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Appraisal Framework Module 14. Operational Efficiency: Ground-Infrastructure Heathrow Airport Extended Northern Runway

Airports Commission

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Executive Summary

This purpose of this document is to report on the analysis of the Heathrow Airport Extended Northern Runway scheme against the Operational Efficiency module of the Airports Commission's Appraisal Framework, April 2014.

The proposed Heathrow Airport Extended Northern Runway scheme including an additional runway, taxiways and new terminal is capable of being delivered as a fully safety and security compliant airport. The proposed scheme would provide capacity for substantially greater numbers of flights and passengers, and more cargo to be handled by the airport.

The concept of an in-line runway is unconventional, has never been used elsewhere and is not envisaged in international, EU or national regulatory instruments, standards or recommendations for safe design or operation. Furthermore, airline operations and insurance requirements do not contemplate this runway configuration. New regulations, recommendations and accepted industry practices, including flight crew training, will be needed to address the physical and operational parameters of this runway concept. This may introduce a time delay to operational opening, and there is a risk that unforeseen regulatory (and therefore potential planning and design) issues may arise. These could have implications for detailed design and costs, and the time periods required to resolve these issues are difficult to estimate.

The proposed additional runway would enable the airport to handle a c 46% increase in air transport movements per annum from the current cap of 480,000 to 700,000. Although a few pinch points in the taxiway network are likely to create congestion at peak times, overall the taxiway network would be able to support those additional movements. The proposed new T6 terminal and its satellite, along with phased expansion of T2 and associated satellites will enable the airport (along with utilisation of spare capacity at T5) to handle the proposed increase in passenger capacity, with a standard of passenger experience comparable to that currently experienced at the airport.

The expanded airport could be expected to meet a wide range of possible future fleet mix scenarios and airline business models, including Code F aircraft. The airport would be able to sustain minimum connection times of 60 to 70 minutes for transfer traffic between terminals. A tracked transit system would facilitate high capacity transfers between terminals and their satellites. While the airport proposed operating model is complex and may be subject to further refinement, it can be developed to meet the proposed demand. Although as with all airports, it becomes more challenging at peak times, the airport's overall resilience and reliability would be enhanced by the additional runway and associated taxiway and terminal infrastructure.

There is limited scope to expand terminal and stand capacity further on the proposed land area. Given the constrained site, additional runway capacity would likely require construction of another in-line runway to the west of the southern runway, or expansion to the southwest or the northwest. All such options are likely to be challenging given the presence of the reservoirs and motorways respectively.

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1 Introduction

1.1 Purpose

This document consists of the consolidated analysis of the Heathrow Airport Extended Northern Runway scheme (hereafter “the scheme” or “the proposal”). The analysis has been undertaken against the Operational Efficiency module of the Airports Commission’s Appraisal Framework, April 2014. It is the professional assessment of the key metrics, measures and judgments across the individual units within Operational Efficiency module.

It is structured to report specifically on:

- *Inputs*
- *Assumptions;*
- *Methodology;*
- *Description;*
- *Analysis; and*
- *Appraisal conclusions.*

It is not an economic, financial or commercial assessment of the scheme, but a technical assessment of the qualities of the scheme according to the specific units within the appraisal module. Key assumptions are made based on best available information of current and reasonably anticipated industry practice, but it should be understood that the judgments made in this document could change if significantly different modes of operation or regulatory conditions were implemented that constituted variations to the key assumptions.

Section 2 presents a general overview of the methodology adopted in the assessment. Section 3 provides a high-level overview of the proposed master plan, with Sections 4 to 8 presenting the detail of the assessment of each key component of the master plan from runway to terminal facilities. Each of these sections initially discusses the element of the proposed master plan before presenting the results of the assessment against the Appraisal Framework module unit as set out below. Section 9 comments upon the performance of the scheme with respect to the demand scenarios being considered by the Airports Commission.

1.2 Module 14: Operational Efficiency

The Operational Efficiency module is intended to assess how each proposal impacts on the capacity, safety, security, efficiency, reliability, resilience and scalability of the airport and the wider airport system. It is intended to provide an overall appraisal of what the scheme adds to the airport system, enabling comparisons between schemes and a “do-nothing” scenario, and to assess whether the scheme can be implemented to be compliant with safety and security standards, and be sufficiently flexible and scalable to meet changes in demand, modes of operation and safety and security standards.

There are seven units of assessment in this module:

- *Capacity;*
- *Safety and security;*
- *Efficiency;*
- *Reliability and resilience;*

- *Scalability;*
- *Airspace; and*
- *Surface Access.*

This report addresses these units with the exception of the Airspace and Surface Access units, which are being reported upon by NATS and a separate Jacobs report respectively to which reference should be made. In addition, the Civil Aviation Authority (CAA) has undertaken a separate safety analysis of each of the proposals.

There is a considerable overlap between capacity, efficiency, reliability and resilience, as restrictions on theoretical capacity will also reduce the efficiency, reliability and resilience of the airport, although it is not the only factor. Therefore, the capacity appraisal outlines the overall capacity of the expanded airport, and the limitations on that capacity. These are also referred to in the efficiency, reliability and resilience appraisals to reflect this where relevant.

Scalability includes both the potential for the airport to operate flexibly with different types of traffic and aircraft, and expand its capacity within the proposed infrastructure, and also the potential to expand beyond its proposed land footprint. It summarises the challenges of such expansion, as these could be on a scale similar to the scheme being considered in this report.

Not all components of the airport's operational processes are relevant to all units of the appraisal. For example, many process elements are important for safety, but not capacity. Table 1-1 sets out which process elements have been assessed according to their relevance to each of the appraisal units.

	Capacity	Safety and Security	Efficiency	Reliability and Resilience	Scalability
Airfield Components					
Runways	✓	✓	✓	✓	✓
RESA's		✓			✓
Runway approach lighting		✓			✓
Public Safety Zones		✓			✓
Aerodrome safeguarding		✓			✓
Navigation aid safeguarding		✓			✓
Taxiways	✓	✓	✓	✓	✓
Stands and aprons	✓	✓	✓	✓	✓
Cargo facilities	✓				✓
Fuel storage	✓			✓	✓
De-icing facilities	✓			✓	✓
Terminal Components					
Existing terminals	✓	✓	✓	✓	✓
New terminals	✓	✓	✓	✓	✓
Transfer facilities	✓	✓	✓	✓	✓

Table 1-1 Airport Process Components and Relevance to Appraisal Units

1.3 Heathrow Hub Proposal

The proposed airfield layout as set out by Heathrow Hub Ltd / Runway Innovations Ltd in June 2014 encompassed two key elements. The first recognised the potential for a transport hub located to the north of the M4, connected to the airport by an automated people mover (APM). The second developed the concept of a new runway to the west, in-line with the existing northern runway. A high level description of additional airfield facilities was provided to demonstrate how the airport may develop to 2050.

In agreement with the Airports Commission, the promoters' proposal has been developed and amended to the scheme now described in this report. A summary of the changes to the scheme from the original Heathrow hub Ltd proposal is contained in Appendix C.

2 Methodology

2.1 Approach

This section sets out a high level overview of the methodology adopted to complete the analysis. Detailed numerical modelling was not undertaken at this stage. The assessments were therefore primarily based upon desk-top reviews of the proposed master plan including its modes of operation against expectation of industry good practice and by reference to professional experience and observations of comparator airports.

A consistent approach was applied to all schemes short-listed by the Airports Commission. The assessment undertaken was prepared on the basis of a number of key principles including avoidance where possible of relying upon assumptions to form an opinion. In the absence of detailed numerical modelling opinion has been based largely upon professional judgment and comparison with comparable airports and/or operations. The largely qualitative analysis has been sufficient to generate valid assessments of the schemes within the scope of the appraisal units.

The proposed new infrastructure has been assessed against the appraisal units by comparing how operations will be affected. It is reasonable to assume that the airport would seek to achieve at least a similar level of safety, security, efficiency, reliability and resilience to that currently experienced.

2.2 Operational Assessment

To ensure consistency between parallel work streams, a workshop was undertaken with NATS to evaluate the scheme in terms of aircraft ground movements to assess the capacity, efficiency, reliability and resilience of the airfield and coordinate with NATS's assessment of airspace.[1] Each "period" of operation was examined in turn for both arriving and departing aircraft, for each key area of the airfield, under both westerly and easterly conditions. A series of flow diagrams was developed to gain a high level appreciation of flow across the airfield under each of these conditions, identifying areas which may experience congestion when the airport approaches capacity at peak periods. A full set of these diagrams is provided in Appendix B.

It was assumed that a programme of "compass departures" and "terminal Arrivals" would be applied as general practice, although at peak times, especially when the airport approaches capacity, it is likely that this practice will be more difficult to sustain.

Discussions with NATS indicate that sufficient Standard Instrument Departure routes (SIDs) have been developed to accommodate "compass departures" from all runways. NATS has indicated that airspace capacity should not impact this assessment of airfield movements.

In agreement with NATS it is assumed that when operating in mixed mode, the Southern Runway will accommodate around one third of departures and arrivals, with the dedicated arrivals or departures runways taking the remaining two thirds.

[1] See Appraisal Module 14. Operational Efficiency: Airspace Efficiency Report.

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2.3 Runways

To assess whether the proposed capacity of the expanded runway system is reasonable, the projected air transport movements (ATM) capacity was examined under the proposed operating parameters. For the purposes of assessment of safety and capacity, the runways were treated in isolation of airspace and airfield constraints, although the previously noted workshop with NATS ensured consistency of assessment.

The operational concept proposes the use of various noise respite options to reduce noise over central and west London and during the early mornings and late evenings. These are summarised in Section 3.2.

Independent detailed modelling has not been undertaken at this stage, and therefore numerical analysis of runway capacity is not provided.

2.4 Taxiways

Taxiways have been checked for physical compliance with European Aviation Safety Agency (EASA) standards. For the purpose of this report, high level flow diagrams have been drawn up in conjunction with NATS. By developing an overarching understanding of aircraft flows across the airport under different operating patterns, a series of 'pinch points' have been identified, where it is anticipated that the effects of congestion will first be felt when approaching capacity. The ultimate capacity of the taxiway network is subject to detailed traffic modelling.

2.5 Stands and Aprons

Proposed stand dimensions were checked against CAA, EASA and International Civil Aviation Organisation (ICAO) standards and Heathrow and comparator airport stand dimension norms.

The current total number of stands by aircraft size and terminal was provided for both the summer and winter season. The stand layout developed for this scheme is based on a replica of stand provision for the T5 campus, except that all new stands are proposed as Code F stands. This will be subject to the mix of aircraft being accommodated at the airport and the configuration of the stands at the time of design (e.g. the use of multi-aircraft ramp system (MARS) stands to accommodate wide bodied and narrow bodied aircraft peaks on the same area of apron).

2.6 Ancillary Facilities

The scheme includes an expanded cargo facility located in the vicinity of the existing Cargo Centre. A new fuel storage compound is proposed to the south west of Terminal 6 and it is assumed that the provision of aircraft de-icing pads can be positioned near the thresholds of all runways.

The scale of the proposed facilities is intended to minimise the proposed land acquisition for the airport's expansion, and has been compared at a high level to the existing provision.

2.7 Terminals and Transfer Facilities

2.7.1 Terminal Sizing and Phasing

In order to determine whether the proposed terminals would be able to handle the suggested annual throughput of passengers, expressed in million passengers per annum (mppa), the level of service provided to a typical design hour passenger was compared to that in the existing facilities.

A detailed modelled assessment would consider the throughput of the slowest performing passenger process as a limit to the whole complex. It would also consider the provision of terminal processes and identify the floor area of the terminals. However, given the current design stage of the master plan and the uncertainties of the future, only a high level assessment of passenger capacity has been undertaken. A two stage process was adopted to assess whether the proposed terminal and associated satellite and pier infrastructure provide adequate processing capacity.

Firstly, based upon international benchmarks an appropriate "design hour" passenger flow was determined from the annual capacity for the airport. This "passenger design hour" is the hypothetical 30^{th} busiest hour in the year for which the facilities are usually designed. Analysis at a range of international airports demonstrates that the annual throughput drives the factor between that throughput and the passenger design hour. As shown in Figure 2-1, as the annual throughput increases the factor between the throughput and the passenger design hour decreases, i.e. the design hour itself increases, but at a proportionally lower rate than the annual throughput, i.e. the daily (and indeed annual) process becomes less "peaky".[2]

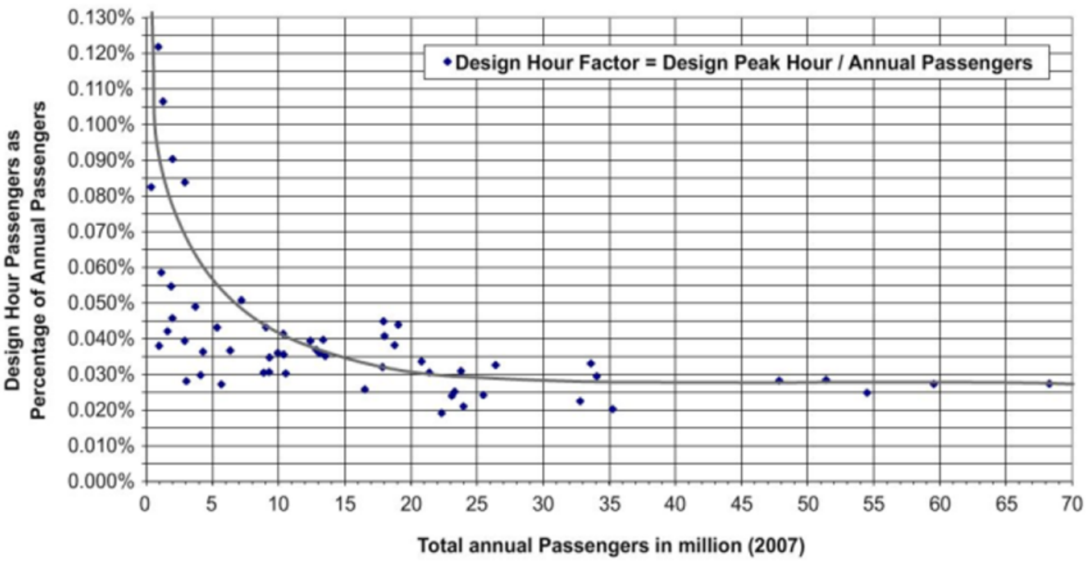

Figure 2-1 Relationship Between Annual Capacity and Design Hour (Source: Airport Evolution and Capacity Forecasting, Bubalo, 2011)

Secondly, the resulting space planning factor (the gross terminal floor area per design hour passenger) was determined and compared to industry experience and

[2] Note that the absolute minimum is 0.016% for a 17h operating airport. This represents an airport with a uniformly distributed, flat profile of passenger flows across the day and year.

benchmarking to assess the resulting likely level of service that the terminal facilities would be expected to deliver. In this way, not only the provision of space is assessed, but also the peak characteristics of an airport are reflected in this high level assessment of the terminal buildings. Other metrics are available to determine the appropriate size of a passenger terminal building; however, these metrics may not include the peak characteristics that can be observed in an airport. As any facility at the airport should be designed to appropriately accommodate the peaking characteristic of demand, the adopted space planning factor metric is appropriate to be used.

It is acknowledged that the provision of gross floor area (GFA) per design hour passenger (DHP) has evolved over recent years particularly with the rise of low cost airlines. Although the scale of GFA per DHP is a continuum with no distinct thresholds, for the purposes of this analysis, the following definitions have been adopted largely based upon IATA recommendations (see Airport Development Reference Manual (ADRM)) as well as professional experience:

- *15 to 20 m^2 per DHP was regarded as being at the low end of the benchmarking, i.e. a very cost efficient and value engineered terminal appropriate for a small facility serving predominantly the low cost market with a corresponding passenger experience;*
- *Approximately 20 m^2 to 35 m^2 per DHP was regarded as an average passenger service level appropriate for most mid-range terminal facilities;*
- *Approximately 35 m^2 to 40 m^2 per DHP was seen as a good passenger service level appropriate for many airports;*
- *40 m^2 to 50 m^2 per DHP was regarded as being at the upper end of the benchmarking expectation for a typical western European gateway airport.*

Such comparisons should be treated with care as each airport, likely serving a balance of different market segments, with differing commercial strategies, across terminals of differing sizes and internal configurations, should ideally be treated upon its individual merits. Nonetheless, this approach is considered appropriate at the current level of detail and provides instructive observations that are based upon empirical observation and not only on a theoretical treatment.

These definitions are not absolute and there is no correct interpretation. The above parameters were adopted on the basis that they provide an appropriate range of service levels within a European and UK context. It is noted that many airports aspire to deliver service standards in excess of the upper end of the above range and that in some regions of the world cultural and/or political aspirations drive space provision far in excess of this upper end.

To provide an indicative comparator, the DHP space planning factors for a range of airports around the world are depicted in Figure 2-2 below. Each point represents an airport in a continent/region, indicating the relatively wide range of standards for different airports.

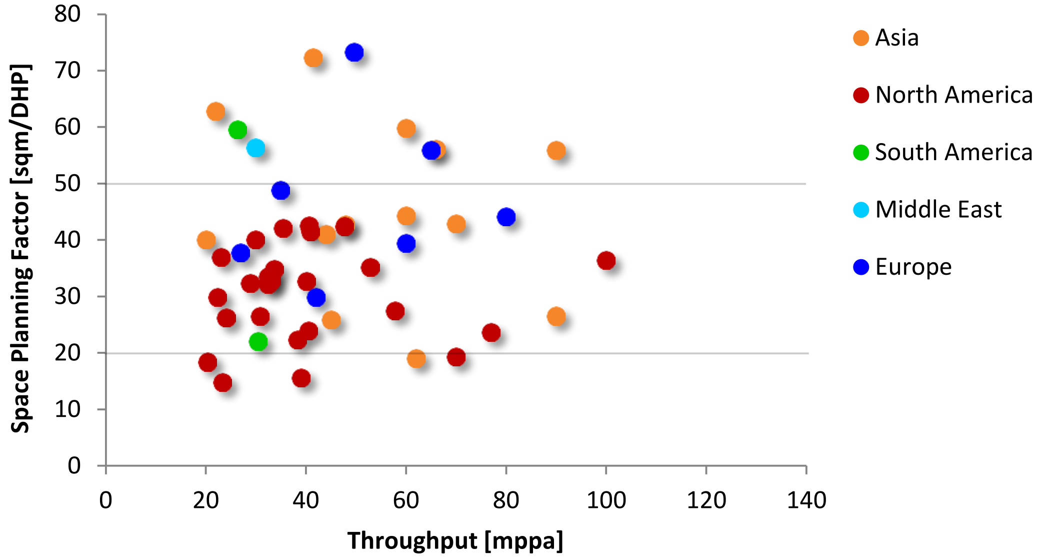

Figure 2-2 Space Planning Factor for Airports with more than 20 mppa

2.7.2 Departures

The departure process, including gates and retail, has been analysed at a high level considering the overall concept of operations.

2.7.3 Gates and Retail

It is not proposed to change the area required for gate processes, so it was not considered necessary to undertake detailed calculations to assess the required area. As the terminal expansion plans are commensurate with the current terminals it was not considered necessary to undertake a more detailed assessment of their impacts on retail provision and therefore a separate section on both gates and retail has not been included.

2.7.4 Arrivals

The arrivals process was analysed at a high level considering the overall concept of operations.

2.7.5 Transfers

The transfer process has been analysed at a step-by-step level to assess the scheme against a reasonable industry benchmarks for airport transfer steps. Minimum connection times (MCTs) were estimated for both passengers and their baggage.

2.7.6 Track Transit System

The proposed track transit system (TTS) system was considered at a high level in comparison to similar such systems at other airports.

3 Master Plan and Operations

3.1 Master Plan

The airport master plan has been laid out in accordance with international standards and appears to comply with both CAP 168 and EASA regulations. However, it is recognised that the concept of an in-line runway has not been adopted elsewhere in the world, and that ICAO, EASA and the CAA do not specifically consider or set out the requirements for the safe operation of this particular runway configuration. Furthermore airline operations and indeed insurance requirements do not contemplate this configuration. New regulations, recommendations and accepted industry practice, including flight crew training, will be needed to address the physical and operational parameters of this runway concept. This may introduce a time delay to operational opening, and there is a risk that unforeseen regulatory (and therefore potential planning and design) issues may arise. As such it is potentially difficult to define time periods required for the resolution of such issues.

Based upon the initial layout proposed, as developed in agreement with the Airports Commission, the proposed master plan is as shown in Figure 3-1. The master plan extends the layout established by the recent and on-going rationalisation and restructuring of the existing infrastructure by building a third runway as an extension of the existing northern runway and extends the “toast rack” terminal concept to the west.

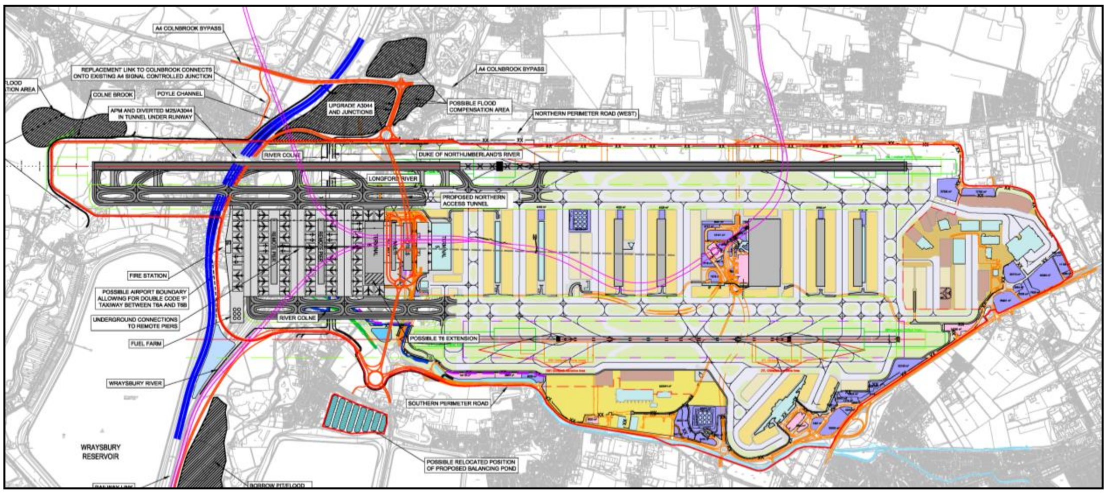

Figure 3-1 Heathrow Airport Extended Northern Runway Master Plan

3.2 Operations

It is proposed to use only one runway in mixed mode and the other two in segregated mode, alternating between runway modes to offer respite and to reflect prevailing winds (and the ‘Westerly preference’, if retained). The two northern runways must always operate in segregated mode, although one may operate in mixed mode if the other one is unavailable or closed for a period of respite. It is also proposed to implement options that offer respite by either not using the southern runway or the existing northern runway.

These options include operating:

- *The new, extended northern runway and the southern runway only, to provide respite for those affected by the existing northern runway;*
- *All three runways, with the southern in mixed mode, to maximise capacity; and*
- *The two northern runways only, to provide respite for those affected by the southern runway ("Southern Relief").*

Similar options are available for easterly operations. It is recognised that some respite options (in particular Southern Relief) may become increasingly difficult to sustain if increased demand requires provision of additional capacity for longer peak periods.

The scheme also includes "compass departures"[3] and terminal arrivals throughout the day. However, to maximise throughput at peak times, terminal departures may also need to be adopted. Operations have been assessed on the basis that they will be optimised according to levels of demand.

A depiction of the issues arising from these modes of operation in terms of airport operations (for runways and taxiways) is in Appendix B.

A depiction of this is seen in Figure 3-2 below for Westerly operations only.

[3] Departures are allocated to runways based on their routing with aircraft heading to the north using the northern runway and those heading south using the southern runway. Such an approach avoids the need to de-conflict departing aircraft in airspace. Reference should be made to Appraisal Module 14. Operational Efficiency: Airspace Efficiency Report.

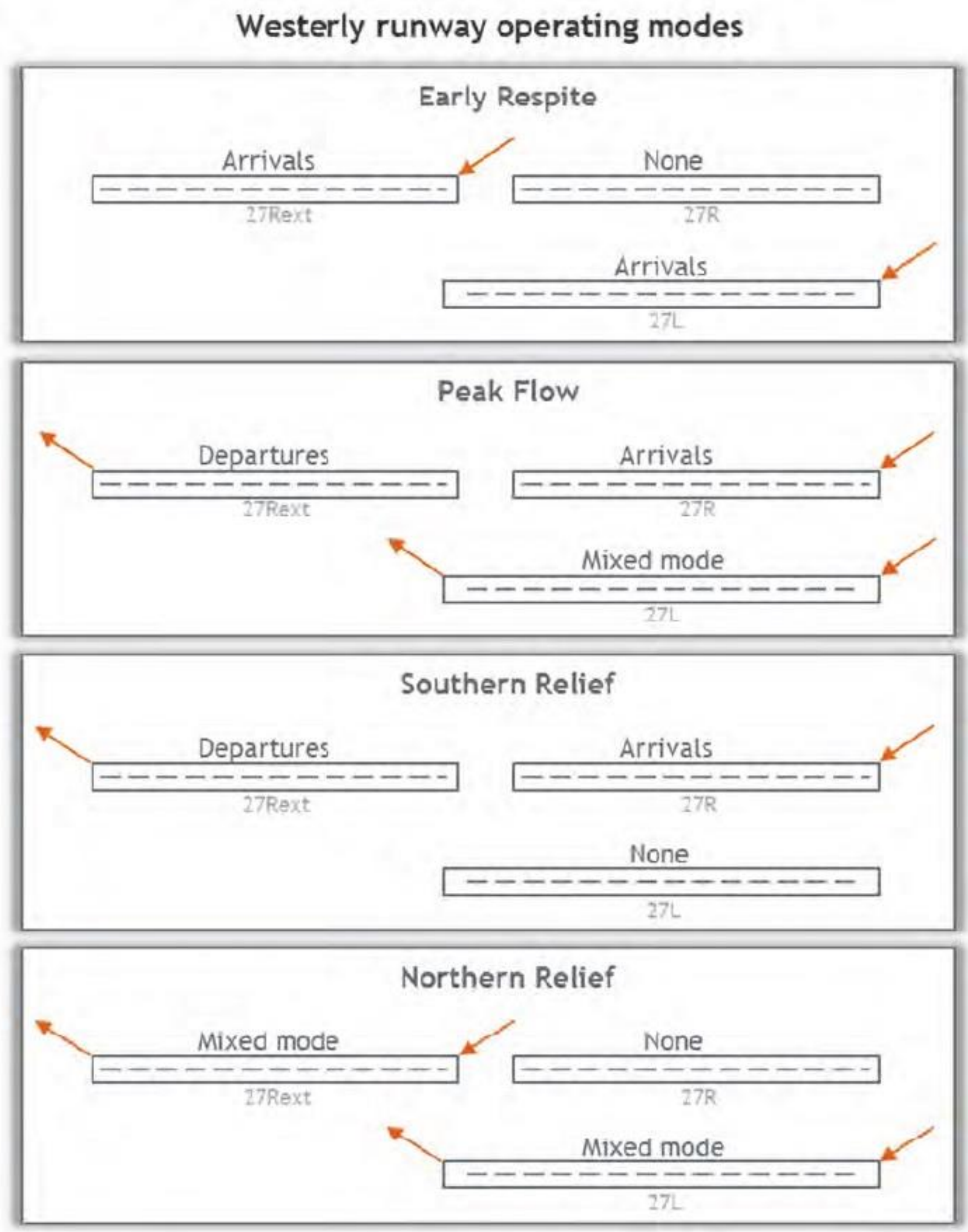

Figure 3-2 Heathrow Airport Extended Northern Runway Concept of Operating Modes (Source: Heathrow Hub Ltd submission to the Airports Commission)

4 Runways

4.1 Runway System

Heathrow currently has two runways operating in segregated mode, alternated at 1500 hours each day. Heathrow currently handles around 472,000 ATMs per annum, with a regulated cap of 480,000 ATMs.

The scheme proposal is for a new runway immediately to the west of the existing northern runway constructed as an extension to the existing pavement infrastructure (i.e. on the same alignment as the northern runway). A 650m area is proposed to separate the new north-west runway from the existing northern (north-east) runway. The existing southern runway would remain the same, and retain the same thresholds, but the existing northern runway would have its thresholds displaced as depicted below.

While the existing runway width of 50m plus 12.5m shoulders would be retained for the current runways, the new runway would be 60m wide with 7.5m shoulders to comply with EASA requirements.

It is proposed that by operating all three runways up to 700,000 ATMs will be handled. It is recognised that this includes the termination of the Cranford Agreement and to allow selective mixed mode operations on the southern runway (and either of the two northern runways if the other is out of operation for respite).

Heathrow currently declares an hourly peak of 44 arrivals or departures (with a rolling hour peak of 46 movements) per runway.[4] It is proposed that the hourly peak will consist of 130 aircraft across the three runways, reducing to 90 during periods of southern relief and 100 during northern relief.

The runway system should be capable of handling most types of aircraft expected and forecast to use Heathrow under typical operating conditions. However, some larger Code E/F aircraft may face restrictions for departures only, when operated near maximum take-off weight (MTOW) on the two northern runways due to the shorter take off run available (TORA) and take off distance available (TODA).

4.1.1 Declared Distances

Current and proposed declared distances on the existing runways and the proposed runways are depicted in Table 4-1 and Table 4-2 below:

Runway	TORA (m)	TODA (m)	ASDA (m)[5]	LDA (m)[6]
09L	3,902	3,902	3,902	3,595
27R	3,884	3,962	3,884	3,884
09R	3,660	3,660	3,660	3,353
27L	3,660	3,660	3,660	3,660

Table 4-1 Current Runway Declared Distances

[4] Source: CL Summer 2014.
[5] Accelerate-stop distance available
[6] Landing distance available.

Runway	TORA (m)	TODA (m)	ASDA (m)	LDA (m)
09L NE	3,000	3,000	3,000	3,000
27R NE	3,000	3,000	3,000	3,000
09L NW	3,000	3,000	3,000	3,000
27R NW	3,000	3,000	3,000	3,000
09R	3,661	3,661	3,661	2,800
27L	3,661	3,661	3,661	2,800

Table 4-2 Proposed Runway Declared Distances

The southern runway retains the current declared distances. Although the Landing Distance Available (LDA) is reduced this does not present an operational issue for landings as the proposed distance is adequate for all aircraft types.

The TORA and TODA for the two northerly runways are proposed to be 3,000m. The operational report produced by Helios on behalf of Heathrow Hub Ltd suggests that there may be a small proportion of aircraft that would be too heavy to take-off within the designated 3,000m, and may seek to use the southern runway given its longer declared TORA/TODA. These would be currently heavier Code E aircraft (e.g. Boeing 777-300ER) operating near or at MTOW. The future proportion of such aircraft using the airport will be dependent on the forecast fleet mix and demand. At present such aircraft consist of around 6% of total movements (noting that the restriction only applies to departures).). Current trends in aircraft fleets[7] are likely to mean that the proportion of such aircraft operating at Heathrow will increase.

However, not all such aircraft would be departing at weights requiring use of the southern runway. Take off close to MTOW occurs when an aircraft is operating with a heavy payload or a high fuel load necessary for longer sectors. Weather conditions also affect performance and the TODA/TORA requirements. Future aircraft, including those known to be under development[8], may have better performance characteristics. Conversely, airlines may have operating requirements that oblige the pilot to request use of the longest available runway irrespective of strict technical need. Whilst unknown, on balance, the possible proportion of departing aircraft that will use the southern runway due to TODA/TORA restrictions on the northern runways could be between, perhaps, 3 to 10%.

Subject to the future removal of the localiser (should conventional instrument landing technology be replaced in time), the 650m sterile zone between the two runways could facilitate a flexible approach to the declared distances for each runway.[9] This may be able to address part or all of the limitations on heavier aircraft. In this scenario, the starter strip for the departure runway could make effective use of the relatively short LDA required for the arrivals runway. The sterile zone would be retained, but would shift to the east or west depending on the mode of operation (which itself is dependent on the wind direction). Further investigation would be required to demonstrate that this could be operated safely and so obtain regulatory approval.

[7] Many airlines are replacing some or all Boeing 747 operations at Heathrow with Boeing 777-300ER, e.g. BA, Cathay Pacific, Air India, and Boeing has a back order of 247 such aircraft as of August 2014.
[8] Boeing 777-X series does not yet have a design take off distance at MTOW. The Airbus A350-1000 has a design take-off distance of less than 3000m.
[9] This would require careful design of runway lighting, but the declaration of starter-extensions could increase the take-off declared distances.

The LDA is sufficient across all runways for all likely commercial aircraft types. Although this would be shorter than the existing provision, it will still be possible for all aircraft forecast to use Heathrow to land safety within the LDA provided.

4.2 Runway End Safety Area provision

Full 240m long by 150m wide runway end safety areas (RESAs), as recommended by ICAO, have been provided for all runways under the proposed layout. The provision of a 650m sterile zone between the northern runways could potentially yield a greater RESA provision, depending on whether an instrument landing system (ILS) localiser array is located in this area. “Deep” landings[10] on the northern runways would also significantly increase the amount of undershoot RESA provided.

4.3 Approach Lighting

Standard 900m full approach lighting systems, commensurate with ICAO, EASA and CAP 168 requirements for Category III instrument runways, have been assumed based on the new threshold positions. The approach light planes have been assessed and are compliant with ICAO, EASA and CAP requirements although care will be needed to ensure that any ILS equipment (if needed) is positioned appropriately so that lighting is not obstructed.

The lighting system for the northern runways will require careful design to ensure that there is no confusion for pilots as to which runway is in use. This will involve runway interlocking to ensure that the correct lights are displayed for the two runways. The approach lighting for each of the northern runways will be inset in the sterile zone, and will extend into the in-line runway pavement. Positioning of centreline lights in relation to the approach lighting will need to be carefully considered in the Aeronautical Ground Lighting (AGL) design.

4.4 Public Safety Zones

Figure 4-1 shows the proposed Public Safety Zones (PSZ) contours. At this stage of planning, the contours should be considered to be indicative only and subject to change dependent on future operating parameters and aircraft mix. PSZ contours are calculated using criteria set out by the Department for Transport. Key variables in determining the extent and shape of the contours include the expected aircraft mix, the number of ATMs and the split of landing and take-off movements.

[10] Landing on the further runway as observed from the direction of approach, over-flying the nearest runway, which would be declared not operational.

Figure 4-1 Heathrow Airport Extended Northern Runway Proposed PSZ Contours (Source: Heathrow Hub Ltd submission to the Airports Commission)

The PSZ provision for the southern runway is likely to be unchanged from the existing contours.

The PSZ contours for the eastern and western extremities of the northern runways appear to be appropriate at this stage of planning.

However, the PSZs between the two northern runways overlap with each other, and extend into the in-line runway. For example, an aircraft lining up for departure on the north-west runway would be in the PSZ for the north-east runway, and vice versa. Although, the aircraft could be considered to be a moving object, this arrangement is not currently contemplated by regulation. Current guidance may therefore require amendment and consideration may be required as to whether this land use within the PSZ is permitted.

Additional investigation would be required to consider the risks and implications of this overlap and how this may be managed through detailed design or with appropriate operational procedures in order to ensure they can be safety compliant.

4.5 Obstacle Limitation Surfaces

Assessment of obstacle limitation surfaces (OLS) safeguarding has been limited to consideration of the approach, take-off and climb and transitional surfaces for areas in the immediate vicinity of the airfield. It is recognised that there are other safeguarded surfaces (inner and outer horizontal and conical surfaces). However, penetrations of these surfaces will either be similar to the existing configuration or are unlikely to have a significant impact on the safety and efficiency of airfield operations sufficient to invalidate the master plan.

4.5.1 Approach Surfaces

The origins of the approach surfaces will reflect the new threshold locations on both of the northern runways. This will have a direct impact on the inner parallel taxiways in that they will be height constrained by the respective approach surface. New obstacles would infringe the redefined surface such as tail fins of aircraft at runway holding points and on the inner parallel taxiways.

The approach surfaces have been assessed for all runways. The approaches to the southern runway are assumed not to change from the existing configuration. The approaches to the two northern runways haves been assessed for each threshold. All approaches appear to be compliant with EASA regulations as currently described.

4.5.2 Take Off and Climb Surfaces

In a similar fashion to the approach surfaces, there is no change to the take-off and climb surfaces (TOCS) for the southern runway. The TOCS for the existing and the proposed new northern runways do not appear to have any significant penetrations under the proposed scheme.

4.5.3 Transitional Surfaces

The master plan layout does not appear to indicate any significant new penetrations to the transitional surfaces. The existing Air Traffic Control (ATC) tower will remain a penetration to the transitional surfaces, as is currently the case. The positioning and elevation of a new ATC tower would need to take into account the safeguarded surfaces.

4.5.4 Obstacle Free Zone

The obstacle free zone (OFZ) has been assessed for each runway operation. The proposed surfaces are clear of obstacles.

Aircraft holding on the de-icing pads at the ends of each runway would penetrate the OLS approach surface, but would be outside the approach surface for the OFZ. As a mobile obstacle essential for the operation of the airport it is understood that the position of the de-icing bays is appropriate. However, further discussion with the CAA is recommended to ensure operational procedures can ensure safe operations with regards to the approach surfaces.

4.6 Navigation Aid Safeguarding

Specific safeguarded areas are imposed for elements of the Instrument Landing System (ILS). This comprises a localiser aerial positioned at the end of the runway and a glide path aerial located at the side of the runway. Careful detailed planning will be necessary regarding taxiways and glide path locations for the two northern runways. The existing systems and locations would be retained for the southern runway.

The 650m sterile zone between the two northern runways includes a 50m area in the centre which would appear to accommodate two localisers and an equipment building offset to the edge of the runway strip or placed below ground with associated clear area and a service road to the equipment building. Further study would be required to determine whether aircraft using either of the two runways would significantly impact the localiser signal although only one localiser will be in operation at any one time.

The glide path aerials for the existing northern runway are around 130m from the runway centreline, with a further 55m to 60m to the airport boundary fence. The northern alignment of the airside boundary is not proposed to change. Therefore it is assumed that the current northern runway glide path aerials continue to function as currently, and that any new navigation aids for the new runway will operate under similar conditions.

Given the expectation that current ILS technology will be phased out and replaced with newer technology over time, the operational impact of this element of the master plan may reduce. Should that not be the case, this issue would require adequate treatment during the detailed design phase or the necessary operational mitigations as agreed with the CAA at the time.

4.7 Sterile Zone

It is proposed that a 650m "sterile zone" be provided between the two northern runways, divided into:

- *Runway strip end (60m at each end);*
- *RESA (240m at each end); and*
- *ILS area for 2 localisers (50m).*

A detailed study into the potential for starter strip operations or a more flexible use of the sterile zone would be required and has not been undertaken as part of this report. Areas that would need to be addressed include, but are not limited to:

- *<u>Impact on runway lighting</u>: This is likely to be complicated with approach lights transitioning the sterile zone. The starter strip would require additional centreline lighting and edge lighting, requiring careful design to define the demarcation between the two runways;*
- *<u>Impact on runway capacity:</u> As the starter strip may be extended into the sterile zone, the inter-dependency of the runways may increase, which may reduce capacity. Given that the starter strip would mostly operate during periods of southern respite, (i.e. when the northern runways are operating in single mode) the impact on capacity is difficult to determine and would require detailed modelling to understand the full impact on capacity; and*
- *<u>Impact on ILS:</u> The initial proposal placed a single localiser at each end of the 6600m of the paved surface. Further study would be required to determine whether aircraft using either of the two runways would significantly impact the localiser signal although only one localiser will be in operation at any one time. The potential impact of construction work for the new runway on ILS signals during the works and the signal emitted for a landing aircraft from a distance of 6,600m would also have to be further analysed.*

Potential options for the sterile zone are depicted in Figure 4-2 to Figure 4-4 below:

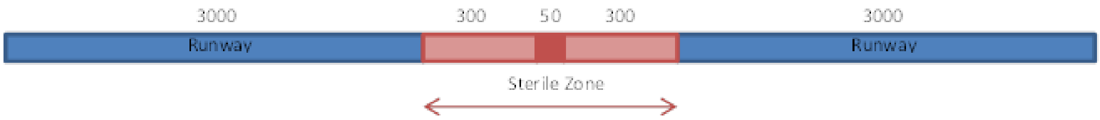

Figure 4-2 Heathrow Airport Extended Northern Runway Layout

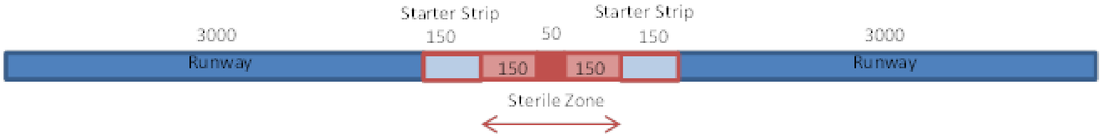

Figure 4-3 Provision of 150m Starter Strips for Extended Northern Runway

![JACOBS]

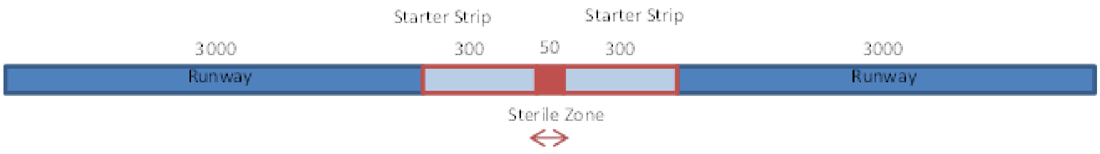

Figure 4-4 Provision of 300m Starter Strips for Extended Northern Runway

Should the ILS system be no longer required the sterile zone could facilitate a flexible approach to the start and end of declared distances for each runway by using the relatively shorter LDA for the arrivals runway. This means the sterile zone would shift to the east or west depending on mode of operation as shown in Figure 4-5.

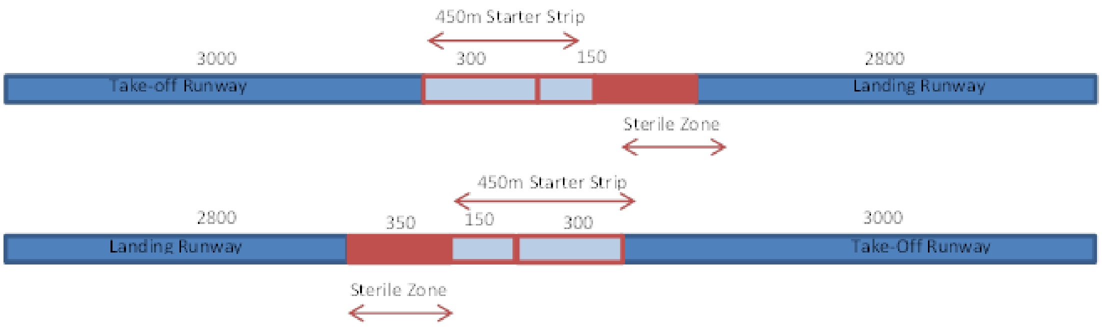

Figure 4-5 Provision of 500m Starter Strips – No ILS – Westerlies and Easterlies Flexible Options

4.8 M25 Tunnel under Proposed Extended Northern Runway

The northern runway extension would be built over the M25, requiring the M25 to be relocated in a tunnel underneath the runway. Whilst this raises safety, security and scalability issues with respect to the highway network, it also raises issues for the airfield.

The new tunnel creates a potential risk for the proposed northern runway in the event of a major incident on the M25 either in or near the tunnel, and conversely a risk for the M25 from aircraft on the taxiways and runway. The tunnel would be built to EU safety standards to contain fire or explosive blasts effectively. It is also proposed to protect the entrances of the proposed tunnel, by incorporating an appropriately sized runway strip either side of the tunnel location. The proposed tunnel may create a scalability restriction for further expansion of the airport west across the M25, primarily due to the difficulty and therefore increased construction cost of relocating and diverting the M25 during construction of a new or extended tunnel south of the proposed tunnel under the new north-west runway.

4.9 Appraisal

4.9.1 Safety and Security

Whilst the proposed runway layout does not appear to present any significant issues with respect to existing standards and recommendations, it is recognised that the concept of an in-line runway has not been adopted elsewhere in the world, and that neither ICAO, EASA nor the CAA specifically consider or set out the requirements for the safe operation of this particular runway configuration. Furthermore airline operations and insurance requirements do not contemplate this configuration. New regulatory provisions will need to address the physical and operational parameters of this scheme.

This may introduce a delay to operational opening, and there is a risk that unforeseen regulatory (and therefore potential planning and design) issues may arise, with potentially unknown time periods required for their resolution.

Some further minor issues relating to the proposed layout have been identified that could be reasonably expected to be resolved through detailed design or the adoption of appropriate operating procedures:

- *The PSZs at the "centre" of the two northern runways overlap and a lined-up aircraft preparing to take off would be within the RESA of the landing runway behind. Both aspects are without regulatory contemplation. These aspects should be adequately addressed during detailed design, but would require amendment to current regulations;*
- *Aircraft holding on the de-icing pads at each end of the runways would penetrate the approach surface. Operating procedures should be developed to ensure this can be managed safely.*

4.9.2 Capacity

Table 4-3 states the current usage and capacity and future estimated capacities.

	2014 Actual Usage	2014 Capacity	2026[11] Capacity	2050 Capacity
ATMs	471,936	480,000	700,000	700,000

Table 4-3 Heathrow Throughput and Proposed Capacity with scheme

The proposed future ATM capacity is considered to be realistic. Heathrow currently declares up to a rolling hour peak of 46 movements per runway, and has proposed an hourly peak of up to 128 movements across the three runway system.

The anticipated departure and landing rates appear to be commensurate with current operations, with a slight increase for the mixed mode runway operation. Given that full mixed mode is not operated at Heathrow, it is not unreasonable to assume that this improvement is achievable. A comparison can be drawn with other airports such as Gatwick which currently declares up to 55 movements per hour, or Stansted which declares 50 movements per hour.[12]

Although the runways are designed to operate independently, it is recognised that there may be occasions when some interdependency will reduce ATM throughput with different modes of operation.

The southern runway is proposed to operate in mixed mode, except during periods of respite, whilst the two northern runways must necessarily operate in segregated mode. This would be expected to support the proposed 700,000 ATMs with sufficient capacity to ensure higher levels of reliability than at present. If all three

[11] Note: 2026 is the earliest that the Airports Commission considers that planning and regulatory processes would enable the scheme to be opened.
[12] Source: CL Summer 2014.

runways operated in segregated mode, the capacity declaration would need to be lower.

The lower declared distances for the two northern runways could mean some heavier Code E aircraft may not be able to use these runways for departures and would have to use the southern runway. The proportion of departures affected by this restriction will be dependent on weight and weather conditions on any single day, but could be between 3-10% of all departures. This may be considered to be a minor capacity limitation, although the sterile zone between the northern runways may be able to be used in a flexible manner to provide sufficient TORA/TODA to address this. The next generation of comparable aircraft may have better take-off performance to reduce the impact of this potential limitation.

The scheme would have a positive net impact on capacity in the wider London airport system and is not anticipated to reduce capacity at other major airports, subject to re-configuration of the London airspace system. However, it may present constraints on expanding utilisation of RAF Northolt given its proximity. NATS is undertaking specific analysis on the impacts of the scheme on RAF Northolt and will be reporting separately on this.

4.9.3 Efficiency

The scheme appears to be capable of efficiently handling the proposed ATMs in total and at the proposed peak levels of departures and arrivals per hour, subject to appropriate slot co-ordination.

The runway system would appear to be able to handle a wide range of commercial aircraft up to and including Code F, although there are likely to be restrictions on some heavier Code E departures operating at near MTOW on the northern runways only.

The scheme will enable the airport to operate in fully segregated mode or allow for the southern runway to operate in mixed mode with the northern runways in segregated mode. Either of the northern runways could also operate in mixed mode if the other were closed.

The scheme will enhance the airport's efficiency, as the additional capacity should help reduce delays on the ground and in the air. The scheme's proposed capacity declaration should help maintain this efficiency by reserving some capacity for resilience.

In conclusion, the design of the runway system should be adequate to allow efficient operation of the airport.

4.9.4 Reliability and Resilience

The scheme should add reliability and resilience to the airport. Even at peak times it should represent an improvement on current conditions, due to the added flexibility and capacity inherent in a three runway airport, with the ability to operate the southern runway in mixed mode during regular operating conditions. Should one of the runways be unavailable, the remaining two should be able to function effectively. Given the current lack of capacity to accommodate delays due to unplanned events, this should be an improvement on current conditions.

However, given the proximity and design of the two northern runways, there may be a greater risk of both northern runways being unavailable simultaneously, resulting in a single runway operation. For example, should an aircraft overrun when landing on either northern runway, both runways may be likely to remain out of operation until the incident could be recovered and appropriate remedial action put in place.

As described in Section 4.9.2 the proposed hourly throughput rates are less than at other runways currently operating in the UK, albeit single runways, suggesting that some resilience has been retained in the runway system to facilitate a more reliable airport operation.

Given the additional flexibility inherent with increased runway capacity, the airport is expected to achieve improved levels of resilience against severe weather than it does at present, and is expected to improve further as technology for automated landings continues to develop.

4.9.5 Scalability

The proposal is to operate only one runway in mixed mode and the remaining two in segregated mode. It would not be possible to operate either of the northern runways in mixed mode with the other northern runway in operation, meaning there would be very limited scope to increase capacity by operational means.

The Operational Efficiency module of the Appraisal Framework includes consideration of the further scalability of proposals. Therefore, the potential for further runway development at the site of each shortlisted scheme has been assessed, to provide a high level indication of the likely challenges. This does not represent a comprehensive assessment of the scope or case for the further runway options under consideration.

Development of an additional runway beyond the proposed extended northern runway presents difficulties that are broadly shared across all of the conceivable options. Even after construction of the scheme, the Heathrow site would remain constrained given built up areas to the south, east and north, reservoirs to the south west and west, and the M25 to the west, M4 to the north and the interchange between them. It appears that any options are likely to need to take account of their effects on residents, businesses and major infrastructure, and will require acquisition and removal of some properties.

Early submissions to the Airports Commission from Heathrow Airport Ltd (HAL) prior to its 2013 Interim Report examined the potential for adding a fourth runway to the south-west of the site. This option is not precluded under the current submission, but it is recognised that the impact on the local area including the reservoirs would be very significant and costly. The option of adding a fourth runway to the northwest of the site, similar to the Heathrow Airport North West Runway scheme, would also not be precluded under this scheme. However, this would face similar challenges regarding the M25 as extending the southern runway westwards. It is also not unreasonable to assume that a fourth runway to the north could further restrict the movements of the two northern runways, although it would be expected to add net capacity, and further work would be required to assess whether or not it would result in significant additional capacity..

It was envisaged in the original proposal that the southern runway could possibly be extended in a similar manner to the northern runway, enabling a similar parallel operation of four segregated in-line parallel runways. This could be expected to have a higher capacity than retaining the southern runway in full mixed mode. However, the tunnelling of the M25 under the extended northern runway is likely to create a scalability challenge for any proposals for further expansion of the airfield westward. Options to temporarily relocate the highway to maintain adequate capacity may be significantly constrained.

5 Taxiways

5.1 Proposed Taxiway Network

Under the scheme, an expansion of the taxiway network is proposed to service the extended runway and associated stands and terminal.

The proposed network would appear to be adequate to manage aircraft efficiently on the airfield. However, some bottlenecks have been identified in the network that could cause congestion during peak periods. The key issue is that the adjacent location of the ends of the two northern runways results in a bottleneck as aircraft taxiing to and from those ends interact to use taxiways in opposite directions. Aircraft holding for westerly departures on the north-west runway may impede the free flow of aircraft arriving from the north-east runway to the T6 campus; whereas for easterly departures, aircraft queuing for departure on the north-east runway may restrict the free flow of aircraft from the north-west runway taxiing to the central terminal area (CTA). It would be possible to divert arriving aircraft through taxiways within the “toast rack” of satellites and to use the alternative southern parallel taxiways to alleviate some of the congestion at this point. However, this may have an effect on the reliability of flight departures from such satellites.

These have been highlighted in Figure 5-1 below.

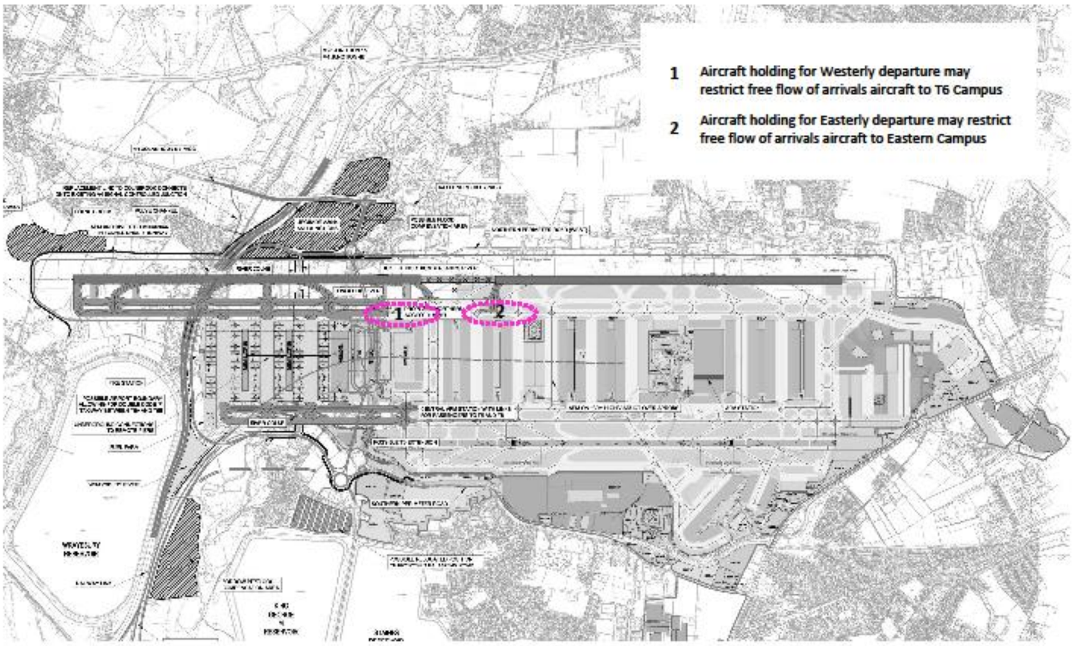

Figure 5-1 Taxiway Operational Pinch Points

The new taxiways appear to have been planned for Code F aircraft, and in accordance with CAP168.

5.2 Runway Access Taxiways

Three runway access taxiways (RATs) are proposed for each end of the new runway, in addition to those at the existing runways. This is commensurate with current operations and is considered to be good design practice.

The proposed RATs are suitable for the overall master plan, would meet safety and security standards and be adequate to service the proposed capacity of the airport.

5.3 Rapid Exit Taxiways

The existing northern and southern runways are equipped with a variety of taxiway exits, with two rapid exit taxiways (RETs) in each runway direction. The current positioning of the RETs is in line with the existing threshold positions, current fleet mix and number of runway movements.

The new extended northern runway has been planned to have two RETs in each direction. These RETs are positioned appropriately in accordance with threshold positions.

It appears likely that some of the existing northern runway RETs will need to be moved to optimise runway throughput. Although this does not appear to have been incorporated in the master plan, it is anticipated that these works could be included in the wider airfield improvement tasks and would not impede the development of the airfield.

The proposed RETs would appear to meet safety and security standards and be capable of adequately meeting the proposed capacity of the airport. However, additional RETs could improve efficiency and resilience across the runway/taxiway network and should be considered during detailed design.

5.4 Runway Crossings

No additional runway crossings are proposed and the new runway configuration does not increase the need for runway crossings. There will continue to be crossing of the southern runway to access Terminal 4. Although this reflects current practice, it is noted that as mixed mode operations will apply to the southern runway, there will be more intensive ATM movements on that runway, which may increase delays for runway crossings. Scheduling arrivals to Terminal 4 and the cargo area for the southern runway exclusively could help to mitigate such delays.

5.5 Parallel Taxiway Network

The parallel taxiway system would be extended to serve the full length of the new runway and to link the new terminal T6A to both the north and south. The T6A taxiway would provide additional resilience to the taxiway network, allowing aircraft to bypass the potentially busy area to the north of T5A/B when taxiing to or from the southern runway. The parallel taxiway system is capable of accommodating Code F aircraft.

The dual parallel taxiway serving the southern runway would also be extended across the south of the T5/6 campus to provide appropriate circulation of aircraft. This will allow aircraft using T6 stands to access the southern runway directly, and will facilitate improved circulation during peak periods when the northern taxiway system becomes busy. The parallel taxiway will also provide improved resilience should the taxiway network be compromised for any given reason (maintenance or unforeseen incident).

The parallel taxiway network would meet safety and security standards and be capable of adequately meeting the proposed capacity of the airport.

5.6 Taxiway Operations

Taxiway circulation has been evaluated in conjunction with NATS to ensure coordination with arrival and departure airspace operations. Indicative flow routes have been identified in order to ascertain whether there are likely to be particular areas of congestion in the future. Independent modelling of aircraft has not been undertaken, although it is recognised that detailed modelling will be required prior to detailed design.

Overall, taxiway circulation appears to be acceptable. However, the following was identified as potentially affecting capacity, efficiency or resilience at peak times:

The proposed taxiway network appears to be adequate to enable a reasonable standard of resilience and reliability of operations. However, as the expanded airport continues to concentrate all airfield movements on the taxiway network constrained by the runway system, it may be seen as generally less resilient than currently. In particular, an incident on the northern taxiway network adjacent to the area between the two northern runways may be expected to significantly degrade reliability of operations.

The area between the eastern end of the new north-west runway and the western end of the north-east runway has been identified as a potential bottleneck affecting the flow of aircraft around the airfield. This is a function of the runway design which requires aircraft to exit and enter the two in-line runways in this area. The potential congestion at this location would need to be managed with operational procedures to mitigate any delays.

It would be possible to utilise the through taxiways to the south parallel taxiway in this case to alleviate taxiing delays to aircraft stands, but this will involve a longer taxi route.

The generally constrained Heathrow layout creates challenges to the efficient operation of the airfield because most terminal space is between the parallel taxiway serving the two runways. The proposed master plan retains that constrained separation and seeking to increase throughput within that constraint could risk reducing the overall efficiency of operations of the taxiway network.

A graphical depiction of the congestion risks on the taxiway network is contained in Appendix B.

5.7 Appraisal

5.7.1 Safety and Security

The proposed taxiway network is consistent with relevant safety standards and recommendations.

5.7.2 Capacity

The proposed taxiway network appears to provide adequate capacity to support the efficient operation to the stated runway capacity.

The area between the eastern end of the new north-west runway and the western end of the north-east runway has been identified as a potential bottleneck affecting the flow of aircraft around the airfield. This is a function of the runway design which requires aircraft to exit and enter the two in-line runways in this area. The potential congestion at this location would need to be managed with operational procedures to mitigate any delays.

Aircraft from T4 or the cargo aprons will have to continue crossing the southern runway (as today) if landing or departing on either of the other two runways. Although this is current practice, it is noted that as the southern runway is proposed to be operated in mixed mode, it will have more intensive ATM movements and so there may be greater delays for aircraft seeking to cross the southern runway. Scheduling arrivals to Terminal 4 and the cargo area for the southern runway exclusively would mitigate this a little.

5.7.3 Efficiency

The proposed taxiway network appears to be capable of handling the proposed maximum capacity of the airport, although the bottleneck between the two ends of the northern runways may create delays at peak times.

There are sufficient RETs and RATs to allow for the efficient use of all of the runways and the proposed dual taxiway to the west of the proposed T6A will improve efficiency at peak times, and when two-way traffic is flowing around the T5/T6 area.

The generally constrained nature of the Heathrow layout, between the parallel taxiway serving the two runways, is generally accepted as an impediment to efficient operation of the airfield. The proposed master plan retains that constrained separation and seeking to increase throughput within that constraint could be seen as reducing the overall efficiency of operations of the network.

5.7.4 Reliability and resilience

The proposed taxiway network appears to be adequate to enable a reasonable standard of resilience and reliability of operations. However, the same issue as mentioned in Subsection 5.7.3 also applies: as the expanded airport concentrates all airfield movements on a taxiway network already constrained by the runway system and separation, the network may become generally less resilient than currently. In particular, an incident on the northern taxiway network adjacent to the area between the two northern runways may be expected to significantly degrade reliability of operations. For example, overrun incidents between the two northern runways are likely to result in the need for both of those runways to be closed.

5.7.5 Scalability

The proposed taxiway network is designed to fit within the master plan's development for the new inline runway and associated stands and terminals.

Further expansion of the taxiway network to the west of the proposed T6C would be constrained by the M25, and it may prove challenging to extend the proposed M25 tunnel further south to accommodate such expansion. Beyond that, there would appear to be little scope to add significant new taxiway capacity without acquiring additional land to the south or north of the airport.

6 Stands and Aprons

6.1 Proposed Stands and Aprons

Heathrow has 170 stands available at present (excluding cargo stands), of which 60 are located at T5, with one third Code C/D and two thirds Code E/F. Although details are not provided, a significant increase in the number of stands is proposed.

Given that the predicted throughput of the new terminal T6 is likely to be similar to that of T5, it is not unreasonable to assume that the stand provision should be broadly similar. The apron allocation across the new development is safeguarded for Code F aircraft, allowing maximum flexibility in terms of stand development. Provision has been made for close contact stands along the western face of new terminal T6A with direct access to both the northern and southern taxiway systems. It is proposed that the new satellite terminal T6B has stands on either side of the building with a remote apron to the south of the terminal building.

Improvements to the eastern airfield campus around T2 will also increase the efficiency of stand allocation in existing areas of the airfield by progressively redeveloping the area with a “toast rack” layout, which also allows for phased expansion of stands according to demand.

The stand provision is considered to be acceptable, and is sufficiently flexible to accommodate different combinations of aircraft types.

6.2 Appraisal

6.2.1 Safety and Security

The proposed stands and aprons can be safely laid out in accordance with EASA standards. The proposed stands and aprons would support the continued safe and secure operation of the airport.

6.2.2 Capacity

It appears that there is sufficient capacity in terms of numbers of stands and apron capacity to meet the runway capacity proposed. A wide range of aircraft types will be able to use the airport.

6.2.3 Efficiency

The proposed stands and apron will support the efficient operation of the airport and a range of aircraft types. The proposed restructuring and development of the airport into a “toast rack” configuration will enhance its overall efficiency and enable efficient access to and from taxiways.

6.2.4 Reliability and Resilience

The proposed stands and aprons would appear to support reliable and resilient operation of the expanded airport. The spread of stands across the airfield should enable adequate provision of capacity at peak times. The “toast rack” layout allows for relatively straightforward re-allocation of aircraft in the event of stands becoming unavailable.

6.2.5 Scalability

The “toast rack” layout lends itself to phased development according to need, with the development of T6B and T6C able to follow future demand, up to the capacity of the runway system. There is scope to utilise land allocated for ancillary facilities opposite T6A which could be redeveloped as stand space if required. The proposed stand allocation would be able to accommodate a wide range of commercial aircraft types.

7 Ancillary Facilities

7.1 Introduction

A wide range of ancillary facilities are provided at the airport including, but not limited to, offices, hotels, catering, power, and fuel farms. Much of the land for such facilities is already under the control of HAL. The use of the land split between these facilities will be dependent on demand over time. The scheme's proposal is to use the land to the south adjacent to the cargo area and Terminal 4, and also includes some land adjacent to the proposed T6 satellites to the west.

7.2 Cargo Facilities

The current facility processes an annual cargo throughput of 1.5m tonnes.

It is proposed that the total cargo capacity be doubled to handle 3m tonnes per annum, with around 13.3ha of land allocated. This is a 30% increase on the current area allocated to cargo, and is achieved by reallocating underutilised airfield space adjacent to the current facilities, and redeveloping some existing dated facilities.

The increase in footprint, improved efficiencies and processing facilities appears to be appropriate to support the proposed increase in cargo throughput.

7.3 Fuel Storage

The airport is not responsible for the fuel infrastructure. However it is possible to increase the existing fuel farm provision at the midfield, from 6 to 12 tanks, and another site on the south of the airfield could also accommodate an additional 9 tanks.

This level of provision would appear to be sufficient to maintain adequate storage for the expanded airport, given it is a significant increase on the current provision. Furthermore, there is further land that may be utilised for expansion of these facilities if required.

7.4 De-icing Facilities

It is proposed that three de-icing pads be integrated into the parallel taxiway infrastructure at each runway threshold. This allows for multiple aircraft to be de-iced simultaneously at either end of each runway depending on weather conditions. Implementation of de-icing zones as indicated would be an improvement on the current situation in terms of reliability and resilience, and there is sufficient area to expand this further if required.

However, the de-icing pads sit within the safeguarded surfaces (but outside the obstacle free zone associated with a missed approach). This should be addressed at the detailed design phase and with appropriate operational procedures to ensure the safe operation of the airport.

It is also noted that the use of these pads will present a ground support operation challenge as each pilot is required to satisfy himself that his aircraft is in a safe condition to fly. This check is readily undertaken on stand, but may be more difficult to achieve on a remote pad. Nonetheless, the safety benefit of de-icing immediately prior to take-off is noted and it does not appear unreasonable to assume that an effective operation could not be configured that meets airline and pilot requirements.

7.5 Appraisal

7.5.1 Safety and Security

The cargo, fuel and de-icing infrastructure can reasonably be expected to be built to the prevailing safety and security standards at the time and so are likely to have no net effect on safety and security at the airport. The location and operation of the de-icing pads will have to be finalised at the detailed design phase to ensure that they can operate safely given their proposed location within the safeguarded surfaces and with respect to airline and pilot requirements. De-icing immediately prior to take-off would be expected to improve safety compared to de-icing on stand.

7.5.2 Capacity

Providing a doubling of air cargo area capacity when the airport forecasts around a 54% increase in total ATMs appears to be a reasonable response to possible future demand for air cargo. Given that the current constraint on cargo capacity is runway capacity, and that there is significant flexibility to develop capacity based on demand, the proposed provision appears reasonable.

Significant provision has been made for sites to allow for expansion of fuel storage to over three times the current capacity. This is likely to be scalable and will not be a restriction on the utilisation of the airport's capacity.

The proposed scope for de-icing facilities is an increase on the current provision. As de-icing facilities, by the nature of their operations, tend to be subject to demand peaks when required, it is likely that when required, the need for de-icing will constrain the airport's capacity. However, it is the prevailing climate conditions, not the lack of de-icing facilities, that creates this constraint, as de-icing adds time to the departure process. It would appear likely that if demand increase for such facilities, that there will be scope for additional de-icing facilities to be offered.

7.5.3 Efficiency

The proposed expansion of cargo, fuel storage and de-icing facilities are all likely to add to the overall incremental efficiency of the airport.

7.5.4 Reliability and Resilience

The proposed provision of additional fuel storage and de-icing facilities are likely to enhance the resilience of the airport in the event of disruption of fuel supplies and severe weather respectively.

The additional fuel storage would appear to exceed the requirement to maintain storage only at current levels. However the additional capacity would add resilience to the airport, in terms of the length of time that the airport could continue to operate in the event of an interruption to incoming fuel supply. Given the increase in total capacity, this enhanced resilience appears to be a reasonable approach.

The provision of the de-icing pads located within the departure process immediately prior to take-off should increase the resilience of the departure process, avoiding the need for an aircraft to return to a stand to be de-iced again should its taxi time from stand to runway have been delayed.

7.5.5 Scalability

The proposed expanded cargo, fuel storage and de-icing facilities are all able to be expanded further within the boundaries of the airport, according to demand.

8 Terminals

8.1 Concept of Operations

The scheme provides a phased set of improvements to terminal capacity as follows:

- *Additional runway and associated aircraft stands to allow greater utilisation of T3 and T5;*
- *Phased expansion of a new T6 with a satellite parallel to the new runway;*
- *Phased expansion of T2, with a new satellite to the east and two additional satellites to the west parallel to T5B and T5C.*

It is proposed to close T1 and T3 and replace them with the expanded T2. These expansions are intended to enable the airport to move progressively from its current maximum capacity to forecast capacity through a modular design.

The proposed concentration of development around the T5/T6 campus and the central terminal area (CTA) with T2 centralises most departure and arrival passenger movements onto two sites, referred to as the Western and Eastern Campus respectively, albeit with T4 retained for the time being.

Access to T6 is proposed from the access road system that currently serves T5 and the T5 railway/London Underground station complex. The expanded T2 will continue to be served by the CTA railway/London Underground stations complex and existing access road system expanded by a second tunnel access. As the current CTA landside access area could be observed as constrained by the surrounding airfield, a similar situation will be created with the T5/T6 campus development. Careful design of the forecourt will, therefore, be required to minimise bottlenecks at times of peak demand.

The scheme includes a tracked transit system (TTS) that would connect all terminals and piers (except T4) to facilitate passenger movements and transfer connections. This is a capital intensive solution, but one that would provide relatively fast travel times and would be a superior passenger experience compared to lower cost solutions such as airfield buses.

Currently T5A (the main processing terminal building) is connected in this way with its satellites: T5B and T5C. Departing or arriving passengers use the TTS to move to/from the aircraft from/to the main terminal where all passenger processes (e.g. security), retail and food and beverage (F&B) are located. Transfer passengers also use it on arrivals to access the transfer security screening in T5A before returning to their departing aircraft (which could be located at T5A, B or C). When a transfer connection is deemed time critical, it is possible for a passenger to be security screened in the pier itself.

Hence, at the moment, Heathrow operates with almost entirely “centralised” security, retail and F&B. Centralising these facilities results in a better usage of staff and facilities themselves. However, for transfer passengers, the journey to/from the main terminal might be observed as being relatively long. It should be noted that piers T5B, T5C and T2B do have some limited retail and F&B, but not to the same extent and range as in the main terminals’ departure lounges.

The scheme proposes that the airport operates decentralised security, retail and F&B to enhance transfer passengers' experiences and make connections easier. Every transfer passenger would be screened at the departing flight pier. Operating in this way mainly impacts the provision of security checkpoint lanes, retail and the design of the TTS.

8.2 Phasing

The proposed phasing of development is in six steps comprising the following stages:

- *Additional aircraft stands – capacity of 80 mppa;*
- *Phase 1 of T6A and T6B and closure of T3 – capacity of 85 mppa;*
- *Phase 2 of T6A and T6C – capacity of 100 mppa;*
- *Opening T2E and Phase 2 expansion of T2A – capacity of 110 mppa;*
- *Opening T2D – capacity of 120 mppa;*
- *Opening T2C and Phase 3 expansion of T2A – capacity of 130 mppa.*

These stages build upon and partially overlap the development of the "toast rack" two-runway master plan that HAL intends to follow irrespective of whether the Heathrow Northern Extension scheme is approved.

8.2.1 Terminal 6

T6 is planned as a facility to the west of T5 to largely replicate the concept of T5 and its satellites. Since the proposed gross floor area and concept of operations is similar to T5, there is no reason to assume it cannot replicate T5's current capacity of 35 mppa.

8.2.2 Terminal 2

It is proposed to expand T2 incrementally to become ultimately the only terminal in the current CTA (Eastern Campus), replacing T1 and T3. The existing terminal building (T2A) is planned to be expanded in a modular manner, with new satellites built parallel to it to enable a continuous 'toast rack' layout from the Eastern to Western Campuses. This approach corresponds with the two runway master plan proposed by HAL in 2012.[13]

8.3 Sizing

Following the approach set out in Section 2.7, the passenger service standard implicit in the space allocation by design hour passenger was assessed for each development phase. Table 8-1 on the next page presents a summary of that analysis. Note that phases have been named to reflect the most important change (e.g.: T3 demolition is included in the figures but not mentioned in the caption).

[13] Heathrow Strategic Capital Business Plan 2013: http://www.heathrowairport.com/file_source/HeathrowAboutUs/Downloads/PDF/SCBP-2013/strategic-capital-business-plan-2013_full-document_LHR.pdf (accessed August 2014).

Phase	GFA (m^2)	Capacity (mppa)	DHP	Space Planning Factor (m^2/DHP)
Existing	971,000	80	22,000	44
With T6 Phase 1	1,030,300	85	23,375	44
With T6 Phase 2	1,216,500	100	27,500	44
With T2 Phase 2	1,441,500	110	30,250	48
With T2D	1,486,500	120	33,000	45
With T2 Phase 3	1,621,500	130	35,750	45

Table 8-1 Proposed Terminal Sizing and Space Allocation

Given that the GFA is a difficult number to pinpoint exactly, for reference a 5% increase or decrease in floor area would correspondingly increase or decrease the space planning factor by 2.2m^2/DHP.

With reference to Section 2.7, Table 8-1 and Figure 2-1 demonstrate that the airport, at its current capacity, operates at a reasonable level of space allocation that appropriately reflects the nature of its operation and types of airlines that use it. Throughout the phases, the resulting level of space allocation improves slightly over the longer term. This level of service can be regarded as towards the upper end for a typical western European gateway airport.

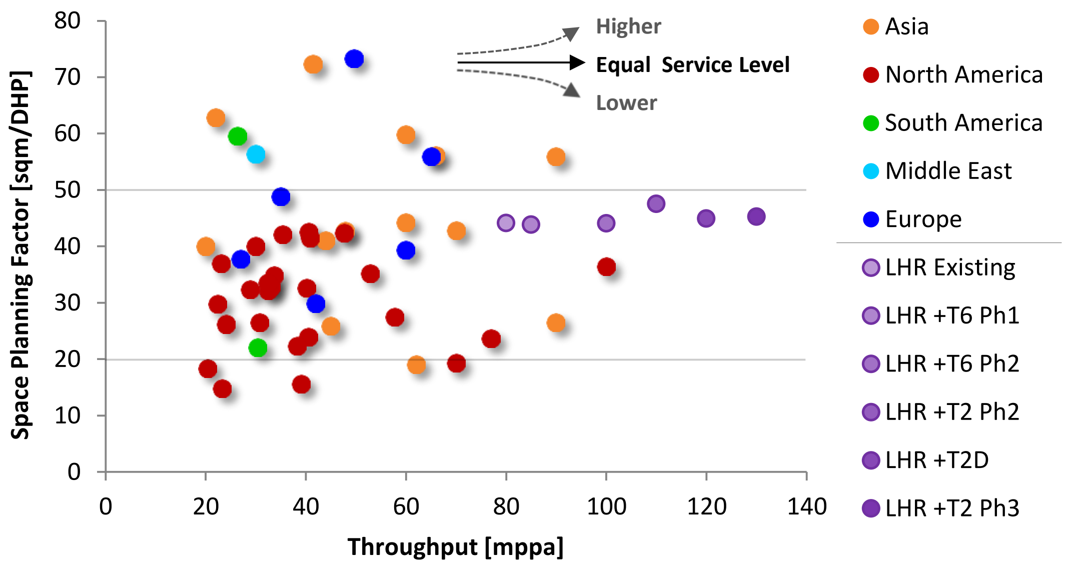

Figure 8-1 Space Planning Factor for Airports with more than 20 mppa, Showing All Phases of the Proposed Scheme

It should be noted that this benchmark serves as an indication of space provision. Two factors can have an impact on the level of space provision and level of service experienced in two airports close to each other in the benchmark: the number of international and, to a lesser extent, transfer passengers. As the former require separate facilities as opposed to domestic passengers (immigration for example) and their dwell times are often longer, more space ought to be provided within the terminal building. Similarly transfer passengers require separate facilities and longer dwell times can be observed to increase the space requirement of the terminal. As the scheme is already acceptable in terms of space provision, there are no significant potential issues with the proposed volume of international and/or transfer passengers transacting at these terminals.

8.4 Departures

Although a detailed analysis has not been undertaken there is no reason to assume that the departures capacity of any of the terminals would not be acceptable. Four areas or processes are discussed in more detail below.

8.4.1 Check-In

Over the past 10 years, the check-in process has changed significantly, mainly driven by technology enhancements such as ease of internet access and smartphones. Given these developments (e.g. self-service check-in, bag drop, bag tagging at home, remote check-in, permanent bag tags, etc.) it is likely that the current requirements for the design of the check-in area and the hall as a whole will change.

It is likely that less space will be required for a passenger to check-in hold baggage. Given that assumption, it is likely that different functions may be provided instead. It is therefore important that this area remains flexible in terms of its design. Within the footprint of all of the expanded and new terminals, it appears that there is sufficient space for a check-in hall to meet the proposed capacity of the airport.

8.4.2 Security

Similarly security regulations have changed significantly over recent years. These changes have significantly influenced process and space requirements for security at terminals. As it is likely that change will continue, it is similarly important that this area be designed to be as flexible as possible.

Given that the scheme facilitates passenger movement and transfer connections between terminals and piers via an underground TTS, every transfer passenger will be screened at the pier of departure. In order to facilitate this, every pier will need to have sufficient security lanes. However, history has shown that volumes of transfer passengers tend to be volatile: there are large variations throughout the day and even between similar days of the week or season. This makes it more difficult to plan staff and design facilities accurately. At centralised facilities, the aggregation of these streams of passengers ensures that the total is less variable. However, with a security checkpoint at each pier, designing sufficient lanes for the design hour of the year becomes more difficult, as there is a need to understand all of the intricacies of transfer passengers, aircraft stands and airline splits between piers. This will have an operational cost consequence as well as capital infrastructure requirement.

8.4.3 Gates and Retail

The scheme provides gate operations that would be similar to the existing open gate system in T2 and T5.[14] Passengers would be able to access the gate of departure at any point until boarding closes. This enables flexible use of available seating and standing capacity, and allows passengers to make maximum use of available time for retail and F&B purchases. However, it can slow boarding as some passengers

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[14] The exception is gates for flights to destinations that require additional passport control (e.g. USA, Israel)

may choose to leave the gate area (or not arrive at it until the final call) to utilise other terminal facilities.

Open gates tend to be favoured by airports as they increase the likely exposure of passengers to retail facilities (as passengers in closed gates are restricted from leaving them), and also because they increase gate flexibility as seating at gates with lightly loaded or smaller aircraft is available for passengers on heavily loaded or larger aircraft at nearby gates. Passengers are more likely to prefer open gates given the increased freedom of movement available. Airlines prefer closed gates because of the increased likelihood of more reliable boarding times.

Similar to the security decentralisation, retail will be decentralised for transfer passengers and be provided in every terminal and pier. However, as the proposed terminals and satellites will have a similar design to the existing ones at Heathrow, they are likely to operate at a sufficient level of service to all passengers.

8.5 Arrivals

The most important arrivals processes are immigration and baggage reclaim. The former is managed by UK Border Agency and is largely outside of the airport's control. Baggage reclaim is largely dependent on the number of checked-in bags. There is no reason to assume that the proposed expanded terminals would not be able to manage the capacity stated for arrivals.

8.6 Transfers

The scheme facilitates transfers within terminals by decentralising transfer security at all terminals and satellites. Passengers transferring within a terminal building/satellite will be expected to do so by passing through security at that building and then entering the departure lounge. Passengers transferring between terminals/satellites will use the proposed TTS system between buildings and then use security at the destination building to enter the departure lounge. Baggage will be transferred through a dedicated system as at present.

An assessment of minimum connection times (MCTs) has been undertaken to determine the reliability of the proposed transfer times. IATA Resolution 765 defines the MCT Interval as the shortest time interval required to transfer a passenger and luggage from one flight to a connecting flight, in a specific location.[15] This time interval should allow for a reasonable amount of queuing at the processes encountered by the transfer passenger.

The MCT is commercially important as it determines the lower limit of time between flight pairs that may be sold by airlines in a single ticket. These MCTs have to be agreed by a working group (the Local Minimum Connecting Time Group or LMCTG).

An analysis of each step an international to international transfer passenger would take for the longest conceivable transfer (T2C to T6B) is summarised in Table 8-2 on the next page.

Excluding any form of queuing and assuming no dwelling by these passengers, the MCT could be 64.4 minutes. A more conservative assessment allowing for queuing times at various steps would result in a MCT of 73.2 minutes. Additional queuing or

[15] Source: IATA Passenger Services Conference Resolutions Manual 30th edition, June 2010.

unforeseen situations that occur on day-to-day operations are not included in this time as it is seen as a minimal connection time. It should be noted that passengers transferring to a domestic flight would require longer as they would need to go through immigration. Transfer to/from T4 is likely to take longer too as it would not be connected to the TTS linking the other terminals and piers.

Process Element	Analysis (minutes)
Disembarkation	15.0
Transfer connection desk	3.0 to 6.0
Walk to TTS platform	6.3
Wait for TTS	2.0
TTS to T6	18.3
Walk to transfer security	2.5
Boarding pass check	0.2 to 1.0
Transfer security	0.5 to 5.5
Walk to gate	11.6
Arrival at gate pre-closure	5.0
Total	**64.4 to 73.2**

Table 8-2 Transfer Process Elements and Times

8.6.1 Baggage Handling for Transfers

The baggage MCTs were estimated as total MCTs require baggage as well as passengers to be transferred in a timely manner to reach the connecting flight.

The scheme connects all terminals and piers via underground baggage tunnels that would allow bags to be transferred around the airport without requiring airside vehicles. For departing bags, a destination coded vehicle (DCV) system is proposed which delivers each bag on a separate tray to the head of the aircraft stand or to the centre of a pier. From those make-up areas bags or universal load devices (ULDs) will be transported and loaded to the aircraft. For arriving bags, it is acknowledged that the choice between the existing tug-and-dolly system or a DCV system, would be determined in a detailed planning and business case exercise.

As the whole airport will be connected by the DCV system, the travel times for bags will be significantly reduced, similar to the TTS system for passengers. However, this integrated approach is relatively capital intensive and more susceptible to system failures than a more disaggregated one. An IT problem in one of the terminals might cause problems in other tunnels, piers or terminals for example. Furthermore, there is only a limited number of DCV trays present in the system. Therefore, this would have to be designed appropriately but may still cause problems in unforeseen situations (e.g. if a significant amount of bags are being checked in, but aircraft are unable to depart). Finally, only one tunnel is proposed between T5 and T6 (and its pier) and between T2 and its piers. This may create problems should tunnel capacity become disrupted and there is a risk of decreased reliability compared to the current operations: for example two tunnels are provided between T5 and its piers.

8.7 Tracked Transit Systems

The scheme includes a new airside TTS to facilitate access between terminal buildings and satellites, in addition to the existing system between T5A and T5B/C.

It is a critical element to providing rapid access from terminal buildings to the proposed satellites for T6 and T2, but also for facilitating transfers between flights.

Departing passengers will be transferred after security to the respective satellites “clean” (UK security screened). For arriving passengers, the proposed system will transfer them “dirty” (not UK security screened) to the respective terminal building to clear immigration, collect baggage and clear customs. However, the proposed system will mean that on certain parts of the network at any one time it could be carrying a mix of “clean” passengers and “dirty” passengers to satellite buildings. The TTS will therefore be required to segregate these different groups of passengers, so that the “dirty” passengers are screened at the satellite security facility, but not “clean” passengers. New technology may be available to accelerate this process, although this should not be assumed. As a result, it is possible that 6 car trains may be required as opposed to 5 with automatic screening.

Furthermore, because of the passenger segregation and the transport of “dirty” and “clean” passengers, the platforms will also need to facilitate appropriate segregation. Not dissimilar to the centralisation/decentralisation discussion above, the appropriate design and provision of segregated platforms, corridors and potentially vertical circulation cores requires detailed knowledge of the volatile streams of transfer passengers. Furthermore, TTS platforms and vertical circulation cores can be regarded as relatively inflexible, i.e. once designed and built it is difficult to vary capacity.

It appears possible to design the airside TTS to deliver the required capacity, but there are some potential risks in the proposed concept that need to be addressed in the design of the TTS, its platforms, corridors, vertical circulation cores and operational procedures.

8.8 Appraisal

8.8.1 Safety and Security

The proposed designs for the terminals appear consistent at this stage with the construction of safe and secure terminals. It is reasonable to assume that at the detailed design phase, the latest standards for construction, fire and other hazard safety and security will be incorporated in the design.

8.8.2 Capacity

The scheme increases terminal capacity progressively after the opening of the new in-line runway with the major increase in capacity arising from the opening of T6. Beyond this opening phase, the proposed phased development of T6 and T2 and their satellites would appear to provide adequate terminal capacity to service the proposed runway capacity.

The proposed T6, expanded T2 and their satellites would appear able to deliver a good level of passenger experience (based on floor space per passenger) similar to that experienced at the airport today. It is likely that the overall passenger experience will improve substantially on the opening of new terminal capacity and moderate as that capacity is used, but remaining at an acceptable level at the stated capacity.

Many of the gates at the proposed expanded terminal system will be MARS compatible and sufficiently flexible to support a wide fleet mix, ranging from Code C or smaller aircraft through to Code F.

8.8.3 Efficiency

The proposed T6 and expanded T2 appear able to provide an efficient operation to meet increased demand.

The proposed new T6 and its satellite would appear to be able to provide an efficient operation, with the satellite most efficiently supporting utilisation of the new runway.

8.8.4 Reliability and Resilience

The proposed T6 and satellite, and the expanded T2 should be capable of providing similar or better levels of reliability than at present, in part due to the increased efficiency of the proposed ‘toast rack’ layout, but also because of the significant increase in supply of gates suitable for a wide variety of aircraft.

Improved links between the CTA and T5/T6 will improve resilience by providing alternative access to and from the CTA should the tunnel be out of service.

It is estimated that the MCTs are likely to be around 64 to 73 minutes.

The proposed TTS presents challenges to detailed design and to resilient operations seeking to segregate “clean” and “dirty” passengers within one train and through the station infrastructure. Whilst this could be designed to operate well if all elements of the process, including the passenger, follow the correct process, the system may be somewhat less resilient to errors (for example a passenger who fails to exit the TTS at his/her correct satellite) or to system disruption. This however could be mitigated by careful design.

8.8.5 Scalability

The proposed T6 and its satellite, and the expansion of T2 and three new satellites are all proposed to be constructed in phases. Within each phase, the opportunity would exist to scale stands and passenger processing facilities to meet different mixes of aircraft types, and to match terminal design to aircraft demand. The modular nature of T2 lends itself to additional expansion.

Given the constraints of the site, there appears to be little scope to expand terminal capacity further to the west, beyond the proposed T6C, without building over the M25. Other options to expand terminal capacity are also constrained, such as the possible reutilisation and redesign of the T4 site or the area to the east of T2.

9 Comparison with Demand Scenarios

The Airports Commission has developed a range of demand scenarios that consider a range of forecast drivers and their impact upon demand at Heathrow Airport. Additional airport infrastructure would be required at different points in time depending on the particular demand scenarios. The runway and associated airfield infrastructure is dependent on the forecast ATMs whereas the terminal development depends on forecast passengers. The date of opening of the third runway and associated infrastructure is further dependent upon the relevant regulatory and planning processes.

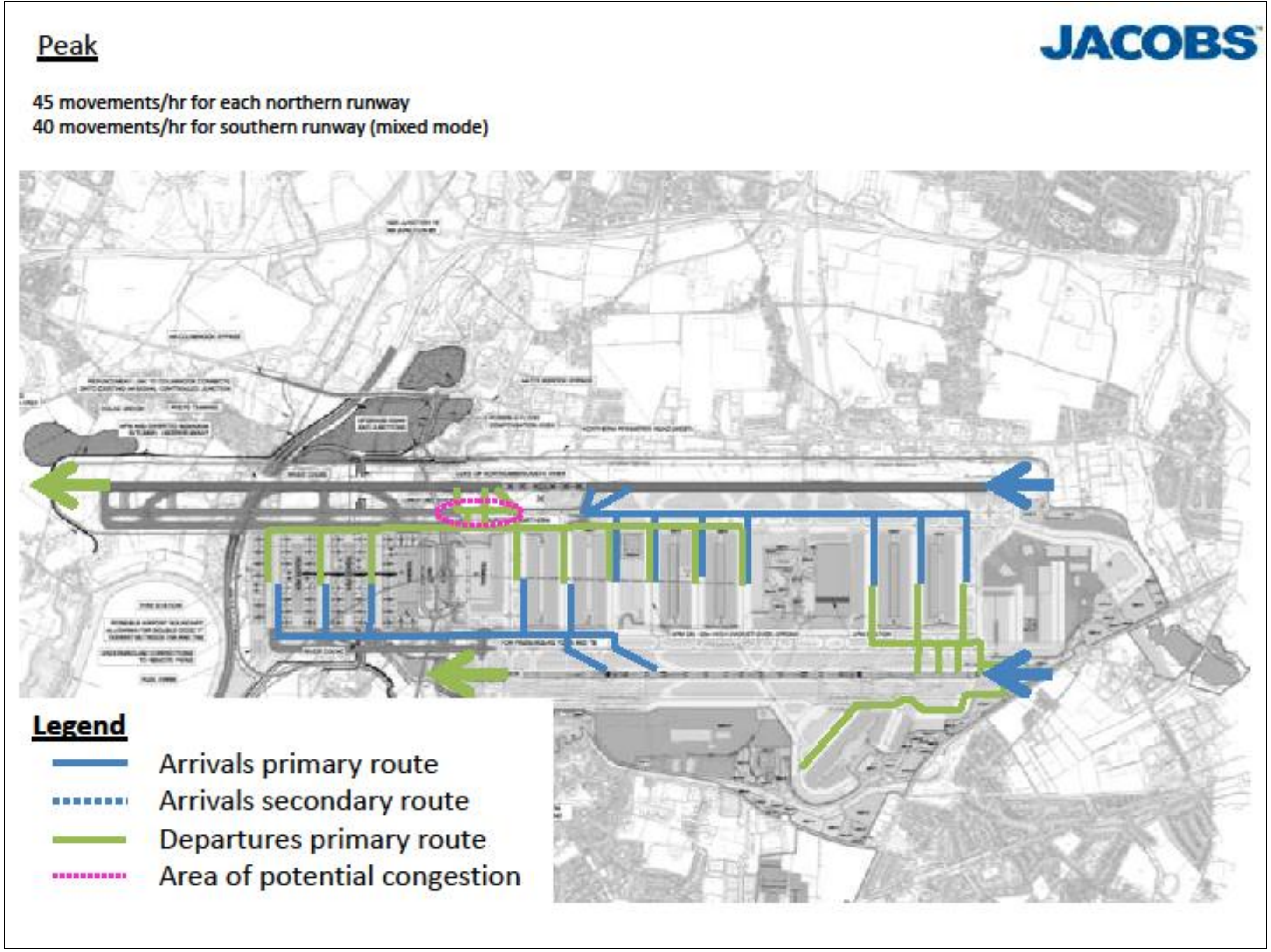
As described in Section 8.2, the terminal development is designed to be modular so allowing the provision of infrastructure when required by the forecast. The scheme provides each phase of additional capacity in line with demand such that the passenger service standard is maintained as set out in Figure 8-1.

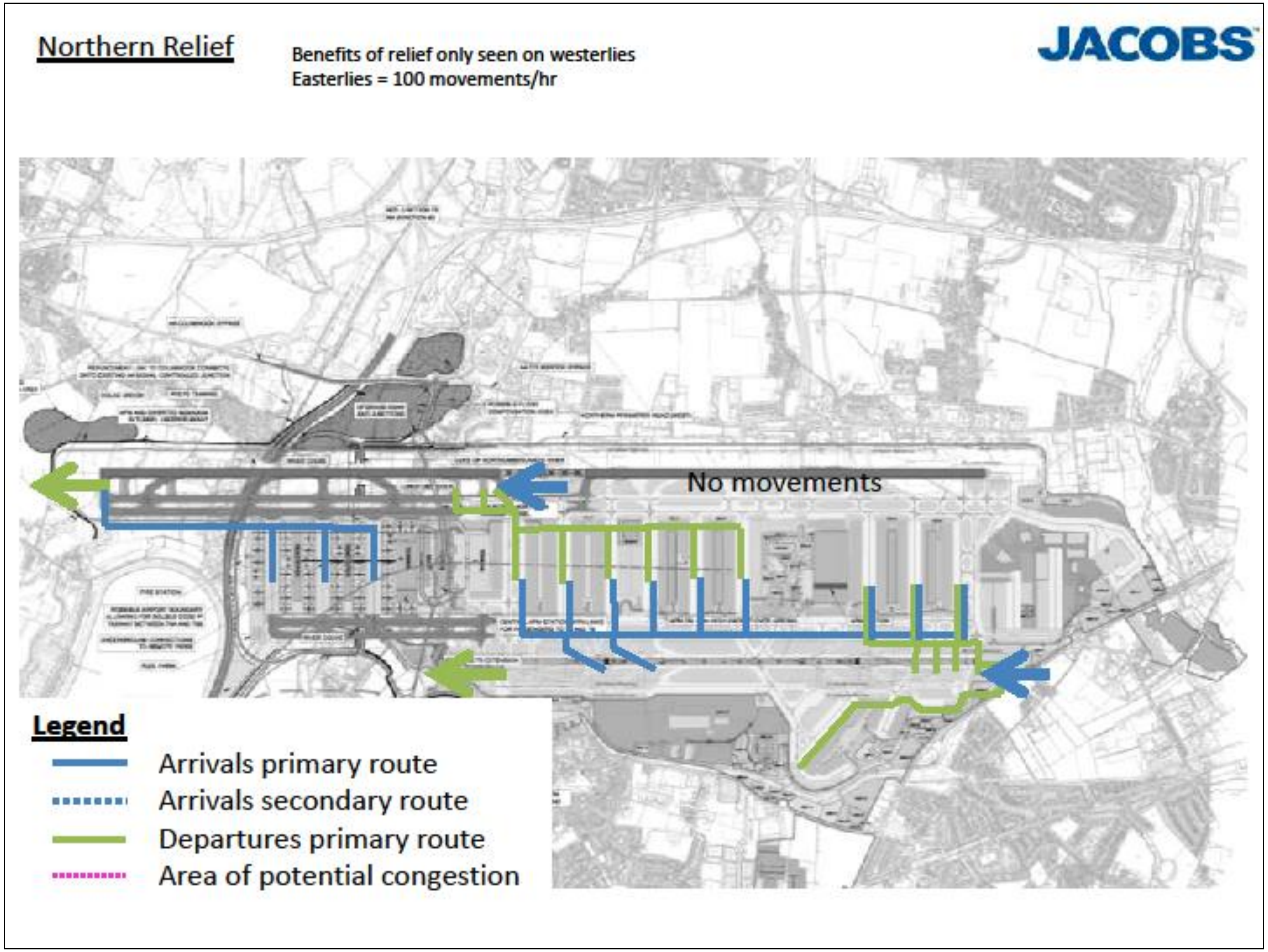
It is noted that the majority of scenarios considered forecast passenger throughput to reach around 125 to 130 mppa by 2050. However, it is also noted that the "Global Growth Carbon Traded" forecast predicts 142 mppa by 2050 resulting in an additional 12 mppa above design capacity. Against such a growth scenario, it would be expected that the airport would seek to expand terminal capacity beyond the current design capacity of the scheme. In the absence of such additional capacity the space planning factor would reduce to 42 which, although still a good passenger service level, is lower than today's. This would be likely to mean that longer queue times than today would be observed, increasing congestion, reducing reliability and resilience, and, given the reduction in airside dwell time, reducing non-aeronautical income.

Appendix A Glossary

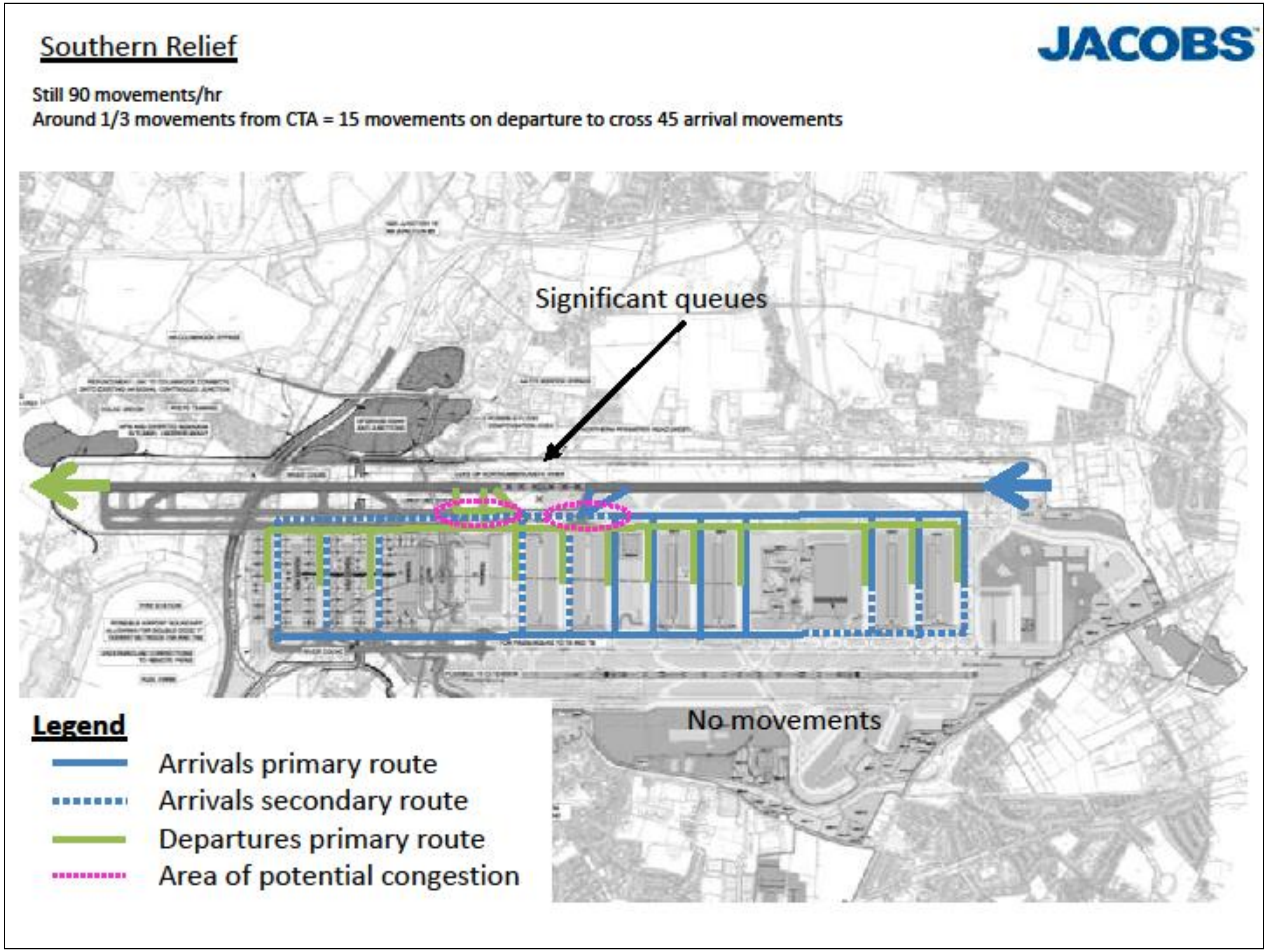
ADRM	Airport Development Reference Manual, IATA
AGL	Aeronautical ground lighting
APM	Automated people mover
ASDA	Accelerate-stop distance available
ATC	Air traffic control
ATM	Air transport movement
CAA	UK Civil Aviation Authority
CAT II	ICAO ILS category with a Runway Visual Range of at least 1,200 feet, and Decision Height of between 200ft and 100ft
CAT III	ICAO ILS category with a Runway Visual Range of 700 ft, 150ft or zero respectively (for CAT III a, b or c), and Decision Height of less than 100ft.
CTA	Central terminal area
DHP	Design hour passenger(s)
EAT	End around taxiway
EASA	European Aviation Safety Agency
GFA	Gross floor area
HAL	Heathrow Airport Limited
HH	Heathrow Hub Limited
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ILS	Instrument landing system
LDA	Landing distance available
MARS	Multi-aircraft ramp system
MCT	Minimum connection time
MPPA	million passengers per annum
MTOW	Maximum Take Off Weight
NATS	UK National Air Traffic Services
OFZ	Obstacle free zone
OLS	Obstacle limitation surface(s)
PSZ	Public Safety Zone
RAT	Runway/rapid access taxiway
RESA	Runway end safety area
RET	Rapid exit taxiway
RIL	Runway Innovations Ltd
SID	Standard instrument departure route
STAR	Standard arrival route
TOCS	Take-off climb surface
TORA	Take-off run available
TODA	Take-off distance available
TTS	Tracked Transit System

Appendix B Operational Mode Diagrams





Northern Relief
Benefits of relief only seen on westerlies
Easterlies = 100 movements/hr
JACOBS
No movements
Legend
Arrivals primary route
Arrivals secondary route
Departures primary route
Area of potential congestion


Southern Relief
Still 90 movements/hr
Around 1/3 movements from CTA = 15 movements on departure to cross 45 arrival movements
Significant queues
No movements
Legend
Arrivals primary route
Arrivals secondary route
Departures primary route
Area of potential congestion

JACOBS

Appendix C Scheme Changes Compared to the Heathrow Hub Proposal

The following is a summary of the key differences between the Heathrow Extended Northern Runway scheme as described in this document, and the proposal submitted by Heathrow Hub Ltd/Runway Innovations Ltd to the Airports Commission. It also explains the reason why the scheme as described in this document is different from that submitted by the promoters.

- ***Full dual parallel taxiways provided to the western end of pavement**. In the June 2014 submission the dual taxiway extended approximately half way to the end of the pavement, with an option to extend in the future. In order to provide greater flexibility for sequencing of aircraft on departure, and to accommodate simultaneous arrival and departure flows, full dual parallel taxiways are now included in the scheme as part of the first phase of development;*

- ***Dual taxiway to the south of T5/T6**. The June 2014 submission showed access to the T6 aprons via taxiways to the north of the terminal buildings. In order to avoid congestion and to improve airfield resilience, the scheme now includes a dual taxiway network to be extended to the south of T5/T6, thus improving aircraft ground circulation;*

- ***Runway Links**. Runway access links have been incorporated in the scheme to improve the ability to sequence aircraft on departure. Rapid Exit Taxiways have been incorporated in the scheme to facilitate aircraft movements during peak times;*

- ***T6 Apron Layout**. A revised apron layout has reduced the number of stands pushing-back onto the dual parallel taxiway network. Most stands in the scheme now push back into taxilanes (as currently provided across the majority of T5 and T2 under the HAL master plan); and*

As set out in the Airports Commission's Interim Report, the transport hub element of the proposal has been treated as a distinct separate component. Many of the effects arising from the transport hub have little impact on airfield infrastructure. In particular, it was assumed that the Automated People Mover (APM) in the proposal is inherently linked to the transport hub and is, therefore, not included within the scheme description. Reference should be made to the Appraisal Module 4. Surface Access: Heathrow Airport Hub Station Option and Surface Access: Heathrow Airport Extended Northern Runway reports.

Appendix D Summary Appraisal

Element	Safety and Security	Capacity	Efficiency	Reliability and Resilience	Scalability	Comment
Proposed runway	• Proposed runway concept is unproved and not included in international or national regulatory instruments for runway design and safe operation. • International, European and national regulatory approval would be needed.	• Declared distance may restrict departures for some heavy Code E aircraft. Detailed design may enable the Sterile Zone between the two northern runways to address this, or operational procedures would restrict such departures to the southern runway.	• Both northern runways restricted to operating in segregated mode dependent on each other, unless one is closed, enabling the other to operate in mixed mode.	• Higher risk that an incident on one of the in-line runways will constrain or close the other in-line runway.	• Options to build another in-line runway to the west of the southern runway, or to build a new southwest runway or northwest runway similar to the Heathrow North West Runway scheme. • All options are likely to be disruptive and challenging.	
Proposed runway RESA						
Existing runway/s amended	• Proposed runway concept is unproved and not included in international or national regulatory instruments for runway design and safe operation. • International, European and national regulatory approval would be needed.	• Declared distance may restrict departures for some heavy Code E aircraft on the existing northern runway. Detailed design may enable the Sterile Zone between the two northern runways to address this, or operational procedures will restrict such departures to the southern runway.	• Both northern runways restricted to operating in segregated mode dependent on each other, unless one is closed, enabling the other to operate in mixed mode.	• Higher risk that an incident on one of the in-line runways will constrain or close the other in-line runway.	• Option to extend southern runway as another in-line runway, although this may be challenging given presence of proposed M25 tunnel to the north.	
Existing runway RESA						
Runway Approach Lighting	• Careful design needed to ensure approach lighting for in-line runways is interlocked and not confusing for pilots					
Public Safety Zones	• PSZs between the in-line runways overlap and would include taxiing aircraft. This would need to be addressed in detailed design and require regulation amendment.				• Further expansion of the PSZs would require the airport to obtain control of land currently outside the airport's boundaries.	
Aerodrome Safeguarding System – Protect surfaces	• Transitional surfaces include existing penetration of ATC tower. The need for secondary control towers would need to be considered in detailed design.					
ATC and Navigational Systems	• Safeguarded areas for ILS glide path aerials to be identified at detailed design phase.				• Expansion would involve iteration with designs for taxiways	

Element	Safety and Security	Capacity	Efficiency	Reliability and Resilience	Scalability	Comment
Taxiways		• Detailed airfield modelling could help develop appropriate operational procedures to mitigate potential pinch points in the taxiway network.				
Stands and Aprons						
Cargo facilities						
Fuel storage						
De-Icing Facility						
Existing terminals					• Primarily scope to expand T2 site subject to closure and demolition of T1 and T3.	
New terminals						
Transfer facilities				• Unable to support proposed MCTs before TTS complete between T6/T5 and T2 satellites.	• Complexity of proposed operations may limit flexibility to manage substantial asymmetries in demand.	
M25 tunnel					• Once completed additional western extension of airfield across M25 may become particularly challenging.	

Not applicable

Significant issues with no identified resolution or mitigation.

Significant issues, options to address are difficult/complex

Minor issues, but can be addressed during detailed design phase, or by dispensations or specific operational procedures

No significant issues/limitations, subject to finalisation at detailed design phase