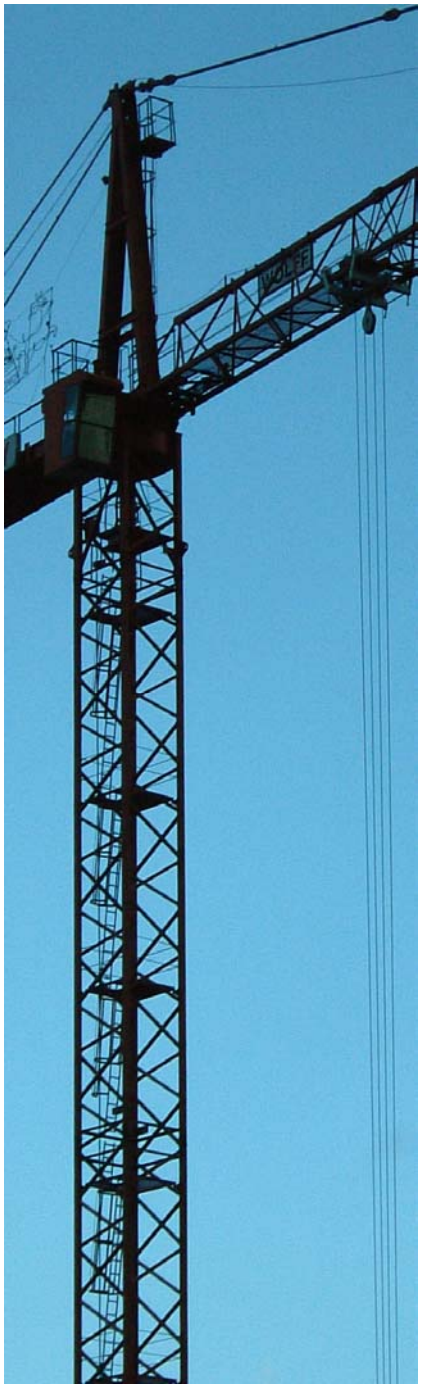

Review of Dublin Airport Authority Capital Expenditure Programme (CIP 04)

For

The Commission for Aviation Regulation

Report No. 4 – Review of DAA Terminal Sizing

16th May 2007

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rr

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0651	1	Final Issue	18th May 2007	RTA	GJB	None	CAR

1. Introduction / Scope:

Rogerson Reddan & Associates Ltd., in conjunction with Vector Management Ltd., (RR&V), have been commissioned by the Commission for Aviation Regulation, (CAR), to undertake a review of the sizing of the new Terminal 2 proposed by Dublin Airport Authority (DAA

This review was undertaken based on information and documentation provided by the DAA, along with DAA responses to written questions, these are included in Appendix B.

RR&V were appointed in early April 2007, with a timescale requiring completion of the review and reporting by end of April 2007 (subsequently extended to 17th May 2007).

It should be noted that in any review such as this, carried out to a tight timescale, we are dependant on being provided with comprehensive and accurate information by the parties involved. We have relied in the performance of our services upon information and documentation provided to us by the DAA and other parties engaged by the DAA.

We have relied on the DAA to check properly beforehand that any information provided to us is complete, current, true, fair and accurate and not misleading. We have, as far as it remains within our expertise, considered and relied upon such information provided by the DAA, the content of which we have reviewed in the context of our role under this appointment. It is not possible, however, to warrant that such information is correct. In certain instances relatively little information has been made available and consequently this report should be read on the strict understanding that it is issued on that basis.

We would stress that our analysis has been confined to assessing DAA's assumptions, methodologies and planning parameters with to regard to how these impact on the sizing of the proposed Terminal 2 processor building at Dublin Airport. In this analysis we do not consider any residual capacity in T1, neither do we consider the form, geometry or location of T2 as this is outside our current scope of works. We would also point out that in our analysis we have not analysed the proposed Pier E as this requires a more detailed study as a result of the operational relationship between Pier E and the other Piers at the airport as these are all linked airside.

Phase 2 terminal requirements have not been analysed or assessed in this report as this is outside of our scope and also outside the current CIP.

2. Executive Summary:

This summary highlights our key findings and is intended to be read in conjunction with the remainder of the document. It should not be relied on a sole basis.

In order to assess the sizing of Terminal 2 we have reviewed and analysed DAA's methodologies and assumptions primarily with regard to forecast schedules, forecast busy hour rates and the translation of these into terminal requirements. This section of the report summarises our key conclusions from each of the key sections of our report.

In analysing DAA's annual traffic forecast scenarios we have found it difficult to reconcile DAA's 2013 design capacity of 11.4mppa[1]. Our analysis shows that this level of demand could be reached as early as 2010. In assessing DAA's Scenario C we estimate that a throughput of between at least 13.1mppa and 13.5mppa (depending on whether CityJet are included in T2) would be more consistent with DAA assumptions.

In order to establish a future design flow DAA developed a 2006 schedule as a basis for forecast phase 1 and phase 2 schedules, the design busy hours were then derived from these schedules. Vector Management Limited (VML) has not been convinced that the methodology used to develop the DAA 2006 schedules produce suitable busy hour passenger flows. There are several issues relating to the methodology utilised by the DAA that may explain the apparently high passenger design hour rates that have been forecast for both 2006 and 2013, namely:

- The 2006 schedule was apparently based on 2004 and 2005 busy aircraft movement days;
- The schedule peaks were apparently not developed with reference to either historical 95th percentile passenger or aircraft movement busy hour values;
- The load factors used to derive passenger hours were apparently not developed with reference to historical load factors corresponding to 95th percentile passenger busy hours;
- The bottom up schedule based analysis does not appear to have been complemented by a high level top down ratio analysis.

It is common practice, when planning terminals to adopt the 95th percentile busy hour (5% BHR) for forecasting future design passenger flows. In our own analysis of 2006 historical

1 Million passengers per Annum

data, based on an analysis of the hours immediately around the 95th percentile passenger BHR[2] we have been unable to replicate a value similar to the 157.1 pax/ATM[3] ratio implicit in the DAA 2006 schedule. We note that the actual 2006 95th percentile passenger busy hour was 1,660 compared with the DAA's assumed 2006 schedule projection of 2,200.

The DAA forecast 2006 base passenger BHR of 2,200 appears to be more representative of a 99.73th ranked percentile and designing a terminal to meet such a highly ranked percentile is not normally considered to be an efficient and economic use of terminal space.

Furthermore our analysis has also shown that the relationship between the DAA forecast busy hour passenger flows and forecast annual throughput increases from 0.063% in 2006 to 0.080% in 2013 (this is based on a throughput of 11.4mppa). We find this increase surprising as in our experience we would expect to see this ratio decline; this would also indicate that the forecast design flows for T2 are higher than expected and that DAA's forecasts may not be internally consistent.

We are also concerned that DAA's bottom up schedule based analysis does not appear to have been validated by a high-level top down analysis. When benchmarked against a number of other international airports and DAA's own historic performance, the DAA forecast design passenger hours appear to be very high and do not conform to any values that Vector has experienced, even allowing for peak congestion or unconstrained growth.

Vector (VML) engaged specialist traffic consultants Aviation Economics (AE) to undertake an independent review of the forecast schedules produced by DAA. Aviation Economics detailed scheduled analysis also indicates that the busy hour forecast for T2 in 2013 is constructed from a number of assumptions at the high end of expectations and this has resulted in an "*inflated*" busy hour forecast for T2 of 4,144 passengers / hour.

AE have concluded that a combination of small changes to the schedules and an adjustment to load factors could feasibly reduce the forecast peak hour flow to 3,062/php without materially impacting Aer Lingus either operationally or financially.

From our own analysis of historical data VML has also calculated a range of possible alternative busy design flows in order to assess the impact on terminal size.

2 Busy Hour Rate

3 Passengers/ Air Traffic Movement

Vector would expect the 2013 passenger busy hour equating to 11.4 mppa T2 (10.5 mppa EI[4]) to be in the region of 2,716 (value of central scenario). DAA's value of 4,200 is some 55% higher than this. The reasons for this difference appear to be due to the following factors:

- As stated previously the 2006 base schedule does not appear to produce a representative 95% pax BHR
- The 4,200 schedule does not appear to be internally consistent with an annual passenger throughput of 11.4 mppa;
- And / or the 4,200 schedule projection does not appear to be internally consistent with the 2006 schedule.

Using the range of possible alternative busy design flows Vector was able to carry out a high level analysis of terminal space requirements that would indicate it could be possible and feasible to reduce the size of the T2 terminal processor;

- Based on a 2,534 departure passenger busy hour and 11.4mppa throughput (10.5mppa EI) it could be feasible to build a terminal of 44,607m^2, or some 40% smaller than the proposed T2;
- Alternatively if T2 were designed for airlines other than Aer Lingus, based on a 1,849 departure busy hour and 11.4mppa throughput (assumes non EI airlines) it could be possible to build a terminal of 32,541m^2 or some 56% smaller than the proposed T2.

We also considered in our analysis a suitable terminal size for a throughput 13.2mppa (based on the DAA Centreline, 12mppa EI) and a revised BHR established in our assessments of schedules;

- Based on a 2,897 departure passenger busy hour it could be feasible to build a terminal of 50,980m^2 or some 32% smaller than the proposed T2;
- Based on the AE assessment of departure passenger busy hours it could be feasible to build a terminal in the range of 51,445m^2 – 53,891m^2.

Our high-level analysis of the proposed level of service concluded IATA[5] Level of Service C to be an appropriate design standard and does not materially result in over provision of terminal space, as it only relates to queue zones and waiting areas. In general we are also

4 Aer Lingus

5 International Air Transport Association

satisfied that the key terminal planning parameters, such as processing times, are appropriate for the proposed airline occupancy strategy.

Our high-level analysis of runway capacity has raised a number of issues around the capacity of the current runway system and proposed future runway system. We have not been convinced that there will be sufficient runway departure slots available to meet the forecast schedules ahead of the opening of the new parallel runway. Even with the additional capacity generated from the new runway we have concerns about the ability to meet the forecast schedules post 2012.

3. Scope of Review:

High Level Review of Overall Terminal Sizing

Our deliverable, which is intended to assist CAR in preparing their Interim Review included the following, based on the assumption of an early meeting with DAA and that detailed information was made available in a timely manner:

1) A review of the DAA's Future Schedule, Traffic Forecasts & Busy Hours including:
   a) Commentary on the traffic forecasts and airline strategy underpinning the schedule and the likely risks associated (in conjunction with Aviation Economics) including:
      i) Review of existing passenger and hourly demand forecasts;
      ii) Analysis of the underlying strategy and logical consistency of these forecasts;
      iii) […….]
   b) Commentary on whether the schedule day represents an appropriate busy day;
   c) Internal consistency of the schedule in relation to the fleet plan, routes and airline strategy as well as runway capacity;
   d) Consistency of the hub strategy (arriving and departing waves);
   e) Comparison with the current schedule for proposed T2 occupants;
   f) Comparison with the current and future schedule of non T2 airlines (if available);
   g) Comparison of the resulting busy hours (pax and aircraft movements) resulting from this schedule compared with one based on current traffic profiles;
   h) Comparison with busy hours for selected international airport terminals and hubs.

2) A review of the DAA terminal sizing calculations and verification for internal consistency based on stated parameters. This assumes an early meeting with DAA and that relevant information is made available in a timely manner:
   - A high level view of the capacity that could be obtained from the proposed T2 with a less peaky busy hour based on different assumptions;
   - An initial high level estimate of an alternative terminal size based on lower busy hours using approximate Size/Busy Hour ratios;

4. Annual Traffic Forecasts, Schedules and Busy Hour Rates

4.1 DAA Planning Horizons

DAA have projected future Terminal 2 requirements with reference to forecast schedules in two phases (Phase 1 & Phase 2). The planning horizons for these phases are:

Phase 1: 2010 to 2016
Phase 2: 2016 to 2021

We understand that the Phase 1 schedule was developed for the centre of the planning horizon 2013 (i.e. 2010 – 2016).

Phase 2 has not been considered in this report as it falls outside of the scope of the current CIP.

4.2 Annual Traffic Forecasts

DAA have provided a breakdown of annual traffic forecasts for Aer Lingus (EI), Ryanair (FR) and CityJet up to 2010 for the Centreline and High (Scenario C) scenarios. VML have projected these forwards assuming a constant market share after 2010 (numbers in red). Also Vector (VML) have estimated the traffic for future T2 occupants (including CityJet) based on ratios of the non EI/FR market share

DAA Centreline Forecast

Year	Forecast EI Annual Pax	% EI Share of DUB	VML Estimate T2 Pax p.a. Excl. CityJet	VML Estimate T2 Pax p.a. With CityJet
2006	[.....]	[.....]	8,035,320	[.....]
2007	[.....]	[.....]	8,706,782	[.....]
2008	[.....]	[.....]	9,452,363	[.....]
2009	[.....]	[.....]	10,158,264	[.....]
2010	[.....]	[.....]	10,795,356	[.....]
2011	[.....]	[.....]	11,278,165	[.....]
2012	[.....]	[.....]	11,692,222	[.....]
2013	[.....]	[.....]	12,085,401	[.....]
2014	[.....]	[.....]	12,464,616	[.....]
2015	[.....]	[.....]	12,838,293	[.....]
2016	[.....]	[.....]	13,226,976	[.....]

Table 1: DAA Centreline Forecasts (Source DAA & VML)

The Gateway 2 Report explains that Phase 1 capacity has been designed to cater for 2013 demand which is the midpoint of the planning horizon 2010 to 2016. A variety of schedule scenarios were considered including Centreline, Scenario C (High Growth Forecast) and an even higher Aer Lingus growth scenario. The resulting planning schedule which was an average of these has a higher number of based aircraft than Scenario C (High Growth Forecast) and so it is reasonable to assume that the associated annual passenger throughput would also be higher than Scenario C.

However, it is noticeable that even under the Centreline forecast it is difficult to reconcile the design capacity of T2 of 11.4mppa with these traffic forecasts. This level of demand would be reached shortly after 2011 under the Centreline Scenario if CityJet is excluded or after 2010 including CityJet, which is the year that T2 is due to begin operation.

DAA Scenario C Forecast (Aer Lingus High Growth)

Year	Forecast EI Annual Pax	% EI Share of DUB	VML Estimate T2 Pax p.a. Excl. CityJet	VML Estimate T2 Pax p.a. With CityJet
2006	[.....]	[.....]	8,035,320	[.....]
2007	[.....]	[.....]	9,020,689	[.....]
2008	[.....]	[.....]	9,859,199	[.....]
2009	[.....]	[.....]	10,836,474	[.....]
2010	[.....]	[.....]	11,705,738	[.....]
2011	[.....]	[.....]	12,269,023	[.....]
2012	[.....]	[.....]	12,717,361	[.....]
2013	[.....]	[.....]	13,143,277	[.....]
2014	[.....]	[.....]	13,553,938	[.....]
2015	[.....]	[.....]	13,958,609	[.....]
2016	[.....]	[.....]	14,380,131	[.....]

Table 2: DAA Scenario C Forecasts (Source DAA & Vector)

Under Scenario C (High Growth Forecast) 11.4 mppa would be reached by 2010 (with or without CityJet) which is the year that T2 is due to begin operation. Under this scenario Aer Lingus alone will have exceeded 12 mppa by 2013.

The DAA planning schedule is based around a scenario which has slightly higher busy hour passenger flow and a larger based EI fleet than the Scenario C (High Scenario). In the absence of a corresponding higher annual traffic forecast we make reference to the DAA Scenario C in 2013 which would indicate that a consistent throughput for the terminal should be at least 13.1 mppa (excluding CityJet) or 13.5 mppa (excluding CityJet) compared with the 11.4 mppa as stated in the Gateway 2 Report.

It should be noted that DAA's terminal projections did not initially include CityJet who account for around 0.4 mppa. In further analysis we have tended to remove CityJet from the T2 total.

Given that the planning horizon for the terminal is 2016, however, VML believe that it would not have been unreasonable to base the design throughput on the DAA Centreline Forecast in 2016. This would indicate a throughput of around 13.2 mppa (excluding CityJet), or 13.8 mppa (including CityJet).

This approach would allow sufficient headroom in the event that the higher Scenario C forecasts were achieved, under which circumstances the Phase 2 extension would have to be brought forwards to around 2013 to 2014.

4.3 DAA Methodology & Overview of DAA Design Hour Forecasts

This section of our report reviews the methodology used by DAA to produce its Design Hour Forecasts and evaluates the reasonableness of these forecasts.

DAA have projected future busy hour passenger estimates by developing forecast schedules as follows;

- A 2006 schedule was developed by DAA as the basis for future Phase 1 & 2 schedule scenarios;
- The Phase 1 schedule, which we understand was developed for the centre of the planning horizon 2013 (i.e. 2010 – 2016);
- In addition to this a Phase 2 schedule was developed for 2018 (centre of 2016 to 2021). The Phase 2 schedule has not been considered in our analysis as it falls outside of the scope of the current CIP.

4.3.1 Overview of DAA Design Hour Forecasts

A standard aviation industry approach to establishing suitable hourly design flows is to adopt the 95th percentile Busy Hour Rate (BHR). This is defined as the value of passenger flow for which 5% of the passengers encounter a flow rate at this level or above. This is a key concept in relation to passenger service standards, including IATA[6] Levels of Service. In a terminal designed to Level of Service C, for example, 95% of the passengers would

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experience a standard that is equal or above level of service C. Using the 95th percentile is considered to result in an economic provision of infrastructure, where a tolerable degree of congestion can be expected without incurring prohibitive costs associated with attempting to meet all eventualities.

Vector has extensively relied on 95th percentile BHR values generated by IMR following detailed analysis of all traffic data between 2002 and 2006 as part of a previous study for CAR[7]. These values are based on 15 minute intervals (15, 30, 45, and 60) for each hour of every day between 2002-2006. It should be noted that Vector has not independently verified the production of these historical busy hours.

The following table compares the resultant design passenger hours for the 2006 and 2013 forecast schedules with the actual recorded 95th percentile busy hour for 2006.

	Departures Pax Hour	Forecast EI Departing Pax	% BHR / Annual
2006 EI 95th % BHR (actual)	1,660[8]	3,617,382	0.046%
DAA T2 2006 Schedule	2,200	3,471,289	0.063%
DAA T2 2013 Schedule (11.4mppa)	4,200	5,250,000[9]	0.080%
DAA T2 2013 Schedule (13.2 mppa)	4,200	6,000,000	0.070%

Table 3: Comparison of DAA Projected BHR with 2006 Recorded Value (Source DAA, IMR & VML)

Key considerations:

- The actual 2006 95th percentile busy hour was only 1,660 compared with the 2006 schedule projection of 2,200.
- There also appears to be a lack of internal consistency between the 2006 forecast busy hour and the 2013 forecasts. This is illustrated by the busy hour ratio rising from 0.063% to 0.080% (assuming 11.4 mppa) or from 0.063% to 0.070% (assuming 13.2 mppa).

The passenger design flow derived from the 2006 schedule, upon which the Phase 1 forecasts are subsequently based, does not appear to be representative of a 95th percentile passenger busy hour. With reference to IMR's analysis the DAA's 2006 forecast value of 2,200 pax/hour would correspond to the 99.73th ranked percentile.

7 IMR: High Level Analysis of DAA's Investment Plans, Key Issues, 09th February 2007

8 Note DAA have provided VML with 2006 95th percentile busy hours based on a clock hour basis. These values differ from those produced by IMR which are based on 15 minute hourly intervals which is considered to produce a more reliable and less random result. For example the DAA clock hour value for 2006 EI departures is 1,801, compared with IMR's value of 1,660.

9 5, 250,000 is based on an annual throughput 11.4mppa 6,000,000 is based on an annual throughput of approx. 13.2mppa refer to section 4.2

Put into context this would indicate that if the value of 2,200 were used to size a terminal to IATA Level C space standards in 2006 only 0.27% of annual passengers would either experience a level of service comparable to IATA C or below. The remaining 99.73% of passengers would experience a level of service comparable to IATA C and above, with a high proportion experiencing a level of service superior to IATA B and A. As we have previously indicated this would not normally be considered an efficient and economic use of terminal capacity and would normally not be considered a suitable design criterion for Terminal 2.

It is useful to consider ratios of busy hour passenger flows to annual throughput to compare and project forwards. This ratio has been shown empirically by several organisations including the UK Civil Aviation Authority (CAA) and US Federal Aviation Authority (FAA) to reduce as annual passenger volume increases and it has been shown that the relationship of busy hour to annual passengers tends to conform to a line log10 regression. This is shown graphically on the next page, including DAA and BAA historic data.

In this context it could be considered peculiar for this ratio to increase from the 2006 forecast of 0.063% to either 0.080% or 0.070% depending on whether the denominator is 5.25 or 6 million EI[10] departing pax (i.e. EI at 10.5 mppa or 12mppa overall with reference to the previous section). Even allowing for further peak concentration such a rise could be considered to be somewhat surprising.

As has been commented in other reports, including the previously referenced IMR report, the DAA forecast passenger design hours also appear to be very high compared with benchmarks at other airports, as well as with historical values for Dublin.

The following graph compares 95th percentile busy hours for Dublin and BAA airports with the DAA's forecast design hours (assuming both 5.25 or 6 departures mppa denominators).

The chart below illustrates that there is a close correlation between historic BAA and DAA values. Vector's experience from other airports we have been involved with, including Barcelona and Madrid[11], for example, indicates that other airports also tend to conform to this relationship. The design hour values proposed by DAA could be considered to be rather

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11 Between 1998 and 2004 Vector played a key role in the strategic planning, including the establishment of planning schedules and the assessment of required capacity, for the new Terminal SUD at Barcelona Airport, which is currently nearing completion. As part of the AENA's Strategic Planning Team we coordinated with the team for the new Terminal 4 at Madrid, as well as having access to detailed historic data for Madrid and Barcelona and other key AENA airports. In addition VML has been involved in the strategic planning of new terminals at many other international airports, including Heathrow T5, Manchester T2 and Birmingham Airport.

surprising in this context and they do not appear to conform to any values that Vector have experienced in the past even allowing for the effects of peak congestion or unconstrained growth.

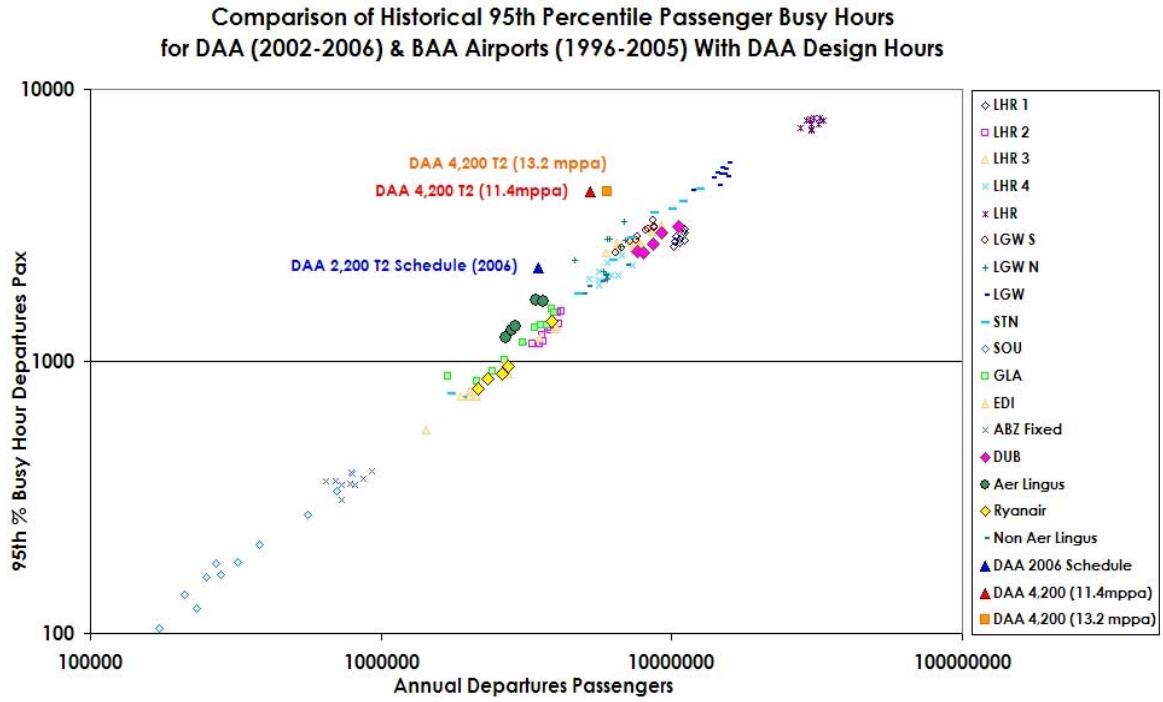


Figure 1: Comparison of DAA & BAA Historical BHR with DAA Forecasts (Source DAA & BAA)

4.3.2 Commentary on DAA Methodology

There are several issues relating to the methodology utilised by the DAA as explained in their document GS: 07/01[12] that may explain the apparently high passenger design hour rates that have been forecast for both 2006 and 2013, namely:

- The 2006 schedule was apparently based on 2004 and 2005 busy aircraft movement days;
- The schedule peaks were apparently not developed with reference to either historical 95th percentile passenger or aircraft movement busy hour values;
- The load factors used to derive passenger hours were apparently not developed with reference to historical load factors corresponding to 95th percentile passenger busy hours;
- The bottom up schedule based analysis does not appear to have been complemented by a high level top down ratio analysis.

Although there is no agreed common standard used in terminal design worldwide, the different accepted methodologies do tend to share the objective of producing suitable forecast hourly traffic flows (passengers and aircraft movements) which determine terminal and airfield capacity. Methods include the BHR (95th percentile busy hour), Standard Busy Rate (SBR equivalent to 30th Busiest Hour) and other methods which rely on the busiest hour in a given month or on a typical day.

In the case of the latter Vector would normally expect a typical day to be selected on the basis that it displays certain characteristics such as approximating to the passenger or aircraft movement busy hour. The choice of a typical day on the basis that it contains a total number of daily aircraft movements that is equivalent to the 95th percentile aircraft movement day, is no guarantee that it will produce a corresponding 95th percentile passenger or aircraft movement hour. Other factors such as aircraft size and load factors could also vary considerably in the peak of such days compared with the recorded 95th percentile passenger hour.

It should be noted that passenger terminals are designed in terms of the design hour (or even 15 minute flows etc.) not the flows for an entire day. It is, therefore, essential that any methodology results in robust and representative hourly design flows (or 15 minute flows etc.).

12 GS:07/01 DAA Group Strategy, Converting Forecast Annual Movements to a Daily Schedule for a Busy Day 19th January 2007.

From past experience detailed bottom up methodologies may produce a result to an apparently high level of accuracy; however, this does not necessarily mean that it is correct. Vector would advise that it is also sensible to carry out a complementary high level analysis to act as a validation check. This could be paraphrased in terms of ensuring that the result is approximately correct, rather than taking the risk that the result could be precise but erroneous.

Vector's previous experience of producing schedules for terminal design, including the new Terminal Sud in Barcelona, for example, reinforce our belief that a complementary traditional BHR approach based on ratios of annual passengers and aircraft movements form an important element of the audit trail and verification. Vector would advise that this is especially the case when peak profiles are expected to alter (as was the case in Barcelona). In section 5.5 of this report 'Busy Hour Analysis', we consider estimates of alternative forecast busy hours based on such an approach.

4.4 Aviation Economics Schedule Analysis

Vector (VML) engaged specialist traffic consultants Aviation Economics (AE) to undertake an independent review of the forecast schedules produced by DAA. In particular Aviation Economics were asked to review the robustness and internal consistency of these schedules and in particular the factors leading to the resulting busy hour passenger forecasts.

The AE analysis concentrated on the internal consistency of the 2013 (4,200) Planning Schedule as well as making comparisons with the forecast Base 2006 Schedule (SO6). Their work did not include an analysis of whether the Base 2006 Schedule (SO6) represents a suitable design day or whether the resulting 2006 busy hours represent suitable design busy hours (this has been carried out by Vector in sections 4.3 DAA Methodology & Overview of DAA Design Hour Forecasts and 4.5 Busy Hour Analysis).

Aviation Economics' full report is included in Appendix A. The following is an Executive Summary of their main findings which should be read in conjunction with their full report:

4.4.1 Overview

AE's overall view is that the busy hour forecast for T2 in 2013 is constructed from a number of assumptions which are generally at the high end of our expectations. In combination, these assumptions result in a busy hour forecast for T2, of 4,144 departing passengers, more than twice the equivalent 2006 throughput, that appears to be inflated. With relatively minor changes to the key assumptions used in the forecast AE has estimated a busy hour throughput of 3,062 departing passengers which we would regard as more realistic.

AE Busy Hour Departing Passenger Throughput Scenarios

DAA 2013F	AE Revised schedule	AE Revised schedule with adjusted load factors	AE Lower Growth (2 less based EI a/c)
4,144	3,256	3,062	2,923

Table 4: AE Busy Pax Hour Flow Analysis (Source AE estimates & DAA)

4.4.2 Schedule adjustment

The bunching of departures in the busy hour (06:15-07:14) is the key sensitivity in the analysis of the peakiness of T2 departures; it is clear from a comparison of 2006 and 2013 DAA-

provided forecast schedules that the DAA forecasts assume a much greater concentration in the busy hour in 2013 than in 2006.

In AE's opinion there is no obvious justification for this high degree of concentration. A reallocation of just five of the busy hour departures to leisure/non time-sensitive destinations to neighbouring hours has a significant impact on reducing the forecast busy hour volume. Moreover, in AE's view this rescheduling would have no material impact operationally or financially on Aer Lingus. In addition, an examination of the 2013 schedule revealed a duplication of outbound Manchester departures at 06:30, which AE has corrected in the adjusted forecast.

4.4.3 Load factor adjustments

The DAA appears to have increased the forecast load factors in the 2013 busy hour forecast to an extent that AE regards as questionable, given recent load factor trends at EI, projected capacity additions and intensifying competition. Again the adjustments AE has made – reducing A320 loads from 85% to 80% and A321 loads from 93% to 90% - are relatively minor but have an important impact on busy hour volumes.

4.4.4 Based aircraft

AE has accepted the DAA's assumption on the number of EI aircraft based at Dublin in 2013 as it is consistent with the airline's fleet development plans. It should be noted, however, that there is inevitably a large element of uncertainly in any such prediction. EI currently operates as a majority private owned carrier in an almost fully deregulated market, characterised by intense competition, not least from Ryanair. Moreover, growth plans can be affected by exogenous events (price of oil, terrorism, etc).

4.4.5 AE Conclusion

Our analysis of the 2013 schedule shows that it is highly sensitive to slight changes to scheduling in the busy hour of 6:15-7:14. A combination of small changes to the schedule and more realistic load assumptions produces an approximate 26% decrease in the Busy Hour departing passenger throughput in 2013 from 4,144 to 3,026.

4.5 Busy Hour Analysis

A basic high level estimate of the future departures busy hour can be produced based on the 2006 busy hour for proposed T2 occupants (1,893) provided by DAA based on clock hours[13]. Projecting this forward for 11.4mppa would give a future departures busy hour of 2,508 compared with DAA's value of 4,200.

Estimates of Forecast BHR for T2 at 11.4mppa

Basis of Projection	T2 Annual Total Pax	T2 Annual Departure Pax	% BHR / Annual	Departures 95th % BHR
T2 % BHR ('06)	11,436,847	5,718,424	0.0439%	2,508

Table 5: Estimate of 11.4mppa BHR based on T2 2006 equivalent (source DAA & VML)

Given the DAA busy hour was originally projected around Aer Lingus' morning peak it is possible to calculate the overall peak for T2 based purely on Aer Lingus 2004, 5 & 6 busy hour data. Note it is assumed that EI annual share of passengers in 2013 will be 10.5mppa (excluding CityJet). This approach gives a similar range of future busy hours from between 2,409 to 2,595 when compared with DAA's value of 4,200.

Estimates of Forecast BHR for Aer Lingus at 10.5mppa

Basis of Projection	T2 Annual Total Pax	EI Annual Total Pax	EI Annual Departure Pax	% BHR / Annual	Departures 95th % BHR
EI BHR (2004)	11,436,847	10,500,000	5,250,000	0.0464%	2,437
EI BHR (2005)	11,436,847	10,500,000	5,250,000	0.0494%	2,595
EI BHR (2006)	11,436,847	10,500,000	5,250,000	0.0459%	2,409

Table 6: Estimates of EI 10.5mppa BHR based on EI 2004 to 2006 values (source DAA, IMR & VML)

The above projections do not take account of any changes in the shape of the future schedule and the proposed concentration of EI morning departures. However it does give a useful reference point.

VML have not been convinced that the days used to develop the DAA 2006 schedule produce suitable busy hour passenger flows. This is mainly due to the days being selected on the basis of daily busy aircraft movement flows. In particular the load factors and

13 Note IMR values were not available for future T2 occupants. The DAA value based on clock hours may not be fully comparable with the IMR values used extensively in this report.

Pax/ATM[14] on these days are particularly high compared with recorded 95th percentile pax BHR.

To evaluate the effect of peak concentration, VML have analysed the hours immediately around the 2006 95th percentile BHR. 10 examples have been chosen within the range 94.9th to 95.1th percentile that display the characteristics of being in the spring and summer period and in the morning peak (note several other similar BHR values relate to the p.m. peak and the winter autumn).

It is noticeable that the 95th percentile of 1,660 actually related to 14 ATM which is the equivalent of the 70% departures ratio which DAA's 2006 schedule (2,200 BHR) was based upon. However, it is noticeable that there is wide variation in the ATM and related peak pax/ATM that are likely to result from different aircraft sizes and load factors. For this reason it is prudent to look at a range of values.

Analysis of Hourly Flows Around 2006 95th Percentile Passenger Busy Hour

Date	Time	Percentile Pax/Hour	Departure Pax/Hour	Departure ATM/Hour	Dep. Peak Pax/ATM
[.....]	[.....]	95.10%	1,669	15	111.3
[.....]	[.....]	95.05%	1,666	14	119.0
[.....]	[.....]	95.04%	1,664	15	110.9
[.....]	[.....]	94.99%	1,660	14	118.6
[.....]	[.....]	94.97%	1,658	13	127.5
[.....]	[.....]	94.96%	1,658	12	138.2
[.....]	[.....]	94.93%	1,657	12	138.1
[.....]	[.....]	94.92%	1,657	14	118.4
[.....]	[.....]	94.91%	1,657	13	127.5
[.....]	[.....]	94.90%	1,656	12	138.0
			Average Pax/ATM		**124.7**

Table 7: Analysis of Hourly Flows Around 2006 95th % BHR (Source DAA, IMR & VML)

The above sample gives a range of peak pax/ATM of between 110.9 & 138.2. None of these values approaches the 157.1 pax/ATM value implicit in the DAA 2006 schedule. Compared with the sample average of 124.7 pax/ATM, the DAA 2006 schedule would appear to be inflated by around 26% compared with values for recorded values in the vicinity of the 95th percentile pax BHR. Taking the average value from the sample of 124.7 pax/ATM, we are able to estimate what a 95th percentile pax busy hour could be if the peak hour departures were not constrained as shown in the table below.

[14] **ATM Air Traffic Movements**

VML Estimate of 2006 BHR for Peak Concentration Scenarios

Dep. Peak Concentration[15]	Departure ATM/Hour	Average Departure Peak Pax/ATM	Estimated Departure BHR	% Departure BHR / mppa
70%	14	124.7	1,746	0.0483%
75%	15	124.7	1,871	0.0517%
80%	16	124.7	1,996	0.0552%

Table 8: VML Estimate of 2006 Equivalent Peaking Scenarios (Source DAA, IMR, VML)

Ratios of % Departure pax BHR / mppa have been calculated as a basis for future projections (below).

Estimates of Forecast BHR for Aer Lingus at 10.5mppa (Total T2 11.4 mppa)

Dep. Peak Concentration	T2 Annual Total Pax	EI Annual Total Pax	EI Annual Departure Pax	% BHR / Annual	Departures 95th % BHR
70%	11,436,847	10,500,000	5,250,000	0.0483%	2,534
75%	11,436,847	10,500,000	5,250,000	0.0517%	2,716
80%	11,436,847	10,500,000	5,250,000	0.0552%	2,897

Table 9: VML Estimate of 11.4mppa BHR for Peaking Scenarios (Source VML)

Using this approach we would expect the 2013 passenger busy hour equating to 11.4 mppa T2 (10.5 mppa EI) to be in the region of 2,716 for a departures ratio of 75%.

DAA's value of 4,200 is some 55% higher than this. The reasons for this difference appear to be due to the following factors:

- 2006 base schedule does not appear to produce a representative 95% pax BHR
- The 4,200 schedule does not appear to be internally consistent with an annual passenger throughput of 11.4 mppa;
- And / or the 4,200 schedule projection does not appear to be internally consistent with the 2006 schedule.

15 The proportion of Aer Lingus' short haul fleet departing in one hour

5 Runway Capacity and Taxiway System

5.1 Introduction

The development of Terminal 2 as outlined in the CIP2006 is predicated on the basis of a concentrated early morning departure peak with a high number of aircraft movements. It is, therefore vital that the runway capacity can meet this demand. This section of report provides a high-level analysis of current and future runway capacity at Dublin Airport and assesses this against the provision of additional terminal capacity.

Time has not permitted us to undertake a thorough review of runway and taxiway capacity at Dublin Airport. To this end we have relied heavily on the work undertaken by National Air Traffic Services (NATS) in their Phase 1, 3-6 and 7 Runway Capacity Studies. We have also reviewed other documentation, including ACL Start of Summer 2007 Season Report and considered the responses to our questions from DAA.

We understand that the NATS studies were concluded in 2002 and were unable to consider the impact T2 and Pier E could have on taxiway and runway capacity. We believe it would have been prudent to update this analysis in order to ensure that the proposed location, stand configuration, taxiway layout and operation associated with T2 does not cause unnecessary congestion and therefore affect runway capacity.

5.2 Assessment of Runway Capacity

Our high-level review of runway capacity raises a number of key concerns in relation to providing balanced airside and landside capacity at Dublin Airport;

- The ability to fully meet the forecast schedule proposed for phase 1 of T2 appears to rely on the premise that additional departure runway movement slots can be provided ahead of the terminal opening;
- The declared peak runway capacity for summer 2007 is 47 […….];
- Runway Departure capacity is further constrained by hourly and 15 minute limits, which restricts departure movements to only:
    - 8 in any 15 minute period, or;

- 25 in any given hour.

We understand that the DAA forecast indicates that there will already be:

- 36 busy hour departure movements in 2009 between 06:15 and 07:14;
- 38 departure movements in 2010 between 06:15 – 07:14, and;
- The overall forecast peak hour movements for 2009 and 2010 are 55 and 60 respectively)

As the runway capacity ultimately determines the capacity of the airport we are concerned that without the delivery of additional runway capacity by 2009 the proposed terminal capacity at Dublin will far exceed runway capacity resulting in an inefficient use of capital investment.

Several solutions for providing additional runway capacity at the airport, including greater use of runway 11/29 in conjunction with 10/28, extending 11/29 and use of the cross wind runway, were considered in the NATS capacity studies in 2002, however, a number of operational and procedural constraints restrict the number of additional hourly runway movements that can be achieved, delivering at very best 30 additional hourly runway movements.

Our primary concern is that without the provision of additional runway capacity ahead of T2 opening the airside capacity of the airport will be unable to satisfy the proposed unconstrained landside demand.

We understand that the parallel runway is currently going through the planning process and is scheduled to open in 2012. Once opened the new runway will initially deliver 30 additional peak hour runway slots; although there may be provision to increase this number with changes to operating procedures at the airport.

The NATS report indicates that the future declared capacity for the Dublin Airport runway system will be between 74 and 87 movements per hour, depending on mode of operation, post 2012. There will, however, still be hourly and 15 minute restrictions on movements resulting in:

- No more than 42 Departures to be scheduled in any one-hour period, and;
- No more than 14 Departures in any 15 minute period.

Again we are concerned that the runway capacity at the airport may be unable to satisfy the forecast busy hour movement demand from 2012 onwards if demand for departure slots in the peak hour is forecast to be in excess of 42 movements per hour.

DAA have produced a T1 schedule for 2013 which together with the T2 (4,200) schedule indicates that if the peaks of T1 & T2 airlines do not coincide then it would be possible to operate the proposed T2 schedule within the runway constraints. However, should this not be the case then it is possible to imagine the scenario of the T2 schedule not being plausible within the runway constraints. Certainly this potential situation would become more apparent under the proposed 2018 (5,500) schedule.

Compounding this situation is the fact that it is not normally possible to bring on the full capacity potential of a new runway from day one (primarily as a result of new and revised operating procedures). We are concerned, therefore, that even with the new parallel runway; airside capacity at the airport may not be able to fully support the proposed peak schedules.

We would recommend that a detailed runway capacity analysis is undertaken, taking into account the forecast schedules for the airport, the location of the proposed terminal and the proposed operating strategy. We believe that this is necessary to provide confirmation that the airside capacity of the airport is capable for supporting the demand generated from the land-side infrastructure.

6 Terminal Sizing

6.1 Introduction

This section of our report presents our findings with regard to the proposed sizing of Terminal 2 at Dublin Airport. Our report only addresses DAA's design assumptions and planning parameters in relation to the sizing of Terminal 2. In addition we consider the impact on the sizing and complexity of the terminal as result of several alternative operational scenarios and planning assumptions.

We make no comment within this report as to the form or architecture of terminal building other than where this may result in an increased foot print, neither do we consider the residual capacity of T1 or the location of Terminal 2 as this is currently outside of our Scope of Works. In addition we do not seek to make an assessment of the reasonableness, or otherwise, of retail provision in the terminal as this requires a detailed review of the balance between capital investment; commercial revenues and the trade-off against aeronautical revenues.

This section of our report is divided into two distinct elements; firstly, we consider the sizing of the proposed terminal in relation to DAA's Design Peak Hour Passenger demand and the planning parameters contained in the Gateway2 Report. We include an assessment of proposed service levels, process rates and space standards.

Finally in this section of our report we assess the impact on terminal size resulting from a number of alternative design busy hour rates and terminal planning parameters. In addition we provide a high-level assessment of airline specific areas within the proposed terminal and measure the impact on overall terminal size of removing or reducing these areas. It should be noted that these space savings are only indicative based on an approximate high level approach.

6.2 Terminal Planning Parameters

The feasibility of DAA's proposed design peak flows are dealt with in the previous sections of this report, therefore, this section focuses on the reasonableness of the key terminal planning parameters included in appendix D of the Gateway 2 report. Where possible we have validated key requirements, such as the number of check-in desks and passenger

security devices etc. against the IATA Airport Development Reference Manual (ADRM) and BAA terminal processing requirement methodologies/ models.

A major driver of space is the requirement for a high level of on-pier / contact stand performance; however, in discussions with DAA, EI and York Aviation[16] this does appear to be a requirement of Aer Lingus, Ryanair and other airlines operating at Dublin airport. We understand that airlines operating at Dublin would resist any move to reduce on-pier performance at the airport.

In general we consider the planning parameters presented in appendix D of the Gateway 2 report to be realistic for the DAA busy hours and profiles of the proposed tenant airlines for Terminal 2.

6.3 IATA Level of Service C

In considering the planning assumptions supporting the sizing of Terminal 2 it is important to consider whether the proposed level of service to be offered within the terminal is appropriate. The design brief for Terminal 2 identified IATA Level of Service C as the minimum standard for the 2013 design year.

IATA level of Service C principally applies to space standards in queuing, waiting and main processing areas, therefore, a reduction in service levels normally results in only marginal overall space saving in terminal buildings.

We have undertaken a high level assessment[17] of the impact on the overall Terminal 2 area of reducing the Level of Service to IATA D. We have concluded, assuming that all other process standards remain equal, that this would only result in a space saving of around 3% for 2013. (see the table in section 7.4 below).

Given the proposed mix of tenant airlines in Terminal 2 we, therefore consider IATA Level of Service C to be a reasonable and appropriate design standard for the planning of Terminal 2 at Dublin Airport.

16 We met with Louise Congdon of York Aviation who is acting as a Consultant on behalf of Ryanair

17 In order to establish the impact of IATA C standards on terminal size we reviewed the DAA area schedule for T2 (as included in Appendix C and D of the DAA Dublin Terminal 2 Gateway No.2 Report, September 2006). We identified those areas and processes impacted by IATA level of Service C and reduced these in accordance with the IATA Airport Development Reference Manual standards for IATA Level of Service D.

6.4 Impact on Terminal Areas of Alternative Busy Hour Rates and Design m2/php

The following analysis highlights the impact on the overall required terminal area relating to a range of alternative peak hour flows, as developed in the BHR Analysis section of this report. This analysis only considers space requirements for the T2 processor and does not consider Pier E requirements.

As a preliminary estimate we have based our proposed future terminal sizing on a ratio of terminal size per departuring passenger BHR derived from the terminal sizing calculation in the Gateway No. 2 report, previously referenced. We would stress, however, that this simplistic analysis does not take account of terminal geometry and in practice there may be diseconomies of scale involved with reducing the terminal size.

Furthermore, it should be noted that the forecast DAA arrivals passenger BHR is proportionately low in comparison to the DAA forecast departures BHR. Vector's revised departures hour would result in a more proportionate relationship between the arrivals and departures busy hours. We have estimated, therefore, that a suitable ratio between BHR and sqm/ dep. BHR could be as high as 20m²/ php[18]., for similar service and processing rates.

Although VML consider that a Terminal T2 throughput of 11.4mppa does not appear to be consistent either with the DAA proposed schedules or the annual traffic forecasts for 2013, an estimate of an appropriate terminal size for 11.4 mppa has been produced for theoretical comparison purposes. The table below estimates the required terminal size for 11.4 mppa based on the range of passenger busy hours developed, assuming 17.6m²/php.

Comparison of VML Estimates of Terminal Space & BHR with DAA for 11.4 million pax (Of which EI 10.5mppa)

Basis of Projection	% EI Departure BHR / mppa	Estimated Departures 95th % BHR	T2 Processor sqm / Dep. BHR	Estimated T2 Processor (sqm)
DAA Planned		4,200	17.6	74,555
2006 EI BHR	0.0459%	2,409	17.6	42,402
VML EI 70%[19]	0.0483%	2,534	17.6	44,607
VML EI 75%	0.0517%	2,716	17.6	47,793
VML EI 80%	0.0552%	2,897	17.6	50,980

Table 10: VML Estimate of Terminal Space for 11.4mppa (Source DAA, VML)

18 Peak Hour Passengers

19 Note percentages refer to the proportion of Aer Lingus based fleet departing in one hour

Key Considerations:

- VML estimates that an indicative Terminal 2 size of around 44,607m^2, based upon the estimated EI 70% departures ratio busy hour, could potentially provide an adequate size for a throughput of 11.4 mppa. This is in line with the DAA's proposed space and processing standards and would potentially be some 30,000m^2 smaller than DAA's planned terminal;

- A 44,607m^2 terminal would represent some 40% reduction in required area in relation to DAA's proposed Terminal 2.

We would stress, however, that this simplistic analysis does not take account of terminal geometry and in practice there may be diseconomies of scale involved with reducing the terminal size or the rebalancing of the arrivals and departures areas.

If we were to assume an estimated higher ratio of space to BHR passenger of 20m^2/ dep. php that takes account of these effects, it could result in a terminal size of some 51,000m^2.

The following section of our report considers the effects on terminal size of designing a similar terminal around airlines other than Aer Lingus. Based on current pax BHR ratios we would estimate the following terminal sizing scenarios as shown in the table below.

VML Estimates of Terminal Space & BHR for 11.4 million Pax for Other Airlines

Basis of Projection	% Departure BHR / mppa	Estimated Departures 95th % BHR	T2 Processor sqm / Dep. BHR	Estimated T2 Processor (sqm)
DAA Planned		4,200	17.6	74,555
VML EI 70%	0.0483%	2,534	17.6	44,607
VML Non EI Airlines	0.0323%	1,849	17.6	32,541

Table 11: VML Estimate of 11.4mmpa Terminal Space for Other Airlines (Source DAA, VML)

Key considerations:

- Although somewhat theoretical, as Non EI airlines would fill T2 today, this does give a useful comparison. We estimate that in theory a new T2 processor designed to cater for non EI airlines with a throughput of 11.4 mppa could be sized at 32,541m^2.

- A 32,541m^2 terminal would represent some 56% reduction in required area in relation to DAA's proposed Terminal 2.

As previously stated we would stress, however, that this simplistic analysis does not take account of terminal geometry and in practice there may be diseconomies of scale involved with reducing the terminal size or the rebalancing of the arrivals and departures areas.

If we were to assume an estimated higher ratio of space to BHR passenger of 20m^2/ dep. php that takes account of these effects, it could result in a terminal size of some 37,000m^2

As stated previously, however, given the planning horizon for T2 phase 1 is 2016, it would appear that a sensible design throughput based around the Centreline forecast would have been around 13.3mppa (excluding CityJet). Taking the busy hours developed in the previous sections the following scenarios have been developed to show terminal size for a 13.3mppa throughput.

VML Estimates of Terminal Space & BHR for 2016 Planning Horizon Under Centreline Scenario: Estimated 13.2 mppa (of which EI 12mppa)

Basis of Projection	% EI Departure BHR / mppa	Estimated Departures 95th % BHR	T2 Processor sqm / Dep. BHR	Estimated T2 Processor (sqm)
DAA Planned		4,200	17.6	74,555
AE (33 based)		2,923	17.6	51,445
AE (35 based)		3,062	17.6	53,891
VML EI 70%	0.0483%	2,897	17.6	50,980
VML EI 75%	0.0517%	3,103	17.6	54,621
VML EI 80%	0.0552%	3,310	17.6	58,262

Table 12: VML Estimate of Terminal Space for 13.2 mppa (Source VML, AE)

Key considerations:

- VML estimate that in theory an indicative Terminal 2 processor of around 50,980m^2 is possible for the estimated EI 70% departures ratio busy hour and could potentially accommodate 13.2 mppa; this could provide a space saving of some 23,500m^2 compared to the DAA's planned terminal;

- A 50,980m^2 terminal would represent some 32% reduction in required area in relation to DAA's proposed Terminal 2.

- A similar terminal size (between 51,445m2 and 53,891m2 could be estimated from the busy pax hours resulting from Aviation Economics analysis of the 4,200 planning schedule. Although the Gateway 2 report states that this schedule relates to 11.4 mppa it appears likely that it relates to a higher passenger throughput. It is difficult, however, to determine what this level should be given that the 4,200 planning schedule includes more based aircraft than the equivalent Scenario C (High Forecast) schedule.

- It would appear that the Aviation Economics adjusted schedules, approximating to 33 or 35 based aircraft, could also relate to a passenger throughput in the order of 13mppa;

We would stress, however, that this simplistic analysis does not take account of terminal geometry and in practice there may be diseconomies of scale involved with reducing the terminal size or the rebalancing of the arrivals and departures areas.

If we were to assume an estimated higher ratio of space to BHR passenger of 20m^2/ dep. php that takes account of these effects, it could result in a terminal size of some 58,000m^2.

APPENDIX A

AVIATION ECONOMICS REPORT

Aviation Economics

Review of Dublin Airport Authority's Capital Investment Plan

CONTENTS

This review has been prepared by Aviation Economics in accordance with the instructions of Vector Management Consultants and on the basis of information provided by the DAA, Arup, CaR or which is publicly available. While Aviation Economics believes this report to be accurate and soundly based, no liability whatsoever is accepted for any of the information, projections or opinions contained herein nor any errors, omissions or misstatements

Introduction

Vector Management has engaged Aviation Economics (AE), to advise on the robustness of the busy hour traffic forecast for 2013 contained in Dublin Airport Authority's (DAA) Capital Investment Project (CIP) relating to the new Terminal (T2). The busy hour is used to estimate the peakiness of traffic at the airport and is a key determinant of infrastructural requirement and capital expenditure. This review forms part of an overall objective of assessing how much of the projected costs of T2 relate to specific airline requirements.

In preparing this forecast, AE has reviewed numerous documents prepared by the DAA, Arup, and the Commission for Aviation Regulation (CAR) along with submissions made by various parties in the Oral Hearings. Particular attention was paid to the 2013 forecast airline schedule for T2 as supplied by the DAA. AE has used its own experience and knowledge of the development of air transport markets in analysing the profile of the schedule for T2.

Executive Summary

AE's overall view is that the busy hour forecast for T2 in 2013 is constructed from a number of assumptions which are generally at the high end of our expectations. In combination, these assumptions result in a busy hour forecast for T2, of 4,144 departing passengers, more than twice the equivalent 2006 throughput, that appears to be inflated. With relatively minor changes to the key assumptions used in the forecast AE has estimated a busy hour throughput of 3,062 departing passengers which we would regard as more realistic.

Busy Hour Departing Passenger Throughput Scenarios

T2 Operators '06	DAA 2013F	AE Revised schedule	AE Revised w adjusted load factors	Low Growth (2 less based EI a/c)
1,998	**4,144**	**3,256**	**3,062**	**2,923**

Source: Aviation Economics estimates, DAA

Schedule adjustment

The bunching of departures in the busy hour (06:15-07:14) is the key sensitivity in the analysis of the peakiness of T2 departures; it is clear from a comparison of 2006 and 2013 DAA-provided forecast schedules that the DAA forecasts assume a much greater concentration in the busy hour in 2013 than in 2006. In AE's opinion there is no obvious justification for this high degree of concentration. A reallocation of just five of the busy hour departures to leisure/non time-sensitive destinations to neighbouring hours has a significant impact on reducing the forecast busy hour volume. Moreover, in AE's view this rescheduling would have no material impact operationally or financially on Aer Lingus. In addition, an examination of the 2013 schedule revealed a duplication

of outbound Manchester departures at 06:30, which AE has corrected in the adjusted forecast.

Load factor adjustments

The DAA appears to have increased the forecast load factors in the 2013 busy hour forecast to an extent that AE regards as very questionable, given recent load factor trends at EI, projected capacity additions and intensifying competition. Again the adjustments AE has made – reducing A320 loads from 85% to 80% and A321 loads from 93% to 90% - are relatively minor but have an important impact on busy hour volumes.

Based aircraft

AE has accepted the DAA's assumption on the number of EI aircraft based at Dublin in 2013 as it is consistent with the airline's fleet development plans. However, it should be noted that there is inevitably a large element of uncertainly in any such prediction. EI operates as a majority private owned carrier in an almost fully deregulated market, characterised by intense competition, not least from Ryanair. Moreover, growth plans can be affected by exogenous effects (price of oil, terrorism, etc).

Fleet Plan and Based-Aircraft Assumptions

A crucial part of understanding the future scheduling requirements of T2 relates to the growth profile of the anchor tenant, Aer Lingus. Currently, EI operates a fleet of 28 short-haul aircraft (A320/A321) and seven long haul aircraft (A332/A333). Two new A330s are to be delivered within the next two months along with four new A320s by the end of 2007. Both EI and the DAA confirmed that the expectation is for the entire EI fleet to expand eventually to 42 short-haul and 14 long-haul aircraft, though it is not possible to specify the exact year in which this total will be reached. The 2013 schedule assumes that Aer Lingus will base 36 aircraft at DUB.

It was also stated that EI has secured short-haul aircraft that will take them to 33 (from the current 28) and there are no further A330s on order once the two units have been delivered this summer. While the market for narrow-body aircraft is tight at the present time, we would expect EI to secure further A320 family aircraft over the next five to six years mainly from operating leasing companies. EI has also studied proposals from both Airbus and Boeing for long haul aircraft, with the choice being between the A350XWB and the 787. If EI orders the A350XWB, we would expect Airbus to provide interim lift through new A330s prior to A350XWB deliveries commencing sometime around 2013-2014. The 787 order backlog is extensive with over 550 orders prior to the first plane rolling off the assembly line in 2008. New 787 customers are currently looking at delivery times between 2012 & 2013.

Prospects for long-haul expansion have been enhanced following the implementation of US-EU Open Skies agreement in April '08. This will release EI from the obligation of the so-called 'Shannon stop' and will allow EI to fly to any US destination that it finds commercially viable.

However, we do not expect the increase in the long haul fleet to impact the morning peak as most if not all of the long haul departures will take place after 10:30 as this is what best suits the trans-Atlantic market and also minimises aircraft downtime at the US/Canada destination point.

[…….]

Hubbing

It should be clarified that the forecast peakiness of traffic at DUB is not related in any way to a hubbing operation by EI at the airport. The busy hour is driven essentially by EI scheduling short-haul aircraft to depart as early as possible in order to achieve as many rotations as possible during the operating day.

The EI business model has rapidly moved away from a traditional flag-carrier operation, following its near collapse in 2002, to one that incorporates many of the best practices of many of the LCCs including on maximising aircraft utilisation (which is very difficult to achieve in a hubbing model). Its primary focus is on point-to point operations, while wherever possible facilitating transfers between short and long-haul services but not scheduling aircraft in any "wave" pattern typical of a hubbing operation.

Our conversations with the airline confirm that it has no intention to pursue a hubbing strategy and its primary focus will remain on point-to-point (P2P) operations. We foresee EI continuing down the P2P path. We would not envisage a new entrant establishing a network carrier based hub & spoke model at Dublin airport in the future.

Future Schedule / Traffic Forecasts

The relatively large size of T2 per annual passenger relative to T1 appears to be driven by the future airline schedule. This schedule assumes that Aer Lingus' fleet grows and that the shape of its schedule changes such that higher concentrations of based aircraft depart in the morning peak. The DAA has informed us that the 2013 T2 Schedule was produced using information provided to it by Aer Lingus and other airlines.

Our analysis is based on DAA-provided Forecast Schedule data for their choice of '95% Forecast Busy Day' for both 2006 and 2013, which in both cases is the final Friday for the month of July in both years. The DAA stated that Arup used the busy day schedules DAA provided it for 2010, 2016 and 2021 for Centreline and Scenario C to derive the busy hour planning flows. Arup then created a planning schedule for the planning years to approximate that busy hour planning flow. Furthermore, these two representative days were the only days provided to us by the DAA.

The expected users of T2 as stated in the Gateway No.2 report and those for which the DAA's 2013 forecast schedule applies to are listed in the table below. In respect of the busy hour analysis, EI dominates accounting for 100% of total passengers. For the entire busy day, EI accounts for about.92% of total T2 passengers.

T2 Airlines

Base Carrier	OneWorld	Others
Aer Lingus	American	Continental
	British Airways	Delta
	Finnair	US Airways
	Iberia	Air Canada
	Malev	United

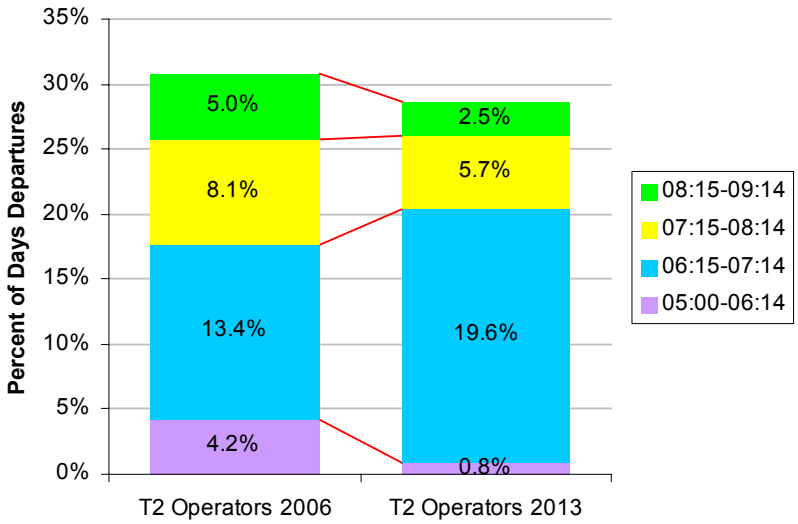
Source: DAA Gateway No. 2 report

The DAA has stated that Cityjet may be included as a future T2 tenant in order that it can feed traffic to fellow SkyTeam members Delta and Continental, although the Gateway 2 report does not list this carrier. AE sees little strategic rationale in Cityjet embarking on such an arrangement, as its primary role is either feed parent airline Air France at Paris CDG or as a point-to-point operator serving London City and other business destinations. We therefore feel that there is no pressing requirement for Cityjet to be based in T2 and have therefore left the T2 tenant list intact as it was presented in the DAA's 2013 T2 Schedule.

In the chart below, we compare the peakiness profile of T2 users in 2013 as forecast by the DAA against the profile of those same T2 tenants for the Forecast Busy Day in 2006.

During this day in 2013 28.6% of traffic is assumed to be in the morning peak period against 30.7% in 2006, but there is a major change within this period with the percentage of passengers travelling in the busy hour (6.15-7.14) increasing from 13.4% to 19.6%, while the proportionate traffic in the neighbouring hours nearly halves from 17.3% to 9.0%.

T2 Airline Early Morning Departing Passenger Profile, Forecast Busy Day 2006 vs Forecast Busy Day 2013



Source: DAA forecasts, 2006 data

The 2013 schedule that the DAA provided forms the basis of the 4,144 peak hour departing passenger forecast. Aer Lingus departing passengers account for 3,815, or 92%, of the early morning departing passengers at T2 in the 2013 forecast schedule.

There was one particular anomaly with this schedule - the DAA assumes that 27 EI short-haul aircraft will depart in the peak hour (06:15-07:14). In the schedule, they have two Manchester departures at the same time (06:30) and this error implies that 28 aircraft are departing in the peak hour. We have therefore removed this departure and the impact is incorporated into our "Revised Forecast" (see below).

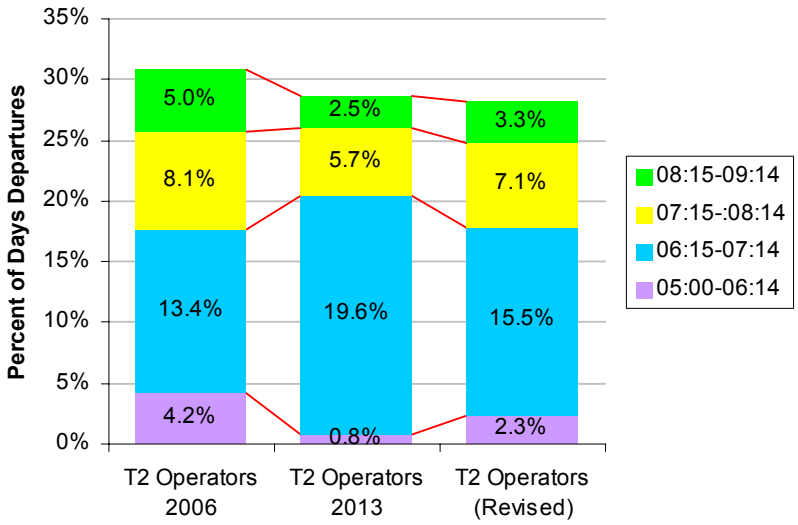
We then made some fairly minor changes to the scheduled departure times of five flights, two of which were moved to before the busy hour and three after. No flight was changed by more than 40 minutes. We estimate that this will have little or no impact on EI operationally or financially, the earlier departures potentially allowing an extra daily rotation to be added. We would regard all of the five routes as being overwhelmingly leisure-orientated and non-time-sensitive. [.....].

[.....]

The resultant decrease in passenger throughput in the busy hour is a significant decrease of 21.4% from 4,144 departing passengers to 3,256.

The graph below compares the peak profile of our slightly revised 2013 schedule to DAA's 2013 schedule and the forecast 2006 busy day data for T2 operators.

2013 Revised T2 Airline Early Morning Departing Passenger Profile



Source: DAA forecasts, 2006 data, Aviation Economics estimates

The five routes that we moved out of the peak busy hour are all projected new routes for Aer Lingus. The forecast schedule also implies that EI will commence [seven other] services [.....]. The timing of commencement of these services will have an important impact on load factors as new routes often take time to develop; indeed EI attributed the 3.8 percentage point decline in its load factor between 2005 and 2006 to the effects of starting up new routes.

Load Factors

The projected load factors are a key determinant of the busy hour forecast. In the 2013 schedule the DAA assumes that the A320s will all operate during the morning busy period (5.00-9.14) with a load factor of 85% and the A321s with an average load factor of 93%, which seems to be a high rate, even for peak periods. For comparison the 28 July '06 schedule showed average load factors of 77% in the morning busy period for the A320 and 90% in the morning busy period for the A321 services.

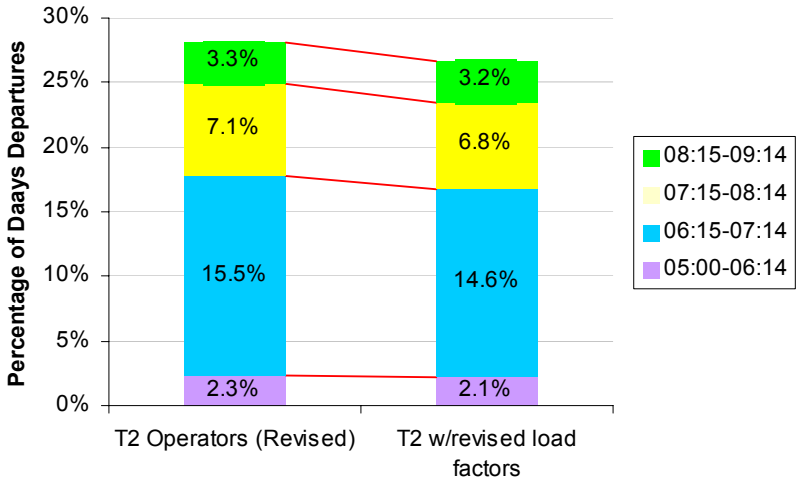
It is not apparent to AE how this increase in assumed load factor can be justified. EI's overall load factors have actually been declining in recent years: 82.0% in 2004, 81.4% in 2005 and 77.6% in 2006. Load factors on short-haul

routes have in recent years been about 9 percentage points lower than on long-hauls.

On the short haul routes, we would expect a stabilisation of EI's load factors [as]: first, additional capacity is being added into the market, secondly there should be increasing competition on city-pairs between EI, FR and other airlines, [.....].

Nevertheless, AE has, in its adjusted forecast, factored an increase in load factors, although a lower increase than that assumed by the DAA: during the morning busy period, 80% for the A320 services and 90% for the A321 services. The impact is shown on this graph.

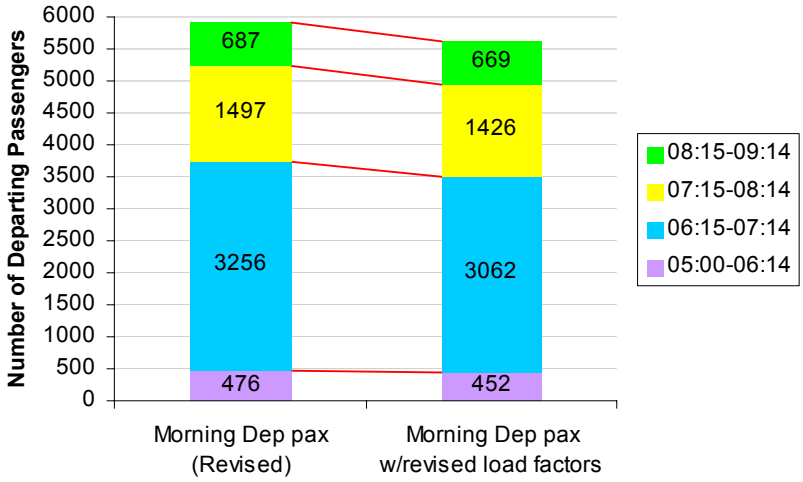
Revised T2 Airline Early Morning Departing Profile with Adjusted Aer Lingus Load Factors



Source: DAA forecasts, Aviation Economics estimates

The effect in terms of number of departing passengers in the busy hour would be an approximate 6% reduction from 3,256 to 3,062 as depicted in the chart below. It is worth noting that as A320 aircraft operate all of the scheduled departures in the Busy Hour, changing our assumptions for A321 load factors would have no impact on the Busy Hour throughput.

Revised T2 Airline Early Morning Departing Profile with Adjusted Aer Lingus Load Factors by Passenger Throughput



Source: DAA forecasts, Aviation Economics estimates

Reduction in Base Aircraft from 35 to 33

While we are fairly confident of the sustainability of EI's business model, intense competition from FR on either or both of their short-haul or trans-Atlantic long-haul network could force the airlines growth to slow. AE has modelled the effect of a reduction in based aircraft from 35 to 33 and a reduction of the departing busy hour aircraft from 27 to 25. The effect on passenger volumes taking into account the lower load factors would reduce the Busy Hour throughput by a further 4.5% from 3,062 to 2,923.

Busy Hour Departing Passenger Throughput Scenarios

T2 Operators '06	DAA 2013F	AE Revised schedule	AE Revised w adjusted load factors	Low Growth (2 less based EI a/c)
1,998	**4,144**	**3,256**	**3,062**	**2,923**

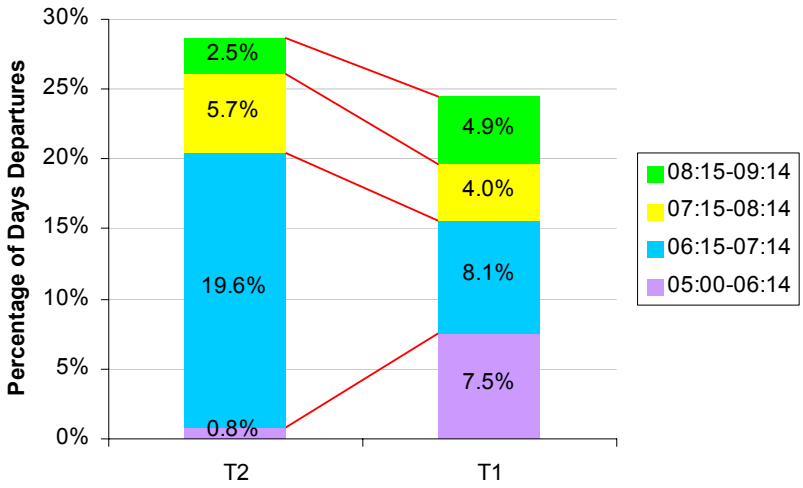
Source: Aviation Economics estimates, DAA

T2 versus T1

The DAA has also supplied us with a forecast schedule for T1 in 2013, whose main tenant will be Ryanair once Aer Lingus have moved into T2. There is a fairly stark contrast in the peakiness profile as illustrated by the numbers of

departures in the four morning hour slots as a percentage of each terminals day figure.

Peakiness Profile of DAA 2013 Forecast Schedules for T1 versus T2



Source: DAA forecasts

Internal Consistency of Forecast Schedules/Traffic projections

The 2013 T1 Forecast Schedule supplied by the DAA contains seven Aer Lingus departures, implying that EI would use both T2 and T1.The forecast schedule also indicates that two of the departures are undertaken by based aircraft which makes reconciliation with the T2 based aircraft assumptions problematic. From an airline perspective, it is more efficient operationally and financially to base all of their operations within the same terminal.

The DAA supplied a projection for Aer Lingus passenger growth up until the year 2010 under two scenarios: 'Scenario C' and the more conservative 'Centreline' forecast. In the table below we illustrate the output of these two scenarios on 2010 Forecasts and then factor each scenario's forecast up to a 2013 total based on the combined annual growth rate implied in the 2006 to 2010 period. Even under the Centreline assumption the passenger throughput for Aer Lingus alone would exceed T2's specified annual capacity of 11.4 million passengers as stated in Section 8 of the DAA's Gateway 2 report. We have also performed a similar analysis taking EI's projected traffic under the two scenarios as a percentage of the DAA's Dublin airport total forecast and then assuming that EI's market share remains constant at 2010 levels up until 2013. In this case the Centreline projection for 2013 of 10.98m passengers is below the T2 capacity limit, but EI would have to account for 96% of throughput compared to approximately 92% assumed in the busy hour forecasts.

Aer Lingus Implied Passenger Forecast

	Scenario C	Centreline
2006	[.....]	[.....]
2010	[.....]	[.....]
CAGR	[.....]	[.....]
2013 Implied	[.....]	[.....]

Source:DAA, Aviation Economics Estimates

Aer Lingus Implied Passenger Forecast

	Scenario C	Centreline
2010 DUB	24,979,586	24,717,291
2013 DUB	28,047,238	27,671,007
Aer Lingus Forecast		
2010	[.....]	[.....]
Share of Total	[.....]	[.....]
Aer Lingus Implied at Constant Share of DUB Total		
2013	[.....]	[.....]
% of T2	[.....]	[.....]

Source: DAA, Aviation Economics Estimates

Proportion of transfer passengers

Both the DAA and EI confirmed that approximately 20% of T2 traffic is expected to be transfer passengers of which 75% will belong to Aer Lingus. This number seems high to us as Aer Lingus are not operating any type of hubbing operating at DUB.

[.....]

Runway Capacity

The DAA combined 2013 T1 and T2 schedule indicate that during the 06:00-06:59 hour, 35 departures are due to takeoff while the runway capacity for 2007 showed a maximum of 29 departures during the 06:00 hour. The timing of either a mixed mode runway or the completion of the proposed second runway would be crucial to an assessment of whether the airport could handle the proposed schedules.

Aircraft size

There is very little change envisaged as the forecast period (2013) predates the introduction of the next generation of narrowbody aircraft from Airbus and Boeing. We would expect these new aircraft to have a higher passenger capacity than current models employed by both Ryanair (B737-800) and EI (A320/321).

Conclusion

Our analysis of the 2013 schedule shows that it is highly sensitive to slight changes to scheduling in the busy hour of 6:15-7:14. A combination of small changes to the schedule and f more realistic load assumptions produces and approximate 26% decrease in the Busy Hour departing passenger throughput in 2013from 4,144 to 3,026.

APPENDIX B

DAA RESPONSES TO QUERIES RAISED DURING REVIEW

[…….]