient to industry changes. In addition, the airport would provide the required capacity with minimum noise impact and emissions.

The original concept for Thames Hub was based on work done for the 2003 SERAS White Paper, “The Future of Air Transport”. This was chosen as an initial basis, as its parameters and arguments for its configuration had been tested and were generally well understood. In the early stages of development, an incremental approach looking at optimised locations rather than facility configuration was deemed more important. During our further development work, a large number of runway configurations, terminal layouts and positioning of support facilities have been studied.

A critical assessment of the airport design is its ability to be flexible. Ensuring we have the right runway configuration may be an early decision but confirming its underlying flexibility for efficient future use is essential for land development purposes, as well as for guiding functional facility decisions.

A master planning exercise has been undertaken which developed the initial Thames Hub layout in greater detail to reflect key facilities and areas accurately. The layout evolved during this process, which resulted in other alternatives being developed. One concept was selected based on its ability to deliver the required capacity with a greater level of resilience, among other factors, and was detailed further.

In this section we describe the design and its underlying assumptions, how the airport would operate, and how the airport facilities have been positioned to work in a balanced, optimal manner to provide sufficient hub capacity for generations to come.

5-2 Airport Concept and Capacity

5-2-1 Chosen Concept

Thames Hub would open with a capacity of 110 mppa and would have the potential to expand in incremental steps to 150 mppa and beyond as demand dictates. The airport is proposed to be built on a platform, 8.7 km long, 4.2 km wide and 7 m above sea level, located partly on land and partly in the estuary. To provide the most efficient operating layout, it would have four runways, each pair bestriding the two central terminals and satellite concourses. Given the prevailing winds, the airport's location would allow 24 hour operation with aircraft approaching or departing over water. This is expected to significantly reduce the noise, air quality and safety problems of aircraft currently over-flying London.

Continuous operations also mean maximising utilisation of the airport infrastructure. Additional capacity afforded by 24 hour access allows passenger services and increases hubbing opportunities, as well as opening up new market prospects. This also permits night hours to be used by freighter services, thereby freeing up more valuable daytime slots if so needed. In addition, 24 hour operations would significantly strengthen the airport's resilience to incidents compared to airports with night curfews.

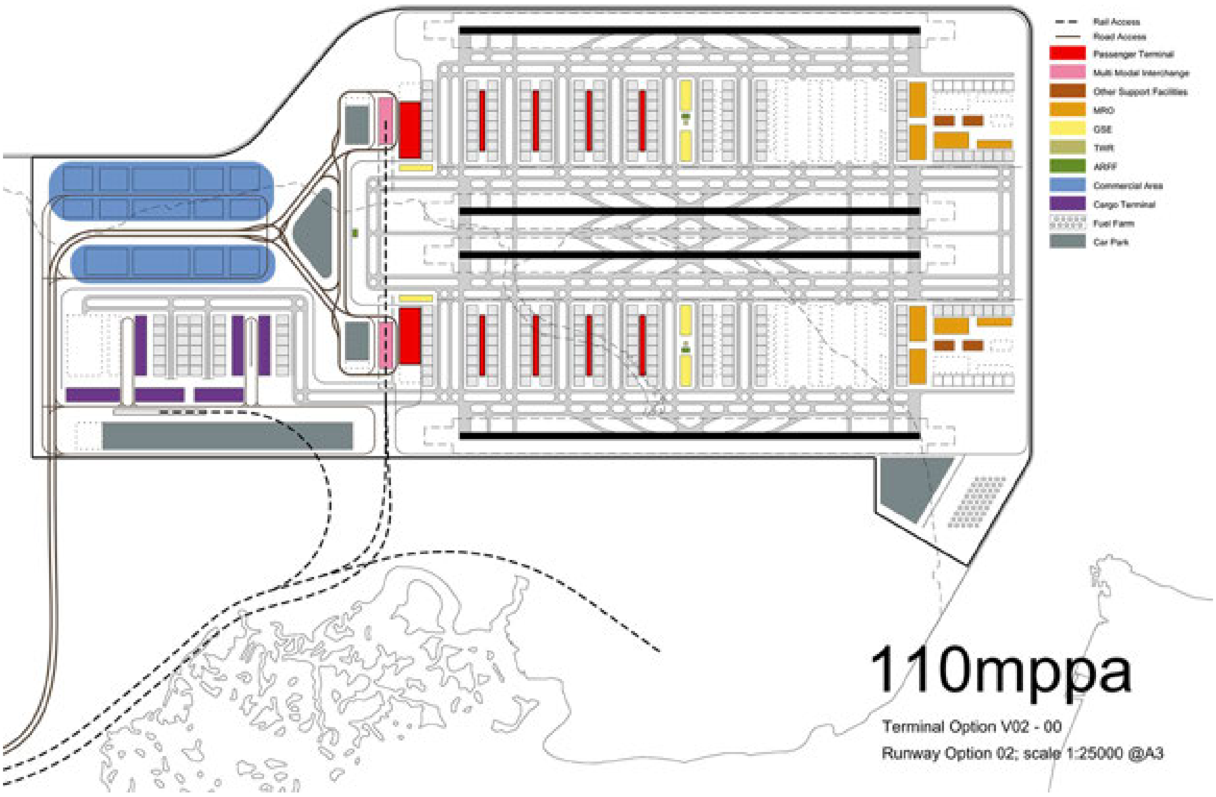

Figure 5-1

5-2-2 Operating Capacity

For the opening capacity of 110 mppa, annual aircraft movements, described as an arrival or departure, of 750,000 – 810,000 can be expected, which translates into a peak hour runway demand of approximately 123 movements, depending on the demand profile. The purpose of designing to the peak day in an average month ensures that the airport is designed to accommodate the majority of traffic without over-designing the facilities. The annual passenger capacity and the ATMs are linked by the average number of passengers per movement, which can fluctuate over the years based on aircraft size and airline scheduling patterns. It is projected that this figure will be in the region of 150 passengers in the mid-term. This is lower than Heathrow today, as short-haul feeder traffic, which is essential to hub operations, will be attracted and reintroduced. With a resulting wider range of smaller domestic and European aircraft feeding long-haul routes, the average number of seats, and thereby passengers per flight is reduced.

The ultimate 150 mppa phase translates to about 1 million ATMs. These figures have been adopted as drivers for the airfield layout configuration.

In both phases of airport development (110 and 150 mppa), higher numbers of aircraft movements and passengers are possible depending on Air Traffic Control (ATC) procedures, improved airspace procedures and operational factors.

The runway-taxiway system layout must be able to cater for such expected demand in a reliable and sustainable manner, delivering unconstrained peak capacity and operational redundancy. This means the layout must respond to individual arrival or departure peaks, and the combined aircraft movement peak, by guaranteeing a minimum of taxi delay and immediate aircraft stand availability. The resilience to cater for weather-related delays is a further requirement which the design fulfils.

Thames Hub airport facilities have been designed to accommodate up to the world's largest aircraft, referred to as Code F per ICAO standards (such as A380). All airport facilities are sized to accommodate this aircraft, including the runways, taxiways, aircraft stands, terminals, and safety areas.

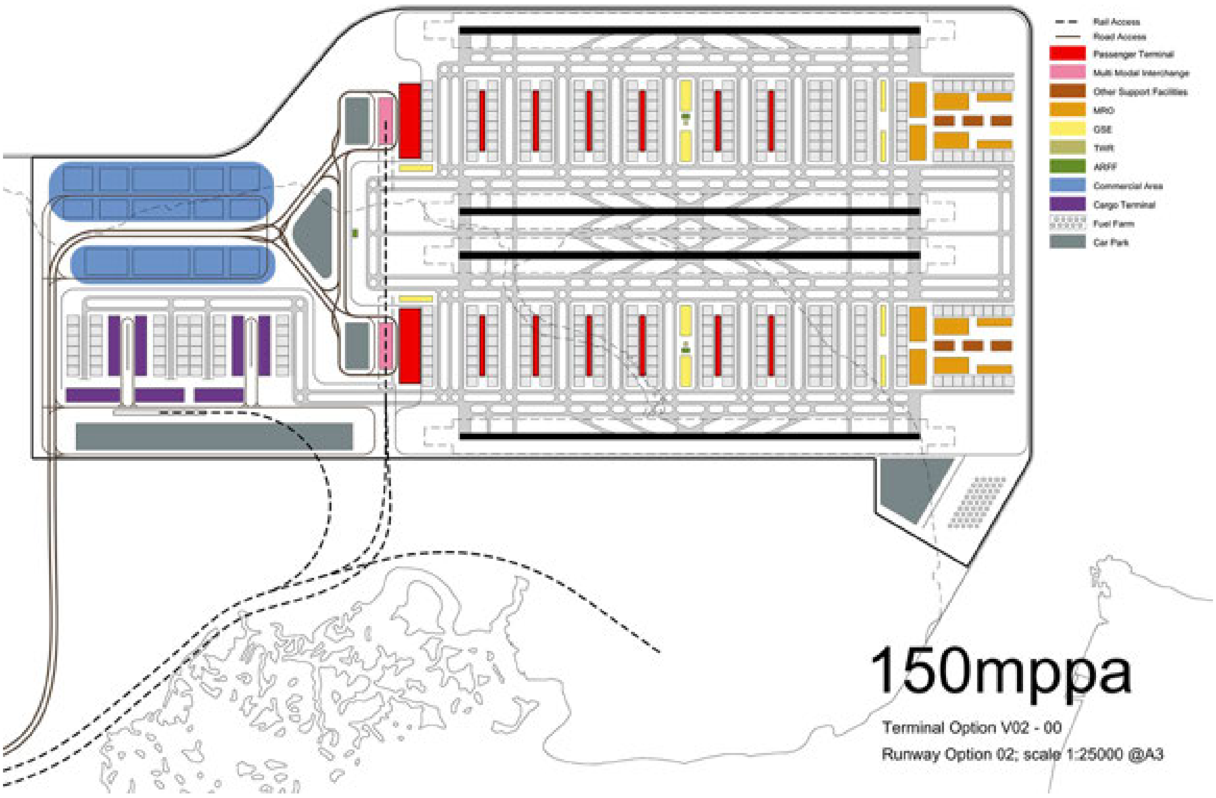

Figure 5-2

5-2-3 Concept Alternatives

The following thumbnails depict concept alternatives, considered during the master planning exercise, to provide options for further optimisation.

For example, consideration was given to the development potential of various terminal/satellite layouts, differing runway lengths, staggering of runways, different runway separations.

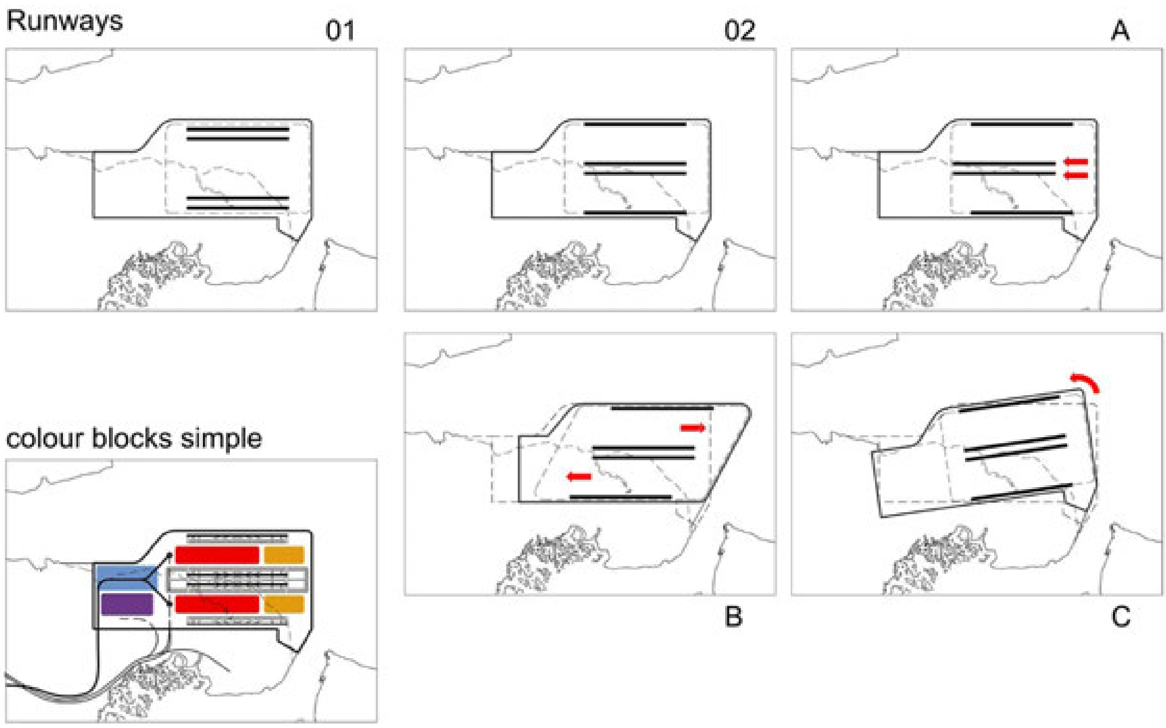

Figure 5-3

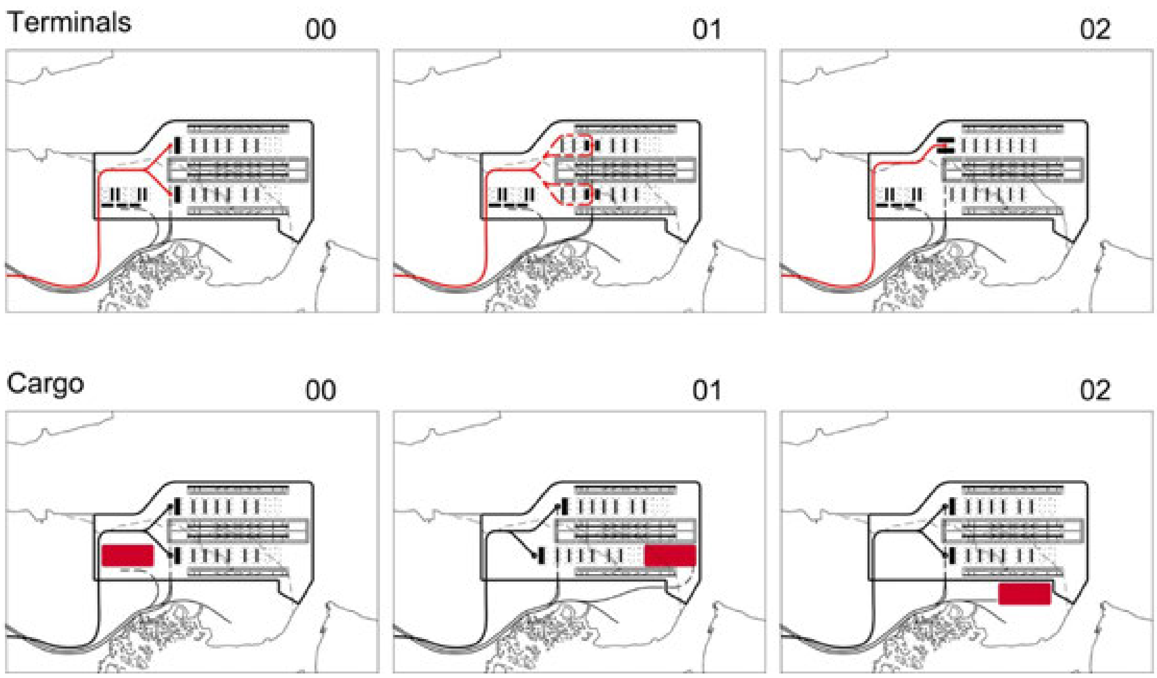

Figure 5-4

5-3 Airside Layout

5-3-1 Runways

The preferred runway layout consists of 4 parallel runways, all 4,000 m long. However, there are possible efficiencies that could be evaluated for an optimised airfield scheme at a later stage. Such a length guarantees take-off capabilities of all aircraft types under Maximum Take-Off Weight (MTOW) and all weather conditions. For full operational flexibility, all runways have the same length. The runways are aligned in east-west direction according to the predominant wind direction.

The landing thresholds have been displaced from all runway ends by 550 m. This aids a reduction of land take for approach lights, shortens the Public Safety Zones (PSZ) and reduces the impact of Take-Off Climb and Approach Surfaces, thereby freeing up land for other uses in the extension of the runway centrelines. A further benefit is the reduction in length of the wrap-around taxiways at the ends of both inner runways. The resulting Landing Distance Available (LDA) of 3,450 m at each runway is still sufficient for all aircraft types.

To achieve the maximum number of peak and annual aircraft movements utilising these 4 runways within the platform dimensions, an arrangement had to be found which maximised the number of independent movements. The optimum runway layout for the airport envelope consists of two pairs of wide-spaced runways where each pair of outer plus inner runway can operate fully independent. The inner runways are dependent, but sufficiently spaced to accommodate a central parallel taxiway in order to provide full east-west accessibility. Each outer and inner runway pair is separated by 1,570 m, which gives sufficient space to develop efficient terminal areas and aircraft stands. The two inner runways show a separation of 380 m, which enables the positioning of a single taxiway between them.

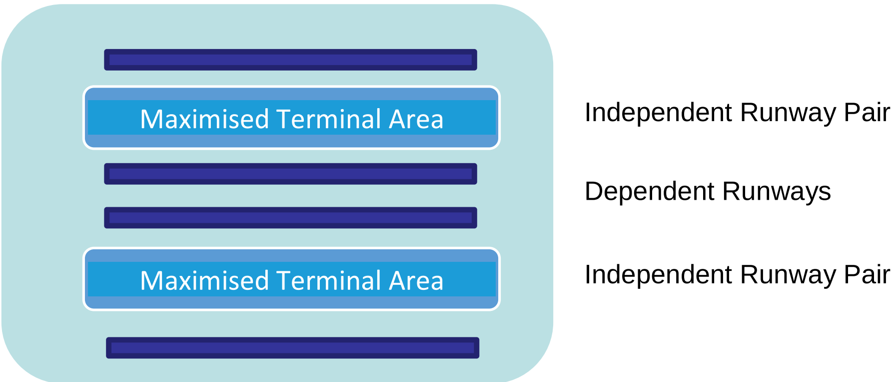

Figure 5-5 Optimum Runway Layout

5-3-2 Operational Modes

Thames Hub would be a true 24 hour-airport. We currently envisage that 2 of the 4 runways would only be needed for 18 h per day, as the demand during the night decreases. This offers the flexibility for the airport to maintain the level of service and still conduct routine maintenance. Due to the optimum layout and the operational modes envisaged, the runways can handle over 1 million ATMs with an average 85% utilisation. This allows for traffic peaks, maintains an enhanced level of passenger experience and minimises unnecessary aircraft fuel burn, whilst being sufficiently resilient to recover from any weather-related delays.

Our preferred mode of operation would be segregated operations in an “arrivals/departures/arrivals/departures” pattern across the 4 runways. This would offer independent arrival and departure operations on the outer runways. On the inner runways, dependent arrivals and departures would be operated, where two subsequent arrivals on one runway can be interlaced with departures on the other one. Such an operational mode would enable both the northern and the southern part of the airfield to operate largely independent from each other.

An “arrival/departure/departure/arrival” pattern is also possible, as is operations in mixed mode, since the layout offers full flexibility to suit any specific demand and the preferences of the air traffic service provider.

About 70% of arrival movements are expected from the east, i.e. over the sea, but as the airfield is balanced, full runway capacity is also provided when aircraft movements operate in west-east direction.

5-3-3 Safety Zones

Public safety and development control near airports is regulated by the UK CAA's Public Safety Zone Policy. This is based on risk contours defining areas where people would be exposed to a specified annual risk of death due to an aircraft crash. The two zones extending off every runway end are defined as 1:10,000 and as 1:100,000. No one is allowed to live or work inside the higher risk zone, and there should be no new development within the lower risk zone. There are also restrictions on new transport infrastructure in these risk zones.

The size of these areas is different for each airport and depends on the annual number of aircraft movements on each runway. Based on comparable runways in the UK, a triangular area extending at least 3 km from each runway threshold and about 800 m wide should be kept free of new development. The higher-risk 1:10,000 zones would be largely contained within the airport boundary. The eastern end risk zone and the risk zones of the northern runway pair would extend over water.

Runway-End Safety Areas (RESAs) have been implemented to confirm with ICAO standards and recommendations.

Obstacle Limitation Surfaces (OLS) define the airspace in the vicinity of an airport which has to be kept free of obstacles. All facilities at Thames Hub airport have been positioned to avoid infringements of the OLS within and outside of the airport boundary.

5-3-4 Taxiways

The taxiway system supports the runways and is essential for a free circulation of aircraft ground movements between the runways and the aprons. Each runway is supported by three parallel taxiways of which two facilitate rapid egress from the runways for arrivals or direct access to the runway ends for departures. The third taxiway can be used for stand access, apron circulation, towing or taxiing in opposite direction to the parallel taxiways.

All passenger aircraft stands can be accessed by taxiways perpendicular to the runways. Further taxiways for through-traffic (i.e. not accessing stands) are provided in the west, the east and centrally of the airfield, connecting the parallel taxiways.

Each runway shows three Rapid Exit Taxiways (RETs) in each direction. These are spaced at optimal intervals to facilitate quick runway egress of landing aircraft, thus minimising runway occupancy time and providing high runway capacity whilst being responsive to changes in aircraft mix. Link taxiways enable landed aircraft to immediately turn onto the inner or outer parallel taxiway in free flow to then taxi directly to their aircraft stand.

Both inner runways offer end-of-runway taxiways, or wrap-around taxiways. These enable aircraft to reach another runway for take-off or after a landing without directly crossing the particular runway (moving in north-south direction or vice versa). The set distance off the runway ends ensure free taxi movements under a landing aircraft or behind an aircraft taking off, without infringing Obstacle Limitation Surfaces (OLS) or being affected by jetblast.

5-3-5 Aircraft Stands

In its initial phase for 110 mppa, Thames Hub will feature 192 passenger aircraft stands. Currently, all of these have been planned to enable Multi-Aircraft Ramp System (MARS) operations, thereby enabling two narrow-body aircraft of Code C size to be parked on one wide-body stand. This results in a theoretical capacity of 384 Code C aircraft stands, or 288 aircraft of various sizes if 50% of the MARS stands are used for wide-body aircraft.

Figure 5-6

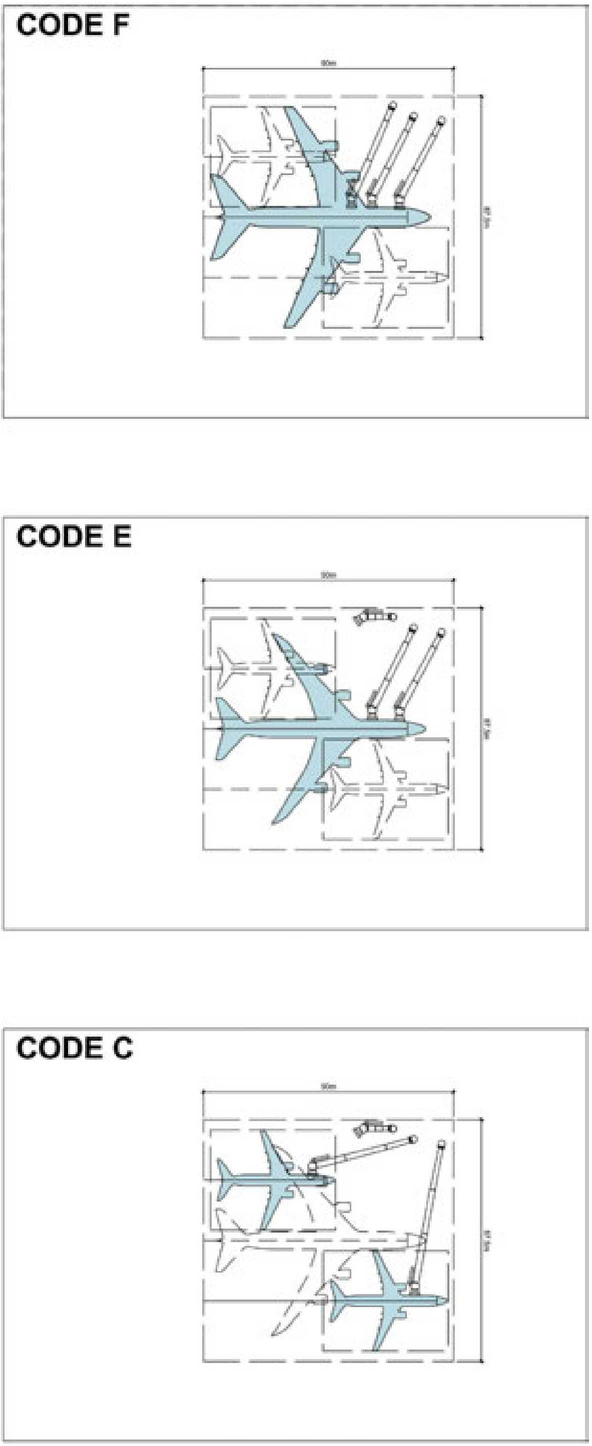

Figure 5-7

For the 150 mppa phase, 256 MARS stands for passenger services are envisaged.

Such high degree of flexibility enables the operations to respond to any variation in demand and the differing peaks of narrow-body and wide-body aircraft movements throughout the day and year.

It is foreseen that approximately 75% of the passenger aircraft stands are contact stands, which enable ease of passenger embarkation and disembarkation via airbridges. Such a split ensures that over 90% of annual passengers are being bridge-served. The remaining 25% of stands are used for operational short-term parking and longer lay-overs

5-3-6 Airside Road Network

All aircraft stands, Ground Support Equipment (GSE) storage areas and support areas will be connected by an efficient, airside road network. This will extend to the cargo area to facilitate fast connections between passenger stands and cargo buildings for belly-hold cargo. Where baggage or cargo dolly/ULD train traffic is expected, a minimum three lanes will be provided to enable overtaking of slow-moving vehicles.

For each satellite-apron campus, ramps will connect the head-of-stand roads to the airside road tunnels. The lower-level roads will link the main aprons to avoid taxiway crossings. For remote aprons, aircraft maintenance areas and the cargo compound, which all see less frequent aircraft movements, taxiway crossings are envisaged at grade.

5-4 Terminals

5-4-1 Terminal Concept

For the scale of the Thames Hub airport in its initial phase and its later stages, a single passenger terminal would not be feasible. To enable separate operations by the main airline alliances and to allow their capacity development to be phased individually, our concept entails two separate main terminals. Each would be connected to the satellite concourses by high-speed and high-capacity transit systems.

Such a split into two main complexes offers operational resilience in case of a security or health alert in one terminal by utilising the other terminal for a short period. Each terminal will have a capacity of approximately 55 mppa in the opening phase, growing to 75 mppa and beyond, depending on each alliance and airline's actual demand increase.

5-4-2 Main Terminal

The main terminals will house all processing facilities for originating and terminating passengers and their baggage, such as check-in, immigration, retail and baggage handling systems (BHS). The facilities will be dimensioned on the basis of expected busy hour passenger figures.

The compact concept of the core terminals allows for short distances from landside to airside, enabling a direct passenger flow with a minimum of vertical circulation. It is envisaged that the terminals serve a number of contact stands directly, which would be prioritised for domestic and other short-haul flights. Sufficient space is safeguarded for future expansion of all processing, circulation and commercial areas.

The available space between the runways provides a high degree of flexibility for different terminal concepts during the design stages. Whilst a conventional box concept is shown on the current layouts for the most efficient use of space, the development of even larger terminals in H-shape or Y-shape footprints with more contact stands is feasible. The current layout therefore does not preclude design variations in any way, instead giving total freedom to terminal designs that respond to future architectural requirements.

5-4-3 Satellites

The satellites have been arranged parallel to their respective main terminal buildings in a so-called "toast rack" system. This is the most space-efficient layout for aircraft stands and passenger orientation. The length of the satellites results in optimal passenger walking distances, which in turn helps to achieve low connection times. It is also incrementally expandable, according to demand. For the shown configuration, initially 8 satellites (4 per main terminal) are required. This number is expected to grow to 12 for the 150 mppa demand level.

The terminal-satellite layout currently shown offers the flexibly of the development of different configurations, though, should operational requirements drive a variation in design.

5-4-4 People Mover System

An efficient, high-capacity and high-frequency airside people mover system is crucial for the operations of Thames Hub Airport and for adhering to the stipulated passenger minimum connection times (MCT). Each main terminal will be connected to its satellites and there will also be a loop to connect both terminals with each other. All capacity contingencies and operational redundancies required for such a key system will be implemented.

A segregation concept to separate "clean" departing passengers from potentially "dirty" transfer and arrival passengers will be developed in line with regulatory demands to reduce the need for passenger rescreening.

5-5 Landside Facilities

5-5-1 Multi-Modal Interchanges

Approaching the airport and transitioning from land to air transport in a relaxing manner is an essential part of the passenger experience. The multi-modal interchanges, situated right outside both terminals, facilitate such transition by providing ample space for modern public transport modes. Uncongested, calm realms enable easy transfer from regional rail, high-speed rail, coach and buses to the terminals and vice versa, aided by short walking distances and a minimum of vertical changes.

5-5-2 Car Parking

5-5-2-1 Short-Stay

Whilst the mode share of private car use is expected to drastically reduce over time due to the growing attractiveness of efficient, affordable public transport to Thames Hub, a number of car parking spaces has been planned to cater for this market segment and to offer non-aeronautical revenue opportunities for the airport operator. All car parks have been planned in a way that allows incremental expansion in line with an increase in demand.

The short-stay car parks, arranged in multi-storey structures, are located in the immediate vicinity of the terminal buildings. Maintaining security-related stand-off separations, these car parks would be in walking distance of the terminals.

5-5-2-2 Mid-Stay

This type of car park enables the airport operator to offer a differentiated product a short shuttle distance away from the terminals. This car park can be combined with some employee parking, rental car facilities and taxi holding areas.

5-5-2-3 Long-Stay

The main long-stay car park is situated in the southwest of the airfield, partially within a PSZ. This utilises the respective area in an optimal manner, as such car park is one of the few new structures that is permitted within a PSZ.

5-5-2-4 Employee Parking

Only minimal employee parking is envisaged in the airport’s western areas, where the required spaces can be integrated in the mid-term and long-term car parks. In the east, near the aircraft maintenance and support areas where no rail access is available, an employee car park has been safeguarded for.

5-5-3 Airport City

The configuration of the airport terminals and their landside access roads offers unparalleled opportunities for commercial exploitation. Over 280 ha are available in the vicinity of the terminals alone for prime retail, hotels and other high-value businesses. The proximity to the world-class hub airport will attract international companies due to its unrivalled connectivity will all existing and emerging world markets.

Further commercial areas have been earmarked near the cargo terminals and the maintenance compounds for logistic warehousing, haulage companies and aviation equipment suppliers.

5-6 Cargo and Support Facilities

5-6-1 Cargo

Cargo operations require both front-line and supporting infrastructure. Our on-airport facilities, with direct airside access to aircraft stands, include general cargo warehousing and sorting buildings, forwarders' facilities and specialist integrators' buildings. The landside provides extensive lorry parking and loading areas.

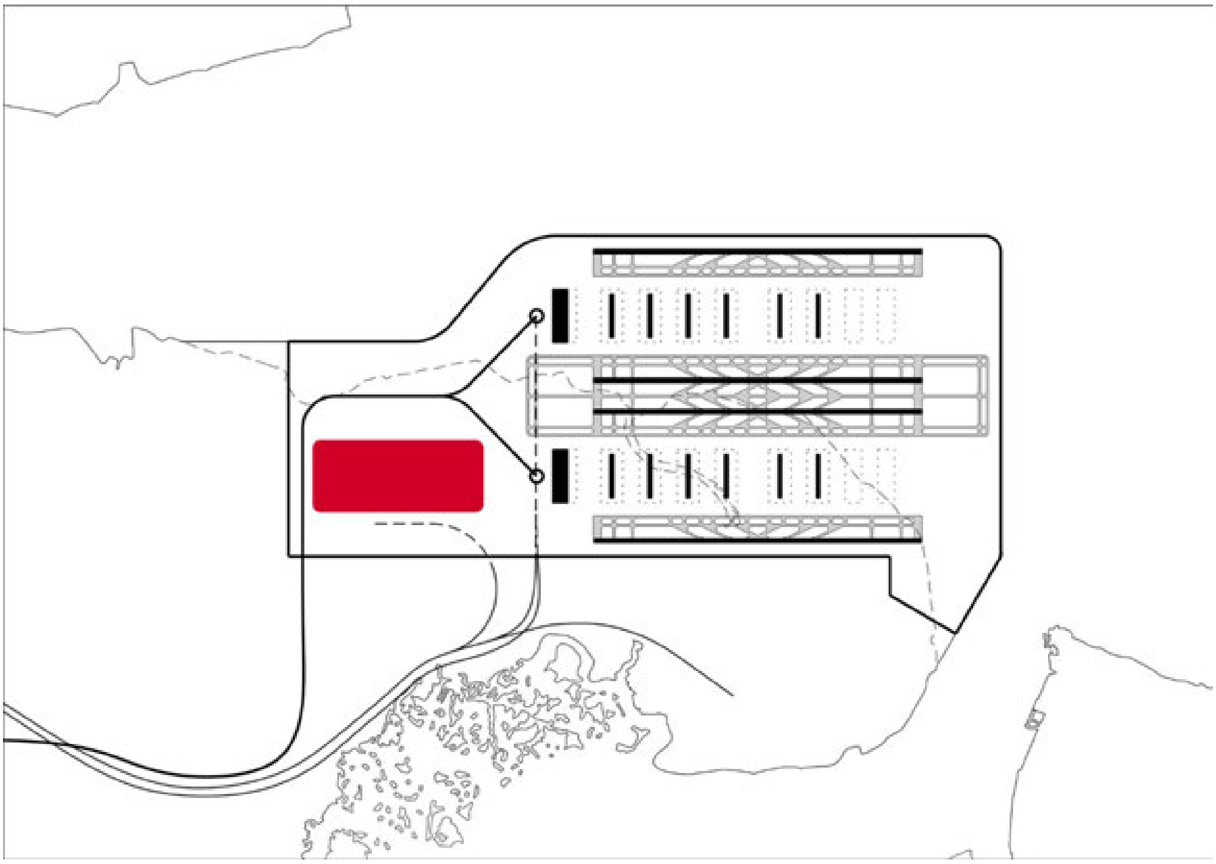

Figure 5-8

The cargo area is located to the west of the airport, with a total safeguarded space of 270 ha. Its 24-hour operating capability increases opportunities for cargo and offers the development of a true logistics hub through the integration of a sophisticated air-rail facility. A wider trading capability could be achieved via adjacent ports.

The airside of the cargo area initially affords 24-26 aircraft stands of Code F size, which have been dimensioned to offer nose-loading capability. Generous airside equipment storage areas are also safeguarded for. The freighter aircraft stands are connected to the remaining airfield by a dual taxiway system. For the 150 mppa phase, 40 Code F stands are envisaged.

A large proportion of future cargo tonnage will continue to be transported as belly-hold of passenger aircraft, drawing on Thames Hub's unparalleled connectivity and frequent passenger services to all the world's markets. Therefore, an efficient, direct road connection between passenger stands and cargo area will be implemented.

As our cargo areas would have direct rail access for cargo trans-shipment, the demand for high-intensity road access would be drastically reduced.

5-6-2 Air Traffic Control Tower

The sheer size of Thames Hub and its split into two distinct areas north and south necessitates the implementation of two air traffic control (ATC) towers. Each tower would be located as centrally as possible between its 4 respective runway ends to provide similar distances for controllers to observe the runways and the rest of the operational airfield. Each tower is approximately 65 m high, which facilitates unobstructed line of vision to the runways. The resulting vision angle is in line with international best practice and exceeds minimum ICAO requirements.

5-6-3 Fuel Farm

The fuel farm has been situated in the southeast of the airport in safe distance from operational areas. Its location next to the “Medway Approach” offers the opportunity for fuel deliveries by ship.

5-6-4 Airport Rescue and Fire Fighting

The airport fire stations have to be located in a way that enables the firefighting services to respond to any incident on the airfield within 2 minutes. By determining possible driving distances, a number of 3 stations is required to cover all operational areas. The main stations are located centrally to the runways, near the ATC towers. A third station is located in the west to cover the cargo area.

5-6-5 Ground Support Equipment

Areas for Ground Support Equipment (GSE) parking, workshops and storage need to be distributed across the airfield. The main GSE bases are situated in the central support areas near the fire stations and ATC towers. Further GSE areas have been planned in the western part near the terminals and in the east in the vicinity of the maintenance campuses, which can be expanded during each development phase.

Further GSE parking and staging areas are available at each apron and within the cargo area.

5-6-6 Aircraft Maintenance

The number of based airlines and other airlines operating at Thames Hub requires extensive aircraft maintenance facilities. An area of 300 ha has been safeguarded for in the eastern part of the airfield. It is envisaged that the hangars, related aprons, workshops and support buildings will be developed by the airlines themselves and by third parties.

Each of the two campuses has direct taxiway access to the runways and the other operational areas of the airfield for ease of taxiing or towing to and from the terminal areas. Landside access is provided through a main road parallel to the eastern perimeter road.

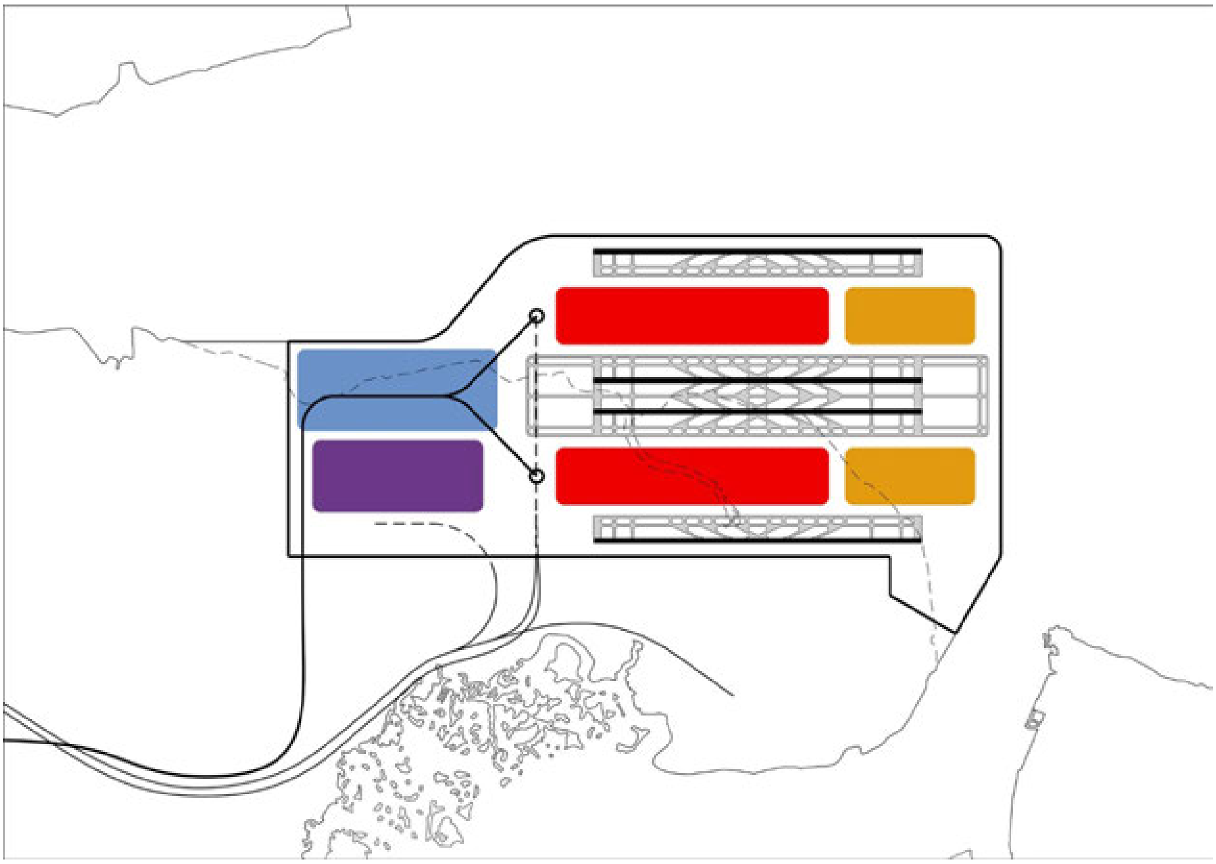

Figure 5-9