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Development and Assessment of Airport Capacity Options

Long Term Options: Approach and Assumptions

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1. INTRODUCTION

A consortium of consultancies was appointed by the Airports Commission ("the Commission"), through a contract with Jacobs, to support and advise the Commission in its consideration of potential options for the provision of airport capacity. This report sets out the approach and key assumptions adopted in the preparation of advice relating to the long term options.

This report considers the approach taken in the assessment of the long term options. The approach taken in the assessment of short term options is reported separately.

Nature of Output

The output to the Commission was presented in a series of "templates", which presented the key data providing information to the Commission in support of its sifting process and decision making. These templates increased in detail as the Commission proceeded through its sifting process and the number of schemes remaining under consideration reduced and the extent of information required to inform subsequent sifts increased.

Templates were produced for three principal option concepts:

- options submitted to the Commission by promoters of schemes for the provision of capacity at new or existing airports in response to the Commission's Guidance Document 01: Submitting evidence and proposals to the Airports Commission, February 2013;
- similarly, submissions made to the Commission but proposing alternative solutions to additional airport capacity; and
- proposals for additional capacity, generated by the Airports Commission, which were not reflected in received submissions.

In each case the templates reflected the sift criteria set out in the Commission's Guidance Document 02: Long Term Capacity Options: Sift Criteria, May 2013. This report is structured to follow the outputs generated enabling the reader to understand within each category of assessment the general approach adopted and the key assumptions made.

The first sift stage (Sift Stage 1), generated short, maximum two-page templates, summarising the key aspects of the proposals. Sift Stage 2 generated longer templates of the options that remained under consideration. Sift Stage 3 generated similar templates that considered the remaining options with more detailed analysis, where possible, of key aspects of the proposal.

As a consequence of the process and as appropriate for this phase of study the assessments were undertaken at a reasonably high level without, in many cases, firm data upon which to base detailed analyses. Therefore, whilst assessments were based upon rigorous analysis when possible, necessarily in other instances they relied upon the exercise of appropriate professional judgement taking due account of the uncertainty of data and the potential for differing interpretations.

Consideration of Submissions to the Commission

Proposals for long term capacity options were received by the Commission in July 2013. These were reviewed and clarification questions/requests for further information raised with the proposers through July and August 2013. Responses were received through August and September 2013. The original submission and any subsequent additions/clarifications formed the base material for our assessment.

2. ECONOMY

Impact on Industry

A strategic assessment of the high level impact of the proposal was made considering the capacity that would be provided, whether it would be adequate to meet forecast demand and what the summary impacts would be on airports, airlines and passengers, and any other strategic impacts (e.g. closure of airport enabling site redevelopment).

Impact on airports

A strategic assessment was made of the effect of the proposal on airport demand, including the effects on other airports, and the overall impact on capacity and competition between airports. This included a strategic market analysis of the response of airlines to the new capacity.

Impact on airlines

A professional market assessment of what types of airlines (by market segment) and what types of airline services would benefit from, or be relatively disadvantaged by, the proposal (either from capacity changes or consequential impacts on other airports) was made. Airline behaviour was qualitatively assessed (as to the effects on routes and frequencies by market segment). This also included a regulatory competition assessment of the impacts of the proposal on competition between airports, and what this would mean for airlines by market segment. A strategic assessment of whether the proposal would contribute towards improved resilience and reduced delay was also made.

Impact on passengers

The key impacts on consumers assessed were: the extent to which the proposal would facilitate market demand for more flights (and the likely market profile of those flights, based on professional judgment of airline preferences); and how passengers would be affected by the surface access dimensions of the proposal (e.g. increased or reduced travel times). The geographical catchments of the affected passengers were indicated with a high level assessment of those likely to benefit or disbenefit from the proposal.

Local and Regional economic impacts

The borough and county where the proposal was located was identified, along with the adjacent boroughs, and if relevant, the immediately neighbouring counties. Unemployment and average salary data for the boroughs where the airport proposal was located, and the immediate neighbouring borough, were sourced from National Online Manpower Information System (NOMIS, Office of National Statistics). GVA data by county were also sourced from the Office of National Statistics. These data were used to assess the economic characteristics of the location of the proposal and the extent to which the proposal would contribute towards economic development in a location with below average levels of economic activity. Professional judgment was used to assess the scale of impacts of the proposal on local businesses, based on the likely additional demand catalysed by the airport proposal. The effects on existing employment were assessed, based on the analysis of surface access impacts and travel times. Promoters' claims of generated employment were assessed against evidence from a range of studies around the impact of airports on local employment, to determine their high level credibility.

National economic impacts

A professional assessment of the extent to which the proposal would facilitate increased connectivity and meet expected long term demand was undertaken, taking into account likely market demand from airlines likely to use the airport (including their market profiles and network strategies) and the relative impact of surface access costs upon users.

3. SURFACE ACCESS

The assessments for Sift Stage 1 were principally based upon a qualitative assessment of the proposed options and a critical appraisal of the comments, proposals and, when available, submitted supporting evidence provided by the individual promoters including responses to questions. Sift Stages 2 and 3 were based upon a more detailed, quantitative assessment that followed a number of key steps:

- estimation of hourly passengers from the forecast annual demand;
- selection of the appropriate modals splits for surface journeys; and
- treatment of employee journeys; leading to
- determination of total surface passenger and employee trips; enabling
- assessment of the impact of this demand on the capacity of the road and rail networks.

The quantitative analysis was undertaken in 2031 against transport networks likely to be in place at that time.

The following sections consider each of these stages in turn.

Passenger mppa to passenger hourly flows

The key input was the projected passenger demand, expressed as million passengers per annum (mppa), at each airport. This analysis used the same forecast dataset as described below for the noise and cost analyses.[1]

Interlining passengers were extracted to generate only passengers leaving the airport, being of interest to surface access trips. Current interlining percentages were used for the existing airports and the current Heathrow percentage was used for the Stansted hub option and the Inner Estuary hub option. The output from this stage was numbers of annual arriving and departing passengers. The annual total passengers were split into arriving and departing passengers: a simple 0.5 factor was used.

Surface access capacity analysis needs to be undertaken on an hourly rather than an annual basis, thus the next step was to convert the annual arriving and departing passengers to hourly flows, by direction. This involved a number of stages as follows:

- converting annual flows to peak daily flows: we assumed a factor of 0.003125 (1⁄320) based upon current Heathrow data;
- converting peak daily flows to peak hour flows to and from the airport. From an analysis of current passenger arrive and depart profiles at Heathrow, we identified the peak hour as 07.00-08.00, during which 8% of the daily passengers depart from the airport and 6% of the daily passengers arrive at the airport. We used this daily profile for all existing airports. For the Stansted hub option and the Inner Estuary hub option we assumed a slightly flatter profile of 7% arriving and 7% departing, due to the likelihood of less restrictive night/early morning flight restrictions and a more even distribution of passengers throughout the day. We adjusted travel patterns with respect to the hour of the flight: for airport arrivals we estimated that they leave the airport an hour later and for departing passengers we estimated they arrive two hours beforehand.

The output from this stage was peak hour passenger trips to/from the airport.

[1] The forecasts of demand for each of the Sift Stage 3 options were based upon two demand forecasts, provided by the Commission, of carbon-capped but capacity constrained and carbon-capped but capacity unconstrained to 2050 within the London system. Additional capacity at Heathrow and the new hub options was assumed to capture 100% of the lost system demand (i.e. the difference between the constrained and unconstrained system forecasts). As working assumptions, Gatwick was assumed to similarly capture 80% of the lost system demand and Stansted 70%. Where an option caused a reduction or closure of another airport it was assumed to capture the displaced demand over a five year period post opening.

Passenger mode split

A key aspect of the methodology was the assumed future mode share of surface access passenger (and employee trips). Of interest was the main mode split between car/taxi and public transport and the public transport sub-mode split between rail and bus/coach.

This information was available for each existing airport and was analysed. Each option proposer also provided their prediction of the mode share for their proposal and in each case predicted a significant increase in the public transport mode shares (particularly rail). Where appropriate certain assumptions by promoters were queried and written responses justifying the future year mode share assumptions received.

For each option, we reviewed the responses from the proposer and assessed how likely the predicted increases in rail mode share would be, given the improvements to rail services to the airport (which consisted of both new rail lines and improved services and frequencies on existing rail lines). Independent professional judgement led to the determined future mode shares that we felt were realistic.

In the case of the new Stansted and Inner Estuary hub airports, we followed the same process of challenging the promoter's assumptions and using our own professional judgement to determine future mode shares that we felt were realistic. In this case, we also benchmarked the forecasts against examples around the world (Europe and Asia).

The output from this stage was hourly passenger trips to/from each airport, split into three modes: car/taxi; rail and bus/coach. Car trips had to be weighted by an occupancy factor to output cars/vehicles rather than car passengers. Based on current Heathrow data, a factor of 1.6 was applied.

Surface distribution of passenger trips

Using 2012 Civil Aviation Authority passenger origin data at each existing airport we determined the geographic distribution of surface access passenger trips at a regional level (with 11 regions defined). Within the London and the South East Region, we used a finer level of detail provided at the Local Authority level (with 20 zones defined). Thus we defined a zone system of 30 zones (20 London and South East zones and 10 regional).

We assumed that this spatial distribution of surface access trips for each existing airport would remain constant over time and applied the zone factors to the future year peak hour passenger trips.

For the new hub airports at Stansted and the Inner Estuary, we used a coarser zone system for the distribution of passenger trips.

In order to allow for higher public transport use for passengers departing and heading for London, a 50% increase was applied to the weighting for London public transport trips and a 50% deduction was applied to the weighting for London road trips, with other destinations increased/decreased to reflect that change.

The output at this stage was hourly passenger flows to/from each airport, split by mode and by geographic distribution.

Employee numbers to employee hourly flows

Employee estimates were generally provided by each of the promoters. Where they were not, we made our own estimates based upon the ratio of employees to mppa at existing airports, with some allowance for the assumed greater employee efficiencies at a new hub airport, compared to existing airports.

Not all employees work each day, so we used current Heathrow data (being data more readily available and considered reasonably reflective of airports of the potential scale being considered) to estimate the percentage (57%) of total workforce working on a particular day.

As above, the surface access capacity analysis needs to be undertaken on an hourly rather than an annual basis, thus the next step was to convert the daily employee trips to hourly employee flows, by direction. From an analysis of current passenger and employee arrive and depart profiles at Stansted (being data more readily available), the peak hour for both passengers and employees was 07.00-08.00. The employee peak hour factors during this hour were assumed to be 12% arriving at and 1% leaving. These factors were used across all airports to convert the daily employees to peak hourly flows of employees arriving at/leaving the airport.

The output from this stage was peak hour employee flows to/from the airport.

Employee mode split

Information on employee mode split was fairly sparse for most of the existing airports. The information that was available was collated and analysed. Each option promoter also predicted what these mode shares would be in the future and in most cases predicted a significant increase in the public transport mode shares (particularly rail). Where appropriate certain assumptions by promoters were queried and written responses justifying the future year mode share assumptions received.

For each proposed option, we reviewed the responses from the promoters and assessed how likely the predicted increases in rail mode share would be, given the improvements to rail services to the airport (which consisted of both new rail lines and improved services and frequencies on existing rail lines). Independent professional judgement led to the determined future mode shares that we felt were realistic.

In the case of the new Stansted and Inner Estuary hub airports, we followed the same process of critically reviewing the promoter's assumption and using our own professional judgement to determine future mode shares that we felt were more realistic than the very high employee mode shares assumed.

The output from this stage was hourly employee trips to/from the airport, split into three modes: car/taxi; rail and bus/coach. Car trips had further to be weighted by an occupancy factor, to output car/vehicles, rather than car passengers. Based upon current data at the existing airports, and some assumption for greater employee car sharing (part of the demand managements measures cited) a factor of 1.2 was applied.

Surface distribution of employee trips

Data were available for each of the existing airports of the geographical distribution of employees. We analysed these data and created a bespoke zone system for each airport (as employee trips tended to be localised around each airport), and distributed the employee trips to this zone system.

We assumed that this spatial distribution of employee trips for each existing airport would remain constant over time and applied the zone factors to the future year peak hour passenger trips.

For the new hub airports at Stansted and the Inner Estuary, we used information provided by the promoters and our own professional judgement to determine the distribution of employee trips.

The output at this stage was hourly employee flows to/from each airport, split by mode and by geographic distribution.

Total passenger and employee trips

We combined the outputs of the surface distribution of passenger trips and surface distribution of employee trips described above, to form a model of total peak hour trips, spilt by direction, by mode (car and rail) and spatial distribution.

As described below, the total airport-related rail trips were manually assigned to the rail network to determine their impact on rail services, and the additional airport-related car trips (i.e. the car trips due to the increasing size of the airport not the total airport-related car trips) were manually assigned to the strategic road network. Note that the airport-related bus/coach trips were not assigned.

Impact of passenger and employee rail flows on the rail network

As stated above, the total airport-related rail trips were manually assigned to the rail network to determine their impact on rail services. The rail services were defined from information provided by the promoters, the Rail Utilisation Study (RUS) which provides line capacity predictions for each line into London, and discussions with Network Rail regarding train frequencies, available train paths and train capacities.

For each airport, the model of airport-related rail trips, by geographic location was taken, and the trips were manually assigned using our professional judgement to each rail service to/from that airport depending on their destination. For some trips (e.g. Heathrow to Central London) we used our professional judgement to split the trips between the competing services (e.g. Crossrail, underground, HEX). At a later phase, a logit model could be developed to undertake this sub-mode split in more detail taking into account journey times, fare and frequency, but at this stage our professional judgement sufficed, given the lack of detail available for potential fares and journey times.

We collated the number of airport-related rail trips per hour on each rail service and compared these to the capacities (derived from the number of train services per hour and train capacities). For services that were totally dedicated to airport-related demand (e.g. HEX) we were able to compare the demand against the capacity and make recommendations as to whether there was adequate capacity. However, the majority of the services cater for both airport-related and non-airport related demand. In these cases we were able to identify the percentage of capacity that would be utilised by airport related demand and use our professional judgement to determine whether there may be sufficient capacity on these services for the airport-related demand, given the expected level of non-airport-related demand.

This type of analysis is more robust at the corridor level, where the demand on individual services can be brought together and our assumptions on which airport-related demand uses which service are less critical. However, we were able to make some critical recommendations on individual service capacities, which could be further assessed at a later phase.

Impact of passenger and employee highway flows on the highway network

As stated above, the additional airport-related car trips (i.e. the car trips due to the increasing size of the airport not the total airport-related car trips) were manually assigned to the strategic road network.

The strategic road network was defined as the motorway network around London (M25, M11, M1, M4, M3, M23, M2, and M20) and other strategic roads affected by the airports (A1M, A23, A2, A4 A289 and A120). In total 182 links (sections of roads between junctions) were defined.

For each of these links, 2012 annual average daily traffic flows were extracted from DfT Traffic count web tool. Background growth between 2012 and 2031 was calculated using the Dft's Trip End Model Presentation Program software (calculated as 31%), giving predicted background flows on each strategic link in 2031.

The current capacity of each link was calculated and the committed roads improvement programme interrogated to determine the capacity of each strategic link in 2031. Daily flows and capacities were converted to hourly flows and capacities assuming a factor (8%) derived to convert the daily flows and capacities to peak hour (7am-8am: the period over which the analysis was focussed) flows and capacities.

By comparing the predicted traffic demand and the capacity on each link, we were able to identify any sections of road network over capacity due to general traffic patterns, not due to airport growth.

The additional airport-related car peak hours trips (by direction, by geographic area) were manually assigned to the strategic road network. For most trips, this was straight forward as their routing on the strategic road network was obvious. For a few, less obvious, trip patterns professional judgement was used to determine trip (for example which way round the M25 a trip from Gatwick to Bedford would use).

The flows including these additional airport related trips were then compared to the capacities on each strategic link to determine which links required additional capacity due to the expansion of the airport. Only link capacities were assessed, junction capacities would require assessment at a later phase.

4. ENVIRONMENT AND PEOPLE

In a similar fashion to the surface access assessment described above, the environment and people assessments for Sift Stage 1, generating the shorter, high-level templates, were principally based upon a qualitative assessment of the proposed schemes, a critical appraisal of the comments, proposals and, when available, submitted supporting evidence provided by the individual promoters including responses to questions. Sift Stages 2 and 3, generating the longer templates, were based upon a more detailed, quantitative assessment across the parameters set out within the Commission's Environment and People sift criteria.

The analysis providing the basis for the templates included:

- review of proposer submissions and responses to questions;
- compilation of available data on designations and other key environmental constraints though GIS mapping and using GIS based data analysis;
- compilation of population, social, health and quality of life indicators using GIS based data analysis; and
- independent noise modelling for a range of noise contours using 2012 and forecast 2030 populations.

The review was undertaken with reference to the Commission's sift criteria with the aim of providing key relevant information to assist in comparing environmental and social negative and positive impacts for the different options.

Spatial Environmental Constraints

Airport Outlines

Geographical Information system (GIS) software was used to compile environmental constraints within and around the airport footprints. The outlines for each airport included existing airport infrastructure and were based on either the proposer's footprint provided or, in the absence of such a defined boundary, as independently generated to include the key essential airport infrastructure.

The airport outlines were mapped using the GIS software. In addition to the airport outlines, buffer areas around the airport were also generated for distances of 2km, 5km and 10km around each airport. This provided the basis for analysis of information within the airport footprint or within the areas around the airport as relevant for the issue under consideration.

Environmental Designations

Designations data were sourced in GIS compatible format so that the data could be analysed for overlap with and proximity to the proposed airport options. Designations included European Sites and UK national nature conservation, landscape and cultural heritage designations. In addition flood risk zones and agricultural land classification areas were mapped. A full list of data sets and sources is provided in Table 1.

Table 1: List of data sets and sources

Data Set	Source	Date
Special Area of Conservation (SAC)	Natural England	September 2013
Ramsar	Natural England	September 2013
Special Protection Area (SPA)	Natural England	September 2013
World Heritage Site	English Heritage	September 2013
SSSI	Natural England	September 2013
Listed building	English Heritage	September 2013
Scheduled monument	English Heritage	September 2013
Flood Zone 2	Environment Agency	June 2012
Flood Zone 3	Environment Agency	June 2012
National Nature Reserve (NNR)	Natural England	September 2013
Area of Outstanding Natural Beauty (AONB)	Natural England	September 2013
National Park	Natural England	September 2013
Registered Park and Garden	English Heritage	September 2013
Local Nature Reserve (LNR)	Natural England	September 2013
Ancient Woodland	Natural England	September 2013
Agricultural Land Classification (ALC)	Natural England	1976
Critical Infrastructure	OS Address Base Plus	2013
Conservation Area	Local District Websites	2013
Air Quality Management Area (AQMA)	Defra	2013
Index of Multiple Deprivation (IMD)	GOV.UK Government Publications	2013
Residential Properties	OS Address Base Plus	2010
Resident Population	OS Address Base Plus and Office of National Statistics (ONS) data	2013

GIS tools were used to select designations that a) intersected the airport options and b) were within a distance 2km of the airport options. Where airport options resulted in a direct overlap with an environmental designation, the area of intersection was calculated and the percentage of the site option covered by the designation was derived.

Additional information collected included Conservation Areas and checked Greenbelt information from relevant Local Authority documents for the airport footprints and immediate vicinity. These were not available as layers for GIS mapping.

For the designation impacts reported in the templates we have provided the number of sites, area or proportion within the airport footprint to indicate direct loss. Where it was clear that a designated site related to an existing airport area (and has so far been unaffected) it has been presumed that the site would be unaffected by further expansion, we have adjusted the figures accordingly. Key sites located near the airport outline that might be affected were also identified and reported.

Mitigation Costs

Specific mitigation requirements that were considered significant included:

- high loss of flood plain likely to require compensation storage was required (1 in 100 year flood outline);
- loss of drinking water storage reservoirs;
- major obstruction to flood conveyance; and
- compensation habitat recreation for direct loss to European Site (Natura 2000 site).

Likely mitigation costs were based on a review of comparable examples and included within the independent cost assessment as discussed below.

Habitats Regulations Assessment Issues

Key points from a review of the potential issues relating to compliance with Habitats Regulations were provided based on our experience of Habitats Regulations Assessment and recent case history.

Population and Socio-Economic Analyses

Residential properties were filtered from Ordnance Survey Address Base Plus product (OSABP). A count of residential properties was generated for direct overlap with the airport outline boundary and for a 2km buffer of the site option. The property numbers within the airport footprint gave an approximation of the numbers of residential properties that might need to be demolished. The data used identifies each registered address as a separate property. It was recognised that the figures might be different to the numbers provided by proposers. Proposals did not specify how proposers had derived their figures but variance could be due to e.g. use of localised street surveys at differing levels of detail and/or accounting for properties close to existing infrastructure. However, for our Sift Stage 3 assessment, the use of the airport outlines and the OSABP address base data provided a consistent approach for estimating potential numbers of properties demolished for the different options and was considered appropriate at this stage for comparative purposes, although the numbers should not be considered definitive. Due to limited detailed data, and again for comparative and indicative purposes, the resident population was also derived from this data source by multiplying the number of residential properties by 2.4 (national statistic on residents per household from the 2011 census[2]).

Dependent on location, the people with protected characteristics (PPCs), as defined by the Equality Act 2010, may be differentially affected (i.e. affected more than people without these characteristics) by airport development, particularly in terms of key local environmental impacts of noise and air quality. In our current assessment this has been referenced under 'vulnerable groups' by proxy use of statistics from the Index of Multiple Deprivation (IMD), which indicates the potential for differential impacts in terms of equality. IMD data were downloaded in tabular format for all Lower Super Output Areas (LSOA is an administrative geography of areas smaller than local districts from 2004). The data provided a relative measure of deprivation at a small area scale across England. This information was joined to a GIS file of area polygons so that it could be analysed spatially. An average IMD score was calculated, based on LSOAs that fell within the 2km, 5km and 10km distance buffers of each site option. IMD is broken down into several domains and the following were analysed:

- Overall (a combined index of overall deprivation);
- Income;
- Employment;
- Health, Deprivation and Disability;
- Education, Skills and Training;

[2] http://www.ons.gov.uk/ons/rel/census/2011-census/population-estimates-by-five-year-age-bands--and-household-estimates--for-local-authorities-in-the-united-kingdom/rft-table-h01uk.xls

- Barriers to Housing and Services;
- Crime; and
- Living Environment.

The overall index incorporating all domains averaged over the 5km distance around the airport option was reported in the template. Population around the airport data and IMD index were provided as indicators for people whose quality of life might be affected and potential for vulnerable groups to be affected (positively or negatively).

Noise Modelling

Noise modelling was undertaken at a high level during Sift Stage 2 and in more detail during Sift Stage 3. This was required as the noise information provided by proposers for the various submitted options varied both in extent and derivation. As the aim of each sift stage was to compare the options, a common approach to the modelling was taken subject to taking into account the details of the individual options as indicated by the proposers. The modelling therefore differs to some degree from that conducted by the proposers of the options (e.g. the aircraft fleet mix assumed and in some cases in the modelling software used). Whilst the differences in approach and assumptions will result in some differences in the modelled outputs, they are not considered significant in the comparative exercise being undertaken. A summary of the noise modelling approach is given below.

Noise contours were prepared for 2030 based on the latest version of the FAA Integrated Noise Model (INM). For all the noise contours an assessment was made of the population they would contain in 2030. This used a data-base of population by postcode generated for 2030, by applying the forecast change by ward to a population by postcode database for 2012 derived by census data from CACI Ltd.

2030 populations within the following noise contours were calculated: 57 dBA $L_{eq,16h}$, 55 dBA L_{den}, and 50 dBA L_{night}. The population for each option within the 57 dBA $L_{eq,16h}$ contour for 2030 but currently not within the corresponding 2012 contour was also calculated.

The N70 metric was also calculated as this has been found to be a useful metric for improved communication of noise impacts (particularly to a non-technical audience). It is based on the contour for a given number of events (the contour for 50 events is reported) at an outdoor maximum noise level (L_{max}) of 70 dBA or more.

The approach taken and the general and airport specific modelling assumptions discussed below were considered to provide a reasonable indicative and comparative approach appropriate for the Sift Stage 3 assessment.

For the Sift Stage 3 assessment, assumptions were made to allow noise modelling of the schemes in relation to:

- aircraft movements and mix;
- general airport operations; and
- option specific operations.

Aircraft Movements and Mix

The analysis used the same demand forecasts as discussed above for use within the surface access assessment. The 2030 forecast demand of aircraft movements (ATMs) and annual passengers specific to each option was used. To obtain a set of aircraft movements by type for modelling purposes, the activity at Heathrow Airport in 2011 was used (480,906 ATMs and 69,433,230 passengers) as a basis as it provided a model of a UK hub operation.

Firstly the 2011 Heathrow Airport aircraft mix was extracted and combined with information on published seating capacities and the total passengers to determine representative load factors. The

current Heathrow mix was then revised to allow for fleet modernisation by 2030. This included the replacement of many of the current aircraft with their re-engined replacements or upgrades. For example, the Airbus A320 was replaced by the Airbus A320neo, and the British Airways Boeing 747 fleet was retired. This led to the introduction of the Airbus A350, the Boeing 787, and increased movements by the Airbus A380.

With this updated fleet mix, revisions were then made (using information on seating capacities and the load factors determined previously) against the forecasts of annual traffic movements and annual passengers. In particular the average number of passengers per aircraft was determined from the forecasts. These fell into two groups, a figure of 164 passengers for the Heathrow and Hoo Peninsular options, and a figure of around 150 passengers for the Gatwick and both Stansted schemes. If the Stansted +4 scheme were to operate with similar loadings to Heathrow and Hoo peninsular options, this would result in fewer ATMs with a slightly different fleet mix. The decision was therefore taken at this stage of the assessment to be guided by demand data supplied and to apply a consistent approach to passenger loadings and fleet mix derivation.

Consequently for 2030 two aircraft mixes have been used; one for the Heathrow and Hoo Peninsular schemes which has a greater proportion of larger aircraft, and one for the Gatwick and both Stansted schemes which have a greater proportion of single aisle aircraft such as those used by the low cost airlines. The resulting mix for the Heathrow and Hoo Peninsular schemes and that for the other schemes at Stansted +4 and +1 and Gatwick is given in Table 2.

Table 2: Fleet mix assumptions

Aircraft Type	Proportion of Mix (%) for Heathrow and Hoo Peninsular	Proportion of Mix (%) Stansted and Gatwick
Airbus A319neo	15%	15%
Airbus A320neo	30%	20%
Airbus A321neo	12%	10%
Boeing B737 Max 8	5%	30%
Boeing B787	15%	10%
Boeing B777	10%	7%
Airbus A350	8%	5%
Airbus 380	5%	3%

The assessments therefore reflect the demand forecasts which indicate a difference in the forecast activity at some of the schemes. Once specific potential developments have been identified it would be possible to conduct sensitivity tests on the noise impacts resulting from them which could consider likely variations in the fleet mix (for example to reflect demand responses to economic conditions or new aircraft delivery schedules).

General Airport Operation Assumptions

For each of the schemes the assumed method of operation includes the following key elements:

- arrival and departure routes are initially straight;
- no dispersion from the arrival and departure routes;
- 70% of the activity, split equally by type and operation, occurs during the day period (7am – 7pm);
- 20% of the activity, split equally by type and operation, occurs during the evening period (7pm –

11pm);

- 10% of the activity, split equally by type and operation, occurs during the night period (11pm – 7am); and
- the activity is spread evenly across the year;

Option Specific Operation Assumptions

Whilst many of the assumptions made during the noise modelling were common for all schemes, some details differed to reflect the individual options. These included, in the case of the Heathrow Airport options, to allowing for displaced landing thresholds and steeper approaches, at 3.2 degrees as opposed to 3 degrees used today.

The steeper approaches were used for the Heathrow options to reflect specific proposals as set out by proposers and to allow consistent comparisons between the Heathrow options, however it was considered that this approach would not significantly affect comparisons with other schemes.

The runway displacements indicated for each scheme were used to reflect current practice to operate with some landing threshold displacement and proposer comments to use this in future.

The effect of these measures is to reduce to some extent the noise impact assessed from the Heathrow schemes but it is not considered significant in the context of the comparative exercise being undertaken. For example the daytime noise from the Heathrow North West option has been reassessed with the approaches at 3 degrees and the change in the 57 dBA $L_{eq,16h}$ contour is an increase in contour area from 72.0km^2 to 73.9km^2 (2.63%) and an increase in population exposed from 142,600 to 147,000 (3.08%).

The key assumptions made were:

- For all of the Heathrow options we assumed the following:
  - 77% of the arrivals are from the east and 77% of the departures are to the west (this reflects the 1992-2011 Summer average at the airport as reported by ERCD); and
  - steeper approaches are used. Specifically, aircraft have been assumed to approach at 3.2° compared to 3° currently.
- Heathrow North West: the retained current runways 27L and 27R and the proposed runway have displaced landing thresholds of 300m added; these are similar to the existing landing thresholds on runways 09L and 09R.
- Heathrow South West: the retained current runways 27L and 27R and the proposed runway have displaced landing thresholds of 300m added; these are similar to the existing landing thresholds on runways 09L and 09R.
- Heathrow 4 Runways: the retained current runways 27L and 27R and the proposed runways have displaced landing thresholds of 300m added; these are similar to the existing landing thresholds on runways 09L and 09R.
- Heathrow Hub – Northern Runway: This was based upon the Heathrow Hub proposal but with only the existing northern runway extended to the west (similar to Phase 1 of the proposal). The proposed early morning noise reducing operations in the submission have been developed so that at night all the operations are on the extension of the northern runway. The retained current runways 27L has a displaced landing threshold of 300m added; this is similar to the existing landing threshold on runway 09R which is retained.
- Gatwick 2 Runways: 73% of the arrivals are from the east and 73% of the departures are to the west (the 1992¬2011 Summer average at the airport as reported by ERCD). The new runway has displaced landing thresholds of 400m added; these are similar to the existing landing thresholds on the main current runway.
- Stansted+1 (2 Runways): 71% of the arrivals are from the east and 71% of the departures are to the

west (the 1992¬2011 Summer average at the airport as reported by ERCD). The existing displaced landing threshold on runway 04L of around 300m has been retained.

- Stansted+4 (5 Runways): 71% of the arrivals are from the east and 71% of the departures are to the west (the 1992¬2011 Summer average at the airport as reported by ERCD). The existing displaced landing threshold on runway 04L of around 300m has been retained. It has been assumed that by 2030 only 3 of the new runways will have been built, and specifically that the eastern most of the new runways is not present.
- Isle of Grain: 75% of the arrivals are from the east and 75% of the departures are to the west (based on the activity over the last 20 years at Heathrow and Gatwick Airports which have similar runway alignments).

5. COST

In a similar fashion to previous sections, the assessment of cost developed through the sift stages from a qualitative consideration of the promoter's cost estimates to the production of independent cost estimates.

In each sift stage a similar process was followed using the outline approach and data sources discussed below. In Sift Stages 1 and 2 the approach enabled comment on the promoter's estimates, based upon the scale of the development as proposed. In Sift Stage 3 specifically, based upon the submitted proposal, but as interpreted to deliver the infrastructure required to serve the forecast demand[3], independent cost estimate for 2030 and 2050 were derived.

The components of the cost were categorised into three key elements:

- on-site works relating to the development of the airport including on-site surface access works;
- off-site surface access works as determined from the analysis discussed above;
- other scheme specific costs necessarily required as part of the scheme but not ordinarily part of either the airport or surface access works; and
- appropriate allocation for risk.

Given the high-level nature of the technical submissions to the Commission, for all schemes it was necessary to apply engineering judgement to develop information to define the full scope of works to a consistent level to enable the costing assessment. Given the high level nature of the provided information appropriate risk allocations were made for unknown details of the identified works and for unknown, but necessary other elements as discussed below.

For the schemes prepared on behalf of the Commission, and not the subject of public submission, high level layout plans were produced using principals taken from CAA CAP 168, ICAO Annex 14, IATA Airport Development Reference Manual and other relevant design guides. In a similar fashion, for the Sift Stage 3 assessment of an Isle of Grain airport, elements of all relevant submissions were considered to generate an independent scheme for the purposes of analysis.

The cost estimates were undertaken based upon 2013 costs. When reporting the order of magnitude costs, they were split into three categories: airport, surface access and other. Each of the components contributing to these categories are summarised in the table below. The table also identifies the source upon which the cost estimates were based.

[3] The Sift Stage 3 cost estimates are thus related to our assessment of the infrastructure required to serve the forecast demand, limited by the maximum runway capacity of the proposed scheme. The cost estimates therefore may not reflect the cost to construct infrastructure to serve the theoretical scheme maximum capacity in cases where the forecast is below theoretical capacity in 2030 or 2050.

Table 3: Cost Component and Source Data

Component	Component Content	Cost Information Source
Category 1 – Airport		
Land Acquisition	Assumed that the airport was developed on either Development Land, Residential Land, Agricultural Land or Land Reclamation in the Thames Estuary. Classification of land was by visual inspection of satellite imagery.	The Valuation Office Agency Property Market Report 2011, adjusted to 2013 prices.
Ground Enabling Works	Preparation of land including drainage and fill required for land reclamation.	SPONS Architect and Builders Price Book 2013.
Airfield Infrastructure	Construction of runways, taxiways, aprons, AGL, navigational aids and other hard standing infrastructure. Quantities derived from scaled submission drawings or where layouts were not provided, high level plans were produced using principals taken from CAA CAP 168 and ICAO Annex 14 Volume 1.	Comparative recent projects and published pricing references.
Terminal Infrastructure	Terminal Buildings and Baggage Systems. Terminal requirements were based upon capacity information provided within the submissions, independent assessment and guidance from IATA Airport Development Reference Manual, FAA circular:150/5360-13 and "Planning and Design of Airports" by Robert Horonjeff et al.	Costing information from SPONS Architect and Builders Price Book 2013 and comparative recent projects.
Car Parking and Airside/Landside Road network	The size and scope of car parking was derived from submissions and existing airport car parking capacity studies. Airside and local Landside road networks quantities were based on comparative studies of existing airports.	Comparative recent projects and published pricing references.
Operational Ancillary buildings	Aircraft maintenance buildings, hangers, security offices, fire stations, fire training areas, airside fencing, police stations, border protection and other facilities essential to the operations of the airport.	Engineering judgement and cost using SPONS Architect and Builders Price Book 2013.
Air Traffic Control	Engineering judgement was used to determine the requirements for ATC infrastructure. Costing was used based upon complete new provision and in some schemes where existing infrastructure was present, a scale factor was applied.	Comparative recent projects.
Aircraft Fuel	Engineering judgement was used to determine the requirements for aircraft fuelling infrastructure. Benchmarking was used based upon complete new provision and in some schemes where existing infrastructure was present, a scale factor was applied.	Comparative recent projects.
Utilities	Provision of gas, electricity, water and telephone service to the site commensurate with the site size. Limited information was available to determine specific requirements. Engineering judgement was used to determine a standard scope which was scaled if existing infrastructure is available.	Comparative recent projects.

Component	Component Content	Cost Information Source
Category 2 – Surface Access Requirements		
Road and Rail	Information was taken initially from submissions to the commission and latterly generated by the analysis described above.	SPONS Architect and Builders Price Book 2013, published comparative major scheme estimates and recent projects.
Category 3 – Other		
Environmental issues	Obvious issues such as reservoir replacement, river diversions and sea defences were assessed and a scope derived. In addition a cost allocation was adopted across all schemes based on a judgement of typical environmental works including flora and fauna, flood assessment, off site drainage, off site habitat protection and replacement, noise related issues, environmental management etc.	Comparative recent projects

Fees, Risk and Optimism Bias

Within each of the categories stated above, a 15% allowance was included for professional fees during planning, design and construction. For the purposes of the commercial assessment it was assumed that this would be distributed 10% for upfront planning, environmental and design fees, and 5% during construction.

Risk allocations were made as follows:

- 40% risk/contingency allocation to the base total cost (of airport, access and other costs); and
- 50% optimism bias applied to the risk-adjusted cost.

These allocations sought to address two parameters of unknown:

- the unknown engineering detail of the identified works which would be expected to lead to an under estimate of the cost although the scope may be reasonably defined; and
- the unknown scope of all necessary works, including all off-site works, which could extend significantly throughout the transport and utility networks, to deliver the fully operational scheme.

6. OPERATION VIABILITY

In a similar fashion to the above, the assessment of operational viability of the schemes was based upon a qualitative consideration of the parameters of the proposal relating to:

- resilience, reliability and efficiency;
- safety; and
- potential for future scalability.

The consideration of capacity, and therefore of airspace issues, was more qualitative in nature noting the high level nature of the assessment and that no modelling was undertaken of either ground based infrastructure or of airspace to confirm assumptions.

Capacity and Airspace

The templates present three key aspects of capacity:

- firstly, either the proposer's statement of potential maximum capacity, with comment in instances where we are concerned that it may be difficult to achieve, or our independent assessment when we found the claimed capacity to be so difficult to achieve as to be an unreliable basis for assessment;
- secondly, the net impact on the London system of the additional scheme specific capacity taking into account consequential impacts at other airports. This assessment was informed by the advice given to the Commission by NATS; and
- finally, based upon the foregoing estimated demand, the use of the maximum potential demand at the airport in 2030 and 2050.

The assumed capacities of existing airports, against which net capacities were reported, were as stated in Table 4:

Table 4: Assumed Airport Current Maximum Use Annual Capacities

Airport	ATM	Passenger (mppa)	Comment
Heathrow	480,000	90	ATM capacity as currently limited.
Luton	160,000	18	Based upon 2012 master plan. Could be expanded, but no expectation of additional capacity until the 2030's.
Stansted	275,000	40	Based upon anticipated maximum build-out of the single runway.
London City	100,000	7	Broadly in line with 2006 master plan. Could be expanded, but no expectation of additional capacity until the 2030's.
Gatwick	280,000	50	Based upon anticipated maximum build-out of the single runway.

Through own our assessment and informed by the advice of NATS to the Commission, the following schemes were assumed to have the following system impacts:

- single runway expansion at Heathrow and Gatwick: no reduction in capacity at other airports;
- single runway expansion at Stansted: 20% reduction in capacity at Luton;
- five runway development at Stansted: 80% reduction at Luton, 50% reduction at London City; and
- four runway development on the Isle of Grain: closure of London City.

In addition, within the non-Heathrow new hub options (five runway Stansted and Isle of Grain) Heathrow was assumed to close on commercial grounds irrespective of airspace constraints.

Future throughput at Stansted Airport was not considered within the demand forecast and therefore the impacts on Stansted of the proposals were not considered. The net effect is considered to be minimal.

The assessment of capacity of individual airport configurations was based upon the general assumption that a single runway has a capacity of around 250,000 ATM pa. Scheme specific adjustments to this general assumption were made to reflect the specific configuration or operational modes proposed by the specific promoter. In some submissions promoters stated a capacity below this theoretic maximum value reflecting their intention to mitigate noise impact or to improve resilience and efficiency of operations.

7. DELIVERY

As with other criteria above, the assessment of the commercial viability and delivery of the schemes was in Sift Stages 1 and 2 based upon a qualitative consideration of submissions. In Sift Stage 3 an independent assessment was made as discussed below and presented in the separate report to which reference should be made: High-Level Commercial/Financial Assessment of Selected Potential Schemes, December 2013.

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