APPENDIX 6(c)
REPORT ON CAPACITY ISSUES
AT WELLINGTON AIRPORT
PREPARED BY LEK
CONSULTANTS

L.E.K.

TRAFFIC CAPACITY FORUM

Report on Aviation Congestion Issues

16 March 2000

L.E.K. CONSULTING

L.E.K.

L.E.K. CONSULTING

LEVEL 13, 52 SWANSON STREET
PO Box 105-480
AUCKLAND 1
NEW ZEALAND

T: 64.9.377 8376
F: 64.9.913 4616

TRAFFIC CAPACITY FORUM

Report on Aviation Congestion Issues

16 March 2000

AUCKLAND
BANGKOK
BOSTON
CHICAGO
LONDON
LOS ANGELES
MELBOURNE
MILAN
MUNICH
PARIS
SYDNEY

L.E.K. CONSULTING PTY LTD
ACN 003 780 523

L.E.K.

TABLE OF CONTENTS

1. **Executive Summary** 1

2. **Introduction** 3

   2.1. *Background* 3

   2.2. Consulting Process 3

3. **Understanding Congestion** 4

4. **Level of Congestion** 5

   4.1. Overall 5

   4.2. Impact of Growth 5

   4.3. Flight Arrival Delays 7

   4.4. Departure Delays 8

   4.5. Passenger Delays 8

5. **Cost of Congestion** 9

   5. I. *Arrival and Departure Costs* 9

   5.2. Future Cost of Congestion 10

   5.3. Other Costs 11

6. **Recommended Solutions** 12

   6.1. *Measuring Congestion* 12

   6.2. Optimising the Use of Existing Assets 12

   6.3. Managing Demand 13

   6.4. Increasing Capacity 15

Appendix 16

   Types of Delay 16

   Definition of Time Periods 16

   Categorisation of Aircraft on Performance Characteristics 17

L.E.K.

1. EXECUTIVE SUMMARY

The Traffic Capacity Forum comprises representatives of each of the major airlines, the international airports and Airways Corporation. The Forum was established in 1996 to address issues around optimising the capacity of the national air traffic system for the benefit of airlines and passengers. The industry recognises that many parts of the aviation system are capacity restricted. As demand grows, some parts of the system will require more active management in order to best utilise the system and reduce delays. The current study was commissioned to understand the overall impact of congestion and recommend solutions for managing demand and reducing congestion.

While increasing demand will lead to congestion problems across a number of aspects of the New Zealand aviation system, the most immediate problem is in relation to Wellington Airport. As such, the Report uses Wellington as a case study for New Zealand's emerging congestion issues. The Report's main findings are:

- Wellington faces an immediate congestion problem during bad weather when a combination of Wellington's topography and low performing aircraft reduce Wellington's runway capacity by 26%
- Growing demand at Wellington means that delays will increase during good weather over the next few years. Average peak hour movements will be at or in excess of Wellington's capacity by 2005
- Flight arrivals are currently delayed by an average of 0.8 minutes in good weather and 4.1 minutes in bad weather. Delays on individual flights can be considerably greater. Average flight arrival delays will increase to 1.2 minutes in good weather and 14.6 minutes in bad weather in 2005
- Departure delays due to air traffic control and related factors average 5 minutes during good weather but almost double to 9 minutes during bad weather. The majority of departure delays occur at the gate
- The direct costs of fuel and maintenance associated with delays at Wellington currently amount to $2.4 million per annum. The addition of other airline costs (staffing, aircraft ownership, etc) could increase this direct cost to as much as $6.0m per annum
- Passengers are also inconvenienced by delays to the extent that they experience longer journey times. The addition of $5.5m passenger costs takes the total cost of delay to $11.5m per annum
- The cost of delay will escalate over time as congestion increases. The total cost of delay including the cost of passenger time is expected to increase from $11.5m per annum in 1999 to $19.6m per annum in 2005 (and $65m per annum in 2015)
- The most appropriate solution for reducing congestion depends on the cost and nature of congestion. Congestion and bottlenecks lead to queuing. A degree of queuing (e.g.

1. EXECUTIVE SUMMARY

The Traffic Capacity Forum comprises representatives of each of the major airlines, the international airports and Airways Corporation. The Forum was established in 1996 to address issues around optimising the capacity of the national air traffic system for the benefit of airlines and passengers. The industry recognises that many parts of the aviation system are capacity restricted. As demand grows, some parts of the system will require more active management in order to best utilise the system and reduce delays. The current study was commissioned to understand the overall impact of congestion and recommend solutions for managing demand and reducing congestion.

While increasing demand will lead to congestion problems across a number of aspects of the New Zealand aviation system, the most immediate problem is in relation to Wellington Airport. As such, the Report uses Wellington as a case study for New Zealand's emerging congestion issues. The Report's main findings are:

- Wellington faces an immediate congestion problem during bad weather when a combination of Wellington's topography and low performing aircraft reduce Wellington's runway capacity by 26%
- Growing demand at Wellington means that delays will increase during good weather over the next few years. Average peak hour movements will be at or in excess of Wellington's capacity by 2005
- Flight arrivals are currently delayed by an average of 0.8 minutes in good weather and 4.1 minutes in bad weather. Delays on individual flights can be considerably greater. Average flight arrival delays will increase to 1.2 minutes in good weather and 14.6 minutes in bad weather in 2005
- Departure delays due to air traffic control and related factors average 5 minutes during good weather but almost double to 9 minutes during bad weather. The majority of departure delays occur at the gate
- The direct costs of fuel and maintenance associated with delays at Wellington currently amount to $2.4 million per annum. The addition of other airline costs (staffing, aircraft ownership, etc) could increase this direct cost to as much as $6.0m per annum
- Passengers are also inconvenienced by delays to the extent that they experience longer journey times. The addition of $5.5m passenger costs takes the total cost of delay to $11.5m per annum
- The cost of delay will escalate over time as congestion increases. The total cost of delay including the cost of passenger time is expected to increase from $11.5m per annum in 1999 to $19.6m per annum in 2005 (and $65m per annum in 2015)
- The most appropriate solution for reducing congestion depends on the cost and nature of congestion. Congestion and bottlenecks lead to queuing. A degree of queuing (e.g.

aircraft circling) is not necessarily *a* bad outcome, depending on the cost of congestion and the cost of solutions

- In order to be able to manage congestion, the aviation system needs to be monitoring the level of congestion and measuring delays. There is scope to improve current systems to measure and monitor performance

- The first step in congestion management needs to be optimising the use of existing assets and facilities. This may require incremental capital expenditure. There is scope to improve underlying operational performance of the aviation system and the Operations Committee of the Transport Capacity Forum is investigating options

- The second step generally involves some form of demand management. Demand management may take the form of either an administrative system (rationing) or market-based system (pricing). While administrative systems are generally required to ensure fair and equitable access in situations of chronic congestion, there are advantages in first introducing a market-based system in order to impose some discipline around the value of access to a congested resource

- Expansion of the aviation system's capacity needs to be weighed against the cost of such an expansion. There may be relatively low cost capacity expansion options for individual airports which may be preferable to demand management systems

- The solution to congestion will be airport specific as the characteristics of demand and the options to expand capacity will differ across airports.

As noted above, New Zealand aviation participants have funded this Report. While the Report focuses on Wellington Airport as the most immediate example of emerging congestion issues, the industry recognises that Wellington Airport is a precursor of things to come elsewhere in New Zealand. As such, the main industry stakeholders have cooperated in developing a framework for managing congestion that can be applied consistently as bottlenecks emerge elsewhere.

2. INTRODUCTION

2.1. Background

The Traffic Capacity Forum was formed in 1996 to develop policies necessary to optimise the capacity of the national air traffic system for the benefit of airlines and passengers. The Forum comprises representatives of Air New Zealand, Ansett New Zealand, Auckland International Airport, Christchurch International Airport, Wellington International Airport, Airways Corporation, the Board of Airline representatives and the Aviation Industry Association.

In September 1997, Airways Corporation, on behalf of the Traffic Capacity Forum, commissioned traffic forecasters, Leigh Fisher, to prepare forecasts of aviation demand at Auckland, Wellington and Christchurch International Airports. The Leigh Fisher Report identified congestion problems at Wellington becoming of real concern from 2000 onwards, with problems at other airports emerging over time. Congestion leads to queues building and queues cause delays. Delays constitute a cost to all aviation industry users, whether it be in the form of the direct costs experienced by airlines as aircraft wait to land, or the indirect cost of passengers being inconvenienced by longer journey times.

In order to develop a long term solution, the Traffic Capacity Forum determined a need to understand the overall impact – economic, operational and social – of these delays on all stakeholders and use that as a benchmark to measure proposals for change.

In October 1999, the Traffic Capacity Forum appointed international strategy consultants, L.E.K. Consulting, to model the economic impact of delays and develop a range of scenarios which mimimises the impact of delays. L.E.K. Consulting has offices throughout UK/Europe, North America and the Asia/Pacific region, including Auckland. L.E.K. Consulting advises public and private sector organisations on all facets of strategy and have considerable experience in assisting organisations find solutions which balance commercial and social objectives.

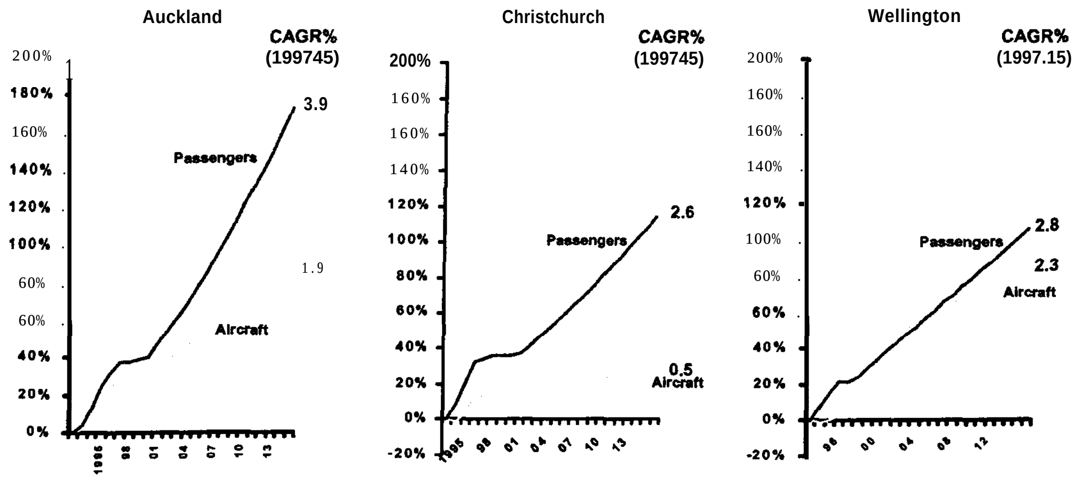
2.2. Consulting Process

Members of the Traffic Capacity Forum have jointly funded the Report on Traffic Capacity Issues. Forum participants have supplied data, partaken in interviews and participated in a series of workshops to discuss findings and share ideas on ways to minimise the cost of congestion.

The consulting process was based around four modules: Understanding the Level of Congestion, Quantifying the Cost of Congestion, Developing Scenarios and Evaluating Options.

3. UNDERSTANDING CONGESTION

The Leigh Fisher Report identified that passenger numbers are expected to grow at a compound annual rate of up to 5% over the next 15 years. Wellington will face particular issues as the rate of aircraft growth is expected to almost match the rate of passenger growth due to its particular mix of traffic. Under Leigh Fisher's Base Case forecast (shown below), Wellington's passenger growth is 2.8% per annum while its aircraft growth is forecast to be 2.3% per annum.



Source : Leigh Fisher Associates, April 1998

At times, Wellington is already operating at close to its theoretical visual capacity of 38 movements per hour. However, the topography of Wellington combined with poor weather means that the capacity of Wellington is reduced by 26% (to 28 movements per hour) around 11% of the time. This is because of a requirement to keep aircraft safely separated in the event of a missed approach in below circling conditions (poor weather). A wide variety in the performance of aircraft using Wellington means that aircraft have different speed and climb performance, hence wider separations are required during poor weather than would be the case for an airport serving similar aircraft types.

While other airports in New Zealand will face congestion problems over time, Wellington faces an immediate congestion issue in bad weather and an emerging congestion issue in good weather as a consequence of growing demand. On this basis, the Report uses Wellington as an example in order to quantify the level and cost of congestion and provide the basis for the discussion on congestion management. While other airports will face similar issues over time, the exact nature of the solution for individual airports will to some extent depend on how congestion manifests itself and the cost of different solutions.

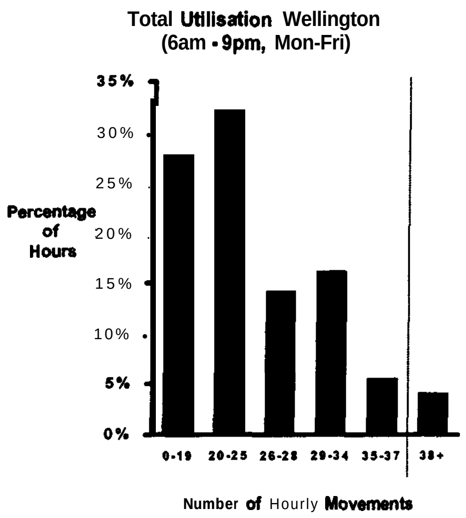
Within this context, congestion leads to a variety of different forms of delay. The main focus of this report is on flight arrival and departure delays as illustrated overleaf. Other sources of delay are illustrated in the Appendix.

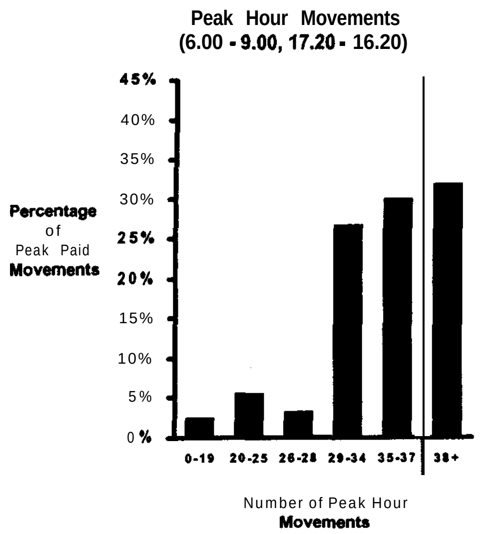
4. LEVEL OF CONGESTION

4.1. Overall

If traffic movements are considered in the context of an overall day, Wellington does not appear to have a significant congestion problem. Less than 10% of flights over the course of a day are during time slots where the number of aircraft movements is 35 per hour or greater.

However, there is high demand from people to travel at specific times of the day, hence there tends to be peaks and troughs in demand. During the morning and evening peak hours there are 35 or more aircraft movements over 60% of the time. Peak hour movements are at or in excess of capacity over 30% of the time.

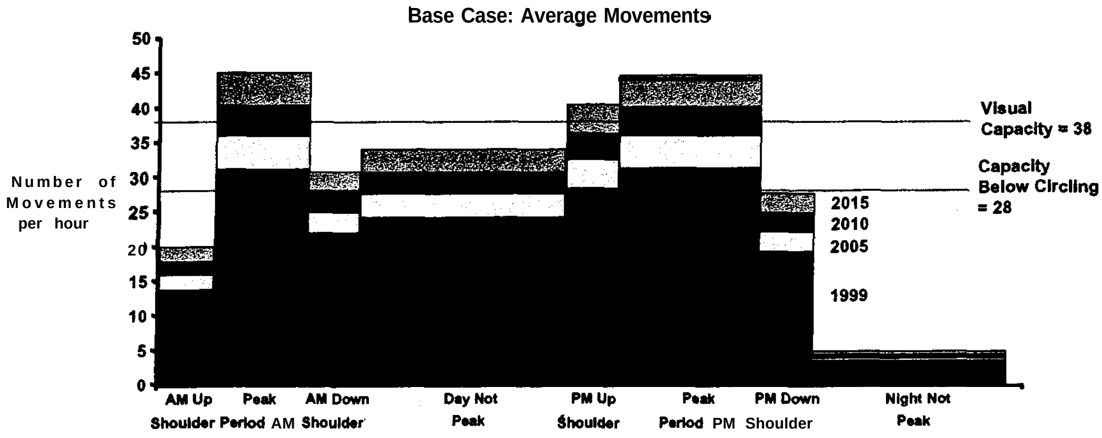




Source: Airways Corporation, June 1998 - June 1999

4.2. Impact of Growth

Unconstrained growth in demand in line with Leigh Fisher's Base Case forecast is likely to result in prolonged periods of congestion by 2005. Average demand during peak periods is almost at Wellington Airport's capacity, while average middle of the day demand is at Wellington's below circling capacity. This is shown overleaf.

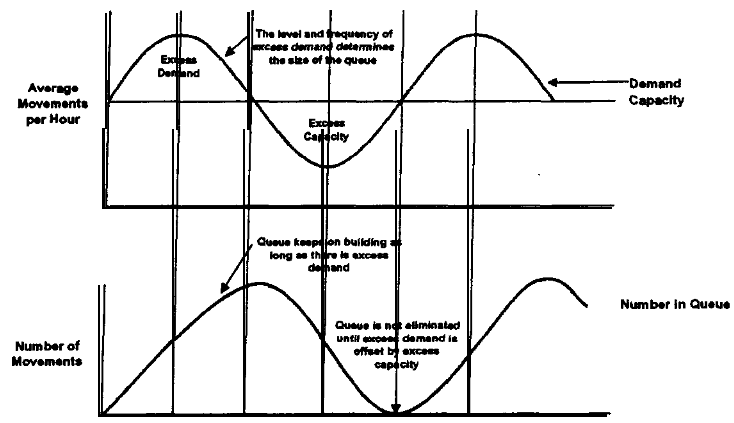


Source: Airways Corporation; L.E.K. analysis

The chart shows average demand through different periods of the day. The situation during the actual peak hour is more acute. By 2005, average morning peak hour movements are forecast to grow to 38, while there will be an average of 41 peak hour movements in the evening. By 2010, peak hour movements at Wellington are substantially above capacity, averaging somewhere in the range of 45 movements per hour. Individual peak hour movements may be considerably greater.

These forecasts illustrate that there will be periods of considerable congestion at Wellington Airport even in good weather. When the weather deteriorates to below circling, Wellington Airport will be very congested throughout the day by 2005.

The usual response to congestion is for demand to spill into adjacent time slots. However, if underlying demand in the adjacent time slots is also at or near capacity, it takes a long time to eliminate queues and return to normal conditions. As a consequence, a queue is not eliminated until there is sufficient excess capacity to offset excess demand as illustrated in the chart. As underlying demand at an airport builds, it becomes more and more difficult to avoid perpetual queuing. On current forecasts, Wellington airport is likely to begin facing perpetual queuing at some point during the next decade.

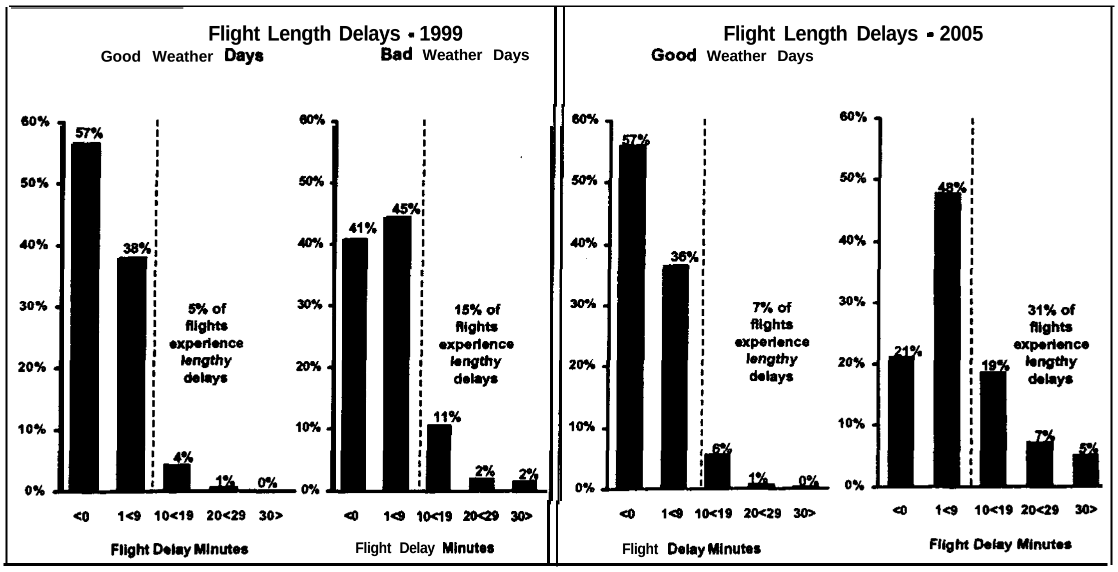


A shift to larger aircraft by the airlines would absorb some of the increase in demand without increasing aircraft numbers and would therefore assist in delaying the level of congestion being experienced. However, the recent trend in New Zealand has been towards smaller aircraft flying more frequently which only exacerbates congestion. Whilst there may be a slight increase in average aircraft size in the future, the increase is likely to be marginal given New Zealand's population distribution and the need to balance aircraft capacity and schedule frequency in providing services to a number of small markets.

Likewise the industry anticipates that growth of direct point-to-point flying between regional centres is likely to be limited and not have a material impact on reducing demand for Wellington Airport. Wellington Airport's location means that it will always remain an attractive hub.

4.3. Flight Arrival Delays

Flight arrival delays have been measured by comparing the actual flight times of arrivals into Wellington, compared with standard flight times. While lengthy delays are currently only a bad weather problem, lengthy delays will increase over the next five years as traffic at Wellington airport increases.



Note: Flight Times versus Standard Flight time - from wheels touching and leaving the tarmac. Arrivals only
A sample of flights from 1 Jan - 30 June
Source: Airways Corporation; L.E.K. Analysis

Average flight arrival delay minutes across all aircraft are currently very low, but are substantially greater across delayed aircraft.

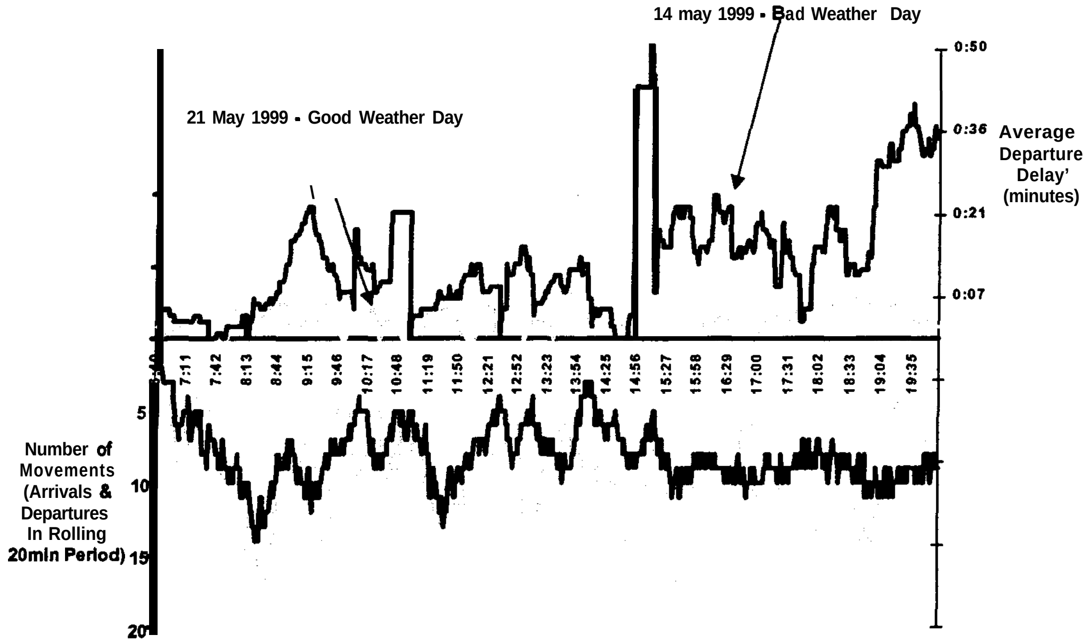
	Peak Period - 1999		Peak Period - 2005	
	Good Weather	Bad Weather	Good Weather	Bad Weather
All Aircraft	0.8 min	4.1 min	1.7 min	14.6 min
Delayed Aircraft	4.4 min	7.9 min	5.7 min	14.6 min

While average demand will increase by 14% over the next five years, average delay minutes will grow substantially faster.

4.4. Departure Delays

Departure delays arise either as a consequence of an aircraft being held at the gate due to congestion, or otherwise incurring a longer taxi time as it waits in a queue to take-off.

Departure delays on good weather days average around 5 minutes and exhibit a typical "saw-tooth" pattern with delays building through congested periods and easing as demand reduces. Departure delays through bad weather are considerably greater and the average length of delay tends to build throughout the day because the underlying level of demand is close to capacity, hence there is little room to clear queues and reduce delays. Departure delays in bad weather average around 9 minutes currently.



Note: - Average delay = average delay being experienced by all departing flights in each 20 minute period
Source: Airways Corporation; L.E.K. Analysis

The cumulative departure delay on a bad weather day across all aircraft can be of the order of 40 hours.

The majority of departure delays occur at the gate, with only 20% of the departure delay being incurred whilst the aircraft is taxiing. Clearly it is lower cost for the airlines for delays to occur before the aircraft has started up.

4.5. Passenger Delays

Passengers are inconvenienced by delays to the extent that they incur longer journey times. This may take the form of unnecessary time spent in the air waiting for the aircraft to get clearance to land, or additional time on the ground waiting for an aircraft to board and eventually takeoff.

The overall passenger delay minutes for a given aircraft delay is substantially greater because every minute of aircraft delay has to be multiplied by the number of passengers affected. The number of passengers affected can vary from 15 on a fully loaded Bandeirante through to 113 on a fully loaded B737-200.

This report concentrates on the delays being experienced by passengers arriving into Wellington and departing from Wellington. Clearly there are wider implications in terms of passengers being delayed throughout the network and having to wait at remote airports as a consequence of delays at Wellington. On the basis that it generally takes at least half a day to currently clear a queue, it is probably reasonable to assume that the passenger delay minutes could be double the level outlined in this report.

5. COST OF CONGESTION

5.1. Arrival and Departure Costs

The direct costs of congestion include

- Additional fuel and maintenance requirements associated with delays
- Longer journey times by passengers
- Other airline operating costs such as the requirement for additional crewing, ground handlers, aircraft and so forth. For example, a crew can only fly a set number of hours, hence delays could result in a change in crew being required after fewer flights than normal. Likewise, an airline may need to increase fleet size in order to maintain some semblance of a schedule and offset poor aircraft utilisation.

The additional cost of fuel associated with congestion has been calculated by building up the delay minutes across different aircraft types and applying the respective holding pattern fuel burns for each aircraft type and the current cost of aviation fuel. The fuel burn whilst taxiing is assumed to be 50% of the holding pattern fuel burn.

The additional cost of maintenance has likewise been built up from calculating the delay minutes associated with different aircraft types and then applying that element of maintenance cost that varies with block hours (some maintenance costs are fixed).

Other airline operating costs (crew, ground handling, aircraft ownership, etc) have been estimated to represent 60% of congested-related airline costs. However, as indicated earlier, the full quantum of these other costs is only relevant if airline systems are approaching capacity and hence these semi-fixed costs become variable.

The cost of time for business travellers has been estimated at $33 per hour while the cost of time for leisure travellers has been estimated at $16 per hour. These estimates have been derived from applying internationally referenced multipliers to average income and applying internationally referenced relationships between the cost of business travel and the cost of non-business travel. Delays during peak periods where the majority of passengers are travelling for the purpose of business are more costly than delays through off peak periods.

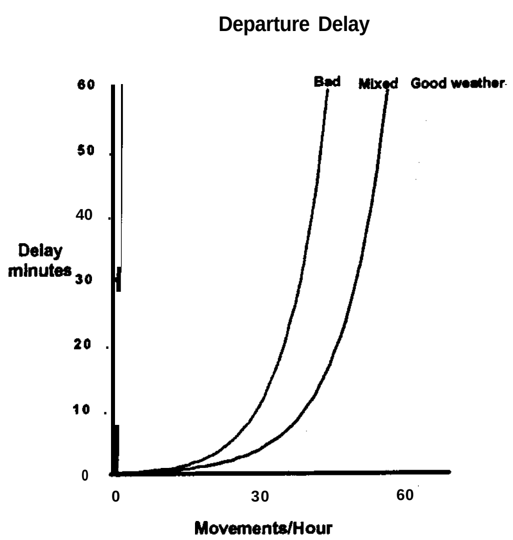
Based on the costs outlined, the cost of congestion at Wellington Airport today is of the order of $11.5 million per annum.

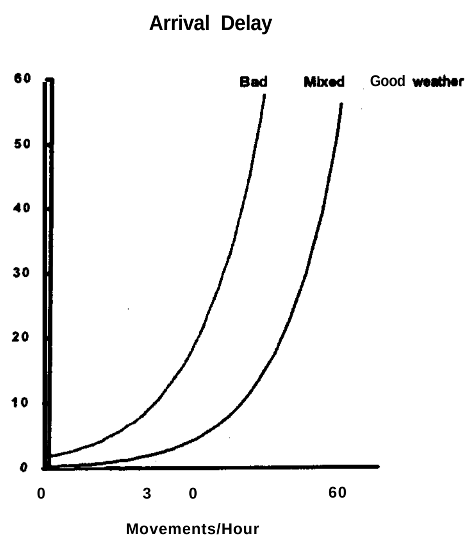
	Arrival	Departure	Total
Fuel Costs	$0.9m	$0.3m	$1.2m
Maintenance Costs	$1.2m	-	$1.2m
Other Airline Costs	$3.1m	$0.5m	$3.6m
Subtotal Direct Costs	$5.2m	$0.8m	$6.0m
Passenger Costs	$1.6m	$3.9m	$5.5m
Total Costs	$6.8m	$4.7m	$11.5m

Every minute a large aircraft is delayed is substantially more costly than a delay associated with a smaller aircraft. This is due to the larger number of passengers impacted by the delay. Every minute a jet aircraft such as a B737-200 or a BaE146 is delayed costs around $112 whereas every minute a Bandeirante is delayed costs just $29. If the primary objective is to reduce the cost of delay, it is imperative to reduce the cost of delay associated with large aircraft carrying lots of passengers.

5.2. Future Cost of Congestion

Average delay minutes will escalate as congestion grows and there is difficulty in clearing queues. This is illustrated below.





Source: L.E.K. Analysis

As a consequence, the cost of congestion will also escalate exponentially over time, as shown overleaf.

Future Cost of Congestion

	1999	2005	2010	2015
Fuel and Maintenance Costs	$2.4m	$4.0m	$7.1m	$13.6m
Other Airline Costs	$3.6m	$6.1m	$10.7m	$20.4m
Subtotal Direct Costs	$6.0m	$10.1m	$17.8m	$34.0m
Passenger Costs	$5.5m	$9.5m	$16.7m	$31.4m
Total Costs	$11.5m	$19.6m	$34.5m	$65.4m

5.3. Other Costs

In addition to these direct costs of congestion, airlines may experience other costs in the form of a loss of premium revenues as passengers choose to travel outside of peak periods in order to avoid delays. The actual level of these costs depends on the pattern of congestion. If demand is very peaky, some passengers could change the time at which they travel. However, if congestion is acute, the airlines are unlikely to differentiate between peak and off-peak pricing. Under this circumstance, the airlines lose revenue from those passengers who choose not to travel, but the airlines gain from higher average fares (a cost borne by the travelling public).

A number of costs of congestion have been excluded. Not only are some costs difficult to quantify with any degree of certainty, but the industry is also primarily commercial in its orientation, hence it is more likely to base its decisions on direct costs and benefits as opposed to the full economic costs associated with “public goods”. Costs that have not been estimated include:

- The cost of reduced safety arising out of increased congestion
- The cost of reduced national/regional economic activity arising from the multiplier effect from the loss of passenger time and the uncertain delivery of goods and people

In addition, some network costs have been excluded on the basis that they cannot be quantified with any degree of accuracy without extensive and sophisticated network modelling. The following are examples of exclusions:

- Increased airport operating costs in the form of more gates or bigger terminals in order to cope with delays on the ground. These additional airport operating costs are likely to be incurred across the network as aircraft are increasingly held on the ground at remote airports in order to reduce queuing at the congested airport
- Lower capacity utilisation of airport infrastructure.

6. RECOMMENDED SOLUTIONS

A multi-pronged approach is recommended for managing congestion. The first element requires ongoing measurement of congestion in order to be able to manage it. The remaining three steps relate specifically to congestion management and involve 1) optimising the use of existing assets, 2) managing demand and 3) building new capacity.

The exact sequencing of each element and hence the most appropriate solution at any given point in time depends on the cost and nature of the resulting impacts. Aircraft queuing is not in itself bad and the aviation industry generally accepts queues up to the point that delays become too costly. Queuing may be perceived as less costly than for example the operating and/or capital costs associated with reducing delays.

Whether an individual airport solves congestion through, for example, managing demand or increasing capacity, largely depends on the cost effectiveness of capacity increments relative to the cost of congestion. The industry will be prepared to fund capital expenditure to offset delays if this capital expenditure is demonstrated to be effective in reducing the cost of delays and accommodating future growth.

6.1. Measuring Congestion

The industry primarily defines congestion in terms of the length and frequency of delay. Extensive "spot" measurement of congestion and delays has taken place during the course of the Forum's analysis of traffic capacity issues. However, the industry needs to better understand what delays are occurring and why on an ongoing basis in order to provide an objective basis for consultation on access, pricing and investment going forward.

Much of the information is already available but accountability for maintaining congestion measures needs to improve. Two sets of information are required:

- Firstly, Productivity and Utilisation data, e.g. average movements per hour (relative to capacity), runway occupancy times, gate utilisation, etc in order to identify opportunities for performance improvement, if any

- Secondly, Level of Congestion data, e.g. average departure delays, average flight time delays, % of aircraft for which gates are unavailable, etc

Airways Corporation is instituting systems to better measure and monitor congestion, and the Airports and Airlines have also agreed to take more responsibility.

6.2. Optimising the Use of Existing Assets

Optimising the underlying performance of the aviation system needs to be the first step in meeting growing demand. At present, offschedule operation appears to be not just confined to the most congested periods, suggesting that there may be opportunities to improve underlying performance of the aviation system.

Productivity improvements such as staging areas to order departing aircraft, sequencing of arriving aircraft, rounding of exitways, high speed taxiways, schedule coordination to avoid bunching, reducing separation rules and increasing pilot reaction times can represent opportunities to increase effective capacity. Options such as staging areas and sequencing allow greater control over queuing i.e. queues can be reordered in a way that minimises costs and optimises value.

Options for improving underlying performance tend to be airport specific.

6.3. Managing Demand

Managing demand implies that some users will not have the freedom to access the aviation system when and how they want to. While any system which restricts access is less equitable than "open access systems", the New Zealand aviation system is a largely commercial system and as such, will migrate towards outcomes which impose the true cost of travel on users.

There are two main families of demand management options – administrative rationing or market rationing. Market-based rationing uses tools such as pricing to encourage the market to find its own solution. The price of access during congested periods is substantially greater, hence only those users who can afford to pay a premium for access will continue to use the system when it is congested. Administrative rationing attempts to temper a purely market based system with equity considerations, for example, "grandfathering" the right to access the system to incumbents, or "ringfencing" parts of the system to protect access for those who do not have the same ability to pay.

The criteria in assessing which option or family of options needs to apply in particular circumstances are outlined briefly below.

Criteria	Observations
Optimises Capacity	• Low performing aircraft reduce capacity of some airports in poor weather • Small aircraft consume capacity for the benefit of relatively few passengers
Maximises Productivity	• Schedule bunching contributes to delays
Optimises Cost of Delays	• Airborne costs are substantially greater than on-ground costs • Delays associated with large aircraft are more costly
Fair and Equitable	• A substantial proportion of flights serve regional and provincial centres; a number of passengers are transiting to other flights • A number of new operators have emerged
Balances risks and rewards	• Delays are currently random
Simple and transparent	• Industry systems are currently not well adapted to measuring congestion and monitoring delay

Depending on the particular circumstance, some criteria are likely to be more important than other criteria. For example, if intermittent congestion results as a consequence of low performing aircraft reducing capacity in bad weather, the solution is more likely to focus on how to minimise the impact of low performing aircraft during periods of bad weather. By contrast, an aviation system that is perpetually congested is likely to give greater weighting to equity considerations in order to ensure access for those that might have difficulty in independently gaining access.

A brief description of different demand management options is provided below.

System	Examples	Description	Comment
Administrative	Aircraft prioritisation	Rules around aircraft size and performance govern access	• Optimises capacity and reduces expensive airborne delay as larger aircraft are favoured • Regional and transit passengers may not have access when congested unless airlines invest in larger (potentially suboptimal) aircraft to serve these markets • Benefits of reduced risk and cost obtained by operators of larger aircraft while others suffer greater risk of delay and greater cost • Approach used elsewhere eg London airports
	Capped schedules	Scheduling committee adheres to a maximum number of movements which is set to avoid delays	• Underutilises capacity if cap is too low • Lower volume reduces airborne delay • New entrants will find it harder to gain access • If delay is intermittent, system may be being overmanaged • Approach used elsewhere eg Sydney
	Slot allocation	Scheduling committee allocates specific times to users	• Spreads demand and reduces airborne delay • Encourages discipline around onschedule operation • Fair if rights are "grandfathered" and/or access for particular groups (regional, new entrants) is ringfenced • Grandfathering may be suboptimal if users have never had to differentiate the value of accessing the system during congested periods versus quiet periods • Approach widely used in aviation
Market-based	Peak pricing	All users through a congested period are levied with a surcharge	• Favours larger aircraft to detriment of smaller aircraft and shorter routes • Spreads demand, reduces expensive airborne delay • Requires lower pricing offpeak or capex plans to address congestion if system is to avoid generating excess returns • Forces users to value capacity but prices not directly related to costs • Approach is widely used in aviation
	Interruptible supply contracts	Tiered pricing based on a choice of continuous access, "best endeavours" access, or discontinuous access	• Greater incentive to continually maximise the number of movements • Airborne delays are avoided as some operators are periodically excluded • Regional passengers may have reduced access at particular times if operators choose an interruptible supply option • Balances risk and reward as some operators pay more in return for reduced risk of delay, others pay less in exchange for greater risk of delay • Approach widely used by energy utilities
	Tradeable slots	Secondary cash market is established for slots	• Encourages efficient allocation of capacity as slots are purchased by those who value them most • Spreads demand, reduces expensive airborne delay • Creates discipline around avoiding delay • Regional services, new entrants priced out of the market • Approach is used by some domestic airports in the United States

Against this background, we recommend that aviation system operators required to manage excess demand adopt some general principles:

- Firstly, excess demand that is intermittent (e.g. resulting from bad weather, or is seasonal around holiday periods) requires a different approach to perpetual congestion. It is important not to over-manage intermittent congestion. Equity considerations are less germane to the solution as there are other opportunities to gain access. Ideally there should be some form of exchange of costs and benefits between those who are worse off and those who are better off

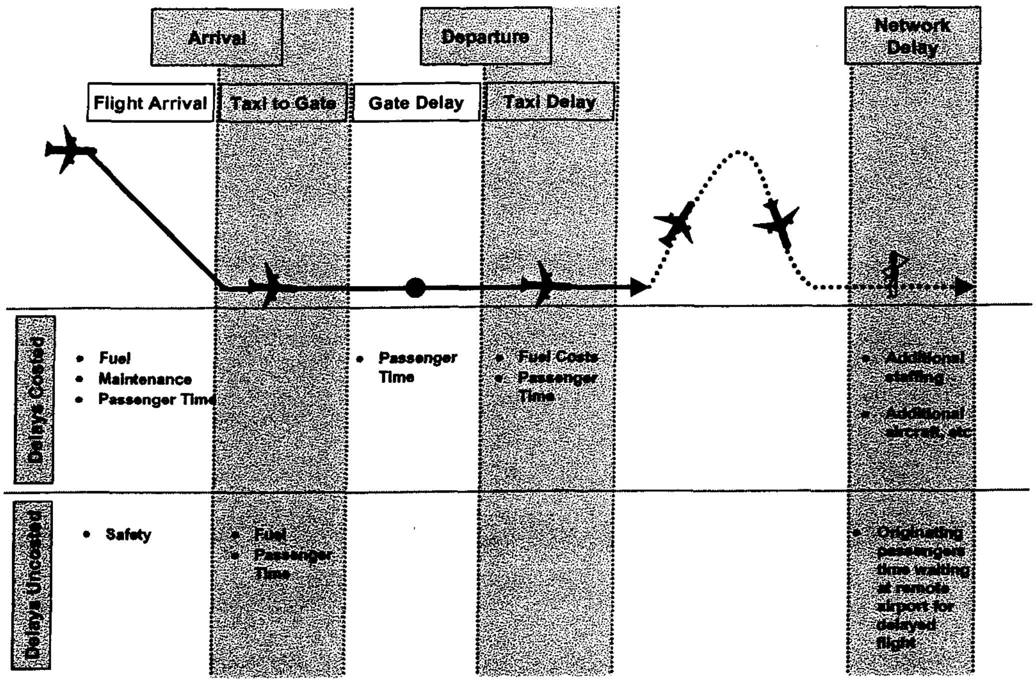
- Secondly, if congestion is perpetual, we recommend that some form of market-based demand management is introduced for a period prior to introduction of administrative rationing of demand. A market-based system imposes greater commercial discipline and encourages greater economic efficiency whereas immediate introduction of an administrative system (via grandfathering) is likely to suboptimal if users have never had to value access. Eventually, the demand management approach will need to contain an administrative element if it is deemed necessary to preserve access for groups who might otherwise be disadvantaged.

6.4. Increasing Capacity

Increasing capacity is an option, provided the associated capital expenditure is cost-effective in reducing the current and future cost of delays. Capital expenditure options such as extending runways and building second runways for smaller aircraft may be cost effective relative to the cost of delays. However, delays would need to be extreme in order to make options such as relocating an entire airport economic.

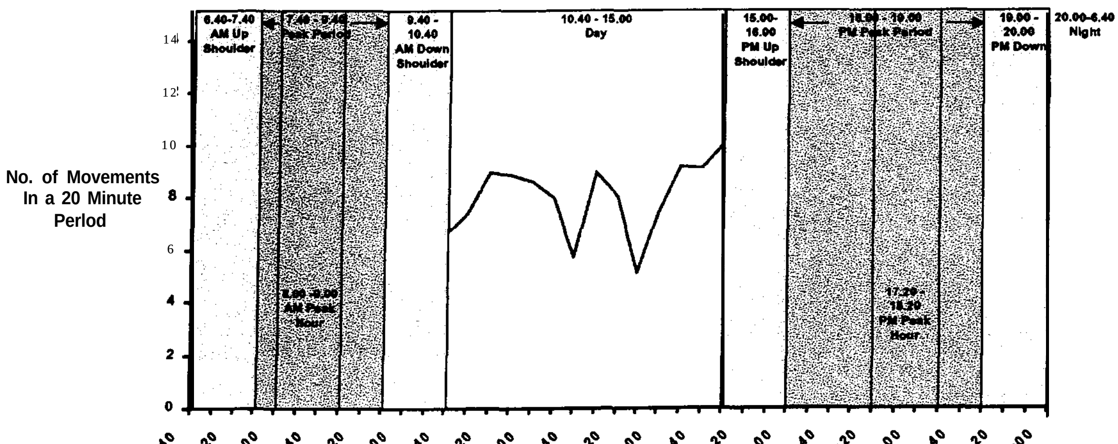
APPENDIX

Types of Delay



Definition of Time Periods

Average Friday Movements
(July 99 -June 99)



% Movemente	3	14	5	27	7	23	6	15

Source: Airways Corporation

Categorisation of Aircraft on Performance Characteristics

Categorisation of Aircraft

Category	Description	Examples	Performance: Approach Speed (knots)	Performance: Climb Speed (knots)	Proportion of Movements
A	Jets	B767, B737, BAe146	120-150	130-150	30%
B	High Performance Turbo Props	ATR	150	140	4%
C	Medium Performance Turbo Props	Metroliner, Jet Stream 31, Saab, Dash 6	120-150	100-120	32%
D	Low Performance Turbo Props	Bandierante*	100-130	90-1 00	18%
E	Other small regionals	Piper, Cessna	100-160	70-90	9%

Note: *Grouped separately as unable to comply with a Wellington speed requirement where as part of approaches to Wellington 160 knots must be maintained to 5 mites from the threshold. 6% of flights are undefined or unclassified

Source: Wellington Airport, Airways Corporation Reports, Airlines