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Appendix P2
Property values

Western Sydney Airport EIS

Potential Impacts on Property Values

Prepared for: Australian Government – Department of Infrastructure and Regional Development

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Executive Summary

Scope and Objectives

This technical paper has been prepared as part of the Western Sydney Airport EIS to examine the potential impact the operation of the Western Sydney Airport (proposed airport) may have on land and property values within the area around the airport site. Specifically it seeks to explore from empirical analysis of sales price data, the effect that aircraft and airport operations may have on property prices in the vicinity, particularly property prices for residential and large lot land holdings.

The most readily apparent and assessable effect of an airport on surrounding non-commercial real estate is from aircraft noise, although potential health impacts and odour as a result of aircraft emissions and fuelling operations can also be significant (Yim et al, 2015; Dedoussi, IC and Barrett S, 2014). Whilst numerous studies attest to these effects, there is no evidence to suggest a separately quantifiable direct impact on property prices. Accordingly for the purposes of this study on property price impacts, aircraft noise is considered as the principal factor, whilst acknowledging that this may reflect a combination of other factors. Other studies also consider a number of additional factors resulting from the implementation of new infrastructure may have a co-incident effect on property prices which are hard to disaggregate including: changes to access conditions, visual effects, subdivision, etc.

This paper does not specifically quantify the impacts of the proposed airport on property prices from commercial or employment based land uses due to difficulties in measurement. Whilst the study addresses noise impact on residential property and large lot land holdings, non-residential land uses may also be affected by proximity to the airport and by noise incidence. Commercial (office, hotel, retail etc.), industrial and employment related uses are considered to be less adversely impacted, due to their building characteristics, nature of activities and lower evening/night time use. More importantly these land uses are likely to materially benefit from the increased economic activity that will come from their proximity of the airport site, which will positively impact land values. Community type land uses, such as schools, places of worship, health care and aged care facilities which are affected by noise are less contestable in the market and likely to be restricted by land use zoning and planning controls, hence the impact of noise is not generally price related. Accordingly, the study does not seek to quantify price effects on such non-residential property.

Using multiple regression techniques to analyse property sales data from areas around Sydney (Kingsford Smith) Airport (Sydney Airport) and a number of other Australian airports, the study seeks to explore the effect of airport operations on the sale prices of residential property and whether such effects are sustained over time. Recognising that the effects may differ depending on the nature of residential development in terms of density and housing type, the study considers property pricing within two separate categories:

1. urban housing within established urban areas, where land parcels are typically less than 2000 square metres, referred to herein as ‘residential’ or ‘residential land’; and
2. dwellings on land zoned for residential, rural or rural/residential use, lying outside the main urban area, with land parcels typically greater than 1 hectare and referred to in this study as ‘large lot land holdings’.

It is noted that much of the land in the vicinity of the airport site falls within this second category, differing markedly from higher density, more land intensive uses surrounding the existing Sydney Airport.

It is noted that there are few, if any, units and apartments in the vicinity of the airport site. Pricing of units has thus been excluded from the analysis because of this and also because units’ characteristics such as; a lack private open space, units are shielded from noise by adjacent units and have varying orientation which may make pricing less influenced by noise than houses with similar exposure. Additionally, new unit developments have a tendency to skew the results because they typically sell for higher prices than the existing stock.

The empirical findings from this quantitative analysis have also been considered in the context of previous Australian and International studies which have sought to gauge the impact of noise and other factors on housing prices in the vicinity of major airports.

Methodology

The methodology in this study builds on the previous studies, particularly those prepared by JLW Advisory (1997) in relation to the Second Sydney Airport Proposal Envirnmental Impact Statement (1997-1999) and JLW Research and Consultancy (1993) in relation to Sydney Airport's third runway. It is informed by a review of these and other published studies seeking to address the impact of noise in property prices in Australia and internationally.

Following an inspection of the area around the airport site, residential and large lot land holdings sales data for areas in the vicinity of the airport site, together with those around Sydney, Adelaide, Brisbane, Melbourne and Perth airports were sourced from data provider, CoreLogic. CoreLogic maintains a comprehensive data series of property sales pricing and transaction information collected from public sources and real estate market participants for all Australian states and territories and is considered to be the most extensive and reliable source of such data.

The sale price data series for analysis were selected at state suburb level, based on inspection of noise data relating to each of the main airports. These data series were 'cleansed' to remove outliers and obvious anomalies and analysed using multiple regression techniques to assess the effect and significance of aircraft noise and other factors on the property sales price.

Unlike previous studies which have largely focused on a single airport, the analysis sought to examine the relationship at a range of Australian airports and to separately explore the impact on residential and large lot land holdings. In addition, by analysing time series sale price data, the study sought to examine the extent to which any impact endured over time, as residential purchasers adjusted to prevailing noise levels and other conditions.

The findings from the analyses were considered in terms of their robustness and significance with reference to standard statistical measures.

The analysis and approach can be considered under the following headings:

Review of Prior Studies:

- literature review of academic and consultant studies from Australia and overseas; and
- review of the JLW Advisory Technical Paper 4 (1997 EIS)

Current Study:

- cross sectional analysis of sales data, being between 2011 and 2014 for residential and between 2000 and 2014 for large lot land holdings. Using multiple regression analysis of these sales with noise exposure included as one of a number of independent variables explaining the dependant variable (sale price);
- longitudinal analysis of sales price data within Sydney over time to compare price trends of noise affected and non-noise affected areas; and
- longitudinal analysis of sales data from suburbs in the vicinity of the proposed airport to examine the impact before and after the 1997 and 2014 announcements of the related to the proposed airport at Badgerys Creek.

Notwithstanding the literature and academic review had reference to some international examples, this report has had primary reference to greenfield and brownfield airports in Australia.

Aircraft Noise Measurement

Aircraft noise is generally regarded as the most apparent and discernible impact on residential property in the vicinity of an airport and under the aircraft flight paths. As noted previously, air pollution may be considered to exhibit co-linearity with noise in terms of possible price effect.

The degree of perceived disturbance is related to factors such as:

- the intensity, pitch and duration of the noise events; and

- the frequency of noise events and their incidence, particularly at different times of the day

These in turn are related to:

- aircraft types and payload;
- aircraft operating characteristics in flight;
- Height and angle of climb/descent;
- Aircraft ground operating modes, taxiing, engine testing and holding;
- Prevailing wind and temperature;
- Ambient noise levels;
- Dwelling construction and orientation;
- Nature and utility of private outdoor areas associated with dwellings; and
- Characteristics of the affected household.

To take account of these various characteristics and perceptions, aircraft noise is commonly measured in terms of Noise Exposure Forecast (NEF), a technique developed in the 1960s in the US to gauge the impact on affected communities. In 1979, the Australian Government commissioned a major survey into community reactions to aircraft noise by the National Acoustic Laboratories (Hede and Bullen, 1982) which led to a refined system named the Australian Noise Exposure Forecast (ANEF).

The ANEF system is primarily a land use planning tool which takes account of the:

- intensity, frequency and duration of aircraft noise events; and
- distribution of take offs and landing movements throughout the day and night, with greater weighting given to noise events between 7pm and 7am.

The information is presented in the form of maps showing sets of contours of equal noise exposure, which may represent:

- actual or historic exposure, termed Australian Noise Exposure Index (ANEI), based on noise measurement of flight data for a previous period, typically for a calendar year
- predicted exposure, termed ANEF which describes potential impacts of aircraft noise based on assumptions of airport and aircraft operations, traffic mix and flight paths.

Under the Airports Act, the Airport Lessee Companies of federally leased airports are required to prepare ANEF maps every five years using Australian Standard AS2021 methodology. These then need to be endorsed by Airservices Australia. They typically have a 20 year time horizon based on forecast traffic mix, and show noise forecasts between 20 and 45 ANEF at 5 step intervals (i.e. 20, 25, 30, 35, 40, 45).

The critical contour is the 20 ANEF which corresponds to the minimum level for acceptability for residential buildings (McLeod I and Latimore M. 2014), Australian Standards AS2021. It corresponds to 10 per cent of the population being seriously affected by noise, according to the 1980 NAL study. The region within the range of 20-25 ANEF is classed as conditionally acceptable for residential buildings, requiring noise attenuation to meet the target levels of AS2021. (McLeod and Latimore, Airservices Australia, 2014).

In addition to ANEF/ANEI measures, aircraft noise is also measured with regard to the number of instances in a given period of noise events above a certain volume. Most Australian airport master plans now include contour maps showing measures such as N70 (N noise events of 70 decibels). Typically the areas affected by 70 decibel events extend well beyond the 20 ANEF area (McLeod and Latimore, op cit). However, these plans are not subject to Airservices Australia endorsement. Because of the dynamic nature of these measures, they are less susceptible to relating to property sales price data and hence have not been used as a primary noise measure in this study.

This study has had regard to ANEI and ANEF contour maps prepared by the airport operating companies for Brisbane, Melbourne, Adelaide and Perth airports and Airservices Australia for

Sydney Airport. In the absence of ANEF plans for Melbourne's Avalon airport, this study has had regard to an estimated impact area, being at the northern point of the runway, 2 kilometres across and 10 kilometres north. These parameters were selected from analysing the ANEF contours of the other selected airports.

Areas falling within ANEI or ANEF contour bands 20 to 35 have been the focus of this study. Areas subject to ANEI or ANEF above 35 are not considered suitable for residential use under Australian Standards and any residences falling within this noise exposure level at other Australian airports have either been subject to Government acquisition or extensively insulated and are not considered a part of the residential market.

Study Limitations

Undertaking analysis to determine the impact on property prices of a new airport is challenging. No single study or method provides definitive results that have perfect comparability for the proposed airport, especially with the context of the current land uses around the airport site at Badgerys Creek which comprises rural, rural-residential and a small amount of traditional residential. Key limitations identified in this report relate to:

- real estate based limitation, relating to the lack of homogeneity in the evidence. Notwithstanding, this, the report has analysed large real estate transactional datasets to derive statistically significant results;
- aircraft noise data limitations; and
- method specific limitations.

Key Findings

Review of Prior Studies

Academic Literature and Professional Studies

A review of a number of Australian and international studies found there is support for the hypothesis that aircraft noise (among other factors) adversely impacts residential property values. Importantly, however, it is noted that these studies have mostly analysed sales of 'traditional' residential property and do not explicitly consider lower density, large lot land holdings similar to those found in and around Badgerys Creek. For these large lot properties, a dwelling potentially represents a smaller proportion of the total asset; as such the noise impact on pricing may be different. This hypothesis has been explored within the current study.

The quantitative studies generally adopt hedonic price modelling techniques (e.g. Kholodilink, 2014, BIS Shrapnel, 1990, Burns & Associates, 1990) which seek to relate the sale price of dwellings to a range of independent variables, including aircraft noise, to enable the impact of noise exposure to be assessed. Others have used matched pair techniques (Nelson, 2004; Bell, 2001) to compare the sale prices for similar properties subject to different noise levels.

These quantitative studies indicate changes in house values range from a low of 0.3 per cent per unit of ANEF to a maximum of 2.6 per cent. They highlight the wide range of factors which influence house prices and also the wider variance in overseas studies compared with those of Australian prices. The results from studies of Sydney Airport for example are more consistent, ranging from a minimum of 0.4 per cent to a maximum of 1.1 per cent per ANEF for a specific flight path, with the greater impact in areas subject to greater noise exposure, suggesting that the relationship between noise and price impact is not linear and increases with ANEF level.

Other consistent findings in the literature suggest that:

- higher priced dwellings are more affected by noise exposure (JLW Research and Consultancy, 1993);
- properties located in areas of higher noise levels suffer disproportionately higher rates of deprecation in comparison to areas with lower noise levels (JLW Research and Consultancy 1993; Levesque, 1994);
- the statistical significance of a relationship between price impact and noise levels below 20 ANEF was consistently found to be low (BIS Shrapnel, 1990; Paulsen, 1990); and

- the impact on property values varies according to the type of property, with some studies showing differences between detached dwellings, units and townhouses, possibly for some of the reasons mentioned above (JLW Advisory, 1997).

Time series analysis indicates that properties affected by noise pollution were reduced in value at a rate of 0.5 to 0.6 per cent per decibel (above standard levels in urban areas). Properties affected by flight path noise experienced average noise levels of 65 to 80 decibels while urban areas outside the flightpath are subject to typical background noise levels in the 50-60 decibel range (Nelson, 2004) Alternative studies indicative higher level affectation of between -15.7 per cent to -19 per cent (Bell, 2001).

A study (JLW, 1997) on the effect of noise on house prices undertaken as part of the previous 1997 EIS for an airport at Badgerys Creek may be of particular relevance. This study included both quantitative and qualitative assessment of the noise impacts relating to Sydney Airport flight paths to the north of the airport following the opening of the third runway in November 1994 and the temporary (and subsequently reversed) closure of the east–west runway in late 1994.

It thus covered areas of both long term exposure to aircraft noise and areas which had experienced recent change in noise levels as a result of the new runway and the closure of the east-west runway. It examined price movements in selected post code areas under existing Sydney airport flight paths, before and after the opening of the third runway and qualitative analysis of perceived impacts on prices in areas where ANEI levels were below 20, based on interviews with real estate agents and valuers.

Using postcode level price data from the NSW Valuer-General, the study compared differences in aggregate house price movements between areas under flight paths and areas not under flight paths in 1994-95. This study also compared house price movements in various ANEI contour zones under the flight paths and in similar control areas away from the flight paths, over the period 1992 to 1996.

Based on a comparison of house price sales from 24 postcodes under the northern flight path, which experienced an average increase in ANEI of 4 units following the opening of the third runway in November 1997, compared with that from 172 post codes not under the flight path, there was a 2.9 per cent divergence in the median sale price in the period leading up to and after the opening of the third runway (i.e. median prices in the affected areas declined by an average of -1.16 per cent whilst those in comparable non affected areas increased by 1.74 per cent).

Conversely, the results under the east-west runway approaches were counter-intuitive. If the reduction in noise levels has been priced into housing, a greater increase in price should have been expected. The study identified two potential reasons. Firstly, buyers believing that the closure was not permanent. Secondly, the postcode data did not precisely match the flight paths.

The study also compared the change in median house price by quartile in a range of areas under the northern flight path subject to changes in ANEI compared to control areas outside the flight path. Although the results from this analysis were inconclusive, it was found that the impact of noise was greatest in higher priced suburbs where it was apparent at levels below 20 ANEI.

In addition to a quantitative analysis of house prices, the study also contained a qualitative survey of real estate agents and valuers. This component of the analysis found:

- a view that aircraft noise was perceived as ‘a big problem’ or ‘of some concern’ in areas within the flight path compared to an issue deemed ‘of little concern’ or ‘satisfactory’ in comparable areas outside the flight path;
- respondents estimated the impact on house prices of between 1.7 and 3.3 per cent in areas within the flight path compared to similar areas and dwellings outside the flightpath;
- the impact of aircraft noise differed depending on buyer type. Young couples with no children were less concerned by aircraft noise when purchasing a property, while conversely elderly and couples with children were more influenced by aircraft noise in their purchase;

- houses were perceived to be generally affected consistently in each area, although higher priced housing in each area appeared to be more sensitive to aircraft noise; and
- apartments or townhouses were perceived to be less affected than houses.

The study had consideration to both the quantitative and qualitative results, as well as the review of literature to determine assumed devaluation factors which it applied to its assessment of the aggregate impact of aircraft noise considered in the EIS. This can be seen in **Table 1** below.

Table 1: Housing Price Devaluation Factors Applied to Badgerys Creek (1997-1999 EIS)

ANEC Band[1]	Devaluation Range	Assumed Devaluation[2]
Under 15	Nil	Nil
15 to 20	0 to 6%	3%
20 to 25	5.9% to 13.6%	8%
25 to 30	8.6% to 19.6%	15%
30 to 35	10.9% to 24.3%	20%

Source: JLW Advisory 1997

Note 1: No devaluation estimates for ANEC > 35 because dwellings located in this noise level at other Australian airports have been either acquired or extensively insulted.
Note 2: Compared to under 15 ANEC.

Current Study

Residential – Cross Section Analysis

To further explore and quantify the impact of noise exposure on residential house prices, sales data from suburbs in the vicinity of Sydney (SYD), Brisbane (BNE), Adelaide (ADL) and Melbourne (MEL) airports were examined using multiple regression analysis.

For each airport, a data set of recent house sales from a range of noise affected and non-noise affected areas was analysed using a number of variables relating to each sale to assess the impact of each on the determination of the sale price. The factors considered were:

- Sale price (the independent variable);
- Sales date (quarter and year);
- Suburb;
- Area of lot;
- Number of bedrooms;
- Number of bathrooms; and
- Noise exposure, in terms of location of dwelling within ANEF/ANEI[1] bands:
    - Less than 20 ANEF/ANEI (considered to be unaffected);
    - 20-25 ANEF/ANEI;
    - 25-30 ANEF/ANEI; and
    - 30-35 ANEF/ANEI.

Sales with in excess of 35 ANEF were not included in the analysis as above this level, property is considered to be unsuitable for habitation.

The time period over which sales data was included varied from 2 years (2013 and 2014) in Sydney and Brisbane and 4 years (2011 to 2014) in Melbourne and Adelaide, resulting in

[1] The following sources were used:
Sydney ANEI, AirServices Australia, 2014
Adelaide ANEI, Adelaide Airport, 2013
Brisbane ANEF, Brisbane Airport Australia, 2014
Melbourne ANEF, Melbourne Airport, 2014 (additionally for large lot land holding analysis)
Perth ANEF, Perth Airport, 2014 (used for large lot land holding analysis)

sample sizes, after removal of outliers of between 290 and 682 observations. The time periods were selected based on the availability of satisfactory sample sizes.

Table 2 on the below summarises the results of the analysis of house prices around four Australian international airports.

Table 2: Significance of Noise as a Determinant of House Prices from Regression Analysis

Airport	N (sample size)	r^2	Noise impact on price	Noise factor significance		Comment
				t -stat	P-value	
SYD	682	64.2%	1.4%	1.55	12.11%	Noise is less likely to be significant
MEL	525	66.9%	-1.9%	-1.37	17.25%	Noise is less likely to be significant
BNE	379	45.2%	-10.7%	-5.54	0.00%	Noise is very likely to be significant
ADL	290	83.3%	-6.6%	-3.31	0.10%	Noise is very likely to be significant

Source: CoreLogic, Airservices Australia, JLL

The analysis suggests that there is a strong and robust relationship between house prices and noise exposure in the house sale price data for Adelaide and Brisbane with a high probability that noise is a significant factor. A P-value of less than 5 per cent suggests that there is a more than 95 per cent probability that the factor is significant, similarly a t-stat of 2 or more generally indicates a statistically significant relationship. Exposure to noise of greater than 20 ANEF was found to have an average negative effect on price of around 7 per cent in Adelaide and 11 per cent in Brisbane compared with housing in areas lying outside the 20 ANEF noise contour.

For Sydney and Melbourne, the data is far less strongly correlated, with a level of probability of greater than 10% that the pricing is not related to or significantly influenced by noise. It is noted that the housing in districts around Sydney Airport may be less homogeneous than Adelaide and Brisbane, suggesting other factors such as proximity to the city, housing pressures restricting location choice or the attractions of inner city locations may outweigh noise concerns. It is also considered that dwelling noise attenuation measures in noise affected suburbs may have partly reduced the noise exposure, although this would require further examination (Burgess 1997).

As the noise to price relationship was considered significant in both Adelaide and Brisbane, the data sets were further analysed to examine the relationship between the level of noise exposure in excess of 20 ANEF on house sale prices.

Table 3: Impact of Exposure to Different Levels of Noise on House Prices, Brisbane and Adelaide

Airport		Noise impact on price (compared to noise levels < 20ANEI/ANEF)		
		ANEI/ANEF 20-25	ANEI/ANEF 25-30	ANEI/ANEF 30-35
BNE	Price impact	-10.7%	N/A	N/A
	Sample size	183	No relevant sales	No relevant sales
ADL	Price impact	-8.3%	-14.7%	-19.8%
	Sample size	132	29	14

Source: CoreLogic, Airservices Australia, JLL

In Adelaide, there were sufficient sales of houses within the 20-25, 25-30 and 30-35 ANEI contours to observe a statistically significant relationship between house price and different noise exposure levels. This indicated that a house within the 30-35 ANEI contour would sell for an average of approximately 20 per cent less than the equivalent dwelling outside the 20 ANEI contour.

For Brisbane, whilst the sale price effect for dwellings within the 20-25 ANEF contour was significant, with prices for the 183 house sales showing an average discount of 10.7 per cent compared with those outside the noise affected area, there were very few sales in higher contour bands within the areas analysed. Hence it was not possible to determine a noise impact on prices at the 25-30 or 30-35 ANEF level.

It is noted that the price impacts observed in Brisbane, Adelaide and in Melbourne were all negative, as might be expected, indicating that house sale prices were lower in noise affected areas. However, although not statistically significant, the impact in Sydney was slightly positive, which could arise if other factors positively affecting price (such as accessibility, proximity to rail station or better quality stock) happened to occur in noise affected areas.

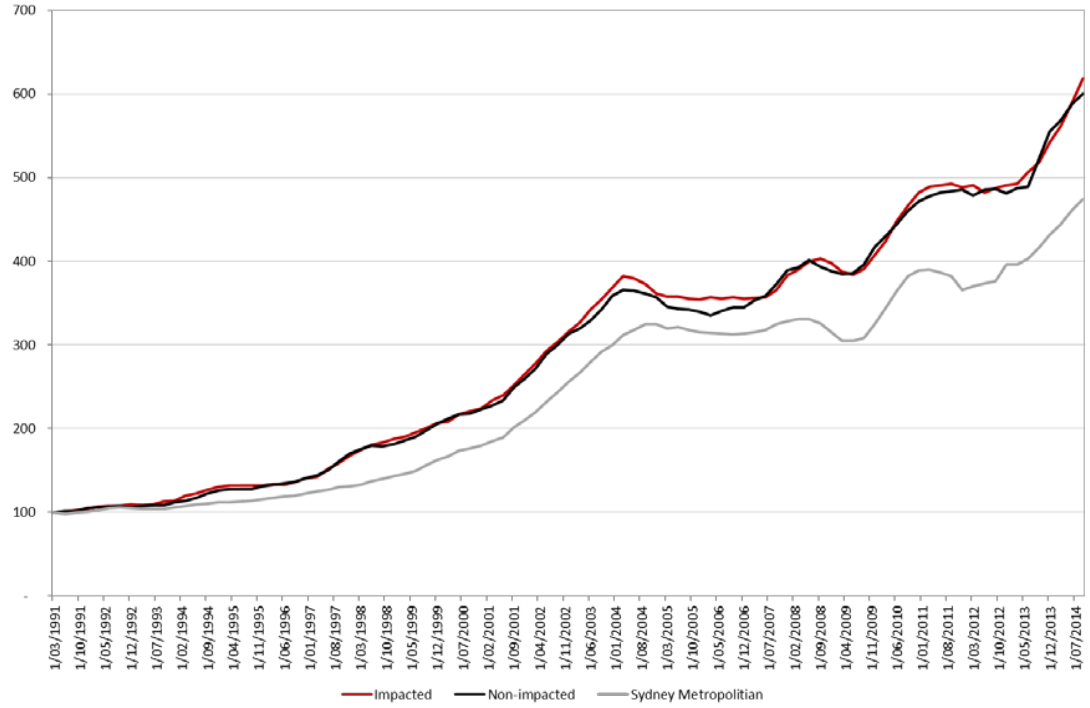
Residential Time Series Analysis (Sydney Airport)

Using the house price sales data for suburbs around Sydney Airport, the impact of noise exposure on long term price growth was explored. In this analysis, the moving annual median house price for 8 affected suburbs and 11 non-affected suburbs listed below were compared, together with that for the Sydney metropolitan area. These suburbs are:

Noise affected:	Kyeemagh, Petersham, Mascot, Stanmore, Tempe, Sydenham, Marrickville and Botany
Non noise affected:	Brighton-Le-Sands, Bexley, Arncliffe, Earlwood, Lewisham, Haberfield, Pagewood, Erskineville, Dulwich Hill, Summer Hill and Alexandria

The annual average median house prices in the two groups compared with that for the Sydney Metropolitan area as a whole are illustrated in **Figure 1**.

Figure 1: Price Growth in Noise Affected & Non-Noise Affected Sydney Suburbs (1991-2015, Based to 100)



Source: CoreLogic, Airservices Australia, JLL

It is apparent that there is no significant difference in price movements and long term price growth between the affected and non-affected suburbs, with both groups showing house price growth at a rate greater than the metropolitan average. This suggests that, in the suburbs analysed, exposure to aircraft noise does not materially impact the long run house price growth rate.

Large Lot Land Holding – Cross Section Analysis

As noted, much of the land surrounding the airport site is zoned for rural use and used for various agricultural and residential purposes, with large land holdings with lots sizes in excess of 2 hectares. It is considered that there may be a difference in the pricing impact of aircraft noise exposure to such holdings compared to higher density residential dwellings in established urban areas.

Although there are few, if any, comparable large lot land holdings in the vicinity of Sydney Airport, areas to the west of Melbourne Airport (MEL) and north of Perth Airport (PER), as well as land around Avalon Airport (AVV) near Geelong have similar characteristics, some of which are subject to aircraft noise exposure. Accordingly, regression analysis of land and dwelling sales in the vicinity of these airports was analysed to determine if there is evidence of any statistically significant relationship between price and noise exposure. The results are summarised in **Table 4** on the next page.

Table 4: Significance of Noise Exposure in Excess of 20 ANEF on Large Lot Land Holdings Pricing

Airport	N (sample size)	r^2	Noise impact on price	Noise factor significance		Comment
				t-stat	P-value	
AVV	330	38.0%	-7.8%	-0.71	47.79%	Not considered significant
MEL	193	54.8%	15.3%	1.88	6.13%	Not considered significant
PER	178	28.9%	0.2%	0.01	98.95%	Not considered significant

Source: CoreLogic, Airservices Australia, JLL

These results suggest that there is no discernible or statistically significant relationship between large lot land holdings exposed to aircraft noise in excess of 20 ANEF and the sale price. It is hypothesized that there are significant factors other than noise which would have a greater impact on price, including the nature and style of the dwelling on the land, the type of activity carried on, the nature and productivity of the land and its physical and biological characteristics.

Structured interviews with real estate agents interstate (Melbourne, Avalon and Perth) could provide a better understanding of the impact on proximity to an operational airport on large lot land holding property values.

Price Change Related to Announcement of Badgerys Creek as a Site of the Proposed Airport

The announcement in April 2014 that the Australian Government is proposing to develop Western Sydney Airport at Badgerys Creek could be expected to have an impact on property values in the vicinity, both from perceptions of possible adverse impacts, such as noise and air pollution, and positive anticipatory and positive effects in terms of improved infrastructure, employment opportunities and potential for higher density and intensity of land use.

This study undertook an analysis on sales in the vicinity of the airport site. The analysis compared the long-term median price growth of suburbs around the airport site with the growth over the same period for Western Sydney and the Sydney metropolitan region. The analysis made primary reference to growth rates both before and after the announcement in April 2014 that Badgerys Creek will be the site for a new airport.

This study has had reference to sales price data series over a 24 year period (1991 to Q1,2015). The study analysed the change in property sales values over the period prior to and the 12 months that followed the April 2014 announcement on land within a 5 kilometre radius of the centre of Badgerys Creek, utilising quarterly moving median prices from the CoreLogic database.

The growth in residential prices in the suburbs lying within 5 kilometres of Badgerys Creek was compared with the Western Sydney and Sydney Metropolitan areas. Overall, this includes some 1,500 residential sales since Q2/1991 in the suburbs of Bringelly, Kemps Creek, Luddenham, Mount Vernon and Rossmore. (Note data series for residential sales in the suburb of Austral and Greendale, which are within 5 kilometres or in Badgerys Creek, were not included due to insufficient sales transactions).

The data represent the average of the four quarterly moving median sale prices for each of the five suburbs around Badgerys Creek (i.e. each quarterly figure is the average of the four preceding quarterly median sale prices for that suburb, and then averaged across the 5 suburbs) index to a base of 100 at Q2 1991.

The findings and growth rates prior to and since the April 2014 announcement are summarised in the table and illustrated in the charts overleaf.

Table 5: Long Term Residential Growth around Badgerys Creek before and after 2014 Announcement

Location	Average Compound Growth Rate 1991 - 2015	
	Pre Announcement	Post Announcement
5 km around Badgerys Creek	6.42%	23.72%
Western Sydney[2]	6.34%	16.65%
Sydney Metropolitan	6.70%	14.04%

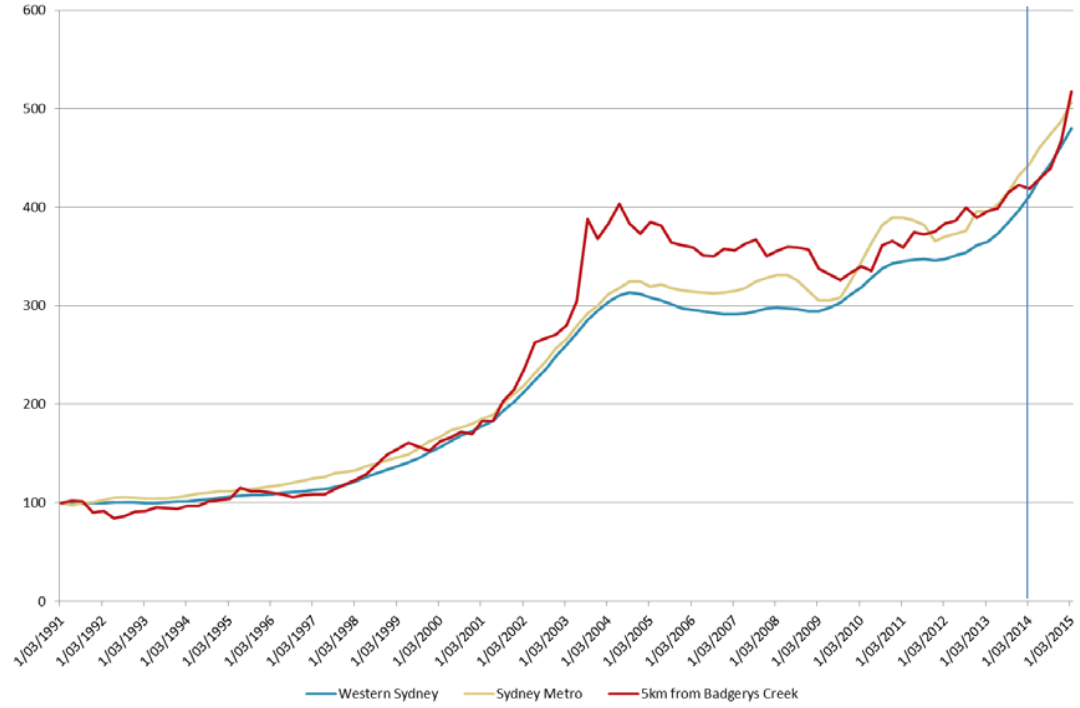
Source: CoreLogic, Airservices Australia, JLL

Whilst average residential prices in the suburbs around Badgerys Creek experienced a growth rate broadly in line with the Western Sydney region and the metropolitan area as a whole, there was a marked acceleration in growth in the 12 months following the 2014 announcement of the proposal to locate the Airport at Badgerys Creek.

Whilst this is not evidence of causality, it is noteworthy that median house prices in the Badgerys Creek area increased at a rate significantly greater than that of the surrounding Western Sydney and the Metropolitan regions. The volume of transactions since the announcement is broadly in line with the long term average of between 15 and 20 sales per quarter.

Although it is not possible to attribute the increased growth to the 2014 announcement, which may be related to a range of external factors including the growing pressures within the Sydney housing market, falling interest rates and the growing commitment to the development of Western Sydney, it suggests that the announcement did not appear to create any diminution in residential values in the broad vicinity of the Airport, which might have been expected if there had been widespread concern about noise or other pollution.

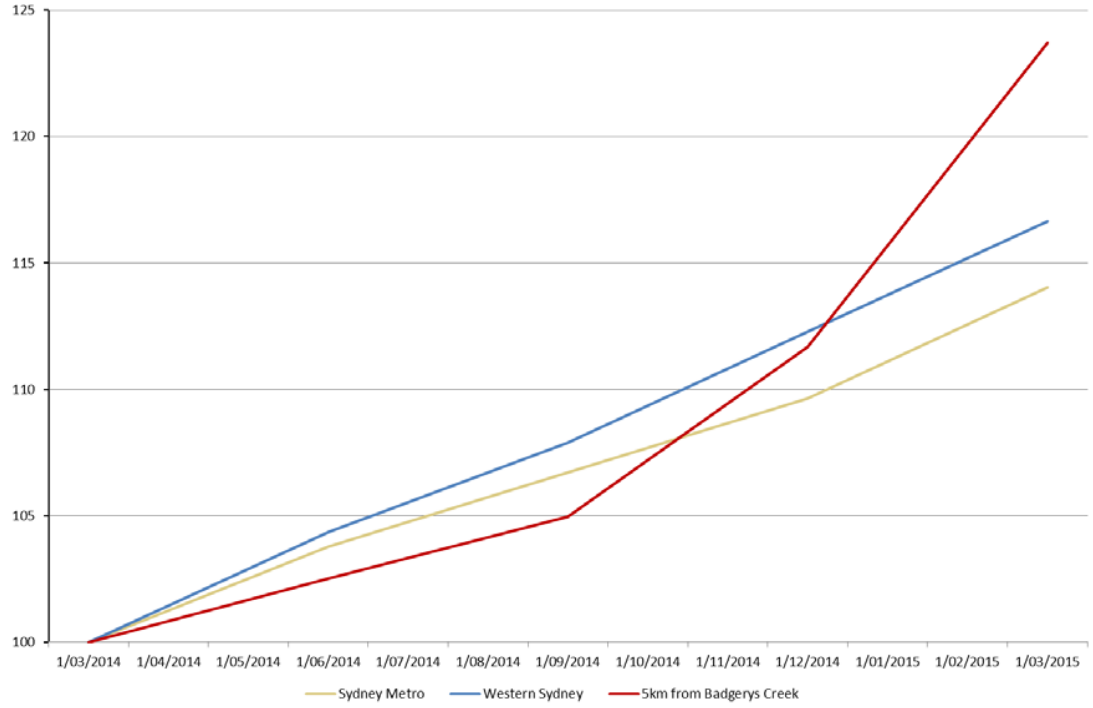
Figure 2: Residential Price Growth around Badgerys Creek (1991-2015, Based to 100)



Source: CoreLogic, Airservices Australia, JLL

[2] Western Sydney is defined as the sum of the following Planning Regions
Sydney South West: Liverpool, Fairfield, Camden, Campbelltown and Wollondilly
Sydney West: Penrith, Hawkesbury and Blue Mountains
Sydney West Central: Auburn, Bankstown, Blacktown, Holroyd, Parramatta and The Hills

Figure 3: Residential Price Growth around Badgerys Creek (Q2-2014 to Q2-2015, Based to 100)



Source: CoreLogic, Airservices Australia, JLL

Summary of Findings

The key findings from this study are summarised below.

- Previous studies have found a relatively consistent adverse effect of aircraft noise on residential prices, of between 0.4 per cent and 1.1 per cent per unit of ANEF, with a greater impact at higher ANEF levels and for higher priced properties.
- None of the previous studies have sought to explore the impact on large lot land holdings comparable to those around Badgerys Creek, where few existing dwellings fall within areas expected to be exposed to noise levels in excess of 20 ANEF.
- The analysis undertaken in this study encompassed over 1,800 residential sales transactions for suburbs in the vicinity of four main Australian international airports found:
    - no statistically significant relationship between noise exposure and housing prices in Melbourne or Sydney;
    - in Adelaide and Brisbane, noise exposure was a more significant factor influencing residential prices;
    - in the case of Brisbane, prices for houses exposed to aircraft noise between 20 and 25 ANEI/ANEF, experienced a -10.7 per cent reduction compared with dwellings outside the noise affected area; and
    - in Adelaide, a statistically significant impact was found ranging from -8.3 per cent (20-25 ANEI/ANEF); -14.7 per cent (25-30 ANEI/ANEF); and -19.8 per cent (30-35 ANEI/ANEF) compared with prices in areas less than 20 ANEI/ANEF.
- At Sydney Airport, analysis of long run house prices since 1991 found no appreciable difference in growth rate between median prices in suburbs subject to in excess of 20 ANEI and those in similar areas not exposed to aircraft noise. Possible reasons may be:
    - housing pressures restrict housing choices;
    - the benefits of living close to the city outweigh possible noise effects in the minds of potential purchasers;

- noise attenuation measures to dwellings with above 20 ANEI may have reduced the impact of noise on residents; and
- aircraft noise sharing protocols and rising ambient noise levels in many suburbs may reduce the perceived impact of noise.

- Examination of sales of large lot land holdings in the vicinity of Melbourne, Perth and Avalon airports failed to establish a statistically significant relationship between noise exposure and property prices. Possible reasons for the lack of clear effect may include:
  - the lesser significance of the dwelling in the context of large land areas, compared with established urban areas;
  - land used primarily for primary production may be less affected by noise; and
  - the wider range of factors influencing price that cannot be analysed from the available sales data, e.g. aspect, topography, soil and micro-climate.
- Analysis of long run growth rates of residential sales in the suburbs around Badgerys Creek indicates that despite short term fluctuations, property prices have grown at a similar rate to the wider Western Sydney and metropolitan regions.
- Rather than suffering a slowing of growth as a result of possible fears of noise or other impact, residential prices in the suburbs around Badgerys Creek grew strongly in the period following the announcement in April 2014 that Badgerys Creek would be the site of the proposed airport, increasing by almost 24 per cent and substantially faster than both Western Sydney and the Sydney metropolitan regions, although it is not possible to attribute this growth to the announcement.
- Overall, the analysis failed to establish conclusive evidence of an adverse impact on large lot land property prices as a result of aircraft noise at levels of 20-25 ANEF that would suggest the development of the proposed airport at Badgerys Creek may have a major adverse impact on property prices in the vicinity.
- Further analysis may be required to provide context to purchasers' preferences that ultimately drives property values around Badgerys Creek. This will be best achieved with structured interviews with real estate agents. Similarly, interviews with real estate agents interstate (Melbourne, Avalon and Perth) will provide a better understanding of the impact on proximity to an operational airport on large lot landholding property values.

After considering the analysis undertaken above the table below summarises the impact of noise on property values by land use type. Broadly, the residential assessment has had primary consideration to the statistically significant results from the Brisbane and Adelaide airports, with support for assessed impact coming from the academic literature and professional studies. The analysis on the large lot land holdings had reference to both the interstate analysis on Avalon, Perth and Melbourne Airports as well as analysis of price changes related to the announcements at Badgerys Creek.

Table 6: Summary of Assessment of Noise Impact on Property Values by Land Use Type

	Noise impact on price (compared to noise levels < 20ANEI/ANEF)		
Land Use	**ANEI/ANEF 20-25**	**ANEI/ANEF 25-30**	**ANEI/ANEF 30-35**
Residential	-9.5%	-14.7%	-19.8%
Large Lot Land Holdings	No discernible impact	No discernible impact	No discernible impact

Finally, consideration was given to the potential impact of property prices that may occur from a second runway opening at the proposed airport. The long term time series analysis on Sydney Airport (see Section 6) suggest no material difference in property pricing of noise versus non-noise affected areas. This outcome is in line with our expectations. That is, that factors of much greater significance will influence property values than any incremental increase in noise. More specifically, it is considered that the positive influences of in-area employment as well as improved amenity and services will more than likely make up for any additional noise from the second runway.

Further, this report makes the observation that there have been significant advancements in aircraft technology over the last 20 years that have meant a material reduction in noise footprints across all major Australian airports, despite increasing aircraft movements. It is considered to be a reasonable assumption that advancements will be made in the future, further reducing aircraft noise. For the above reasons the report has not assessed a negative impact to property prices due to the opening of a second runway at the proposed airport.

Part A – Part A INTRODUCTION

1 Introduction

1.1 Background to the Proposal

Planning investigations to identify a site for a second Sydney airport first commenced in 1946 with a number of comprehensive studies—including two previous environmental impact statements for a site at Badgerys Creek—having been completed over the last 30 years.

More recently, the *Joint Study on Aviation Capacity in the Sydney Region* (Department of Infrastructure and Transport, 2012) and *A Study of Wilton and RAAF Base Richmond for civil aviation operations* (Department of Infrastructure and Transport, 2013) led to the Australian Government announcement on 15 April 2014 that Badgerys Creek will be the site of a new airport for Western Sydney. The airport is proposed to be developed on approximately 1,700 hectares of land acquired by the Commonwealth in the 1980s and 1990s. Construction could commence as early as 2016, with airport operations commencing in the mid-2020s.

The proposed airport would provide both domestic and international services, with development staged in response to demand. The initial development of the proposed airport would include a single, 3,700 metre runway coupled with landside and airside facilities such as passenger terminals, cargo and maintenance areas, car parks and navigational instrumentation capable of facilitating the safe and efficient movement of up to 10 million passengers per year. While the proposed Stage 1 development does not currently include a rail service, planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. A final alignment will be determined in consultation with the New South Wales Government, with any enabling work required during Stage 1 subject to a separate approval and environmental assessment process.

In the longer term, approximately 40 years after operations commence and in accordance with relevant planning processes, the airport development could include parallel runways and additional passenger and transport facilities for around 82 million passenger movements per year. To maximise the potential of the site, the airport is proposed to operate on a 24 hour basis. Consistent with the practice at all federally leased airports, non-aeronautical commercial uses could be permitted on the airport site.

On 23 December 2014, the Australian Government Minister for the Environment determined that the construction and operation of the airport would require assessment in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Guidelines for the content of an environmental impact statement (EIS) were issued in January 2015. Approval for the construction and operation of the proposed airport will be controlled by the *Airports Act 1996* (Cth) (Airports Act). The Airports Act provides for the preparation of an Airport Plan which will serve as the authorisation for the development of the proposed airport.

The Australian Government Department of Infrastructure and Regional Development is undertaking detailed planning and investigations for the proposed airport, including the development of an Airport Plan. The draft Airport Plan is the primary source of reference for, and companion document to, the EIS. The draft Airport Plan identifies a staged development of the proposed airport. It provides details of the initial development being authorised, referred to as Stage 1, as well as a long-term vision of the airport's development. This enables preliminary consideration of the implications of longer term airport operations. Any stages of airport development beyond Stage 1 would be managed in accordance with the existing process in the Airports Act. This includes a requirement that for major developments (as defined in the Airports Act), a major development plan be approved by the Australian Government Minister for Infrastructure and Regional Development following a referral under the EPBC Act.

The Airport Plan will be required to include any conditions notified by the Environment Minister following this EIS. Any subsequent approvals for future stages of the development will form part of the airport lessee company's responsibilities in accordance with the relevant legislation.

1.2 Location Context and Surrounding Land Uses

The preferred site for the proposed airport covers an area of approximately 1,700 hectares located at Badgerys Creek in Western Sydney. The airport site is located within the Liverpool local government area, around 50 kilometres west of Sydney's Central Business District and 15 to 20 kilometres from major population centres such as Liverpool, Fairfield, Campbelltown and Penrith.

Figure 4: Location of the Proposed Airport in Metropolitan Sydney

Source: GHD

Within these areas, most of the potentially affected land is zoned for rural use, although it may incorporate some village areas such as Warragamba, Silverdale and Luddenham.

With much of the land in the vicinity of the airport site zoned for rural purposes, the area has predominantly relatively large lot sizes. To the north east, within Penrith Local Government Area (LGA), under the Penrith Local Environmental Plan 2010 the minimum lot size under the AB3 lot size control is 40 hectares, whilst to the south west, in the Liverpool LGA under the Liverpool Local Environmental Plan 2008 AB lot size control the permitted lots sizes are 10-50 hectares, with some small 'Z' areas with minimum sizes of 2 hectares.

For additional locational context, this report makes reference to the comparative impact on noise at the Badgerys Creek location. Cox (2013) identified that as at the 2011 Census, "at Badgerys Creek Airport, there were 2,913 dwellings within the 20 ANEF contour and 328 dwellings within the 25 ANEF contour. At the 2011 census, at Sydney Airport, there were 86,017 dwellings within the 25 ANEF contour." JLL was unable to verify the ANEF contours referred to within this presentation, as such have assumed these to refer to the ANEF contours established by the previous 1997-1999 EIS.

1.3 Growth of Western Sydney

In terms of a regional context, we have provided below high level observations relating to the South West Growth Centre, Broader Western Sydney Employment Area and Western Sydney Infrastructure Plan due to their interrelationship with the proposed airport.

The NSW Government established the North West and South West Growth Centres in 2005. The objective of the Growth Centres is to ensure the creation of attractive, sustainable new communities by supplying land linked to key infrastructure, employment areas, parks, health and education facilities, shops, services and public transport. The recently released metropolitan plan, A Plan for Growing Sydney (NSW Government, 2014), forecasts that Sydney's population will grow by an estimated 1.6 million people in the twenty years to 2031. Of this growth, more than half will occur in Western Sydney with the North West and South West Growth Centres playing a significant role.

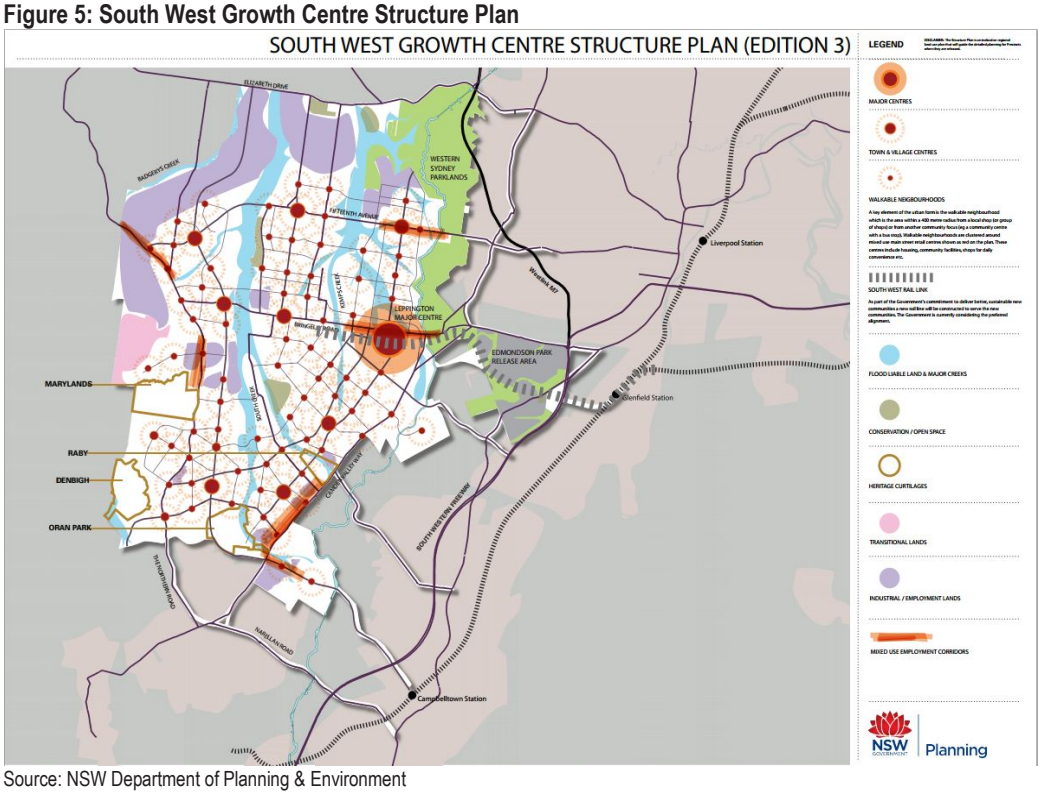
The South West Growth Centre will likely have a particular significance to the immediate area of Badgerys Creek as it is located immediately south of the airport site. **Figure 5** shows the structure plan for the South West Growth Centre. The area is made up of approximately 17,000 hectares and falls within the Local Government Areas (LGAs) of Liverpool, Camden and Campbelltown. The Growth Centre has the potential for over 42,000 homes to accommodate 130,000 residents and will be supported by a major centre at Leppington.

The South West Growth Centre is divided into 18 precincts which are progressively being released for rezoning to enable sustainable long-term development. The status of the precincts, as at August 2014, is shown below in **Figure 6**. As can be seen in the map, seven of the precincts have been rezoned to allow urban development, the Leppington precinct has been released and is undergoing precinct planning, while the remainder are yet to be released or rezoned.

As a means of accommodating the significant growth within Western Sydney, the Australian and NSW Governments are funding a 10 year, $3.6 billion road investment program for western Sydney. The Western Sydney Infrastructure Plan will deliver major road infrastructure upgrades to support an integrated transport solution for the region and capitalise on the economic benefits from developing the proposed airport at Badgerys Creek.

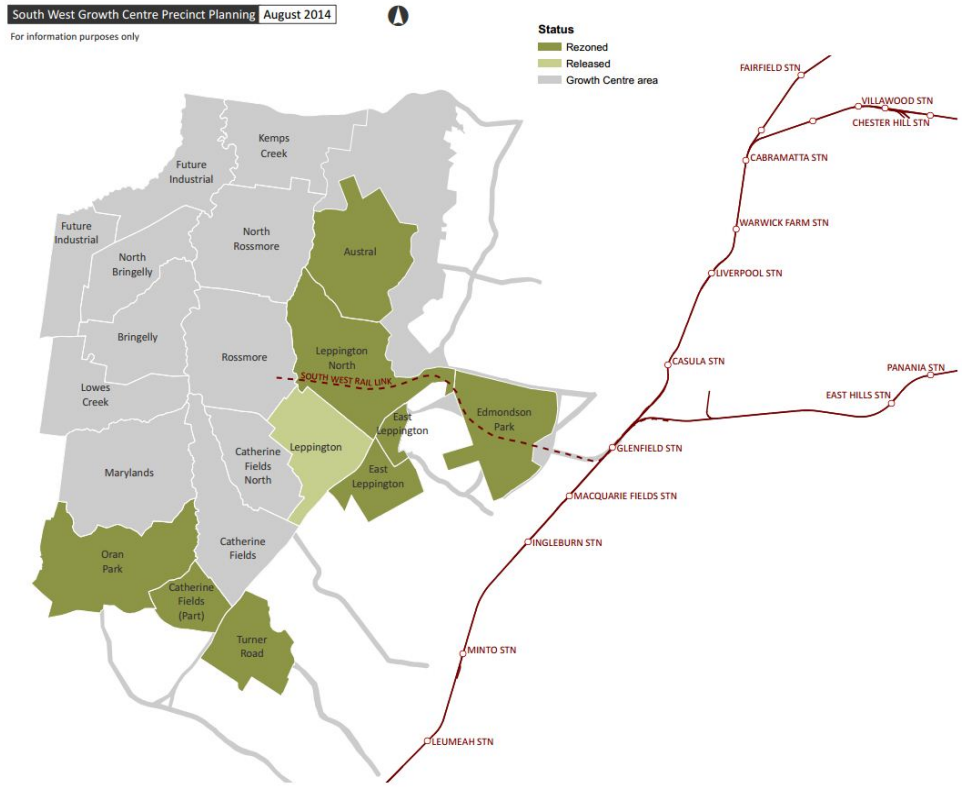
The Plan provides improved road transport capacity ahead of future traffic demand, as planned residential and employment development comes online in western and south western Sydney growth centre precincts and the Broader Western Sydney Employment Area. **Figure 7** identifies some of the key infrastructure to be provided surrounding the airport site.

Figure 5: South West Growth Centre Structure Plan



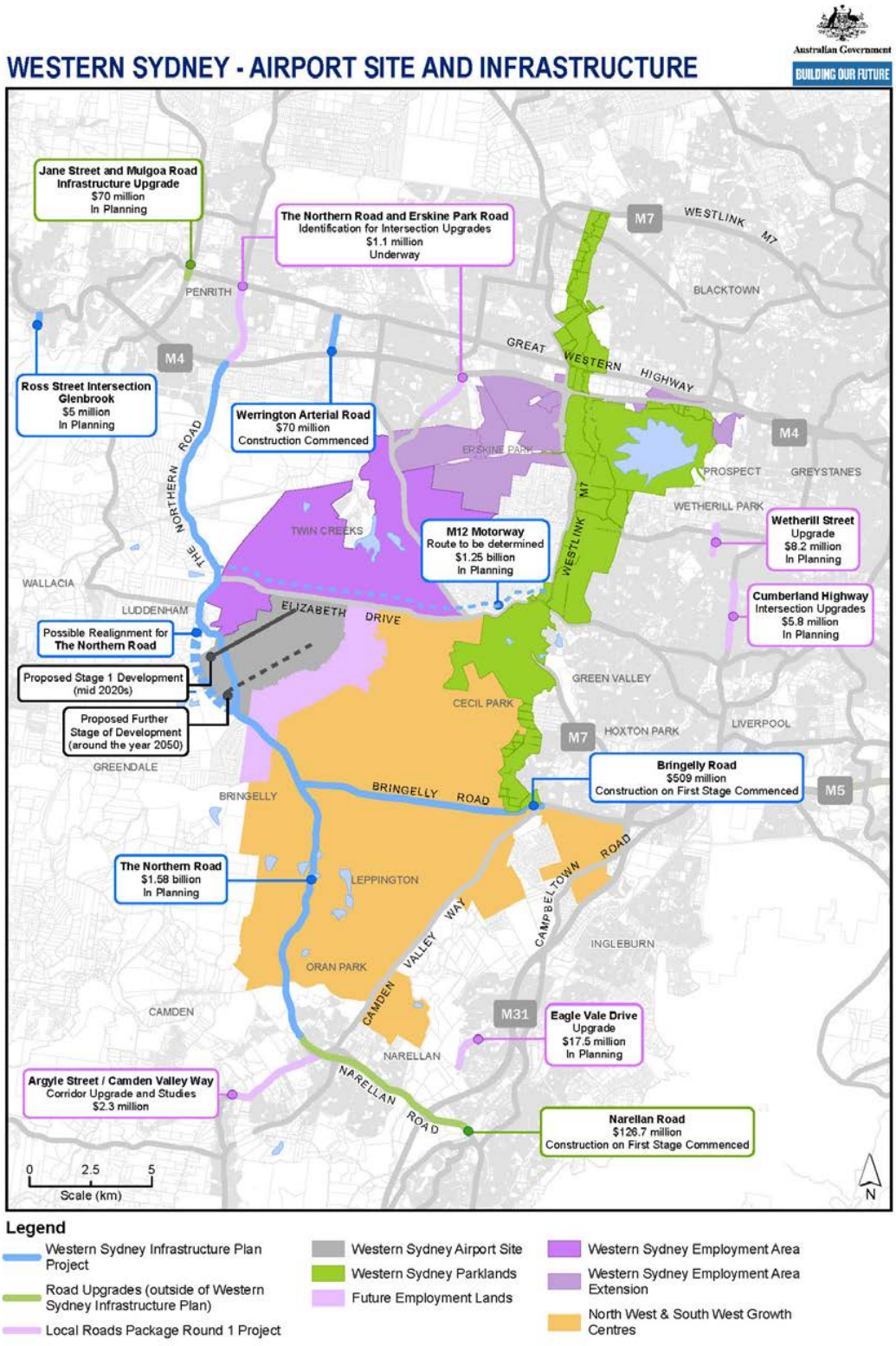
Source: NSW Department of Planning & Environment

Figure 6: South West Growth Centre Structure Plan



Source: NSW Department of Planning & Environment

Figure 7: Western Sydney Infrastructure Plan



Source: Australian Government Department of Infrastructure and Regional Development

2 Potential Impacts on Land Uses

2.1 Impact of a Greenfield Airport on Property Values

The most readily apparent and assessable effect of an airport in terms of surrounding non-commercial real estate is from aircraft noise. Health impacts and odour as a result of aircraft emissions and fuelling operations can also be significant (Yim et al, 2015; Dedoussi, IC and Barrett S, 2014). Whilst numerous studies attest to health effects, there is no evidence to suggest a separately quantifiable direct impact on property prices. Accordingly, for the purposes of this study on property price impacts, aircraft noise is considered as the principal factor, whilst acknowledging that this may reflect a combination of other factors such as air quality emissions and odour as well as noise.

2.2 Residential vs. Non Residential Land Use Considerations

This paper does not specifically quantify the impacts of the proposed airport on property prices from commercial or employment based land uses due to difficulties in measurement. Whilst the study addresses noise impact on residential property and large lot land holdings, non-residential land uses may also be affected by proximity to the airport site and by noise incidence. Commercial (office, hotel, retail etc.), industrial and employment related uses are considered to be less adversely impacted, due to their building characteristics, nature of activities and lower evening/night time use. More importantly these land uses are likely to materially benefit from the increased economic activity that will come from their proximity of the proposed airport, which will positively impact land values. Community type land uses, such as schools, places of worship, health care and aged care facilities which are affected by noise are less contestable in the market and likely to be restricted by land use zoning and planning controls, hence the impact of noise is not generally price related. Accordingly, the study does not seek to quantify price effects on such non-residential property.

Part B – INVESTIGATION AND ANALYSIS

3 Methodology

This section provides a description of the approaches and methodology used in this assessment.

This report has been prepared in accordance with the EIS guidelines for the proposed airport development issued by the Australian Government Department of the Environment on 22 January 2015.

3.1 Approach

Assessing the impact of noise to property values is challenging. This report had initially intended to assess the impact of noise on property values surrounding the airport site through reference to 'greenfield airport' development sites. However, due to the lack of availability of these sites and the lack of location comparability with overseas sites, this report has instead had primary reference to a number of airports throughout Australia. These have been selected based on their comparability of scale and/or proximity to state capital cities.

This assessment adopted a robust multi-tiered methodology that ensures multiple factors are considered.

Review of Prior Studies

To inform the study, an extensive review of prior studies was undertaken. This included a mix of academic studies, both quantitative and qualitative. Approximately 10 studies were reviewed from local and international sources in order to provide context and to determine how other professionals' (academic and industry) research compares with the analysis undertaken within this report. This section makes specific reference to the property value analysis undertaken as part of the 1997-1999 Second Sydney Airport EIS. While the analysis is now dated, it does still provide a robust and valid assessment of the changes in house prices due to aircraft exposure from the establishment of a third runway at Sydney Airport.

Residential – Cross Section Analysis

This report performed a cross section analysis of areas surrounding a number of Australian airports. This analysis was performed on airports where a significant composition of the surrounding land is considered residential land. The cross section analysis utilised multiple regression techniques to identify noise as a variable and determine the impact, if any, it has on sale price.

Residential Time Series Analysis for Sydney Airport

This report performed an analysis of the price change over time which may, in part, be attributable to noise. Utilising Sydney Airport as a case study, we identified suburbs deemed to be affected by aircraft noise and compared their long term historic growth rates with suburbs deemed unaffected by aircraft noise.

Large Lot Land Holding – Cross Section Analysis

This report performed a cross section analysis of areas surrounding a number of Australian airports. This analysis was performed on airports where a significant composition of the surrounding land is large lot land holdings. The cross section analysis utilised multiple regression techniques to identify noise as a variable and determine the impact, if any, it has on sale price.

Price Change Related to Announcement of Airport Development at Badgerys Creek

This report performed analysis on sales within a 5 kilometre radius of the airport site. The analysis compared the long-term median price growth of suburbs around the airport site with the growth over the same period for Western Sydney and the Sydney metropolitan region. The analysis made primary reference to growth rates both pre and post the most recent announcement of 14 April 2014 that Badgerys Creek will be the site for the proposed airport.

3.2 Aircraft Noise Measurement

Aircraft noise is generally regarded as the most apparent and discernible impact on residential property in the vicinity of an airport and under the aircraft flight paths. However, there is no evidence to suggest that air pollution may be considered to exhibit co-linearity with noise in terms of possible price effect.

The degree of perceived disturbance is related to factors such as:

- the intensity, pitch and duration of the noise events; and
- the frequency of noise events and their incidence, particularly at different times of the day.

These in turn are related to:

- aircraft types and payload;
- aircraft operating characteristics in flight;
- height and angle of climb/descent;
- aircraft ground operating modes, taxiing, engine testing, and holding;
- prevailing wind and temperature;
- ambient noise levels;
- dwelling construction and orientation;
- nature and utility of private outdoor areas associated with dwellings; and
- Characteristics of the affected household.

To take account of these various characteristics and perceptions, aircraft noise is commonly measured in terms of Noise Exposure Forecast (NEF), a technique developed in the 1960s in the US to gauge the impact on affected communities. In 1979, the Australian Government commissioned a major survey into community reactions to aircraft noise by the National Acoustic Laboratories (Hede and Bullen, 1982) which led to a refined system named the Australian Noise Exposure Forecast (ANEF).

The ANEF system is primarily a land use planning tool which takes account of the:

- Intensity, frequency and duration of aircraft noise events; and
- Distribution of take offs and landing movements throughout the day and night, with greater weighting given to noise events between 7pm and 7am.

The information is presented in the form of maps showing sets of contours of equal noise exposure, which may represent:

- Actual or historic exposure, termed Australian Noise Exposure Index (ANEI), based on noise measurement of flight data for a previous period, typically for a calendar year; and
- Predicted exposure, termed ANEF which describes potential impacts of aircraft noise based on assumptions of airport and aircraft operations, traffic mix and flight paths.

ANEF maps are prepared for major airports using Australian Standard AS2021 methodology as part of their masterplanning requirements every five years, and are required to be endorsed by Airservices Australia. They typically have a 20 year time horizon based on forecast traffic mix, and show noise forecasts between 20 and 45 ANEF at 5 step intervals.

The critical contour is the 20 ANEF which corresponds to the minimum level for acceptability for residential buildings. It corresponds to 10 per cent of the population being seriously affected by noise, according to the 1980 NAL study. The region within the range of 20-25 ANEF is classed as conditionally acceptable for residential buildings, requiring noise attenuation to meet the target levels of AS2021. (McLeod and Latimore, Airservices Australia, 2014).

In addition to ANEF/ANEI measures, aircraft noise is also measured with regard to the number of instances in a given period of noise events above a certain volume. Most Australian airport master plans now include contour maps showing measures such as N70 (N noise events of 70 decibels). Typically, the areas affected by 70 decibel events extend well beyond the 20 ANEF area (McLeod and Latimore, op cit). However, these plans are not subject to Airservices Australia endorsement and hence, have not been used as a primary noise measure in this study.

This study has had regard to ANEI and ANEF contour maps prepared by Brisbane, Melbourne, Adelaide and Perth airports and Airservices Australia for Sydney Airport. In the absence of ANEF plans for Melbourne's Avalon airport this study has had regard to an estimated impact area, being at the northern point of the runway, 2 kilometres across and 10 kilometres north. These parameters were selected from analysing the ANEF contours of the other selected airports.

Areas falling within ANEI or ANEF contour bands 20 to 35 have been the focus of this study. Areas subject to ANEI or ANEF above 35 are not considered suitable for residential use under Australian Standards and any residences falling within this noise exposure level at other Australian airports have either been subject to Government acquisition or extensively insulated and are not considered a part of the residential market.

3.3 Defining the Outputs from the Regression Analysis

As identified above, for a number of the approaches undertaken, we have utilised regression analysis as a tool to understand the statistical relationship between aircraft noise and property prices.

What is regression analysis?
Linear regression analysis measures the strength in the relationship between two variables. Multi-variable regression analysis measures the strength in the relationship between multiple variables and the dependent variable. For these analyses, a multi-variable analysis using Sale Price as the dependent variable was run. The strength of regression was measured against the independent variables (see **Sections 5.2** and **7.2** for the list of independent variables utilised).

Key Outputs
The regression analyses provide a number of outputs; the key ones utilised for this study are as follows:

- **R-Squared** – This number explains how much of the variation in the dependant variable (sale price) is explained by the independent variables (number of bedrooms, land size etc.). The closer to 1.0, the better the regression line fits the inputted data. For example; the R-Squared of the Adelaide analysis, 0.83, means that 83 per cent of variation in Sale Price is explained by changes in the independent variables selected.
- Any R-Squared value above 0.7 is considered to be a strong and statistically significant relationship. A value between 0.5 and 0.7 is considered a moderate relationship. A value below 0.5 indicates weak-to-no relationship with minimal statistical significance.

- **T-Stat –** This allows determination of the strength in statistical significance of each of the independent variables examined. The t-stat is the coefficient estimate divided by the standard error. If your regression is based on what statisticians call a "large" sample (30 or more observations), a t-statistic greater than 2 (or less than -2) indicates the coefficient is significant with >95 per cent confidence (University of Delaware, 2008).

- **P-Value –** This also allows determination of the statistical significance of each of the independent variables examined. The P-Value is a percentage value of the statistical probability that the hypothesis of the variable being an influential factor upon the dependant variable is not true. A P-Value of less than 5 per cent (5 per cent uncertainty) is considered to be statistically significant for this study. This figure is a benchmark figure from cited literature (Princeton University, 2007).

3.4 Limitations

Introduction

As supported by the report's review of relevant literature, undertaking analysis to determine the impact on property prices of aircraft noise in particular is challenging. No single study or method provides definitive results that have perfect comparability for the proposed airport. Further, consideration must be given to the mix of current land uses around Badgerys Creek which comprises rural, rural-residential and a small amount of traditional residential.

As a result of the above, this report has relied upon a number of methodologies to produce a series of results which when analysed together, can show a general trend. This trend can then be used to draw more clear conclusions on the affectation on property values.

Real Estate Data Limitations

Real-estate, by definition, lacks homogeneity as every landholding and transaction is different. Notwithstanding this, this report has analysed large real estate transactional datasets to derive statistically significant results for this study and our observation is that many of the variables that explain price are not within these data sets. A number of variables that have not been accounted for include, but is not limited to:

- Property views
- Natural light
- Soil type
- Proximity to services
- Accessibility to public transport

This observation holds true, especially on the large lot land holdings, as there can be a larger number of variables that potential buyers may consider including the nature and style of the dwelling on the land, the type of activity carried on, the nature and productivity of the land and its physical and biological characteristics.

Aircraft Noise Data Limitations

In order to determine which properties lie within each contour band, the properties were geographically mapped and then overlayed with ANEI/ANEF mapping. This enabled each property to be individually identified within each ANEI/ANEF range. There may be limitations to the identification of properties in each ANEI/ANEF range due to:

- mapping irregularities
- human error
- properties partially within 2 ranges

The property sales information gathered was supplied by CoreLogic and thus we are unable to ensure its quality and reliability. Notwithstanding this, various initiatives have been implemented to improve the quality and reliability of this data to the extent possible.

Method Specific Limitations

The methodologies used within the report pose some limitations. The limitations are method-specific and will be discussed within each section below.

4 Review of Prior Studies

4.1 Academic Literature and Professional Studies

This review of literature aims to isolate the effect that airports has upon property values. This can be a difficult condition to isolate due to the negatives and positives of the locality (i.e. noise pollution, traffic conditions, ease of public transportation) with a focus on the main influential factor being noise pollution. In order to determine the effects upon property prices that airports have on the local property market, academic articles and industry reports have been reviewed. These documents use differing methodologies and techniques such as exploiting models and equations, measuring noise levels and measuring distances in order to estimate a discount upon property prices within the affected area.

4.1.1 Approaches

1. Hedonic Price Models

Hedonic price models, in the form of multiple regression models, are commonly adopted (e.g. Abelson 1980 & Kholodilin and Mense 2014). The value of a dwelling is assumed to be determined by a range of dwelling-specific and locality-related characteristics, such as: the type of property, the number of bedrooms and rooms, the property's age, the distance to transport, socio-economic characteristics of the neighbourhood and environmental factors. Following this logic, a multiple regression equation can be set up with the property's value as the dependant variable and the various characteristics as independent, explanatory variables. A varying number of models have been designed to determine the value of dwellings, with the primary method altering values dependant on the dwellings noise exposure forecast (NEF).

The strength of the hedonic price model method is that it enables the specific contribution to values (positive and negative) of each housing characteristic to be isolated. Provided that enough of the correct explanatory variables are included in the regression analysis, and that they are accurately measured, the technique should be robust.

Limitations

- It may be difficult to obtain accurate and consistent information for all the explanatory variables that are, and have to be, included in the regression model. In some cases these variables need to be approximated. There may also be a degree of subjectivity in the process of estimation, such as the “quality of a view”;
- If significant explanatory variables are not included in the regression analysis, for example because of a lack of information, then specification errors may arise where significant explanatory power is incorrectly attributed to other variables;
- The explanatory variables have to be truly independent. For example, neighbourhood characteristics can lead to problems of multi-collinearity. This may influence the quantity of variables that should be assessed, with increased quantities of variables increasing chances of overlap. Multi-collinearity may also have a significant bearing on other descriptors such as the size and quality of housing; and
- It may be difficult to achieve a statistically significant result of the impact of aircraft noise on property values. To obtain a statistically significant number is increasingly difficult as the level of noise affectation decreases to levels where there is no consensus on whether the noise affectation noticeably affects people’s lives. The level where it generally becomes subjective to the population is under the 20 ANEF noise contour.

Findings of Hedonic Price Models

This report has selected a number of studies, including those reviewed for the previous EIS (JLW, 1997), that utilise the measurement of noise affectation of ANEF or equivalent. These studies are listed in Appendix A and summarised below.

The studies that determined a quantitative analysis of the affected areas have been made comparable through the associated depreciative property value as a percentage per ANEF

value. The overall assessment of these studies is that there is a correlation within a range of 0.3 per cent to 2.25 per cent discount of property value per unit of ANEF.

The studies illustrate a large range in which property prices can be influenced. However, when looking specifically at the studies directly comparable to Sydney, the rates are more consistent ranging from a discount of 0.4 – 1.1 per cent per unit of ANEF.

While this broad price depreciation range from noise affectation appears to be relevant, there is a number of limitations of applying the results to a broader area. It became apparent from this data that:

- higher priced dwellings are more affected by noise exposure (JLW Research and Consultancy, 1993)
- property located in areas of higher noise levels suffer disproportionately higher rates of deprecation in comparison to areas with lower noise levels (JLW Research and Consultancy 1993; Levesque, 1994)
- the statistical significance of a relationship between price impact and noise levels below 20 ANEF was consistently found to be low (BIS Shrapnel, 1990; Poulsen, 1990)
- the impact on property values varies according to the type of property, with some studies showing differences between detached dwellings, units and townhouses, possibly for some of the reasons mentioned above (JLW, 1997).

2. Match Pair Analysis

Some literature identifies an alternative approach to assess the impact on property values:, a match pair analysis (Nelson, 2004; Bell, 2001; JLW Research & Consultancy, 1993). This method is similar to Hedonic Price Models as noise is still utilised as a variable to explain price. Within this method, properties are selected that are similar in nature (i.e. dwelling and land size, number of bedrooms, aspect, etc.) where one is impacted by noise and the other is considered un-impacted. By comparing the transacted price of two properties with the same characteristics, differentiated primarily by noise, the analysis effectively accounts for all other variables. As such, the theory suggests that the price differential represents the impact associated with noise.

Limitations

The method described above is conceptually similar to the Hedonic Pricing approach, however, the key limitation identified relates to the lack of sample size typically utilised. Further, the potential for human error is introduced in this method with the requirement of selecting similar properties, especially with the lack of homogeneity in Australian housing stock.

3. Time Series Analysis

As an alternative to the above two approaches, some literature discusses the longer term impact of having a property affected by noise. The approach used to assess this impact is a time series analysis (e.g. Bell, 2001 and Nelson, 2004). This is where movements in prices in the affected area are benchmarked against other unaffected areas which have similar housing characteristics. Other factors which may affect the change in median or average prices in an area such as new dwelling construction, alterations and additions activity or the opening of new roads may need to be accounted for. Also, differential growth rates may occur depending upon distance to the city centre and strength of housing sub markets.

Determining price movements in the market around an airport before and after its construction can be further analysed by comparing this to other influential variables such as distance from flight paths, distance from the airport, turnover rates and increase of noise above thresholds.

Nelson (2004) performed a study of 23 airports, both international and Australian, and their impact on the market over a set period of time. The results concluded that properties affected by noise were reduced in value at a rate of 0.5 to 0.6 per cent per decibel (above standard levels in urban areas). Properties affected by flight path noise experience average noise levels of 65-80 decibels while regular urban areas are 50-60 decibels. This finding is consistent with other studies of a property value reduction of 10 per cent.

Furthermore, Bell (2001) also determined how property values are impacted by noise within the United States and came to similar conclusions. It was determined that properties incurred a 1.12

per cent loss of value per decibel above the 'quiet' threshold. This quiet threshold is not directly stated as it can change depending on local conditions. The adverse impact of noise on the residential property market ranges from -15.7 per cent to -19 per cent for moderately priced dwellings which is a higher range than other findings such as Nelson (2004).

Limitations

Housing prices may move in anticipation of an impending change in aircraft noise (or other influence). Following a change in noise levels, the market may 'over-correct' as existing owners sensitive to noise try to sell, leading to a relative oversupply of stock. Hence, time series analysis may be more appropriately undertaken for a period before and after the change in noise levels. It does not account for other factors that could impact upon the median house price such as new dwelling construction, alterations, urbanisation/urban renewal and additions activity or the opening of new roads.

4.1.2 Conclusions and Implications for this Study

While it is noted that there is a large range of influences that could be affecting the variation of property values in noise affected areas, case studies within Australia and internationally support the hypothesis that aircraft noise adversely impacts property values.

The quantitative studies indicate there is a large range in which property prices can be influenced by noise. While this study of reviewed papers cannot directly isolate the price influence of noise, the studies directly associated with Australia and specifically Sydney conclude a more consistent value ranging from 0.4 per cent – 1.1 per cent of depreciation per unit of ANEF. It is also apparent through this data that the values of higher-priced houses are impacted more dramatically than lower-priced houses.

Time series analysis indicates that properties affected by noise were reduced in value at a rate of 0.5 to 0.6 per cent per decibel (above standard levels in urban areas). Properties affected by aircraft flight path noise experience average noise levels of 65-80 decibels while regular urban areas are 50-60 decibels. This finding is consistent with other studies of a property value reduction of 10 per cent. Alternative studies indicative higher level affectation of between -15.7 per cent to -19 per cent.

In summary, the literature review found that predominantly, three methods of analysis have historically been used in assessments of the impact of noise to pricing. These methods assess two different impacts, they are:

- The Hedonic Price Model (also referred to as Regression Analysis) and Match Pair Analysis – these quantify the impact of noise as a variable in determining price.
- Time Series Analysis – this determines any longer-term impact of growth in pricing of a noise affected location compared to a non-noise affected location.

Considering the above, we have determined to utilise a method that assesses each of the above impacts. Based on the ability to draw upon significant data sets, we have elected to utilise the hedonic price model. We have also determined to perform a time series analysis for the study.

Unlike previous studies, we have conducted both approaches on 'traditional' residential uses, as well as on large lot land holdings, which are more comparable with that found at Badgerys Creek and surrounding suburbs.

4.2 JLW Advisory Technical Paper 4 (1997-1999 EIS)

JLW Advisory authored the Technical Paper 4: Property Values that formed part of the 1997-1999 Second Sydney Airport EIS (JLW Advisory, 1997). This report focussed on extrapolating the changes experienced in property values following the opening of the Sydney Airport's third runway in November 1994 which represented the first major change in aircraft operations in Sydney for several decades. Noise levels changed as a result of increased north-south operations on the existing runway and the new runway, and the closure of the east-west runway.

The prior study performed two separate methods of analysis: quantitative and qualitative. These are summarised below.

4.2.1 Quantitative Analysis

The quantitative analysis undertaken involved an examination of housing price changes under the flight paths of Sydney Airport as a result of changed aircraft operations in 1994/1995. The approach used is as follows:

- Establish general housing price trends in the Sydney region;
- Test for differences in aggregate price movements between areas under flight paths and not under flight paths; and
- Examine house price movements in noise zones under flight paths, and in similar 'control areas' away from flight paths.

Sydney Metropolitan and Regional Price Trends

Changes to median house and strata titled dwelling values are provided below in **Table 7**.

Table 7: Median Price Movements – Sydney Region

	Annual Change 1992-96	Total Change 1992 - 1996	Change 1994-1995	Local Government Areas
Houses				
Sydney Region	3.1%	11.9%	0.5%	Excludes Gosford, Wyong, Blue Mountains, and Wollondilly
Northern	3.9%	15.4%	-2.8%	Ku-ring-gai, Ryde, Hornsby, Hunters Hill, Lane Cove, Willoughby
Inner West	5.3%	21.2%	-3.3%	Leichhardt, Marrickville, Drummoyne, Concord, Burwood, Ashfield
Eastern	7.4%	30.8%	-6.8%	Botany, Randwick, Woollahra, Waverley
Southern	3.8%	14.9%	0.4%	Hurstville, Rockdale, Kogarah, Sutherland
Multi-Unit Dwellings				
Sydney Region	3.4%	13.3%	1.8%	Excludes Gosford, Wyong, Blue Mountains, and Wollondilly
Northern	3.7%	14.7%	0.0%	Ku-ring-gai, Ryde, Hornsby, Hunters Hill, Lane Cove, Willoughby
Inner West	4.0%	15.7%	3.2%	Leichhardt, Marrickville, Drummoyne, Concord, Burwood, Ashfield
Eastern	8.0%	33.5%	0.0%	Botany, Randwick, Woollahra, Waverley
Southern	2.0%	7.6%	0.0%	Hurstville, Rockdale, Kogarah, Sutherland

Source: NSW Valuer General
Note: The annual change is the average change between December 1992 and September 1996.

Between December 1992 and September 1996, median annual growth rates for houses and units were in the 3-3.5 per cent range for the Sydney region as a whole.

There are however clear regional differences in growth rates. The following patterns are evident:

- Prices increased most in the eastern region which covers the eastern suburbs excluding the City of Sydney. Median prices for houses and units increased by 7.4 percent and 8 percent per annum respectively;
- The inner west region also grew strongly, by 5.3 per cent per annum for houses and 4 percent for units (strata titled dwellings); and
- Much lower growth was experienced in 1995 in all regions, reflecting the slowdown in the housing market as a whole in that year. The largest fall was in the eastern region, where house prices fell by 6.8 per cent in 1995.

Aggregate Price Impacts of the Opening of the Third Runway

To assess the price impact of the changes in flight operations, the study reviewed house price movements at the postcode level between 1994 and 1995 comparing prices between areas

under the approaches from the north, approaches from the east and west, and all other postcodes in the Sydney region. These results are summarised in **Table 8** below.

Table 8: House Price Movements 1994/95

	Average Change in Price	Change in Prices (Standard Deviation)	T Statistic @ 95% Against Not Under Approaches	Number of Postcodes
Under Northern Approaches	-1.16%	5.33%	1.75	24
Not under Approaches	1.74%	7.85%	-	172
Under East/West Runway	1.55%	4.10%	0.11	20

Based on the above, there appeared to be a statistically significant adverse impact on house prices under the northern approaches compared to not under the approach. Such a finding is consistent with previous airport noise impact research for Sydney Airport (BIS Shrapnel, 1990). However, the results under the east-west runway approaches were counter-intuitive. If the reduction in noise levels has been priced into housing, a greater increase in price should have been expected. The study identified two potential reasons. Firstly, buyers believing that the closure was not permanent. Secondly, the postcode data did not precisely match the flight paths.

Median Price Trends under the Flight Path Compared to 'Control Areas'

To further explore the effects of the changed aircraft noise levels at Sydney Airport, the study identified areas directly impacted by noise, both along the north-south and east-west flight paths. The median price of these areas was then compared to a number of 'control areas' to derive any pattern associated with noise.

The table below identifies the suburbs selected along the north-south flight path as well as the 'control areas'. For the suburbs under the northern flight path, the study provided the 1995 ANEI levels and the approximate change in ANEI between 1992/1993 and 1995.

Table 9: Suburbs under Northern Flight Path and 'Control Areas'

Suburb/Locality	ANEI Band 1995	ANEI Change 1992/3 to 1995 (Increase)
Marrickville	30+	2-3.5
Marrickville/Stanmore	25-30	2.4-4.3
Enmore/Stanmore/ Leichhardt	25-30	2.4-4.2
Leichhardt	25-30	2.4-4.3
Petersham, Enmore, Lilyfield, Leichhardt	20-25	2.8-7.1
Enmore, Lilyfield	20-25	3.6-7.1
Petersham, Leichhardt	20-25	2.8-5.4
Newtown/Annandale/Lilyfield	15-20	3.8-7.1
Drummoyne	20-25	3.1-4.6
Glebe/Balmain (Control)	Under 10	-
Croydon/Ashfield (Control)	Under 10	-
Hunters Hill	20-25	3.2-5.2
Hunters Hill/Boronia Park	15-20	4.3-5.9
Gladesville	10-15	3.3-6.5
Hunters Hill	10-15	3.2-4.3
West Lane Cove	15-20	4.0-5 .3

East Ryde	15-20	4.0-6.5
West lane Cove/ Riverview	10-15	2.9-4.3
East Ryde	10-15	4.6-5.5
West Lindfield /West Pymble	10-15	2.4-3.4
St Ives /East Lindfield (Control)	Under 10	-
Putney/Ryde (Control)	Under 10	-

The key observations from the study of house price movements to the north of Sydney Airport between 1992 and 1996 are summarised below:

- Marrickville, containing houses at ANEI levels above 30 in 1995, experienced a significant reduction in median and mean prices in 1995, compared to 1994, though the volume of sales was relatively low. However, for the whole 1992 to 1996 period, median and mean price growth was not significantly different to that of the inner west as a whole. The ANEI change from 1992/3 to 1995 was between 2 and 3.5;
- Marrickville/Stanmore and the Petersham, Enmore, Lilyfield and Leichhardt areas (being in the 25-30 and 20-25 ANEI in 1995) showed price movements very similar to the control areas (inner west, Glebe/ Balmain and Croydon/Ashfield). There was a reasonably consistent pattern of price growth between 1992 and 1996. Growth rates fell with distance from the city centre. While Marrickville/Stanmore did experience lower overall price growth between 1992 and 1996 than other areas in the inner west, there was no reduction in prices in 1995.
- It was possible that the eastern parts of Marrickville/Stanmore and the Petersham, Enmore, Lilyfield and Leichhardt areas, being between the existing northern flight path and that of the new third runway, would have experienced a more significant price change compared to western parts of these areas. To test this, these areas were split into western and eastern components. The results did not confirm the hypothesis. In fact, properties on the eastern shoulder of the main north-south runway appreciated at least as much or more than those on the western shoulder. Stronger price growth closer to the city centre may have contributed to this;
- Newtown/Annandale/Lilyfield is under the flight path of the third runway and experienced a relatively large rise in ANEI in 1995 (between 3.8 and 7.1). The area was in the 15-20 ANEI band in 1995. Median price growth between 1992 and 1996 and in 1994/95 was very similar to the Glebe/Balmain control area to the east;
- Boronia Park and Hunters Hill experienced a significant drop in sales activity in 1995. Median and mean price growth was well under growth for the northern Sydney region. Middle and upper quartiles grew very little. Sales price movements on the Hunters Hill peninsula are volatile and heavily influenced by waterfront sales;
- A clearer pattern emerged when areas to the north of the Parramatta River were grouped according to the 1995 ANEI level. In the 15-20 ANEI band (Hunters Hill/Boronia Park; West Lane Cove and East Ryde), median and mean price movements were well below the northern Sydney region control area. Sales volumes were also down 24 percent compared to -10 percent in the northern control area;
- Once areas in ANEI 10-15 were aggregated, any third runway price effect possibly evident in some suburbs disappeared. Median and mean price growth was at least equal to the northern Sydney region and no fall in medians or means were evident in 1995, even though the northern Sydney region as a whole fell three percent on both measures; and
- Even though Lane Cove West/Riverview appeared to experience a significant fall in median and average values in 1995, median and mean price growth was around 30 percent for the 1992 to 1996 period, well in excess of the northern Sydney region growth rates.

The table below identifies the suburbs selected along the east-west flight path as well as the 'control areas'. For the suburbs under the eastern and western flight path, the study provided the 1995 ANEI levels and the approximate change in ANEI between 1992/1993 and 1995.

Table 10: Suburbs under Eastern and Western Flight Paths and 'Control Areas'

Suburb/Locality	ANEI Band 1992/3	ANEI Change 1992/3 to 1995 Decrease
Kingsford/South Coogee	20-25	-10 to -15
Matraville/Maroubra (Control)	Under 10	-
Randwick/Bronte (Control)	Under 10	-
Rockdale	25-30	-10 to -15
Penshurst	20-25	-10 to -15
Peakhurst/Mortdale	15-20	Over -10
Kingsgrove (Control)	Under 10	-

Houses in areas west of Sydney Airport, which had previously been under the flight path (Rockdale; Penshurst; and Peakhurst/Mortdale), experienced median price increases of between 25 percent and 33 percent for the 1992 to 1996 period. However, only Rockdale which was in the 25-30 ANEI in 1992/3, experienced a rise in prices in the year following the closure of the east-west runway. Control areas to the north (Kingsgrove) and south (Blakehurst) experienced lower overall growth rates.

Median house prices in Kingsford/South Coogee increased by 26 percent between 1992 and 1996 and six percent in 1995. However there were substantial differences between the control areas to the north and south. To the north, median house price growth in Randwick/Bronte was very high, up 63 percent over the same period. Price growth to the south was much lower at 16 percent.

It could not be concluded that median price growth in Kingsford/South Coogee was a direct result of the reduction in aircraft noise. Rather, growth is consistent with wider house price trends in the area over the period being examined.

Other Influences on Housing Values Under Flight Paths

Apart from general influences on housing markets such as interest rates, other factors identified within the study that may have changed housing values in those areas affected by variations in aircraft noise are discussed below.

- Housing Supply and Improvements – The supply and alterations of housing can cause shifts in housing value. The study identified that aside from typical housing supply and alteration numbers during the period assessed, a significant change related to dual occupancy housing within this period may have had an influence toward house prices. In 1991, State Environmental Planning Policy No. 25 was amended to permit Torrens title subdivision across Sydney down to 230 square metres. In May 1995, the subdivision clause was removed and meant that dual occupancy developments could then only offer separate title in areas permitting strata titled dwellings to be constructed.
- Infrastructure – Three major road infrastructure changes in the Sydney region occurred within the study period. This included; the opening of the Gore Hill Freeway and Harbour Tunnel in August 1992, the opening of the Glebe Island Bridge and Arterial in December 1995 and the opening of the M2 Motorway linking Ryde to Baulkham Hills in 1997.
- Sydney Olympics – The awarding of the 2000 Olympic Games in October 1993 was identified as a potential influence on the housing market in the inner west regions.

4.2.2 Qualitative Analysis (Survey of Real Estate Agents)

The qualitative analysis undertaken involved a survey of 28 real estate agents, covering six areas under the northern flight path of Sydney Airport from West Pymble to Hunters Hill. The study performed this analysis as a way of assessing impacts associated with lower levels of noise as well as a means of verifying the results of the quantitative analysis.

The real estate agents were asked to compare identical dwellings in two nearby areas. One of the properties was under the flight path within 10-15 or 15-20 ANEI (1995) and the other property was in an area under 10 ANEI which was used as a control. The subject and control areas are shown in **Table 11** below.

Table 11: Areas Surveyed with Survey of Real Estate Agents

Interview Area	Comparison Areas		Number of Real Estate Agents Surveyed
	Subject Area (A)	Control Area (B)	
1	Hunters Hill	Woolwich	4
2	Boronia Park	Gladesville	4
3	East Ryde	Ryde	4
4	West Lane Cove	Lane Cove	6
5	West Lindfield, Killara	East Lindfield	6
6	West Pymble	Pymble, St Ives	4

Utilising the conclusions derived from the survey, the study made an assessment of impact related to aircraft noise on property values. This has been summarised in **Table 12** below. Study areas 2 and 3 were excluded from this component of the analysis as the survey identified the subject area property values were higher than the 'control areas' and the housing stock was not homogenous enough to provide confidence in the real estate agents belief of noise affectation correlation to value.

Table 12: Assessed Impact of Aircraft Noise on Property Values from Survey of Real Estate Agents

Interview Area	Average Assessed House Value		Assessed Impact of Aircraft Noise ($) on Subject Area House		Assessed Impact of Aircraft Noise (%) on Subject Area House	
	Subject Area	Control Area	Minimum	Maximum	Minimum	Maximum
1	$656,250	$847,500	$0	$24,400	0	3.1
4	$350,000	$395,000	$0	$9,000	0	2.8
5	$368,333	$407,500	$2,000	$6,000	0.5	1.7
6	$408,000	$463,000	$0	$15,000	0	3.3

There was considerable variation in the estimated impact of aircraft noise in each interview area. Maximum impacts were generally below three percent. In many areas, at least one agent believed noise had no effect on relative values. If selected at all, aircraft noise and over-flying was never the most important contributor to house price differences.

Results for Interview Area 1 (Hunters Hill) and Interview Area 4 (Lane Cove West) were surprising given that the previous median price analysis showed a much more significant price effect in 1994/95. The small impact found in the survey may be because the respective control areas were quite close to the flight path of the third runway and therefore not totally noise free.

These results suggest that there may be a price discount for houses in the 10-15 and 15-20 ANEI ranges, but it is quite small.

Other key observations from the survey included:

- The impact of aircraft noise differed depending on buyer type. Young couples with no children were less concerned by aircraft noise when purchasing a property, while conversely the elderly and couples with children were more influenced by aircraft noise in their purchase;
- Houses were perceived to be generally affected consistently in each geographic area, although higher priced housing in each area appeared to be more sensitive to aircraft noise; and
- Apartments or townhouses were perceived to be less affected than houses with units not positioned on the top floor seen to benefit from a degree of noise insulation both from above and adjacent.

4.2.3 Conclusions and Implications for the Study

Although not directly derived from the quantitative analysis, the study had consideration to the results of the quantitative and qualitative assessments and the literature review to determine devaluation factors applied to the assessment of the aggregate impact of aircraft noise. This can be seen in **Table 13** overleaf.

Table 13: Housing Price Devaluation Results – (JLW 1997)

ANEC Band[1]	Devaluation Range	Assumed Devaluation[2]
Under 15	Nil	Nil
15 to 20	0 to 6%	3%
20 to 25	5.9% to 13.6%	8%
25 to 30	8.6% to 19.6%	15%
30 to 35	10.9% to 24.3%	20%

Note: 1. No devaluation estimates were made for ANEC > 35 in the 1997 study because dwellings located in this noise band at the other Australian airports have been either acquired or extensively insulted.
2. Compared to under 15 ANEC.

The assessment of the possible impacts on residential property values due to perceived noise affectation shows a direct correlation to purchaser's confidence and property value. Within the analysis, there was a clearer relationship between noise affectations to urbanised housing stock in comparison to apartments.

The study did not consider rural land lots which are more highly dominant in areas such as Badgerys Creek. The study then put forward that, with this limitation in mind, it could be assumed that there will be some level of consistency in results.

We believe that the large lot land holdings, comparable with those found in proximity to the airport site, fundamentally differs from traditional urbanised residential property and as such, the impact of noise to its pricing would also differ. Therefore, as previously mentioned, in undertaking this current study separate analysis was performed for traditional residential property as well as large lot land holdings.

5 Residential Cross Section Analysis

5.1 Objective

The objective of this analysis is to gain an understanding of the discount, if any, of aircraft noise to residential property values.

5.2 Methodology

In seeking to derive the potential discount of noise to property values, we have utilised multiple variable regression analysis. This report has performed a cross section analysis of areas surrounding a number of Australian airports. This analysis was performed on airports where a significant composition of the surrounding land comprises residential land in order to achieve a significant sample size. The cross section analysis utilised regression to identify noise as a variable and determine the impact, if any, it has on sale price.

The airports selected for the analysis consisted of Melbourne Airport (Melbourne), Brisbane Airport (Brisbane), Sydney (Sydney) and Adelaide Airport (Adelaide). These airports have been selected based on their comparability of scale and/or proximity to state capital cities.

In order to create a dataset for analysis, recent sales evidence were sourced from the CoreLogic database. In order to ensure a significant sized data set, the period of time was adjusted depending on location. This timeframe was either set at 2011 to 2014 (Adelaide and Melbourne) or 2013 to 2014 (Sydney and Brisbane).

These sales were plotted on a mapping system and overlayed with ANEI/ANEF contour bands of each airport to determine the level of affectation of each property. These ANEI/ANEF contour bands were sourced from airport master plan documents (Adelaide Airport, 2013; Brisbane Airport Australia, 2014; Melbourne Airport, 2014; Perth Airport, 2014) or from Air Services Australia (2014).

Sales of both affected and unaffected residential properties in different ANEI/ANEF contour bands were collated. Four contour bands were used[3]:

- Less than 20 ANEI/ANEF;
- 20 to 25 ANEI/ANEF;
- 25 to 30 ANEI/ANEF; and
- 30 to 35 ANEI/ANEF.

The sales data was then refined in order to determine a more homogeneous property sample as well as to improve the integrity of the data and remove some outliers to the data set. In order to do this, the following were removed:

- Non-residential properties;
- Unit and apartment sales;
- Sales where no bedrooms were noted;
- Land areas of less than 100 square metres;
- Sales exchanged for less than $100,000[4];
- Sales greater than $2,000,000; and
- Any additional outliers we were able to identify (i.e. potential development site sales).

[3] For the purpose of our analysis, we considered "Less than 20 ANEI" as unaffected. We did not source sales within areas greater than 35 ANEI as evidence was too limited to perform the analysis. It is also our understanding that this level is generally accepted as too high for residential occupation.
[4] $500,000 for Sydney

Once the data set was finalised, the regression analysis was performed. The first step in performing this analysis was the identification of various independent variables, which in part explain the dependant variable (sale price). The variables that were analysed, where possible, included:

- Suburb;
- Number of bedrooms[5];
- Number of bathrooms[6];
- Land size;
- Building area;
- Time factor (i.e. when the sale occurred); and
- Noise affectation.

5.3 Melbourne – Melbourne Airport

5.3.1 Locational Context

Melbourne Airport is Victoria's primary passenger airport and is located approximately 23 kilometres north west of the Melbourne central business district (CBD). The table below provides a summary of the aircraft movements for Melbourne airport.

Table 14: Movements at Melbourne Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
MEL	46,664	180,554	806	-	310	**228,334**

Source: Airservices Australia[7]

The airport is surrounded by a variety of land uses, including low density residential, parklands, rural-residential, rural and industrial facilities. The majority of low density residential is clustered towards the east of the airport.

5.3.2 Melbourne Specific Considerations

In performing this analysis specifically for Melbourne Airport, we had reference to the following:

Suburbs analysed: Attwood, Coolaroo and Dallas (All east of airport).

Variables: Suburb, Number of beds, Land size, Time factor and Noise affectation.

Sales period: 2011 to 2014 (inclusive).

The analysis was performed on sales that fell in the following ANEF contour bands: Less than 20, 20 to 25 and 25 to 30.

5.3.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for residential sales surrounding Melbourne Airport.

[5] All sales with a number of bedrooms greater than 5 were noted as 5. This was a small portion of sales (Sydney 10, Melbourne 2, Brisbane 4 and Adelaide 3).
[6] All sales with a number of bathrooms greater than 3 were noted as 3. This was a small portion of sales (Sydney 10 & Adelaide 1). Due to quality of data, we were unable to utilise this variable for Brisbane & Melbourne.
[7] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

Table 15: Results of Regression Analysis for Melbourne Airport

	Result	Implication
R Squared	0.67	Moderate relationship
t-Stat (Noise)	-1.37	Not significant
P-Value	0.17	Not Significant
Impact (Noise)	-1.93%	Not considered

Source: CoreLogic, JLL Strategic Consulting.

The R-Squared reveals a moderate relationship between the independent variables and the dependent variable (sale price). However, the t-Stat and P-Value for the noise variable identifies that, although a relationship between the variables does exist, the relationship between noise and price is not significant. The impact assessed for noise is a devaluation of 1.93 per cent, however it is not considered relevant as neither the t-Stat nor P-Value is significant.

5.4 Brisbane – Brisbane Airport

5.4.1 Locational Context

Brisbane Airport is Queensland's primary passenger airport and is located approximately 18 kilometres south west of the Brisbane CBD. The table below provides a summary of the aircraft movements for Brisbane airport.

Table 16: Movements at Brisbane Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
BNE	22,394	186,498	16,640	210	836	**226,578**

Source: Airservices Australia[8]

The airport is surrounded by a variety of land uses with significant industrial holdings to the south. The majority of low density residential is clustered towards the west, south and south west of the airport.

5.4.2 Brisbane Specific Considerations

In performing this analysis specifically for Brisbane, we had reference to the following:

Suburbs analysed: Cannon Hill, Hawthorne and Morningside (South and south west of airport).

Variables: Suburb, Number of beds, Land size, Time factor and Noise affectation.

Sales period: 2013 to 2014 (inclusive).

The analysis was performed on sales that fell in the following ANEF contour bands: Less than 20 and 20 to 25.

5.4.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for residential sales surrounding Brisbane Airport.

Table 17: Results of Regression Analysis for Brisbane Airport

	Result	Implication
R Squared	0.45	Weak relationship
t-Stat (Noise)	-5.54	Significant
P-Value	0.00	Significant
Impact (Noise)	-10.67%	Considered

Source: CoreLogic, JLL Strategic Consulting

[8] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

The R-Squared reveals a weak relationship between the independent variables and the dependent variable (sale price). However, the P-Value and t-Stat for the noise variable identifies that, although the overall relationship between the variables is weak, the relationship between noise and price is significant. The impact assessed for noise is a devaluation of 10.67 per cent.

A limitation to the analysis performed in Brisbane is the impact to pricing associated with proximity to, as well as views of, water. While the suburb variable will partially account for this factor, it cannot completely asses its impact. The exclusion of this as a variable has likely impacted the R-Squared result for the Brisbane analysis.

5.5 Sydney Airport

5.5.1 Locational Context

Sydney Airport is Australia's primary passenger airport and is located approximately 12 kilometres south of the Sydney CBD. The table below provides a summary of the aircraft movements for Sydney Airport.

Table 18: Movements at Sydney Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
SYD	70,302	239,478	7,362	11,726	720	**329,588**

Source: Airservices Australia[9]

The airport is surrounded by a variety of land uses with significant industrial holdings to the north and north east. The majority of residential properties are towards the west, north and east of the airport.

5.5.2 Sydney Specific Considerations

In performing the analysis specifically for Sydney, we had reference to the following:

Suburbs analysed: Marrickville, Stanmore, Sydenham and Tempe (North and north west of airport).

Variables: Suburb, Number of beds, Number of baths, Land size, Time factor and Noise affectation.

Sales period: 2013 to 2014 (inclusive).

The analysis was performed on sales that fell in the following ANEI contour bands: Less than 20, 20 to 25, 25 to 30 and 30 to 35.

5.5.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for residential sales surrounding Sydney Airport.

Table 19: Results of Regression Analysis for Sydney Airport

	Result	Implication
R Squared	0.64	Moderate relationship
t-Stat (Noise)	1.55	Not significant
P-Value	0.12	Not Significant
Impact (Noise)	1.40%	Not considered

Source: CoreLogic, JLL Strategic Consulting

The R-Squared reveals a moderate relationship between the independent variables and the dependent variable (sale price). However, the t-Stat and P-Value for the noise variable identifies that, although a relationship between the variables probably exists, the relationship between

[9] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

noise and price is not significant. The impact assessed for noise is an appreciation of 1.40 per cent, however, is not considered relevant as the t-Stat and P-Value is not significant.

5.6 Adelaide – Adelaide Airport

5.6.1 Locational Context

Adelaide Airport is South Australia's primary passenger airport and is located approximately 8 kilometres west of the Adelaide CBD. The table below provides a summary of the aircraft movements for Adelaide Airport.

Table 20: Movements at Adelaide Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
ADL	3,574	80,708	18,164	4,912	240	**107,598**

Source: Airservices Australia[10]

The airport is primarily surrounded by low density residential uses, with some industrial facilities immediately adjacent.

5.6.2 Adelaide Specific Considerations

In performing this analysis specifically for Adelaide, we had reference to the following:

Suburbs analysed: Cowandilla, Hilton and North Adelaide (North west of airport).

Variables: Suburb, Number of beds, Number of baths, Land size, Building area, Time factor and Noise affectation.

Sales period: 2011 to 2014 (inclusive).

The analysis was performed on sales that fell in the following ANEI contour bands: Less than 20, 20 to 25, 25 to 30 and 30 to 35.

5.6.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for residential sales surrounding Adelaide Airport.

Table 21: Results of Regression Analysis for Adelaide

	Result	Implication
R Squared	0.83	Strong relationship
t-Stat (Noise)	-3.31	Significant
P-Value	0.00	Significant
Impact (Noise)	-6.59%	Considered

Source: CoreLogic, JLL Strategic Consulting

The R-Squared reveals a strong relationship between the independent variables and the dependent variable (sale price). The t-Stat and P-Value additionally highlights that this relationship also exists for the noise variable as the relationship between noise and price is significant. The impact assessed for noise is a devaluation of 6.59 per cent.

In terms of the Adelaide analysis, it is likely that due to the availability of more reliable data on the building area/size, the R-Squared showed a strong relationship as the relationship between building area and sale price was significant (t-Stat of 14.76).

As Adelaide showed a significant relationship between noise and sale price, further analysis was performed. This analysis separated the different levels of ANEI as separate variables[11]. The results of this additional analysis can be seen below.

[10] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

Table 22: Results of Additional Regression Analysis for Adelaide

Adelaide – Noise impact on price (compared to noise levels < 20 ANEI)			
Correlation			
R Squared			0.83
Noise Specific Outputs			
Noise Range (ANEI)	t-Stat (Noise)	P-Value (Noise)	Impact (Noise)
20 to 25	-2.96	0.00	-8.27%
25 to 30	-2.17	0.03	-14.74%
30 to 35	-2.30	0.02	-19.75%

Source: CoreLogic, JLL Strategic Consulting

The R-Squared remained at a similar level (i.e. maintained an overall strong relationship). While the t-Stat did decrease, it remained significant. The above table shows that according to the regression analysis, the devaluation increases as the noise band increases, although at a lesser rate than the initial devaluation.

5.7 Summary of Key Findings

The table below summarises the key results of the cross section analysis performed for the four case studies.

Table 23: Summary of Cross Section Analysis Results

Airport	N (sample size)	r^2	Noise impact on price	Noise factor significance		Comment
				t -stat	P-value	
SYD	682	64.2%	1.4%	1.55	12.11%	Noise is less likely to be significant
MEL	525	66.9%	-1.9%	-1.37	17.25%	Noise is less likely to be significant
BNE	379	45.2%	-10.7%	-5.54	0.00%	Noise is very likely to be significant
ADL	290	83.3%	-6.6%	-3.31	0.10%	Noise is very likely to be significant

Source: CoreLogic, JLL Strategic Consulting

As identified above and discussed previously, the results of the analysis differed greatly by location. We had primary reference to the relationship between noise and price (represented by the t-Stat and P-Value) as opposed to the R-Squared. This is because we are assessing the impact associated with noise and not the ability of all the variables selected to explain price.

The low percentage of the P-Value of both Adelaide and Brisbane shows the impact of noise affectation on property prices is directly related with a low level of uncertainty. This certainty of the correlation between factors enables the study to focus more clearly on both Adelaide and Brisbane in order to determine definitive results. In contrast, the Sydney and Melbourne analysis provided high uncertainty, and therefore has not been analysed further.

The impact for Adelaide and Brisbane is summarised in the table overleaf. As previously identified, this impact has been split by ANEI noise area.

Table 24: Impact of Exposure to Different Levels of Noise on House Prices, Brisbane and Adelaide

Airport		Noise impact on price (compared to noise levels < 20ANEI/ANEF)		
		ANEI/ANEF 20-25	ANEI/ANEF 25-30	ANEI/ANEF 30-35
BNE	Price impact	-10.7%	N/A	N/A
	Sample size	183	No relevant sales	No relevant sales
ADL	Price impact	-8.3%	-14.7%	-19.8%
	Sample size	132	29	14

Source: CoreLogic, Airservices Australia, JLL

[11] We were unable to perform this additional analysis on the other case study with significant relationship, Brisbane, as the sales for that case study were all either Less than 20 or 20 to 25 ANEF.

6 Residential Time Series Analysis

6.1 Objective

The objective of this analysis is to test if areas impacted by aircraft noise from Sydney Airport have a price growth differential compared with non-impacted suburbs.

6.2 Methodology

In deriving the growth differentials, we have compared growth rates from the following long term data series:

- Average house prices from noise impacted suburbs in Sydney (defined as suburbs with more than 50 per cent of their area within an ANEI of 20 or greater).
- Average house prices from non-noise impacted suburbs in Sydney (defined as suburbs with less than 50 per cent of their area within a ANEI of 20 or greater) but located close to the noise impacted areas
- Average house prices from the Sydney metropolitan area

6.3 Data Analysis

In performing this analysis, research was based on the period commencing 31 March 1991 to period ending 30 September 2014. This report has equally weighted all suburbs by basing all data series to 100.

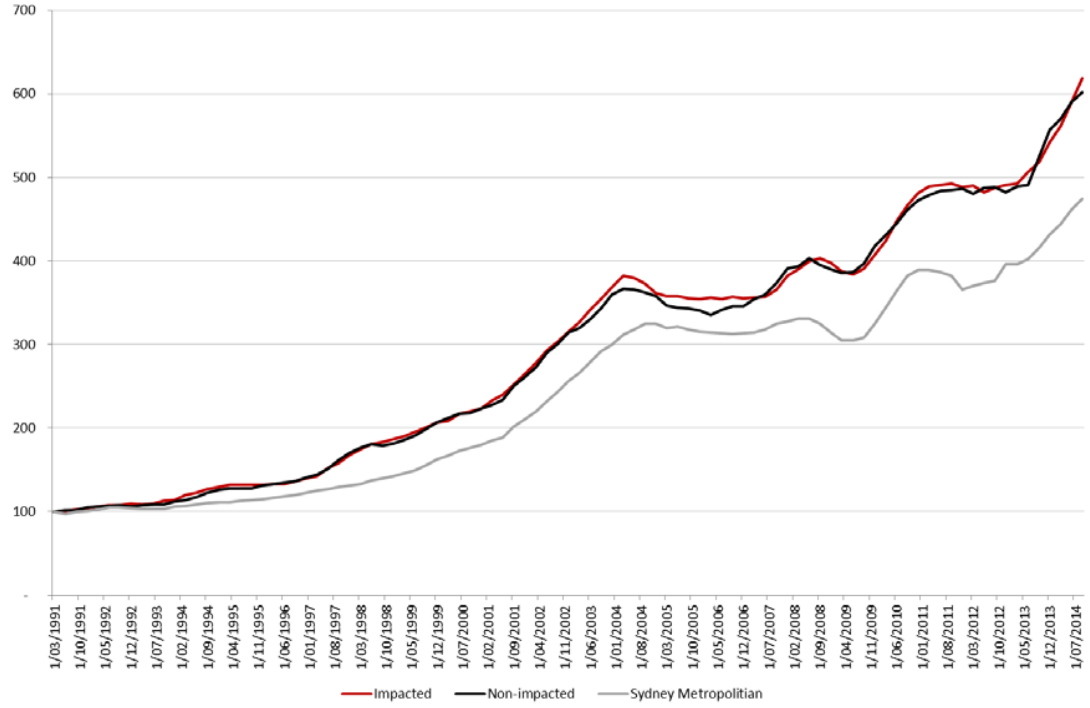
Specific suburbs selected in this analysis are provided below:

Noise Affected:	Kyeemagh, Petersham, Mascot, Stanmore, Tempe, Sydenham, Marrickville and Botany
Noise Unaffected:	Dulwich Hill, Summer Hill Brighton-Le-Sands, Bexley, Arncliffe, Earlwood, Lewisham, Haberfield, Pagewood, Erskineville and Alexandria
Sydney metropolitan:	All Sydney

6.4 Summary of Key Findings

The chart overleaf identifies the relative price growth of all data series. The data series of both affected and unaffected respond to growth similarly due to their proximity to one another. Their growth rate is higher than the Sydney metropolitan area data series due to their proximity to the city and location within high demand areas. The Sydney metropolitan area data set is influenced by all suburbs throughout Sydney and has a lower growth rate due to the incorporation of the suburbs with sub-par growth rates.

Figure 8: Price Growth of Noise Affected, Unaffected and Sydney Metropolitan Area (Base 100)



Source: CoreLogic, JLL

The table below compares the annualised growth outputs of noise affected, noise unaffected and Sydney Metropolitan areas.

Table 25: Price Growth of Noise Affected Areas, Unaffected Areas and the Sydney Metropolitan Area

	Annual Price Growth 1991-2014
Affected	7.98%
Unaffected	7.84%
Sydney Metropolitan	6.77%

Source: CoreLogic, JLL

The results suggest that there is no material difference in property pricing between areas that are defined as noise affected versus those that are nearby but considered not noise affected. This is further supported by the comparison to the Sydney metropolitan area data which comprises an average of all suburbs (but mostly those not affected), and which has shown significant underperformance compared with the two other data series.

This reports observation on the above is that factors of greater significance than noise also affect their long term growth profile, with gentrification being the key factor relevant to the Inner Sydney data series over this timeframe. Another key factor is the level of desirability or demand for housing in inner Sydney areas with proximal localities to amenities and the city.

While this analysis does provide an indication of noise affectation on property values, it cannot draw any definitive findings. Other methods such as cross sectional analysis of large lot land holdings should be able to draw more comparable results to the proposed airport development through the similarity of large lot land sizes.

Leveraging off this analysis, this report has also had consideration to the potential impact of property prices that may occur from a second runway opening at the proposed airport. The long term time series analysis on Sydney Airport (see Section 6) suggest no material difference in property pricing of noise versus non-noise affected areas. This outcome is in line with our expectations – that is, that factors of much greater significance will influence property values than any incremental increase in noise. More specifically, it is considered that the positive influences of in-area employment as well as improved amenity and services will more than likely make up for any additional noise from the second runway.

Further, this report makes the observation that there have been significant advancements in aircraft technology over the last 20 years that have meant a material reduction in noise footprints across all major Australian airports, despite increasing aircraft movements. It is considered to be a reasonable assumption that advancements will be made in the future, further reducing aircraft noise. For the above reasons this report has not assessed a negative impact to property prices due to the opening of a second runway at the proposed airport.

7 Large Lot Land Holding Cross Section Analysis

7.1 Objective

The objective of this analysis is to gain a greater understanding of the discount, if any, of aircraft noise to large lot land property values as distinct from the previous analysis which is primarily related to other types of residential areas which are dissimilar to the context of the proposed airport. It is noted that the combination of the two key factors (new greenfield airport and large lot land holdings) is intrinsically linked and this report has found a scarcity of specific relevant literature which applies to these circumstances.

7.2 Methodology

Similar to the method used to derive the discount for residential property values, this section performed a cross section analysis of areas surrounding a number of Australian airports. This analysis was performed on airports where a significant composition of the land surrounding is considered large lot land holdings, and where the airports are comparable in scale and/or proximity to state capital cities. The cross section analysis utilised regression to identify noise as a variable and determine the impact, if any, it has on sale price.

The airports selected for the analysis consisted of: Melbourne Airport, Perth Airport and Avalon Airport.

Sales evidence was sourced from the CoreLogic database. Unlike the residential analysis, in order to create a significantly sized dataset to analyse, sales evidence over an extended period was required. This timeframe was either set at 2000 to 2014 (Perth and Avalon) or 2004 to 2014 (Melbourne).

Sales of both affected and unaffected large lot land holdings were gathered. Due to the scale and size of the properties and in instances the limited information related to ANEF contours, these sales were assessed based on an affected versus unaffected[12] variable rather than by ANEF contour bands.

The ANEF contours were sourced through the airport master plans for Melbourne and Perth, however the ANEI contours were unavailable for Avalon Airport. Due to this, this report adopted a 2 kilometre wide and 10 kilometre long area from the end of the runway, as an estimated ANEF contour. These parameters were selected from analysing the ANEF contours of the other selected airports.

The sales data was then refined in order to determine a more homogeneous property sample as well as to improve the integrity of the data and remove some outliers to the data set. In order to do this, the following were removed:

- Non-rural or residential properties (i.e. commercial premises);
- Land areas of less than 1,500 square metres[13];
- Sales exchanged for less than $100,000[14]; and
- Any additional outliers we were able to identify (i.e. development site sales).

Once the data set was finalised, the regression analysis was performed. The first step in performing this analysis was the identification of various independent variables, which in part explain the dependant variable (sale price). The variables that were analysed, where possible, included:

- Suburb;

[12] For the purpose of our analysis, we considered “Less than 20 ANEI” as unaffected.
[13] 1,500 sqm was selected as eliminated all ‘traditional’ residential uses from the analysis
[14] $150,000 for Melbourne Airport

- Land size;
- Time factor (i.e. when the sale occurred); and
- Noise affectation.

7.3 Melbourne – Melbourne Airport

7.3.1 Locational Context

Melbourne Airport is Victoria's primary passenger airport and is located approximately 23 kilometres north west of the Melbourne CBD. The table below provides a summary of the aircraft movements for Melbourne Airport.

Table 26: Movements at Melbourne Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
MEL	46,664	180,554	806	-	310	**228,334**

Source: Airservices Australia[15]

The airport is surrounded by a variety of uses, including low density residential, parklands, rural-residential, rural and industrial facilities. The majority of large lot land holdings are clustered towards the north, north-west and west of the airport.

7.3.2 Melbourne Airport Specific Considerations

In performing this analysis specifically for Melbourne Airport, we had reference to the following:

Suburbs analysed: Bulla, Diggers Rest, Oaklands Junction and Wildwood (North, north-west and west of airport).

Variables: Suburb, Land size, Time factor and Noise affectation.

Sales period: 2004 to 2014 (inclusive).

The analysis was performed on sales that were either affected or unaffected by aircraft noise.

7.3.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for rural and rural-residential sales surrounding Melbourne Airport.

Table 27: Results of Regression Analysis for Melbourne Airport

	Result	Implication
R Squared	0.55	Moderate relationship
t-Stat (Noise)	1.88	Not significant
P-Value (noise)	0.06	Not Significant
Impact (Noise)	15.35%	Not considered

Source: CoreLogic, JLL Strategic Consulting

The R-Squared reveals a moderate relationship between the independent variables and the dependent variable (sale price). However, the t-Stat and P-Value for the noise variable identifies that, although a relationship between variables does exist, the relationship between noise and price is not significant. The impact assessed for noise is an appreciation of 15.35 per cent, however this is not considered relevant as the t-Stat and P-Value is not significant.

[15] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

7.4 Melbourne – Avalon Airport

7.4.1 Locational Context

Avalon Airport is located approximately 55 kilometres south west of the Melbourne CBD. The table below provides a summary of the aircraft movements for Avalon Airport.

Table 28: Movements at Avalon Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
AVV	108	3,618	1,038	560	128	**5,452**

Source: Airservices Australia[16]

The airport is surrounded primarily by rural, rural-residential and low density residential land. The majority of large lot land holdings are clustered towards the north and west of the airport.

7.4.2 Avalon Specific Considerations

In performing this analysis specifically for Avalon, we had reference to the following:

Suburbs analysed: Avalon, Lara, Littler River (North and west of airport).

Variables: Suburb, Land size, Time factor and Noise affectation.

Sales period: 2000 to 2014 (inclusive).

The analysis was performed on sales that were either affected or unaffected by aircraft noise.

7.4.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for large lot land holdings sales surrounding Avalon Airport.

Table 29: Results of Regression Analysis for Avalon

	Result	Implication
R Squared	0.38	Weak relationship
t-Stat (Noise)	-0.71	Not significant
P-Value (noise)	0.48	Not Significant
Impact (Noise)	-7.84%	Not considered

Source: CoreLogic, JLL Strategic Consulting

The R-Squared reveals a weak relationship between the independent variables and the dependent variable (sale price). In addition, the t-Stat and P-Value for the noise variable identifies that the relationship between noise and price is not significant. The impact assessed for noise is a devaluation of 7.84 per cent, however, is not considered relevant as the t-Stat and P-Value is not significant.

7.5 Perth – Perth Airport

7.5.1 Locational Context

Perth Airport is located approximately 12 kilometres east of the Perth CBD. The table below provides a summary of the aircraft movements for Perth Airport.

[16] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

Table 30: Movements at Perth Airport for the 2014 Calendar Year

Airport	Over 136 tonnes	Between 7 and 136 tonnes	Under 7 tonnes	Helicopter	Military	Total
PER	30,632	111,774	6,412	678	414	**149,910**

Source: Airservices Australia[17]

The airport is surrounded by a variety of uses, including low density residential, parklands, rural-residential, rural and industrial facilities. The majority of large lot land holdings are clustered towards the north of the airport.

7.5.2 Perth Specific Considerations

In performing this analysis specifically for Perth, we had reference to the following:

Suburbs analysed: Caversham and West Swan (both north of airport).

Variables: Suburb, Land size, Time factor and Noise affectation.

Sales period: 2000 to 2014 (inclusive).

The analysis was performed on sales that were either affected or unaffected by aircraft noise.

7.5.3 Findings and Limitations

The table below summarises the results of the regression analysis performed for large lot land holdings sales surrounding Perth airport.

Table 31: Results of Regression Analysis for Perth

	Result	Implication
R Squared	0.29	Weak relationship
t-Stat (Noise)	0.01	Not significant
P-Value (noise)	0.99	Not Significant
Impact (Noise)	0.20%	Not considered

Source: CoreLogic, JLL Strategic Consulting

The R-Squared reveals a weak relationship between the independent variables and the dependent variable (sale price). In addition, the t-Stat and P-Value for the noise variable identifies that the relationship between noise and price is not significant. The impact assessed for noise is an appreciation of 0.20 per cent, however, is not considered relevant as the t-Stat and P-Value is not significant.

7.6 Summary of Key Findings

The table below summarises the key results of the cross section analysis performed for large lot land holdings sales for the selected three case studies.

Table 32: Significance of Noise Exposure on Large Lot Land Holdings Pricing

Airport	N (sample size)	r^2	Noise impact on price	Noise factor significance		Comment
				t-stat	P-value	
MEL	193	54.8%	15.3%	1.88	6.13%	Not considered significant
AVV	330	38.0%	-7.8%	-0.71	47.79%	Not considered significant
PER	178	28.9%	0.2%	0.01	98.95%	Not considered significant

Source: CoreLogic, Airservices Australia, JLL

These results suggest that there is no discernible or statistically significant relationship between large lot land holdings exposed to aircraft noise in excess of 20 ANEF and the sale price. It is hypothesised that there are significant factors other than noise which have a greater impact on price, including the nature and style of the dwelling on the land, the type of activity carried on, the nature and productivity of the land and its physical and biological characteristics.

[17] http://www.airservicesaustralia.com/wp-content/uploads/Airport-Movement-Calendar-YTD-November-2014_ORS1.pdf

Structured interviews with real estate agents interstate (Melbourne, Avalon and Perth) would likely provide a better understanding of the impact on proximity to an operational airport on large lot land holding property values.

8 Price Change Related to the Announcement of the Proposed Airport at Badgerys Creek

8.1 Objective

The objective of this analysis is to gain an understanding of the impact to pricing, if any, of the announcements of the commencement of the EIS for Badgerys Creek airport in 1996 and the in April 2014 announcement that Badgerys Creek would be site of a new airport to large lot land holdings in the vicinity of the airport site.

8.2 Methodology

In 1996 the then Australian Government announced the commencement of the Second Sydney Airport Proposal EIS (1997-1999 EIS), which was focussed on Badgerys Creek as the site for an airport. Similarily on April 2014 the Australian Government confirmed that the site for Western Sydney's new airport would be Badgerys Creek. These announcements could be expected to have had an impact on property values in the vicinity, both from perceptions of possible adverse impacts, such as noise and air pollution, and positive anticipatory and positive effects in terms of improved infrastructure, employment opportunities and potential for higher density and intensity of land use.

This study undertook an analysis on sales in the vicinity of the airport site. The analysis compared the long-term median price growth of suburbs around the airport site with the growth over the same period for Western Sydney and the Sydney metropolitan region. The analysis made primary reference to growth rates both before and after the announcement in April 2014 that Badgerys Creek will be the site for a new airport.

This study has had reference to sales price data series over a 24 year period (1991 to 2015). The study analysed the change in property sales values over the period prior to and the 12 months that followed the April 2014 announcement on land within a 5 kilometre radius of the centre of Badgerys Creek, utilising quarterly moving median prices from the CoreLogic database.

The growth in residential prices in the suburbs lying within 5 kilometres of Badgerys Creek was compared with the Western Sydney and Sydney Metropolitan areas. Overall, this includes some 1,500 residential sales since Q2/1991 in the suburbs of Bringelly, Kemps Creek, Luddenham, Mount Vernon and Rossmore. (Note data series for residential sales in the suburb of Austral and Greendale, which are within 5 kilometres or in Badgerys Creek, were not included due to insufficient sales transactions).

The data represent the average of the four quarterly moving median sale prices for each of the five suburbs around Badgerys Creek (i.e. each quarterly figure is the average of the four preceding quarterly median sale prices for that suburb, and then averaged across the 5 suburbs) index to a base of 100 at Q2 1991.

8.3 Data Analysis

In order to perform this analysis, we utilised the long-term CoreLogic median house price data series at a suburb level. Included within the CoreLogic data series is their definition of house, being "generally, a house is defined as any dwelling situated on a single title".

Within this analysis we have utilised the definition of 'Western Sydney' as provided by GHD. The table below identifies both the planning regions and Local Government Areas included within this definition.

Table 33: Definition of "Western Sydney"

Planning Region (from A Plan for Growing Sydney)	Local Government Areas
Sydney South West	Liverpool
	Fairfield
	Camden
	Campbelltown
	Wollondilly
Sydney West	Penrith
	Hawkesbury
	Blue Mountains
Sydney West Central	Auburn
	Bankstown
	Blacktown
	Holroyd
	Parramatta
	The Hills

Source: GHD

8.4 Key Findings and Limitations

The analysis indicated a slight diminution of value in the 12 months following the previous announcement of the Airport in 1996 of 2.28 per cent compared with a growth of 3.55 per cent in Western Sydney and 6.50 per cent in the Sydney Metropolitan areas. We consider the findings from the 1996 announcement must be discounted as it relates to the context of that period. Factors that influenced the then announcement include: the lack of site specific certainty, with other locations still considered; noise sensitivity in the community, in part influenced by the opening of the third runway at Sydney Airport; and, the strong local opposition from a number of groups, as well as a statement by Qantas citing its preference of increased capacity at Sydney Airport.

The findings and growth rates for the April 2014 announcement are summarised in the table below and illustrated in the charts overleaf.

After considering the analysis undertaken above the table below summarises the impact of noise on property values by land use type. Broadly, the residential assessment has had primary consideration to the statistically significant results from the Brisbane and Adelaide Airports, with support for assessed impact coming from the academic literature and professional studies. The analysis on the large lot land holdings had reference to both the interstate analysis on Avalon, Perth and Melbourne Airports as well as analysis of price changes related to the announcements at Badgerys Creek.

Table 34: Long Term Residential Growth Rates in 5 suburbs Around Badgerys Creek Before and After 2014 Announcement

Location	Average Compound Growth Rate 1991 - 2015	
	Pre Announcement	Post Announcement
5km around Badgerys Creek	6.42%	23.72%
Western Sydney	6.34%	16.65%
Sydney Metropolitan	6.70%	14.04%

Source: CoreLogic, Airservices Australia, JLL

Whilst average residential prices in the suburbs around Badgerys Creek experienced a growth rate broadly in line with the broader Western Sydney region and the metropolitan area as a whole, there was a marked acceleration in growth in the 12 months following the announcement to locate the proposed airport at Badgerys Creek.

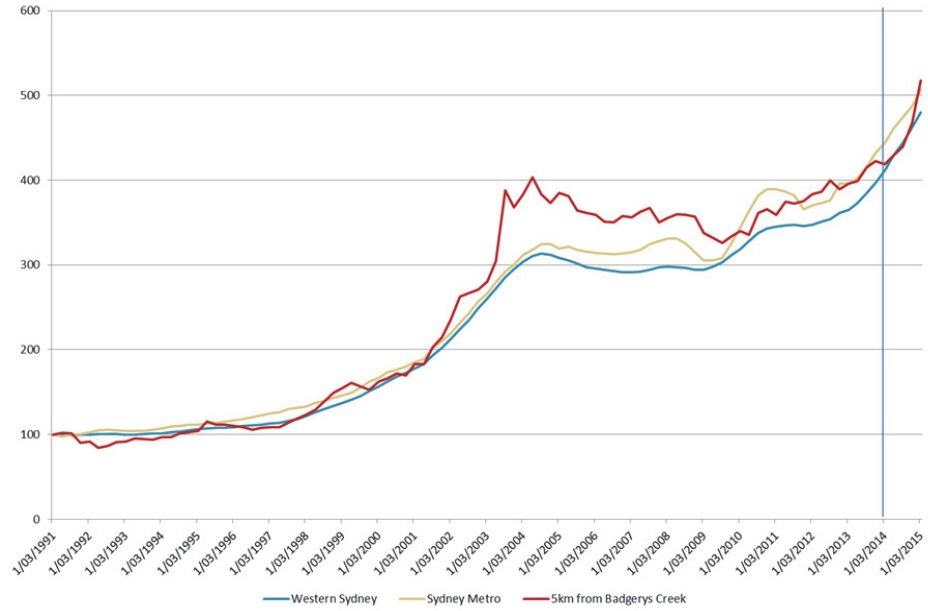
Whilst this is not evidence of causality, it is noteworthy that median house prices in the Badgerys Creek area increased at a rate significantly greater than that of the surrounding Western Sydney

region and the Metropolitan region. The volume of transactions since the 2014 announcement is broadly in line with the long term average of between 15 and 20 sales per quarter.

Although it is not possible to singly attribute the increased price growth to the 2014 announcement, which may be related to a range of external factors including the growing pressures within the Sydney housing market, falling interest rates and the growing commitment to the development of Western Sydney, it suggests that the announcement did not appear to create any diminution in residential values in the broad vicinity of the airport site, which might have been expected if there had been widespread concern about noise or impacts of the airport development.

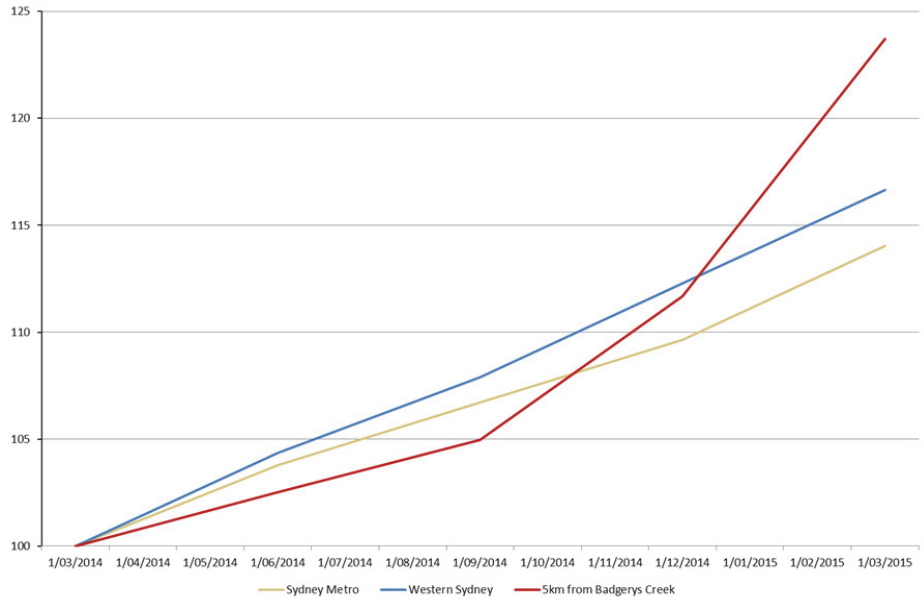
Further analysis may be required to provide context to purchaser preferences that ultimately drives property values around Badgerys Creek. This will be best achieved with structured interviews with real estate agents.

Figure 9: Residential Price Growth around Badgerys Creek (1991-2015, Based to 100)



Source: CoreLogic, JLL

Figure 10: Residential Price Growth around Badgerys Creek (Q2-2014 to Q2-2015, Based to 100)



Source: CoreLogic, JLL

Part C – SUMMARY AND CONCLUSIONS

9 Summary and Conclusions

9.1 Scope and Objectives

This technical paper has been prepared as part of the Western Sydney Airport EIS process to examine the potential impact the operation of the proposed airport may have on land and property values within the area around the airport site. Specifically, it seeks to explore, from empirical analysis of sales price data, the effect that aircraft and airport operations may have on property prices in the vicinity of the airport site, particularly those for residential and large lot land holdings.

9.2 Conclusions and Recommendations

Conclusions

The key findings from this study are summarised below.

- This paper does not specifically quantify the impacts of the proposed airport on property prices from commercial or employment based land uses due to difficulties in measurement however these land uses are likely to materially benefit from the increased economic activity that will come from their proximity of the airport site, which will positively impact land values.
- Previous studies have a found a relatively consistent adverse effect of aircraft noise on residential prices, of between 0.4 per cent and 1.1 per cent per unit of ANEF, with a greater impact at higher ANEF levels and for higher priced properties.
- None of the previous studies have sought to explore the impact on large lot landholdings comparable to those around Badgerys Creek, where few existing dwellings fall within areas expected to be exposed to noise levels in excess of 20 ANEF.
- The analysis encompassing over 1,800 residential sales transactions for suburbs in the vicinity of four main Australian international airports found:
    - No statistically significant relationship was found between noise exposure and housing prices in Melbourne or Sydney.
    - In Adelaide and Brisbane, noise exposure was found to be a more significant factor influencing residential prices.
    - In the case of Brisbane, prices for houses exposed to aircraft noise in between 20-25 ANEF experienced a -10.7 per cent reduction compared with dwellings outside the noise affected area.
    - In Adelaide, a statistically significant impact was found ranging from -8.3 per cent (20-25 ANEF); -14.7 per cent (25-30 ANEF); and -19.8 per cent (30-35 ANEF) compared with prices in areas with less than 20 ANEF.
- In Sydney, analysis of long run house prices since 1991 found no appreciable difference in growth rate between median prices in suburbs subject to in excess of 20 ANEF and those in similar areas not exposed to aircraft noise. Possible reasons may be:
    - Housing pressures restrict housing choices
    - The benefits of living close to the city outweigh possible noise effects in the minds of potential purchasers
    - Noise attenuation measures to dwellings in above 20 ANEF noise contours may have reduced the impact of noise on residents
    - Aircraft noise sharing protocols and rising ambient noise levels in many suburbs may reduce the perceived impact of noise
- Examination of sales of large lot landholdings in the vicinity of Melbourne, Perth and Avalon airports failed to establish a statistically significant relationship between noise exposure and property prices. Possible reasons for the lack of clear effect may include:

- The lesser significance of the dwelling in the context of large land areas, compared with established urban areas
- Land used for primary production may be less affected by noise
- The wider range of factors influencing price that cannot be analysed from the available sales data, e.g. aspect, topography, soil and micro-climate

- Analysis of long run growth rates of residential sales in the suburbs around Badgerys Creek indicates that despite short term fluctuations, property prices have grown at a similar rate to the wider Western Sydney and Sydney metropolitan regions.
- Rather than suffering a slowing of growth as a result of possible fears of noise or other impacts of an airport, residential prices in the suburbs around Badgerys Creek grew strongly in the period following the April 2014 announcement that Badgerys Creek would be the site of the proposed airport, increasing by almost 24 per cent and substantially faster than both Western Sydney and the Sydney metropolitan regions.
- Overall, the analysis failed to establish conclusive evidence of a negative impact on large lot land property prices as a result of aircraft noise at levels of 20-25 ANEF. Suggesting that the development of the proposed airport at Badgerys Creek may not have a major adverse impact on property prices in the vicinity.

The table below summarises the impact of noise on property values by land use type. In deriving the residential component below, this report had primary reference to the analyses which showed a statistically significant result (i.e. Adelaide and Brisbane).

Table 35: Assessment of Noise Impact on Property Values by Land Use Type

	Noise impact on price (compared to noise levels < 20ANEI/ANEF)		
Land Use	ANEI/ANEF 20-25	ANEI/ANEF 25-30	ANEI/ANEF 30-35
Residential	-9.5%	-14.7%	-19.8%
Large Lot Land Holdings	No discernible impact	No discernible impact	No discernible impact

Finally, this report has also had consideration to the potential impact of property prices that may occur from a second runway opening at the proposed airport. The long term time series analysis on Sydney Airport (see Section 6) suggest no material difference in property pricing of noise versus non-noise affected areas. This outcome is in line with our expectations – that is, that factors of much greater significance will influence property values than any incremental increase in noise. More specifically, it is considered that the positive influences of in-area employment as well as improved amenity and services will more than likely make up for any additional noise from the second runway.

Further, this report makes the observation that there have been significant advancements in aircraft technology over the last 20 years that have meant a material reduction in noise footprints across all major Australian airports, despite increasing aircraft movements. It is considered to be a reasonable assumption that advancements will be made in the future, further reducing aircraft noise. For the above reasons this report has not assessed a negative impact to property prices due to the opening of a second runway at the proposed airport.

10 References

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Appendix A – Summary of Literature Reviewed

Author	Year of Study	Location	Depreciation in Housing Values per unit ANEF/NEF (%)	Comments
Australian Studies				
Abelson	1977	Sydney Airport	0.4	Non-linear model. Limited to houses. Significantly greater than 25 ANEF in Marrickville
BIS Shrapnel	1990	Sydney Airport	0.4 – 0.6	Limited to houses. Minimum found for 20-25 ANEF range, maximum for 30-35 ANEF range- both in Marrickville
Poulsen	1990	Sydney Airport	0.86 – 1.1	Range for linear and non-linear models, northern flight path, applies greater than 30 ANEF
JLW Research and Consultancy	1993	Sydney Airport	0.5 – 1.0	Minimum found for less than 30 ANEF in Drummoyne, maximum found for greater than 35 ANEF in Sydenham
Burns and Associates	1990	Adelaide Airport	0.36 – 0.39	Range only applies to houses in the 27.5 – 30 ANEF zone
Overseas Studies				
Emerson	1969	Minneapolis	0.4	
Mclure	1969	Los Angeles	1.62	
Paik	1972	New York (Kennedy)	2.0	
Roskill	1971	London (Gatwick) Medium-priced houses High-priced houses	1.6 2.6	Limited to houses 2 price ranges
Roskill	1971	London (Heathrow) Medium-priced houses High-priced houses	0.9 2.25	Limited to houses 2 price ranges
Colman	1972	Los Angeles	1.6	
Price	1974	Boston (Logan)	0.8	
Dygert	1973	San Francisco (Sam Mateo Country)	0.5	
Dygert	1973	San Jose (Santa Clara Country)	0.68	
Gautrin	1975	London (Heathrow)	0.5 – 0.68	
Nelson	1975-78	Washington	1.0	
DeVany	1976	Dallas	0.58	Within two to three miles of the airport
Maser	1977	Rochester	1.1	
McMillan et al	1978	Edmonton	0.5	

Mieszkowski and Saper	1978	Toronto (Etobicoke, Missisauga)	0.3 – 1.3	Linear models used Limited to Houses
Uyeno et al	1993	Vancouver	0.65 – 0.9	Non-linear model. Minimum detached houses, Richmond, greater than 25 ANEF, maximum units, Richmond, greater than 25 ANEF