The Impact of Aircraft Noise on Brisbane Residential Property Sectors: 1988-2013

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Executive Summary

TO EFFECTIVELY MANAGE FUTURE DEMAND, AN UPGRADE TO EXISTING INFRASTRUCTURE AT BRISBANE AIRPORT IS CURRENTLY UNDERWAY. ANY INCREASE IN AIRPORT INFRASTRUCTURE HAS THE POTENTIAL TO RAISE QUESTIONS ABOUT POSSIBLE IMPLICATIONS FOR RESIDENTIAL COMMUNITIES.

The impact of aircraft noise on surrounding property values has been the subject of much media attention and many international academic studies. Media reports state that the impact of aircraft noise may reduce property value by up to 20%. Although many online blogs recognize that aircraft noise is one factor that is balanced against others in the decision to purchase or rent a home. Frequently locations with a high level of aircraft noise are also close to the CBD or other social infrastructure.

A review of literature showed that the majority of academic studies in this area have been undertaken in the USA or The Netherlands with significantly less attention in the UK and Australia. Predominantly these studies have been based on econometric modeling using hedonic price models. Most commonly these studies found that there was some negative impact on residential properties. However, this was not the case for commercial and industrial property. Academic studies showed the impact of aircraft noise on residential property was only evident beyond 60dB and had no impact up to this level. The deficiency of the majority of these studies was the limited time period over which they were undertaken of 12 or 24 months and the difficulty in isolating aircraft noise as the single influencing factor in resulting property values.

It was recognised that for a more complete analysis of the impact of aircraft noise and airport operations on residential property markets, a longer term analysis is required, and the affected markets also need to be compared across a range of residential property sectors to determine the full impact of this stigma on residential property prices, long term capital growth and buyer and seller behaviour in those markets.

When considering the issue of the impact of aircraft noise on the value of residential property in Brisbane, this study is more comprehensive and longitudinally significant than previous international studies. This study is specific to Brisbane and covers one of the most extensive time periods for a study of this type. The data for this project comprised all residential house and unit sales for 36 suburbs and selected street analysis for house prices in 21 suburbs (selected streets for 15 suburbs represented in the full suburb analysis and selected streets in an additional 6 suburbs). In total there were over 180,000 sales analysed in the study over the period 1988 to 2013. In total this analysis for house prices covers 42 Brisbane suburbs and 36 suburbs for unit/townhouse prices and 36 suburbs for rental values.

The study period is an analysis of property transactions that occurred since commencement of the current airport and runway in 1988. It was at this time that residential property buyers and tenants were likely to be aware of the location of the existing flight paths and this information was widely available to all interested parties. As this study covers the full period of existing airport operations, the results of this detailed study provide an extremely accurate analysis of residential property buyers' behaviour in relation to houses and units impacted by these flight path locations.

The study period also covers a range of significant natural and economic events that have had a direct impact on a range of residential property sectors. These events include the residential property boom from 2001 to 2007, the Global Financial Crisis and the 2011 Brisbane floods. This time period also covers the extensive public consultations, media releases and website information published and broadcast in relation to the approval of the new runway at Brisbane airport, updates on the various stages of construction and details of the various flight paths and expected aircraft movements.

OVERALL FINDING

Houses in Brisbane locations subject to aircraft noise have shown similar and in most cases higher average annual capital returns compared to non-affected properties. The price and performance of these properties is linked more closely to socio-economic status than aircraft noise impact. Location of residential property under Brisbane flight paths has not had any significant effect on the ability to rent residential property or resulted in any differences in weekly rental rates across any of the various socio-economic residential property locations. These results confirm that in Brisbane, the decision to purchase a residential property, in any given location, is based on a range of factors, and exposure to aircraft noise is offset by other factors associated with suburbs located under aircraft flight paths. This has resulted in these aircraft noise affected locations achieving similar and most often higher prices and capital growth despite this exposure to aircraft noise.

SIGNIFICANT FINDINGS

The most significant finding from this extensive study is that location of a residential property under a Brisbane flight path has no significant long term impact on the median and average house price for those locations compared to non-affected residential suburbs in Brisbane and over an extended period have achieved higher capital returns compared to similar socio-economic locations. Although in particular years the median house price in the aircraft noise affected suburbs was lower than residential property in less or non-affected locations, over the 26 years of this study, this only occurred in 8 years (predominately from 1988-1992). From 1993 the median house price for suburbs in Brisbane exposed to the higher levels of aircraft noise was greater than less affected locations, based on the socio-economic status of the suburb.

One of the most significant outcomes of the study is that the fundamental driver of the Brisbane housing market performance is the suburb socio-economic status as opposed to aircraft noise. The data shows that Brisbane locations that are subject to aircraft noise have at least similar, and in most cases higher median house prices and average capital returns when compared to non-affected properties of similar socio-economic status. The location of residential property, under Brisbane flight paths, has not had any significant effect on the ability to rent the property or the rent achievable across any of the various socio-economic clusters.

Based on previous academic studies discussed in section 1; it could be expected that the price of housing would decrease as the levels of aircraft noise increased. In the case of Brisbane suburbs under the airport flight paths the reverse is the case, with median house prices under flight paths decreasing as the distance from the airport increases, despite the decreasing noise levels. This again supports the finding that house prices in Brisbane are driven by location from the CBD, schools and services rather than aircraft noise and is in line with the general property value characteristics of major cities, with location to the CBD reflecting higher prices and capital returns.

Overall, the study showed that during the period from 1988 to 1992 the median price for houses under the existing flight paths for the Brisbane airport runway (opened in 1988) was lower than houses not affected or minimally affected by aircraft noise. However, since 1993 the reverse has been the case, with median house prices being higher in suburbs subject to aircraft noise compared to those with minimal or no noise impact.

The aircraft noise that various locations are subjected to had no impact on the saleability of property. Based on the analysis of 36 Brisbane suburbs subject to varying levels of aircraft noise and aircraft noise complaints (High Noise Complaints [HNC]; Moderate Noise Complaints [MNC] and No or Minimal Noise Complaints [NNC]), there was no

difference between the annual movement in actual houses and units sold in these suburbs. The trend in sales volume from year to year over the period 1988 to 2013 was virtually identical, irrespective of whether the suburb was located directly under current flight paths or not subject to any aircraft noise. The actual number of sales per annum did vary but this was more a factor of available housing stock rather than location under a flight path. This is confirmed by the extremely high positive correlation coefficients based on sales volume movement from year to year. Based on the number of years in this study a significant positive correlation coefficient at the 5% level would be r = 0.37. This analysis shows the correlation coefficient between suburbs with high levels of noise complaints was r=0.90 with the moderate noise complaint suburbs and r=0.89 with the minimal and no noise complaint suburbs. On these results the effect of aircraft noise on the number of properties sold in affected areas is not a significant factor, if a factor at all.

Where there was an extremely high significant correlation between the changes in sales volume from year to year across the various suburbs with high to minimal aircraft noise, this relationship was even stronger when the annual movement in median house prices for each of the suburb rankings based on degree of aircraft noise was compared. The correlation between the change in the median house price across the high aircraft noise complaint suburbs to the moderate and minimal or low noise complaint suburbs was virtually identical over the 26 year period with the respective correlation coefficients being 0.95 and 0.96. This indicates that houses under a flight path and subject to high aircraft noise levels will increase or decrease in median price at the same levels as houses in suburbs with moderate or no aircraft noise impact.

The analysis of the average annual capital return based on both the median price and average price for houses across the 42 suburbs (36 suburbs all street analysis, with selected street analysis for 15 of these 36 suburbs based on location to existing and proposed flight paths) and an additional 6 suburbs (selected street analysis based on existing and proposed flight paths) has shown that not only have the house prices in the high noise suburbs matched the price growth when compared to less or not affected suburbs, but have actually outperformed these suburbs in relation to capital growth over the 26 year period.

All the suburbs in the high aircraft noise complaint locations are classified as middle socio-economic suburbs. When the median and average price per year for these suburbs are compared to middle socio-economic suburbs that have no or less impact from aircraft noise, from 1988 to 1992 the median price was lower in suburbs subject to aircraft noise, particularly from 1988 to 1991 where the percentage difference in price was up to 6.92% less on a median price basis and 19.27% less on an average price basis. However, since 1992 the houses in the high noise complaint suburbs have achieved a higher average and median price compared to similar middle socio-economic suburbs moderately or not affected by aircraft noise. Based on median prices there are only two years when the affected suburbs had a median house price less than the less or non-affected suburbs; with 18 years when the median prices were higher. Across the full study period the median house price of noise affected houses was 2.11% higher than non-noise affected houses. This again supports the fact that aircraft noise is only one factor that house buyers consider when purchasing a property and in the majority of cases it does not result in a lower house price, nor discounts at levels stated in the academic literature review. The sub period analysis confirms that the higher difference in median house prices for the affected suburbs has been greater over the past 15 years, which also reflects the increasing house prices in the southern Brisbane suburbs that had been lagging behind the northern Brisbane suburbs up to the late 1990s.

Sales transactions volume across the 36 suburbs for units has differed significantly to the house analysis. One of the major reasons for this difference is the varying proportion of home units, townhouses and villas across these suburbs. The proportion of home units in total housing stock is greater in the inner city, high value suburbs of Brisbane, with the middle ring suburbs having a lower percentage of units in the total housing stock. These variations in the number of units in suburbs has resulted in the highest volume of sales being in the NNC suburbs and the lowest volume of sales per year in the HNC suburbs. Based on the change in volume from year to year, the only positive significant correlation for unit sales in Brisbane was between HNC suburbs and MNC suburbs (r=0.56).

Median unit prices in all 36 suburbs in the aircraft noise study were higher than the Brisbane median unit price across the study period, although there was only one significant correlation between these three unit markets based on median unit prices (HNC and MNC r=0.71). However, on an average price basis there were two significant correlation co-efficients and all the noise

complaint study suburbs had a positive significant correlation with the Brisbane median unit price. Although the capital return performance for units in Brisbane has not been as strong as the growth in house prices, the median price average annual returns for units in the HNC, MNC and NNC suburbs have been very similar ranging from a high of 7.86% (NNC) to 7.40% for MNC and HNC units 7.66%. Just as was the case with houses, in these three noise classification suburbs; there are no significant differences in the growth and annual change in the median price of units based on the level of aircraft noise. If aircraft noise was the major value driver in these suburbs there would be a significant variation in prices from the HNC suburbs to the NNC suburbs.

When considering the variation in the annual median price of HNC units and middle socio-economic units in the MNC and NNC suburbs, there is a much greater significant positive correlation based on both median and average prices, with the trend in price movement being very similar and average annual capital returns being virtually identical across the 26 year period. Like the house price analysis based on this comparison, the median and average price for units in the HNC suburbs was up to 14% lower than the middle socio-economic units in the MNC and NNC suburbs from 1988 to 1993. However, since 1994 to 2013, in all but three years the average and median house price in the HNC suburbs has been higher. This again supports the fact that aircraft noise is not the main factor that drives unit values in these suburbs of Brisbane.

A similar result to the discussion above has been replicated in the analysis of rents in these 36 suburbs. Despite varying levels of aircraft noise the volume of houses and units rented in the HNC and MNC suburbs are very similar but this is not the case in the NNC suburbs. The actual growth in weekly house rentals across the period 1988 to 2013 has been very similar, as evidenced by the extremely significant correlation across the three sectors with correlation co-efficients ranging from r=0.88 to 0.95. There were also very significant correlations in relation to the weekly rental rates for units in the three suburb classifications. As was the case with house and unit prices, the same relationships apply based on weekly rentals for houses and units with the degree of aircraft noise affectation and proximity under flight paths not having any impact on the ability to rent a property in the HNC and MNC suburbs, nor the weekly rental that can be achieved.

On the selected street basis (covering a total of 21 suburbs) the following were the most significant results.

Houses directly located under the ANEF 20 contour and subject to the most recognised levels of aircraft noise do show a lower volume of sales per year but the trend in sales volume is very similar to houses outside this noise contour. Being located in such high aircraft noise locations does not result in a residential property being unsaleable. Despite the median house price for the higher aircraft noise affected houses being slightly lower when compared to the adjoining locations, the actual movement in the price of houses from year to year has been similar, as has the average annual capital return and volatility, with these noise-affected streets recording an average annual return in excess of 9%. This is well above the Brisbane median house return of 7.72%.

The streets that will be subject to the higher levels of aircraft noise when the proposed runway is in operation are in high value and upper middle value suburbs of Brisbane. At present the areas south of Brisbane that are located under or adjoining the ANEF 20 contour for the new runway are in high value areas and there is currently very little difference in median and average house prices, despite the fact that it is common knowledge that these streets will be subject to aircraft noise. Houses in the streets that are under the ANEF 20 contour have actually shown a higher average annual capital return over the full 26 year period, including the past 5 years. The location of many of these streets on or close to the Brisbane River appears to be a major value driver for this sector of the residential property market. The streets that are under or close to the ANEF 20 noise contour, north of the Brisbane River, have also shown the same trend in sales volume over the study period, with the houses adjoining the contour exceeding sales in the streets within the contour. Although the median price for houses within the contour was less than the streets adjoining, this is more related to the suburb status rather than the location to the airport. The adjoining streets in this particular location are predominately in the suburb of Ascot, a high value residential suburb of Brisbane, while the streets within the new runway ANEF 20 contour are predominately in the suburb of Hendra, a lower value suburb by comparison to Ascot.

Streets in the four selected suburbs subject to the highest volume of aircraft movements are middle to high value middle socio-economic suburbs of Brisbane. The analysis of sales in these streets indicate that the median house prices are higher than the Brisbane median house price across all 26 years of the study and that these streets have recorded higher average annual capital returns when compared to similar value middle socio-economic suburbs in Brisbane. These higher returns were not at significantly higher levels of volatility in median and average house price movements. The various median and average house prices fell as the distance from the airport increased, despite the aircraft noise levels also decreasing as distance from the airport increased. This again shows that the location of a street subject to aircraft noise has its value determined more by distance to the Brisbane CBD rather than aircraft noise levels.

When the analysis is based on the northern flight paths from the current runway operations, the results mirror the situation in the southern suburbs. The streets in the inner city residential suburbs (Albion is excluded due to its large industrial property profile) have consistently outperformed the streets in the suburbs located further away from the CBD. This applied whether the suburb was affected by current or potential aircraft noise.

The price and price movement for residential streets in the suburbs that are not currently affected by aircraft noise from the existing runway but will be under the new flight path, again have shown a very similar trend and overall capital return performance to those suburbs that are affected by aircraft noise. There was no premium evident for the fact that the suburb was not affected by aircraft noise. Again, the dominant value factor appears to be proximity to the CBD and services driving these residential property sectors, with both median prices and capital returns decreasing as the distance from the Brisbane CBD increases. The available information on the location of flight paths and potential aircraft movements that have been published widely since the announcement of the new runway have not seen any discounting of residential house prices in these areas to date.

The analysis of the residential properties in the suburbs that are not subject to any flight paths or aircraft noise both now and in the future, again showed very little difference in median and average house prices and capital growth when compared to similar socio-economic suburbs that were currently under flight paths or would be under flight paths when the new runway operations commence.

When each of the various suburbs in this overall study were compared on a socio-economic basis from low middle socio-economic through to high socio-economic suburb status, the investment performance over the period 1988 to 2013, was virtually identical, whether the suburb was under a flight path, subject to higher levels of aircraft noise or in close proximity to the airport. Overall it appears that aircraft noise may be one factor that is considered upon renting or purchasing a home, however this factor is balanced against many other factors such as location to infrastructure, convenience of transport and socio-economic status.

This report provides an analysis of the impact of aircraft flight paths and noise on the value, saleability and investment performance of residential property in Brisbane dating back to the opening of the current airport facility to 2013. This is an on-going research project and further annual updates to all of the data will be undertaken for the full development period of the new parallel runway at Brisbane airport and for a number of years following the introduction of aircraft operations at the airport on completion of the runway. This continuing study will determine any impact of the planning, construction and operation of the proposed new runway operations on the identified Brisbane residential property locations.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Introduction

TO EFFECTIVELY MANAGE FUTURE DEMAND, AN UPGRADE TO EXISTING INFRASTRUCTURE AT BRISBANE AIRPORT IS CURRENTLY UNDERWAY.

Any increase in airport infrastructure has the potential to raise questions about possible implications for residential communities.

This comprehensive study has been undertaken with the aim of identifying the impact that the existing airport activities have had on affected residential property values and investment performance with a view to identifying how renters and buyers respond to aircraft noise in Brisbane. This market response is likely to determine how the Brisbane residential property market will respond to the impact of future upgrades to airport infrastructure.

The subject of aircraft noise and its impact on surrounding communities has been the subject of a considerable amount of media attention and many international academic studies. A review of academic literature is contained in Chapter 2 and shows that the majority of international studies have been undertaken using econometric methods with a limited sample, either census data or a sales data over a limited period.

A full review of media and online blogs and forums is undertaken in Chapter 3. Not surprisingly much of the media attention has been negative and discussed the negative impact of aircraft noise on property values, in some cases the speculated impact is up to 20%. Some media reports also refer to the balancing of factors some positive and some negative when making a decision to purchase or rent a home. Aircraft noise would merely be one of the factors considered and possibly of lesser significance than the noise generated by neighbours, roads and rail. Although media and online reports are purely anecdotal they are useful to consider the nature of popular opinion from local residents and real estate agents etc. which inform housing choices.

This study seeks to fill a gap in the body of knowledge through the analysis of selected suburb and street locations over a 26 year period. The study starts in 1988 which coincides with the opening of the current airport runway. This date was chosen because at this time the wider community was aware of the opening of the new airport facilities, with widespread consultation and publically accessible information. As a result the impact of these new airport operations would have been a consideration in residential purchases and rental situations. This is the most significant study of its kind in terms of depth and breadth of analysis. The research methodology is fully described in Chapter 5.

Chapter 4 contains an identification and justification of the various suburbs and locations that are analysed. The aspects that were considered in selection of the locations to be studies include the current flight path locations, proposed flight paths on completion of the new run way, locations currently affected by aircraft noise, locations that will be subject to aircraft noise on completion of startup operation of the new runway, locations that will have reduced aircraft traffic movements on completion and startup of the new runway, locations with a significant number of complaints relating to aircraft noise, locations with minimal or no complaints regarding aircraft noise, locations within ANEF 20 Contour (existing runway), locations immediately adjoining AFEF 20 Contour (existing runway), locations within ANEF 20Contour (proposed runway) and locations immediately adjoining ANEF 20 Contour (proposed runway).

A full discussion of results is undertaken in Chapters 6 and 7. The most significant findings of the study are outlined in Chapter 8 and include that there was an impact during the period from 1988 to 1992 when the median price for houses under the flight paths for the Brisbane airport was lower than houses not affected or minimally affected by aircraft noise. However, this impact was short lived and since then the situation has reversed. The median house prices for aircraft noise impacted suburbs has been higher when compared to those with minimal or no noise affectation. There appears to be no impact on annual capital returns with houses in Brisbane locations subject to aircraft noise showing similar or higher average annual capital returns compared to non-affected properties. The price performance of Brisbane property is more closely aligned to suburb socio-economic status rather than aircraft noise impact. Location of residential property under Brisbane flight paths has not had any significant effect on the ability to rent residential property or any differences in weekly rental rates across any of the various socio-economic residential property locations.

2 Literature review (Academic)

2.1 CHAPTER SUMMARY

As the population in major cities expand so does the need for expansion of international and domestic airports. This infrastructure expansion has drawn increased attention to the implications for residential communities, which may be detrimentally affected through increased noise pollution and diminution in residential property values.

The issue of the impact of aircraft noise on property values is internationally significant with a plethora of academic studies having been undertaken since the early 1970's. In this report 45 academic studies have been reviewed to determine their contribution to the body of literature on the topic. Of significance is the fact that the majority of studies on the topic have been undertaken in either the United States or The Netherlands with very limited studies in Australia or the United Kingdom.

There are three methodologies for undertaking a study into the impact of aircraft noise on impacted residential property values, Hedonic Price Modeling (HPM), Contingent Valuation Study – willingness to pay (CVS) or paired sales analysis. The majority of these studies reviewed in this report have adopted the HPM method and have either been based on Census data in the US or sales data in the United Kingdom. In the majority of studies considered the analysis was based on data either from a single 12 month period or in some cases two separate 12 month periods and generally lacks longitudinal credibility.

A further limitation of the studies is that commonly the studies have based their analysis on the difference between house prices for noise affected and non-affected locations at a suburb level and with the exception of one study (Valdes) did not consider repeat sales of these properties to determine price differences over time. This study by Valdes actually resulted in the lowest price differences between noise affected houses and non-affected property.

In addition, all researchers noted that the models adopted cannot account for all factors that drive a particular property market. When a study area is based on data that requires a large geographic area to capture the required data sample over a relatively short time period, i.e.12 months, it can be difficult to capture all the property factors that buyers placed on each purchase during that time period. This is a fundamental flaw in the adoption of HPM methodology.

Similarly to HPM, CTS is a methodology that has limitations and has been criticised as being too subjective to provide a reliable outcome. Paired sales analysis was identified as a suitable methodology to conduct analysis of the impact of aircraft noise on impact residential property values.

2.2 INTRODUCTION

Although not a significantly researched issue in Australia, there has been a continuing debate on the potential negative and positive impact of airport development and subsequent aircraft noise on residential property markets both adjoining airports and those under designated aircraft approach and take off flight paths.

With the increase in demand for additional residential housing in cities with increasing population growth, existing airport precincts are facing greater constraints with respect to noise levels, while balancing the air travel requirements of a growing population base. This is particularly the case for older established airports in major residential cities where the need for increased residential accommodation has resulted in new urban areas being developed close to airports that were once considered remote from the residential population of the city. In addition, expanded airport infrastructure resulting in new flight paths, added aircraft movements and aircraft movements over a greater number of areas have also been an issue facing residential property owners and airport operators.

Residential property studies have highlighted factors that are considered to be both advantageous and detrimental to residential property values and in isolation have been found to increase or decrease property values at a single point in time. Studies on residential property stigma, such as flooding, visual pollution, traffic noise, crime and socio-economics status, have shown results ranging from an immediate but not long-term impact to a continuing

impact. In most cases the impact of the stigma is once only with all other future transactions of such affected properties being based on full disclosure of the negative market issues.

This study will review the 45 academic studies that have been carried out on the impact and effect of aircraft noise on residential property values since the early 1970's. The review will be based on all studies undertaken on this topic and will address aircraft noise from the global perspective and will review the methodologies adopted in these studies as well as the study conclusions in respect to the effect of aircraft noise on residential property prices and values.

The analysis of these studies will be presented in chronological order to show the development of both the study results and methodologies over time. Following a review of relevant studies during the defined periods overall conclusions are drawn.

2.3 REVIEW OF PREVIOUS STUDIES

The report has been structured to include a review of literature over the following time periods:

» Pre 1980

» 1980 to 1999

» 2000 to 2005, and

» 2006 to 2014

STUDIES UNDERTAKEN PRE 1980

Prior to the early 1970s there was very little research carried out with respect to the impact of aircraft noise on residential property adjacent to an airport or under designated flight paths for aircraft landings and take-off. Research on this topic was limited during this time due to a number of factors, including:

» Limited residential development and population close to airports

» Reduced aircraft movements in comparison to current levels

» Different aircraft types and size pre 1970 compared to later time periods

» Limited data availability and statistical modeling tools to enable a study of these issues to be undertaken.

The first significant academic studies on aircraft noise and residential property values were carried out from 1972 and 1974. Nelson (1980) provided a comprehensive overview of the major aircraft noise studies that had been carried out over the period 1972 to 1979, prior to his 1980 paper. A summary of these studies is provided in Tables 2-1 and 2-2.

Table 2-1: Aircraft noise and property value studies 1969 to 1979

Author	Year	Study Airport	Data period
Emerson	1969/1972	Minneapolis, US	1967
Palk	1972	New York, Dallas (LF), Los Angeles	1965
Dygert	1973	San Francisco, San Jose	1970
Price	1974	Boston	1960 and 1970
Gautrin	1975	London Heathrow	1968-1969
De Vany	1976	Dallas	1970
McDougall	1976 (2)	Los Angeles	1970
Maser et al	1977	Rochester, US	1971
Mieszkowski & Saper	1978	Toronto	1969-1973
McMillan et al	1978	Edmonton	1975-1976
Nelson	1978	Washington DC	1970
Abelson	1979	Sydney, Australia	1972-1973

Source: Nelson 1980

Table 2-2: Content of studies 1969 to 1979

Author	Method	Data type/size	Comment
Emerson	HPM	Sales/222	Only 3 months data, 9.8% reduction (Maximum Noise level[MNL])
Paik	HPM	Census block/292	2.09% reduction MNL
Dygert	HPM	Census tract + assessed values	Noise depreciation indexes 0.5% to 0.7%
Price	HPM	Census tract/rent data	At MNL rents decrease by $8.33/$100 per month
Gautrin	Modified Mohring model	Housing sales/67	Noise discount is offset by accessibility premium
De Vany	HPM	Census block/1270	24% discount at MNL
McDougall	HPM	Census block/not specified	Increased noise levels decrease price, data insufficient to specify
Maser et al	HPM	Sales & census block/1388	11% to 16% discount at MNL
Mieszkowski & Saper	HPM	Sales/1130	House price discounts at MNL 7.8%
McMillan et al	HPM	Sale listings/352	7% reduction between houses at NEF 20 and NEF 35
Nelson	HPM	Census tract/162	Noise depreciation index 1.1%
Abelson	HPM	Sales/1417	8 to 10% reduction at MNL

Source: Nelson 1980

A common theme with all of the studies undertaken during this time is that they were all based on limited time periods and the actual data points were relatively small. The studies did not necessarily explain the housing market drivers that could have been influencing the markets at the time of the sales or data collection period. The models based on actual sales and sale listing data showed a lower discount for houses affected by aircraft noise compared to the models based on census block and census tract data. This suggests for the period 1970 to 1979, actual price data input into the HPM resulted in outcomes that were within a much smaller range than the models based on census data. Table 2-2 also shows the number of data points used in the model calculations. The input data for the analysis ranged from a minimum of 67 sales for the Heathrow study to a maximum of 1417 sales transactions for the Sydney study. On a census basis in the US, the model input data ranged from a minimum of 162 to a maximum of 1270. From a HPM perspective it is often argued that the number of transactions are not as important as the quality of the transaction data; however, for a comprehensive analysis of any stigma on property prices and value both quantity over a long time period, as well as quality will provide the most accurate results.

The study that provided the conflicting result was the Gautrin (1975) study based on two suburbs adjoining Heathrow airport. This study also focused on not only aircraft noise but also the accessibility of these two locations to the airport and the London CBD. The rationale for this approach was that the savings on the cost of transport could outweigh the noise impact for a range of house buyers. The results from this study actually showed a premium for houses in Cranford despite being adjacent to the airport due to the emphasis that buyers placed on a superior transport location.

The issue of land rents and prices being a bundle of factors that combine to determine a person's perception of worth and value was also considered by De Vaney (1976) and Richardson (1977) who address the issue of a person's willingness to trade the better accessibility factors with an increase in noise.

Another interesting finding from the studies over this period was the fact that rents were not as heavily discounted for proximity to aircraft noise compared to house prices. For an investor the potential negative impact of aircraft noise on the purchase decision would be of less concern when compared to the owner-occupier, as the rent received would not be significantly less for a

Table 2-3: Aircraft noise and property value studies 1990 to 1999

Author	Year	Study Airport	Data period
Pennington et al	1990	Manchester, UK	1985/1986
Frankel	1991	Chicago, US	1990
Collins and Evans	1994	Manchester, UK	1985/1986
Levesque	1994	Winnipeg, Canada	1985-1986
Feitelson	1996	Undisclosed (US)	1996
Schipper	1996	Various locations	1960 through to 1987
Kaufman and Espey	1997	Reno-Sparks, Nevada US	1991-1995
Johnson and Button	1997	Various locations	1960 through to 1987
Schipper et al	1998	Various locations	1960 through to 1996
Tomkins et al	1998	Manchester, UK	1992/1993
Little V Dept Natural Resource QLD	1999	Brisbane Australia	1998

Source: Authors

house purchased in a quieter location. Based on property investment practice if a house has been purchased for a discount of 10% but the potential rent discount was less than 10% compared to the non-affected property, the investor would actually receive a higher return, which could result in an investor premium for these aircraft noise locations.

STUDIES UNDERTAKEN FROM 1980 TO 1999

The majority of studies on aircraft noise and housing markets during the 1980s through to 1999 were again based on Hedonic Price Models (HPM). Studies undertaken by O'Byrne et al (1985) based their analysis on the previous work by Nelson in the late 1970s. The purpose of this study was to compare the same residential areas affected by airport noise in 1970 to the same market in 1980. Once again this was based on single time periods but 10 years apart. Results from this comparison showed an increase in the impact of aircraft noise from 1970 to 1980 for the same locations. However, the results were qualified by the fact that the databases compared were not identical for the two time periods and changes in the residential property markets over that time span of 10 years were not taken into consideration.

A study of Manchester airport in 1990 by Pennington et al, considered that aircraft noise had limited impact of house prices in affected locations. They considered that other factors needed to be considered when assessing potential aircraft noise on property prices. This paper also quotes the work of Li and Brown (1980) on residential property around Boston airport, who stated:

> "when a variety of neighborhood and environmental factors as well as noise pollution are added to an hedonic price equation (resulting in 39 independent variables) the t-ratio of the co-efficient on the noise pollution variable amounts to little more than unity" (Pennington et al, 1990)

The Pennington et. al. study (1990) was based on actual sales data, 3,472 observations, but like previous studies on aircraft noise only covered a 12 month period. However, at the time this was one of the largest samples used to assess the impact of aircraft noise on residential property prices. After the initial model was tested the results showed a 6% decrease in property prices for high aircraft noise levels. However, on refinement of the model for other variables the results in this study showed that there was a limited difference in house prices in the study area for houses with and without aircraft noise issues.

The 1991 study by Frankel was based on a survey of real estate agents and valuers covering 35 suburbs of Chicago (O'Hare airport) subject to various levels of aircraft noise. This study found that most buyers were aware of the level of noise when purchasing the property and only 9% of vendors reported placing their home on the market because of aircraft noise (across all noise level sectors). However, their survey did indicate that there was generally a buyer concern for noise and over 55% of buyers used the existence of aircraft noise in this market as a bargaining point in their negotiations rather than a reason not to purchase. Another point raised in this 1991 study was the extent that homeowners are impacted by aircraft noise. The author states that the most affected parties are those who purchased their homes prior to the development of the airport or any additions to the airport that result in increased operations. Those who purchase after such events do so with full knowledge of the impact.

In 1994, Collins and Evans used the same data as Pennington (1990) to analyse the impact of aircraft noise on the two locations adjoining Manchester airport. In this study, although the data was the same, artificial neural networks were used as the model. Based on this method a range of values were determined for various house types at various aircraft noise levels. The model indicated that detached houses with the highest noise level locations were 12% (projected) lower in value than non-affected houses. For semi-detached houses in the highest noise zones the price difference was stated to be 7.48% (projected) and a maximum of 6.2% (projected) for leasehold flats. The authors claimed that this modeling was more viable than the HPM carried out by Pennington.

The findings by Levesque (1994) raise some important issues with respect to how the public and home owners view the impact of aircraft noise. Levesque was interested in the Bullen, Hede, and Kyriacos (1986) study of Australian airports that showed the impact of noise should be considered with respect to the number of aircraft movements and the variability in aircraft noise. Although the Levesque study showed that at the 75 (Effective Perceived Noise Level) EPNL, a 1 decibel increase in aircraft noise will result in a possible 1.3% decrease in house prices, the main result of this study was consumer behavior in respect to aircraft noise. These findings were:

» Houses exposed to a higher number of events exceeding 75 EPNL sell at a discount compared to those with fewer events at the same noise level (expected result)

» Houses sell at a premium in areas affected by the same number of events, the same average EPNL level, but with a larger variation in the individual noise levels (unexpected result)

Table 2-4: Content of studies 1990 to 1999

Author	Method	Data type/size	Comment
Pennington et al	HPM	Sales/3,472	12 months data, 6% reduction, initial model, no difference refined model
Frankel	Survey of Real Estate agents and valuers	200 real estate agents, 70 valuers	16 to 25% reduction for severe noise levels, 1.2 to 1.6% for low noise levels
Collins and Evans	Artificial Neural Network	Sales/3,472	12% maximum reduction for detached houses, less for semi-detached and units
Levesque	HPM	Sales/1,635	As the noise factor increases price decreases 1.3% for each decibel above EPNL 75
Feitelson	Contingent Valuation Method (CMV)	Survey 426 residents	Noise levels of more concern to homeowners compared to property renters
Schipper	Meta Analysis	22 previous studies	NDI results from previous studies are basically consistent.
Kaufman and Espey	HPM	Sales/124 (1991); 280 (1992); 390 (1993); 432 (1994) and 370 91995)	Noise levels impact on house prices but distance from the airport is also important
Johnson and Button	Meta Analysis	18 previous airport noise studies	NDI results from previous studies are basically consistent.
Schipper et al	Meta Analysis	30 previous airport noise studies	The results from one study cannot be applied directly to other locations
Tomkins et al	HPM	Sales/568	Distance to the airport can actually add a premium to house prices, even at Leq69
Little V Dept Natural Resource QLD	Court decision		A range of factors have to be considered when determining what impacts on residential property subject to aircraft noise

Source: Authors

The final conclusion from this study was that the introduction of quieter aircraft would lead to a decline in the gap between the price of affected properties and non-affected properties.

One of the first Contingent Valuation Method (CVM) and Willingness To Pay (WTP) studies on airport noise was conducted by Feitelson et al in 1996. This study was based on the telephone interview of 426 residents (owners and renters) adjoining a major US airport. The main questions asked related to the WTP for houses subject to minor to severe aircraft noise as well as properties subject to overflight. These types of surveys are based on personal opinion to a particular scenario and consequently have been criticized as being overly subjective and may not reflect actual property market behaviour. The main findings from this study was that the impact on renters from aircraft noise was not as significant as the impact on house owners and that overhead aircraft movements had a greater impact on a person's WTP compared to non-overhead noise (at the same level).

Actual distance from the airport was considered by Kaufman and Espey (1997) in their study of airport noise at Reno-Sparks airport. Like previous HPM studies they found that for every one decibel increase (above 60 Ldn) there was a 0.29% decrease in property values. These results suggest that the comparative price between two identical houses in the 60 Ldn and the 70 Ldn would be a difference of $2,900. This study also found that once the affected property was more than 3.2kms from the airport the reduction caused by airport noise is not statistically significant.

During the 1990s several authors undertook meta-analysis studies based on the HPM work carried out from 1960 through to 1996. This work was undertaken by Schipper (1996), Johnson and Button (1997) and Schipper et all (1998). The basis of these studies was to analyse the variance between the Noise Depreciation Indices (NDI) calculated by previous authors who had undertaken HPM studies on aircraft noise (as listed in the Tables 2-1 to 2-4). All these studies found that if the results from the 1960 data used by Nelson (1978) were removed, the NDI indices all fell within a narrow range, providing NDIs ranging from 1.06 to 0.15, with higher values in the US compared to studies in other countries. Another finding from the Schipper et al (1998) study was that studies based on higher average house prices resulted in a higher NDI. They also stress in this paper that the differences in the various NDIs calculated in the various studies also mean that the results from one particular study cannot be applied directly to another location.

Tomkins et al (1998) based their study on Manchester airport and focused on the issues of accessibility to airports in relation to industry and employment and the impact of airport related noise. The inclusion of distance to the airport in their model has provided some new insights into the issue of aircraft noise. The study found that there was an 11.8% premium for houses in close proximity to the airport with lower aircraft noise (Leq 60) compared to similar noise affected houses further away from the airport. Even at the higher noise level of Leq 69, the premium for the houses closer the airport was 4%. They also found that the most affected housing markets in relation to house prices were those furthest away from the airport but still subject to considerable aircraft noise levels.

The court case of *Little v Department of Natural Resources* (Land Court 1999) provides a valuation perspective on noise and property values. This case involved an objection to the State Valuation Office (Queensland) assessment of unimproved value on a property in Cannon Hill, Brisbane. The property owner considered the valuation too high as the property was subject to road noise, rail noise, aircraft noise and a sewerage easement at the rear of the block. The valuer in question stated, as agreed by the court, that the value of the land was $92,000 and if all the impediments were removed the value of the property would be $100,000. Although this represents an 8% decrease in price, this reduction is based on a sewerage easement and noise from 3 sources including a railway line and a major arterial road. If the easement, road and railway noise were excluded the impact of the aircraft noise on the property value in this case would be minimal.

STUDIES UNDERTAKEN FROM 2000 TO 2005

With advances in Geographic Information System modeling and access to property information the Hedonic Price Modeling methodology was commonly used for studies from 2000 to 2005. The significant studies undertaken during this period are included in Table 2-5.

Three of the studies (Burns, Theebe, McMillen) undertaken during 2000 to 2005 focused on the impact that aircraft noise on the value of affected residential properties. All of these studies were based on HPM analysis. The social cost of aircraft noise was the topic of the study for Morrell & Lu and van Praag and Baarsma with van Praag and Baarsma adopting a novel methodology of using a happiness survey to identify the variables in the HPM study. Further detail of the methodology adopted and outcomes of the studies is contained in Table 2-6.

Table 2-5: Aircraft noise and property value studies 2000 to 2005

Author	Year	Study Airport	Data period
Morrell & Lu	2000	Schiphol, Amsterdam	1999
Bell	2001	No specific case study: review of previous published studies	1971 – 1999
Burns	2001	Adelaide	1995 and 2000
WAPC	2004	Perth, Australia	Not specified
Theebe	2004	Schiphol, Amsterdam – study includes transport noise pollution generally from air, rail and road. Study area: western part of The Netherlands.	1997-1999
McMillen	2004	O'Hare, Chicago	1997 and 2000
Praag & Baarsma	2005	Schiphol, Amsterdam	Not specified
Baranzini & Ramirez	2005	Geneva	2003
Lazie & Golaszewski	2006	Various	1993-2002

Source: Authors

Table 2-6: Content of studies undertaken from 2000 to 2005

Author	Method	Data type/size	Comment
Morrell & Lu	HPM	Not specified	Measure of the social cost of aircraft noise imposed through a diminution in property value around the airport. Results allocated in cost per landing.
Bell	Review of published studies	Published studies between 1971 and 1999	Discussion of methodology for study addressing the impact of noise.
Burns	HPM	Sales 1995: 5207 2000: 4265	1995: decrease in values where a significant ANEC. Higher ANEW; greater decreases. The diminution in value for those aircraft noise affected properties is greater in 2000 even though the exposure was the same.
WAPC	ID properties within 25 and 30 ANEF contours. Determine aircraft noise and identify noise level reduction packages in buildings.	Not specified	Determined noise reduction for affected residential property development, and noise control measures to satisfy noise targets.
Theebe	HPM	1997-1999 Over 160,000 sales	Sound below 55dB does not harm property value. For every additional decibel the property loses 0.4% in value.
McMillen	HPM	1997 and 2000 107,611 sales	Houses affected by severe noise are 9.5% lower. Between 1997 and 2000 the area in the 65dB contour reduced by one third.
Van Praag & Baarsma	Extended HPM to include residual cost component of life satisfaction established through a survey.	1400 survey respondents	The paper produces a model for the extension of the HPM model to include the disruption to happiness caused by aircraft noise to ascertain the cost of noise from Schiphol Airport.
Baranzini & Ramirez	HPM	13034 observations; 1847 in airport zone	Impact of noise on rents in Geneva. Rent is more impacted in public sector owned apartments in the airport zone than private sector apartments.
Lazie & Golaszewski	Literature review	N/A	Review of literature shows commonly used methodologies HPM, CVS, Meta-analysis.

Source: Authors

Although the study undertaken by Morrell and Lu (2000) considered the social cost of aircraft noise on property values in the surrounding area, it was focused on identifying the charge per aircraft landing as opposed to the overall impact on property value. The study adopted a HPM methodology to estimate the social cost generated by noise nuisance on the local community affected by Schiphol Airport. The study found that the average social cost per landing was E623.60. The sensitivity analysis showed that this may vary between E400 – E900 per landing. These figures are considerably higher than the then amount charged by the Dutch government for noise nuisance of E157.3 per landing.

Bell (2001) reviewed published studies undertaken over the period from 1971 to 1999 and identified that the overall theme in the literature studied was that the impact on residential property affected by noise from a national or international airport was 'universally negative'. Further themes that emerged in the literature reviewed by Bell (2001) would indicate that detached single family houses suffered higher diminution in value than semi-detached or terrace housing and higher value housing is more impacted than lower value housing. The studies reviewed by Bell also suggested that rural areas are more impacted than suburban areas, which in turn are more affected than urban areas.

In addition to discussing the most appropriate measurement of noise, Bell (2001) also discussed the methodologies for undertaking a study into the impact of aircraft noise on property values. Bell (2001) noted that measuring the impact of airport noise on property values could be undertaken effectively through a paired sales analysis. However it was noted that regression analysis and HPM have also been used in studies and that there is no one standard methodology for undertaking such a study.

In a study undertaken by Burns (2001), a HPM was used to assess the impact of aircraft noise on residential properties affected by the Adelaide airport and ascertain how values have been affected over time. The study only used sales data over two, one year periods,1995 and 2000. The 1995 data showed a diminution in value where there was a significant Australian Noise Exposure Concept (ANEC). There was very little difference in value impact for properties affected in excess of 30 ANEC across the two study periods. Interestingly, there was greater diminution in value in the 2000 study period for locations between 20 and 30 ANEC. The decreases in value are represented in Table 2-7. This difference is largely unexplainable due to the high level nature of the data although several possibilities were raised in the concluding remarks. Burns (2001) commented that the issue concerning variable selection and statistical testing remains an issue in HPM.

Table 2-7: Value decrease 1995 and 2000

Locations subject top ANEC	1995: value decrease	2000: value decrease
20-25	-6.8%	-11.71%
25-30	-10.5	-16.17%
30+	-12.68	-12.25%

Source: Burns

The broader impact of transport noise pollution (road, rail and air) on property values in the western part of The Netherlands was considered by Theebe (2004). This study involved a HPM study of over 160 000 sale transactions to determine the impact of transport noise. The study found that traffic noise had an impact on property value. It was found that noise levels below 55dB did not impact property value but traffic noise above 65dB appeared to result in a reduction in value, with a maximum reduction of approximately 12%. With properties suffering noise levels between 41dB and 65dB the actual volume of the noise didn't seem to be matter. However it was evident in the study that property located in a very quiet area (below 40dB) achieved a premium of up to 6.5%. When considering the residential sub-markets the study found that properties in high-income areas were more affected than properties in low-income areas. Similarly detached housing appeared to be more impacted than attached housing.

McMillen (2004) undertook a HPM study into the impact on aircraft noise on properties impacted by O'Hare airport in 2000 using 1997 as a base year. The study involved analysis of over 100,000 transactions. Findings from this study included that whilst it was found that the properties that were severely affected by aircraft noise had a diminution in value by 9.5% it is recognized that O'Hare is a very busy airport by world standards. Further, it was noted that the proposed reconfiguration of flight paths through the expansion of the O'Hare airport coupled with technological advances in aircraft has meant that the total number of properties in a contour zone of 65dB or higher was likely to reduce upon completion of the airport expansion.

Like the study undertaken by Morrell and Lu (2000), Praag and Baarsma (2005) also addressed the social costs of noise from Schiphol airport with a view to assessing compensation and noise insulation for nearby residents. The novelty in the study and contribution it makes to the knowledge base is in the methodology that has been adopted in using an extended Hedonic Price Model, which utilizes a happiness survey to identify variables in the model.

Unlike most studies undertaken on aircraft noise that consider the diminution in value on affected housing, the study by Baranzini and Ramirez (2005) considered the impact that noise has on rents in Geneva. Using HPM methodology, the study looked at noise generally and its impact on rents and then isolated aircraft noise as a variable. The results showed that the mean noise level during the day had more of an impact on public sector rentals than private sector rentals. An increase of 10Lr(dB(A)) resulted in a reduction of 6.5% in the public sector and only 1.8% in the private sector rentals. However, the private sector was more responsive to peak noise with an increase in peak noise of 1dB resulting in a reduction of rentals by 0.63%. When isolating aircraft noise the study found that an apartment in the airport area achieved a 40% higher rental than the public sector apartment. This is compared to an increase of only 36% in the greater Geneva sample. The impact of noise on rent was higher in the public sector apartments than the private sector. An additional 10dB in the airport zone resulted in decreased rents by 8% in public sector properties and 6.6% in private sector properties.

STUDIES UNDERTAKEN FROM 2006 TO 2014

The number of airport and aircraft noise research studies increased over the 2006 to 2014 period compared to the previous time periods covered in this paper. Again, the main focus of these research studies has been based on Hedonic Price Models over selected time periods. These time periods have ranged from 12 months to 7 years, with the majority of the studies based on 12 months of data.

Hui et al (2006) found that in a high density residential property market such as Hong Kong, noise of any kind had less impact on property prices than the actual location of the property relative to transport. This shows that the impact of noise factors is only one of many factors that buyers take into consideration when they purchase a residential property and other factors may actually drive the market for individual property purchasers. In the case of the Hui et al study, the time and cost associated with travel for work and recreation in Hong Kong outweighed factors such as noise from road, rail and aircraft.

Table 2-8: Aircraft noise and property value studies 2006 to 2014

Author	Year	Study Airport	Data period
Hui et al	2006	Hong Kong Region	2000/2001
Pope	2007	Raleigh-Durham, US	1992-2000
Kim et al	2007	Highway Noise, Korea	2002-2004
Valdes	2008	Oakland Airport, US	
Cohen & Coughlin	2008	Atlanta, US	1995-2002
Cohen & Coughlin	2008	Atlanta, US	1995-2002
Chalermpong	2010	Bangkok, Thailand	2002& 2008
Brandt & Maennig	2011	Hamburg, Germany	2002-2008
Stillman et al	2012	Zurich, Switzerland	1999-2005
Nguy et al	2013	Beijing, China	2006-2012
Suksmith & Nitivattananon	2014	Bangkok, Thailand	2013
Wadud	2014	Various locations	1960-2009

Source: Authors

Pope (2007) studied the impact of aircraft noise disclosure on the behaviour of participants in the residential property markets around Raleigh-Durham airport in the US. The Pope (2007) model addressed a number of factors that had not been considered in previous studies, such as new houses having features that assist in reducing aircraft noise. A potential limitation of this study was that sales that occurred in locations near a new interstate highway construction were discarded from the analysis. The issue here is that the highway may have as much negative impact on the residential property markets as aircraft noise. This study found that disclosure of aircraft noise had the greatest affect in high noise locations but very limited impact in the low aircraft noise locations. An important observation in this study was that buyers in the high aircraft noise locations could be "overreacting" in respect to the impact that disclosure had on their purchase decision. An additional conclusion from this study was that the availability of full and complete information and disclosure about the airport and its noise operations actually benefits the residential property market.

The issue of highway noise was addressed by Kim et al (2007) who found that highway noise in Seoul, South Korea had a negative impact on residential property prices, with a 1% increase in highway noise resulting in a 1.3% decrease in land prices. These figures are actually higher than the majority of aircraft noise studies.

Table 2-9: Content of studies undertaken from 2006 to 2014

Author	Method	Data type/size	Comment
Hui et al	HPM	Sales/3000	In densely populated high rise environments location has the greatest impact on property prices regardless of noise levels from all sources.
Pope	HPM	Sales/not disclosed	The availability of disclosure information in relation to aircraft noise reduced house prices by 2.9%
Kim et al	HPM	Sales/114	1% increase in road noise reduces land values by 1.3% in Korea
Valdes	Spatial correlation	Repeat sales/1219	Aircraft noise will not reduce house prices if other external factors are considered more important by buyers
Cohen & Coughlin	HPM	Sales/2,370	House prices increase as noise levels decrease and that the reduction in house prices has been greater during the 2000-2002 compared to previous years
Chalermpong	HPM	Sales/384	Decrease of 19.15% in the most severely affected locations and a 8.55% decrease in lower noise zones
Brandt & Maennig	HPM	Sale listings/4,832	Not only aircraft noise but rail and road noise also impacts on residential property prices
Stillman et al	HPM	Noise and Health statistics	Aircraft noise increase headaches and reduces sleep quality at a cost of USD$400 pa per person impacted
Nguy et al	HPM	Sales/130	Increased aircraft noise of 1dB results in a decrease of 1.05% to 1.28% in residential property prices
Suksmith & Nitivattananon	Regression Analysis	Survey/300 samples	Compensation for airport operations on affected businesses and residents should be based on noise and air pollution factors.
Wadud	Meta Analysis	65 NDI studies	This analysis of previous NDI figures based on HPM suggests that previous figures were slightly higher than this result of an average 0.5% per dB

Source: Authors

Valdes (2008) carried out a study of house prices in areas around Oakland Airport subject to aircraft noise. This study was based on 1,219 repeat sales in the subject locations during the period 1986-2006. The study area was adjacent to the airport but a number of these highly noise affected properties had coastline locations. The results of this repeat sales analysis actually showed that annual growth rates in property values was spatially correlated to the airport noise exposure and showed an overall appreciation in values as CNEL (Community Noise Equivalent Level) noise levels increased among homes located within the 53 and 65db CNEL. The author concluded that homes with high noise levels and water views did not have a reduction in price, suggesting the market placed a higher premium on the view compared to the discount for aircraft noise.

In 2008, Cohen and Coughlin carried out two HPM studies based on data from Atlanta. This study was carried out using data from two separate time periods; 1995-1999 and 2000-2002. An important point that the authors stress is that during these two periods there were differences due to noise regulations, quieter aircraft and improved sound proofing that could not be accounted for in the analysis as these change the noise level in a particular house over time. This study also confirms previous work that actual proximity to the airport can be a positive factor for those working at or requiring regular access to the airport, with noise showing a lessor impact in these cases. Noise discounts ranged from 7.5% to 10.6% at the 65db level and 12.3% to 17.7% at the 70db levels depending on the model structure.

A study based around the Suvarnabhumi International Airport, Bangkok has also shown a decrease in house prices in severely affected noise locations of up to 19.5%, reducing as the level of noise decreases. This study also showed that in the period leading up to the start of operations at this airport in 2006, there had been no impact on the price of houses in areas that would later be subject to aircraft noise. This could be explained by limited disclosure of information prior to the airport commencing operations and the public being unaware of the various noise level contours, a different scenario compared to the Pope (2007) study. In 2014, Suksmith and Nitivattananon used survey data from locations around Suvarnabhumi International airport as a basis for the determination of compensation for parties affected by airport operations. In addition to aircraft noise and property values they were also interested in other airport operation issues including safety, scenery, air pollution and traffic. These are aspects that were not addressed in the HPM of previous studies. In addition, this study focused on other land uses apart from residential. The findings from this study focused on the factors that should drive compensation for airport operations for both businesses and residents affected by airport operations. They state that the main driver should be noise issues, followed by air pollution and traffic.

Road noise and railway noise are also factors that affect residential property prices and these should also be considered whenever residential property markets are analysed to determine the impact of aircraft noise. Brandt and Maennig (2011) determined that in areas of Hamburg, unit prices were affected by locations being subject to aircraft noise, rail noise and road noise. In locations with aircraft noise in excess of 70db, the reduction in house prices was 9.1%, with reductions for rail noise being slightly less than 9.1% and prices for units in close proximity to busy roads were 5% lower. They determined that in Hamburg an increase in 1db of road noise results in a NDI of 0.23%, which is only marginally less than the NDIs calculated in some of the airport studies listed above.

In 2013, Nguy et all carried out a HPM study on airport noise in Beijing. Their results show that as the noise levels increase around the locations close to Beijing International Airport residential property prices decrease. Their figures indicate a NDI decrease of 1.05 to 1.28 for each 1db increase. They compared these results to the other major International airports as below in Table 2-10. It is interesting to note that these authors also state that one can't assume that aircraft noise accounts for all noise in a particular location and this supports the findings of Brandt and Maennig (2011).

Table 2-10: NDI estimates for major international airports

Rank (2011)	Airport	NDI Estimate
1	Atlanta (Hartsfield-Jackson)	0.67 (1985) 0.08 (2003) 0.69 (2006)
2	Beijing Capital international	1.05-1.28 (2011)
3	London (Heathrow)	0.71 (1970) 0.62 (1975) 1.51 (1996)
4	Chicago (O'Hare)	0.88 (2004)
5	Tokyo International (Narita)	Not available
6	Los Angeles International	1.80 (1971) 1.26 (1994)

Source: Nguy et al., 2013

One of the most recent studies on the impact of aircraft noise and residential property values has been the study undertaken by Wadud (2014). Wadud carried out a meta analysis of 65 HPM studies on aircraft noise and residential property values to develop a suggested NDI estimate for a range of countries throughout South East Asia and the Sub continent. These suggested NDIs are shown in Table 2-11.

Table 2-11: NDI estimates

Country	NDI Estimate
Australia	0.61
Bangladesh	0.10
Cambodia	0.13
China	0.23
Hong Kong	0.62
India	0.13
Indonesia	0.14
Iran	0.22
Japan	0.54
Korea	0.42
Malaysia	0.23
New Zealand	0.47
Pakistan	0.12
Saudi Arabia	0.44
Singapore	0.61
Sri Lanka	0.15
Taiwan	0.52
Thailand	0.21

Source: Wadud, 2014

Wadud also found that based on this analysis, previous NDI figures are marginally higher than these current estimates suggest.

2.4 CONCLUSIONS

The impact of aircraft noise on the value of surrounding residential property is a topic that has attracted a significant amount of attention internationally. Numerous international studies have been undertaken to ascertain to the impact of aircraft noise on residential property prices and the main 45 studies have been reviewed in this paper. Many of these studies have been undertaken in the US or The Netherlands. In Australia, only two significant studies have been undertaken to determine the impact of aircraft noise on residential property markets, one in 1975 and the other in 2002. Similarly attention to this topic in the UK has been minimal, with only two significant studies focusing on Heathrow and Manchester Airports.

A common factor with over 90% of studies undertaken is that they are based on econometric modelling using Hedonic Price Models. In the majority of these studies the data used has been mainly census data in the US and sales data in the UK, Asia and Australia, and the time period for the analysis has been single time periods 12 months or less. Generally these studies lack longitudinal depth with very limited examples of studies over a longer time period or based on two individual time periods.

Commonly, the studies have based their results on the difference between house prices for noise affected and non-affected locations at a suburb level and only one study actually looked at repeat sales to determine price differences. This study by Valdes actually resulted in the lowest price differences between noise affected houses and non-affected property and provided evidence that the long term increase in prices for affected and non-affected houses were similar. The studies have generally been based on the difference in price for property at 55dB level affectation from aircraft noise to similar properties at the 65-70dB levels. The NDI figures have ranged from a low of 0.10 to 1.80 per increase in 1dB. Two major studies also reported that variation in aircraft noise was more of an issue compared to the number of aircraft movements. Several studies also pointed out those older studies were influenced by aircraft types that were far noisier than the current generation of new planes, and that the reduced noise will benefit areas that were impacted prior to the new planes coming into operation.

A common limitation listed by all researchers was that the models adopted cannot account for all factors that drive a particular property market. This is also evidenced by a number of studies that found the location, near an airport may have a premium value because the potential buyers in that market are airport workers who value the reduced transport time and cost more highly than the potential downside of aircraft noise. This was particularly the case for airports located close to a major CBD centre. A further issue that is raised in these studies, but not actually tested in any of the models, is the fact that individuals have different levels of tolerance to noise and that people who are really adverse to high levels of noise will not purchase residential property in high noise locations. Home owners in this category are only affected by aircraft noise when an airport is expanded, aircraft operations increase or flight paths change. Residents who purchase or rent residential property under existing airport locations and purchase under existing flight paths do so with full knowledge of the issue of aircraft noise. Any discount of affected properties will only occur once in the property lifecycle, not each time the property is bought and sold. There comes a point in any property cycle subject to stigma of any kind, where the asking and selling price are just market prices, with the market already factoring in any negative factors. The same principle applies to residential property subject to benefits from an advantageous feature, this increase in price only occurs at the time the positive value driver occurs, not each subsequent sale.

When a study area is based on data that requires a large geographic area to capture the required data sample over a relatively short time period, i.e.12 months, it can be difficult to capture all the property factors that buyers placed on each purchase during that time period, and the location factors that drive value in those markets. This is a fundamental floor in the adoption of HPM methodology, which assumes that only those factors identified in the model drive all residential house prices in that particular market. The purchase of any residential property involves a range of emotional factors, such as the colour of the external walls, the roof type, extent of landscaping and ground improvements, aspect, proximity to schools and transport, availability of internet and mobile phone coverage etc.; and as buyers are individuals these factors are extremely difficult to capture in a HPM. Even minor factors such as the name of the street can have a negative impact of residential property prices. Market analysis has shown that a derogatory street name can decrease house prices in that street and these issues are not a variable considered in HPM.

A common result in the studies that looked at the residential rents in airport affected locations found that there was limited effect on rental values for residential properties under flight paths or adjoining airports. This suggests that tenants are more tolerant of aircraft noise compared to home owners. This finding also suggests that a rented property in an area subject to aircraft noise will actually show a higher income return compared to a similar residential property in a quieter location (everything else being equal).

Where the majority of these studies showed a negative impact on residential properties, this was not the case for commercial and industrial property. There was limited impact of aircraft noise on these property types, nor any negative reaction from employees working in these commercial and industrial premises.

The academic studies based on HPM show that residential property in locations with aircraft noise in excess of 60dB have a lower price compared to houses that are not subject to aircraft noise and that below the 60dB level aircraft noise has little impact on house prices. The studies based on surveys and repeat sales analysis, indicate that the impact of aircraft noise is not as great as is proposed by the HPM studies.

A major issue with the majority of the HPM academic studies is the time period that is analysed and the model of the chosen variables, with r2 values around 0.80, which suggests that other factors are also driving the residential property sectors in the study locations.

For a more complete analysis of the impact of aircraft noise and airport operations on residential property markets, a longer term analysis is required, and the affected markets also need to be compared across a range of residential property sectors to determine the full impact of this stigma on residential property prices, long term capital growth and buyer and seller behaviour in those markets.

Of the 45 studies, only two studies have focused on data from Australian airports and there has been a 27 year time difference between these studies, with only the 1975 study being based on one of the top three airports by plane movements in Australia. The Adelaide airport study in 2002 has been the most recent academic study of aircraft noise and residential property values in Australia. Adelaide airport is the 5th busiest airport in Australia but aircraft movements are only a 20%, 25% and 35% of the traffic at Sydney, Melbourne and Brisbane airports respectively. As such there has not been a significant study into the impact of aircraft noise on property values relative to a major Australian airport since 1975.

2.5 FURTHER RESEARCH: THE NEXT STAGES

This literature review covers the major academic international studies addressing the effect of aircraft noise on residential property markets. As stated above, these studies have all been based on quantitative analysis and have to a large extent ignored the important emotional and consumer behaviour that actually drives residential property sales. To balance the academic studies, an additional literature review study will be undertaken to review the popular print, and online media with a view to analyzing the anecdotal evidence relating to aircraft noise and impacted residential property markets. Although this data is not verified or peer reviewed, it does provide an insight into the past and current thinking on the topic and issues raised by the main participants in the residential property markets that adjoin airports and as such are affected by airport operations. The participants who express their views in the media include buyers, sellers, real estate agents, investors and commentators and provide grass roots experiences in relation to the aircraft noise issue.

Once the second literature review is completed the quantitative research investigation and analysis will be undertaken. Unlike the HPM studies reviewed in this document, this study will focus on the longer term impact of aircraft noise on a range of suburb locations and across a range of socio-economic areas. This study is a significant longitudinal study over a 25 year time period and in addition to property prices a range of other residential property market indicators will be examined.

3 Literature Review (media and online)

3.1 CHAPTER SUMMARY

An expansion in populations around the world has led to a need for expansion of international and domestic airport facilities. As an inevitable outcome of this expansion there are residential communities that may suffer negative outcomes such as increased noise and a possible diminution in property values.

The issue of the impact of aircraft noise on property values is internationally significant with a plethora of academic studies having been undertaken since the early 1970's. The first stage of the literature review comprised an analysis of 45 academic studies to determine their contribution to the body of literature on the topic.

This Stage 2 literature review captures and reviews the more anecdotal sources of information such as newspaper articles and letters to the editor, internet news articles, internet discussion forums and blogs.

The outcome of the Stage 2 literature review showed that despite the topic of aircraft noise and the impact on property values being controversial and frequently emotive, there was generally not a lot of media attention to the topic. In Australia, there has been limited media discussion regarding the impact of aircraft noise on property values in most major capital cities including Brisbane, Sydney and Melbourne. Internationally, the topic has been reported in the media in New Zealand, USA, Canada, the United Kingdom and Israel. As a general theme media attention on the topic of airport noise and the impact on property values is at its highest level following the announcement of a proposal to expand an existing airport or change flight patterns.

The media discussion surrounding airport noise and the impact on residents is generally not solely about diminution in property values as a result of airport noise. The discussion may mention the possibility of a loss in value but centered on a more generalized disturbance caused by aircraft noise. However, to balance this perspective the primary consideration in selecting a property to buy or rent was that of location. Aircraft noise was only one consideration that was highlighted and this was balanced against proximity to the CBD, high streets, schools and other facilities. Of the negative considerations in most instances aircraft noise was a lesser consideration than traffic noise and noisy neighbours.

In Australia, it appeared that aircraft noise was one of the many factors that influence resident choices and ultimately value. In Brisbane it is considered that aircraft noise has very minimal impact on value as evidenced by some of the higher valuer Brisbane suburbs such as Bulimba and Ascot being under flight paths. Other suburbs such as Banyo which are more affordable are also under flight paths. However, aircraft noise is not considered to be the reason behind the lower property values.

In Sydney the proximity of the airport to the CBD has meant that many suburbs located under the flight path are also extremely well located with services such as established schools and other infrastructure being convenient in addition to being close to the CBD. For this reason the aircraft noise becomes one of many factors that are considered with choosing where to live or invest. It appears from on line forums that the level of tolerance for noise generally is entirely individual.

Internationally, media attention to the topic is generally at the point of airport expansion plans and in certain jurisdictions such as the United States and Israel there are many reports of class actions against airport authorities by impacted residents. These class actions are seeking compensation for general nuisance and loss in property value as a result of airport expansion. Despite there being some legal precedent for low flying airplanes creating an action for nuisance there are many factors that distinguish such precedent from the impact of commercial air travel in Australia on a single residential property. It is also considered that the conceptualization of private property rights is somewhat different in the USA as compared to Australia. In Australia the very 'ownership' of private property is only by virtue of a grant from the Crown.

In some instances claims are made in media reports about the reduction in value of property subject to aircraft noise. There is speculation that the reduction in value is as high as 20%. However, these claims are purely opinion based and are generally from a party with a personal interest. From Stage 2 of the literature review it is evident that aircraft noise is one of many locational factors that are considered prior to selecting a location to reside or invest.

3.2 INTRODUCTION

The impact of airport development and consequent aircraft noise has been the subject of academic research and in popular print media since the early 1970's. The debate is ongoing as to the potential negative impacts and positive impacts of airport development internationally.

The dilemma exists between increasing demand for residential housing in cities coupled with increased requirements for air travel infrastructure to match the growing population. This is particularly the case for older established airports in major residential cities where the need for increased residential accommodation has resulted in new urban areas being developed close to airports that were once considered remote from the residential population of the city. In addition, expanded airport infrastructure resulting in new flight paths, added aircraft movements and aircraft movements over a greater number of areas have also been an issue facing residential property owners and airport operators.

The Stage 1 literature review was undertaken to identify and analyze the academic discourse concerning the impact of aircraft noise on property values. In this study 45 academic studies were analyzed to identify the resulting themes. Many of these studies were in the US or the Netherlands with only two significant studies having been undertaken in Australia. The outcome of Stage 1 of the literature analysis found the following:

» 90% of studies undertaken are based on econometric modelling using Hedonic Price Models. In the majority of these studies the data used has been mainly census data in the US and sales data in the UK, Asia and Australia, and the time period for the analysis has been single time periods 12 months or less. Generally these studies lack longitudinal depth with very limited examples of studies over a longer time period or based on two individual time periods.

» Commonly, the studies have based their results on the difference between house prices for noise affected and non-affected locations at a suburb level and only one study actually looked at repeat sales to determine price differences. This study by Valdes actually resulted in the lowest price differences between noise affected houses and non-affected property and provided evidence that the long term increase in prices for affected and non-affected houses were similar. The studies have generally been based on the difference in price for property at 55dB level affectation from aircraft noise to similar properties at the 65-70dB levels. The NDI figures have ranged from a low of 0.10 to 1.80 per increase in 1dB. Two major studies also reported that variation in aircraft noise was more of an issue compared to the number of aircraft movements. Several studies also pointed out those older studies were influenced by aircraft types that were far noisier than the current generation of new planes, and that the reduced noise will benefit areas that were impacted prior to the new planes coming into operation.

» A common limitation listed by all researchers was that the models adopted cannot account for all factors that drive a particular property market. This is also evidenced by a number of studies that found the location, near an airport may have a premium value because the potential buyers in that market are airport workers who value the reduced transport time and cost more highly than the potential downside of aircraft noise. This was particularly the case for airports located close to a major CBD centre. A further issue that is raised in these studies, but not actually tested in any of the models, is the fact that individuals have different levels of tolerance to noise and that people really adverse to high levels of noise will not purchase residential property in high noise locations. Home owners in this category are only affected by aircraft noise when an airport is expanded, aircraft operations increase or flight paths change. Residents who purchase or rent residential property under existing airport locations and purchase under existing flight paths do so with full knowledge of the issue of aircraft noise. Any discount of affected properties can only occur once in the property lifecycle, not each time the property is bought and sold. There comes a point in any property cycle subject to stigma of any kind, where the asking and selling price are just market prices, with the market already factoring in any negative factors. The same principle applies to residential property subject to benefits from an advantageous feature, this increase in price only occurs at the time the positive value driver occurs, not each subsequent sale.

» When a study area is based on data that requires a large geographic area to capture the required data sample over a relatively short time period, i.e.12 months, it can be difficult to capture all the property factors that buyers placed on each purchase during that time period, and the location factors that drive value in those markets. This is a fundamental floor in the adoption of HPM methodology, which assumes that only those factors identified in the model drive all residential house prices in that particular market. The purchase of any residential property involves a range of emotional factors, such as the colour of the external walls, the roof type, extent of landscaping and ground improvements,

aspect, proximity to schools and transport, availability of internet and mobile phone coverage etc.; and as buyers are individuals these factors are extremely difficult to capture in a HPM. Even minor factors such as the name of the street can have a negative impact of residential property prices. Market analysis has shown that a derogatory street name can decrease house prices in that street and these issues are not a variable considered in HPM.

» A common result in the studies that looked at the residential rents in airport affected locations found that there was limited effect on rental values for residential properties under flight paths or adjoining airports. This suggests that tenants are more tolerant of aircraft noise compared to home owners. This finding also suggests that a rented property in an area subject to aircraft noise will actually show a higher income return compared to a similar residential property in a quieter location (everything else being equal).

» Where the majority of these studies showed a negative impact on residential properties, this was not the case for commercial and industrial property. There was limited impact of aircraft noise on these property types, nor any negative reaction from employees working in these commercial and industrial premises.

» The academic studies based on HPM show that residential property in locations with aircraft noise in excess of 60dB have a lower price compared to houses that are not subject to aircraft noise and that below the 60dB level aircraft noise has little impact on house prices. The studies based on surveys and repeat sales analysis, indicate that the impact of aircraft noise is not as great as is proposed by the HPM studies.

» A major issue with the majority of the HPM academic studies is the time period that is analysed and the model of the chosen variables, with r2 values around 0.80, which suggests that other factors are also driving the residential property sectors in the study locations.

Of the 45 studies, only two studies have focused on data from Australian airports and there has been a 27 year time difference between these studies, with only the 1975 study being based on one of the top three airports by plane movements in Australia. The Adelaide airport study in 2002 has been the most recent academic study of aircraft noise and residential property values in Australia. Adelaide airport is the 5th busiest airport in Australia but aircraft movements are only a 20%, 25% and 35% of the traffic at Sydney, Melbourne and Brisbane airports respectively. As such there has not been a significant study into the impact of aircraft noise on property values relative to a major Australian airport since 1975.

This academic literature review focused on the major academic international studies addressing the effect of aircraft noise on residential property markets. As stated above, these studies have all been quantitative and have to a large extent ignored the important emotional and consumer behaviour that actually drives residential property sales.

To balance the academic studies, this Stage 2 literature review has been undertaken to review the popular print and internet based media with a view to analysing the anecdotal evidence relating to aircraft noise and impacted residential property markets. Although this data is frequently emotive and not verified or peer reviewed, it does provide an insight into the past and current thinking and issues raised by the main participants in the residential property markets that are impacted by airport operations. The participants who express their views to the popular print media include buyers, sellers, real estate agents, investors and commentators and provide grass roots experiences in relation to the aircraft noise issue.

This literature review has been structured to compare the perspectives of those who are impacted at a local level on a country basis with conclusions and comparisons being drawn at the end of the report. Newspaper searches show that the countries which have had some discussion in local media are Australia, New Zealand, USA, Canada, Scotland and Israel.

3.3 LITERATURE

Literature has been sourced from newspapers, internet based news sites, forums and blogs and has been arranged according to the country of origin.

AUSTRALIA

There has been some discussion concerning the impact of airport operations on residential property in Brisbane, Sydney and Melbourne.

Brisbane

Much of the interest in aircraft noise and property values in Brisbane has been based around local media and online forums and blogs.

An online discussion held in the Somersoft Property Investor Forum over 2008 generally showed that the perception exists that impact of aircraft noise on property values in Brisbane was fairly minimal. However, some residents were personally bothered by the noise and other aircraft factors and chose to move from their current location. The posts to this forum show that aircraft noise and increased traffic is generally not the only reason for selling a property.

In a post on 22 May 2008, Wylie made the following comment:

> 'We also thought we would move, mostly because of the double traffic that WILL happen when the parallel runway is built, but also because we had three kids in a two bedroom house. We thought the value of our house may fall once the news got out, so we sold before it blew up into a huge issue. Of course, house prices went through the roof, just after we sold.'

The suburbs of Tingalpa, Balmoral, Ascot and Coorparoo were the subject of many blogs in the Somersoft Property Investor Forum. The comment was made by Tin Tin on 27 March 2008 that '*Coorparoo gets a lot of planes overhead too and it is a very good investment suburb.*'

There was a general discussion of the impact on aircraft noise on a suburb like Banyo. The comment was initially raised that Banyo is a more affordable suburb than Geebung which is in close proximity to it and this was considered to be because of increased aircraft noise in Banyo. The comment was made by Nth Brisbanite on 24 March 2008 that this has little to do with aircraft noise and rather is as a result of other factors such as a reputation of being a 'rough' suburb and the impact of the gateway arterial road noise.

It was noted by ianinvestor on 22 March 2008 that some of the most expensive suburbs in Brisbane, eg. Ascot and Bulimba, are actually under flight paths and the noise did not present a problem with property values. Trenwith (Brisbanetimes.com, 2010) identified the suburbs of Coorparoo, Camp Hill and Holland Park as being the suburbs from which most aircraft noise complaints generate. However, it was noted in the article that aircraft noise is generally not a reason for buyers not to purchase in these areas. Molloy, Managing Director from the REIQ is reported as saying,

> 'When purchasing property, aircraft noise is often an issue buyers investigate. However, very few people base their decision on this alone and location beats anything in real estate terms… Home buyers make a decision on the potential effects of aircraft noise in suburbs such as Hamilton, Hendra, Ascot and Bulimba, however these suburbs are also very desirable and that will usually be the overriding factor.'

In November 2014 Rooney (Courier Mail) stated that "Home buyers are putting private school fees towards a mortgage to access top state schools". Two of the State school catchment areas identified as increasing value of residential property in those catchment areas were Ascot State High and Holland Park State High, with both these areas also under the current flight paths. The article stated that potential purchasers were paying a premium to live in these catchment areas and no mention was made in relation to the potential aircraft noise. This suggests that the location to a good school was a greater factor in the purchase decision than aircraft noise and some home buyers were prepared to pay more for houses in these catchment areas than surrounding properties outside the catchment area.

Sydney

The impact of aircraft noise on residential property values has been a much debated topic in Sydney. In 1994, the Sydney Morning Herald published an article (Offner, 1994) which discussed the Sydney Airport's third runway. The article discussed how the new runway would impact on the various sectors of the city with a reduction in traffic in the east and west but an increase in air traffic over the northern suburbs. It is reported that '*local real estate agents are preparing for a possible drop in property prices. FAC figures show a $175 million loss in property value for suburbs north of the airport. Hunters Hill and Lane Cove would lose $22.5 million. Private estimates put that figure four times higher*'. However, the Manager of Packard First, Hunters Hill, Mr Bob Shepherd reportedly said that there had been no adverse impacts in the area and that property prices had actually increased in Hunters Hill by 10 to 15%.

In 2011 Lawes reported on the options for purchasing a home in Sydney for around $650,000. With commuting in Sydney a significant issue the popularity of the aircraft noise affected inner west is increasing. Lawes reports, '*This is backed up by agents who report that within this inner ring, buyers are pushing into suburbs previously considered less popular often because of perceived "flaws" such as being under the flight path, close to public housing, or next to an industrial estate'*. Aircraft noise is only one of the factors addressed in the article which also discusses proximity to the CBD, access to public transport, schools and parks. The negative elements discussed in the article include for St Peters '*busy roads, aircraft noise and the fact that it could be the site of a coalmine'. However, it was noted that 'these issues do not seem to be deterring potential buyers'*. As an example St Peters had a growth in median house price $607,000 in 2010 to $655,000 in 2011.

Pascoe (2012: Why aircraft noise is good for you: Sydney Morning Herald; April 16, 2012) proposes a range of economic arguments that support development around airports and new airports. An interesting quote in relation to aircraft noise and existing airports and flight paths relates to the turnover of residential properties over a given time period.

"There are trade-offs with aircraft noise, as there are with most things in life. There might be an old-age pensioner who bought a residence under the present flight path before there was an aircraft noise factor, but it's unlikely – Mascot's age and the rate with which we turn over our houses means people living under the flight path knew or should have known what they were getting into. At a price point, the compromise is worthwhile. Inner-city and "Bennelong Funnel" housing prices indicate it's a compromise plenty find worthwhile".

The suburb of Coogee was identified as being under a flight path and subject to aircraft noise in an online article written by Collier (2012). The article does not refer to an impact on property values at Coogee but rather the general disruption from aircraft noise and a perceived breach of maximum noise levels and airspace curfew. Of interest is the online reaction to the article such as the comment by Brett (2012):

> 'I have lived in Coogee and the Eastern Suburbs my whole life. I grew up when there were a lot less planes coming into Sydney airport. I now have 'hundreds' of planes each day coming in the back door of my house, through the kitchen, and out the front, or so it would seem sometimes. As I put in earier, I live in Coogee, which is under the flight path, but also close to the beach, schools, CBD, shops and many other great things…. If I did not want to hear planes, I would move to the central coast, or as far from an airport as I could, but seeing a though I live less than 5km from one, I expect it.'

The balance between convenience and aircraft noise has also been highlighted by Johnstone (2014: Sydney Morning Herald, 26th June: Millionaires at the end of the runway) who compared the growth in House prices across Sydney,

"For two decades they have been the pariah suburbs at the centre of the aircraft noise debate.

But property values in Sydenham, St Peters and Tempe have soared since the introduction of the third runway at Mascot in the mid-1990s, outpacing growth in the rest of the city, meaning the suburbs are poised to turn their owners into property millionaires".

This study found that while the average growth in house prices for the 20 year period was 225%, suburbs next to the airport and under the near airport flight paths showed price growth ranging from 272% to 394%. St Peters and Sydenham with daily aircraft movements of 103 and 181 respectively had the highest percentage increase in median house prices of 390% and 394%, well above the Sydney average. A comment from one property owner interviewed states:

> "But we could never have a house like this so close to the city if those planes weren't going over our heads," she said.
>
> "And if we bought further out my husband would not be able to see his kids in the evening."
>
> The couple who previously owned an apartment in Camperdown bought a renovated three-bedroom terrace on Sutherland Street for $935,000 in November last year.

This theme has also been continued with an article by Pelosi (Trendy lifestyle drowns out airport noise: Commonwealth Bank of Australia, August 2014) where he acknowledges the substantial increases in property values in the high aircraft noise suburbs of St Peters and Leichardt, compared to the Sydney average for the same 12 month period.

"Living near the airport has never been at the top of anyone's property checklist and yet some of Sydney's hottest suburbs are those sitting right under major flight paths.

The strong desire to be close to town, transport links and amid the bustling inner city lifestyle has seemingly trumped the noise issue in these areas, which tend to be four to seven kilometres from the CBD and include Mascot, Alexandria and Leichhardt".

"Whenever you buy any property you're going to write a list of pros and a list of cons, and a lot of people are moving there [to inner west suburbs] for the pros, which are proximity to the city, cafes and restaurants and the area is becoming more gentrified,". "It's a really buzzing and cool place to live".

"If you are the sort of person that's going to live in that area, it really isn't going to bother you. Clearly it isn't a selling point or a pro but for some people the pros outweigh that con."

Melbourne

Dowling from The Age (2007) report that proximity to the Melbourne airport was likely to see a reduction in property values. The cause of this reduction in value was more the government response to aircraft noise as opposed to the aircraft noise itself. The article reported on a significant planning change that was to impact 5900 homes that either were aircraft noise affected or would become aircraft noise affected in the future. The impacted suburbs included Brimbank, Hume, Melton, Moonee Valley and Whittlesea. The new rules which result in a restriction on subdivision and strict compliance with noise reduction measures during renovation, are anticipated to have an impact on property values. The changes to the planning scheme were viewed positively by the Melbourne Airport. It said the measures provided '*better protection from aircraft noise for residents living in and around Melbourne Airport. The new planning controls are tailored specifically to protect land under current and future Melbourne Airport flight paths, based on detailed noise-forecast maps endorsed by Airservices Australia.*'

For the suburb of Gladstone Park concern was raised through an article by Marie in The Herald Sun (2012) regarding the impact of aircraft noise and pollution from a proposed new runway on property values. It is specified in the article that the impact on property values will be significant. Marie states '*Gladstone Park residents learnt of the impending runway and future flight circuits last night and some were fuming at the prospect of losing up to $100,000 in assets as a result of the development.*' Further claims are made by Steve Hoblos of LJ Hooker Tullamarine saying that '*houses directly under the flight path – mainly in Gladstone Park and Broadmeadows – would immediately drop in value by 10 to 30%.*' He went on to further say that there are also positive outcomes from airport development. He said, '*the airport is already established, so it could be good for us business-wise if it's bringing more activity to the area.*'

NEW ZEALAND

An article in the Evening Standard (Myers, 1998) discussed the proposal to compensate home owners in Palmerston North for the cost of insulating homes close to the airport. There was no proposal to compensate home owners for loss of property value but rather just the cost of insulating entire houses in the 'inner zone' and bedrooms in the 'outer zone'.

USA

There is an acknowledgement in some of the literature that having an airport close by may have a positive impact on property values. Milbourne (1996) made comment that if plans were to go ahead for the El Toro Marine Base to become an airport, nearby residents would be likely to see an increase in property value. In the article, UCI Professor Louis Masotti makes comment that '… *residences beyond 2.3 miles from the end of the takeoff runway should experience no negative effects on property value'*. Comments are based around a study undertaken at Chicago Airport, Dallas/Fort Worth International Airport, Washington D.C.'s National and Dulles airports and Williams Air Force Base in Arizona. In contrast, other community members were interviewed in the article stating that there would be an impact on property values for homes close to the airport. These comments are opinions are not substantiated by any empirical evidence. This proposal was further discussed in the Orange County Register (Rams, 1996) where the opposition to the proposed airport was raised from the perspective that it would lower property values by 20%.

Given the level of air traffic at Chicago O'Hare airport it is not surprising that the impact of this airport on local residents has attracted much media attention. The New York Times (Schmidt, 1989) reported on a pending law suit whereby aircraft noise affected residents were seeking compensation. The article reported that the jurisdiction for landowners to sue the City of Chicago rested with the State Supreme Court. The proposition was put forward in the article that an estimated 90,000 homes over 20 suburbs were noise impacted by Chicago Airport and this resulted in a '*1 to 2 percent loss in property value for every decibel of sound above 65*'. Further, the article states that homes were being cracked by vibrations from the jets and the noise disrupted learning in schools.

Chicago's O'Hare airport also received some media attention in the Chicago Sun Times (Rossi, 2014) in an article relating to airport noise affected residents seeking a reduction in property taxes. A local resident, Yost, is reported as saying, '*It's prima facie evidence that your house values go down [based on airplane noise].*' Yost is appealing her property taxes arguing that the new east to west flight flow has lowered the valuer of her home. This situation did not exist when she first purchased her house. It was also noted in the article that noise complaints to the Department of Aviation had continued to rise since the most recent phase of the O'Hare Modernization Program had been completed. Aviation Officials reportedly also said that the bulk of the 462 complaints in January 2014 came from just eight homes.

There has been a long history of litigation in relation to aircraft noise impacted residents taking legal action for damage suffered from the Minneapolis – St Paul Airport. This has been reported in local media. In 1988 The Star-Tribune Newspaper of the Twin Cities Minneapolis –St Paul reported on a long running class action that centred around whether local residents were able to prove "*a definite and measurable' loss of property value because of airplane noise.'* Although the newspaper report did not provide the outcome of the legal decision, there was some comment from other parties such as a local real estate agent who stated that '*the houses still sell pretty well*'. The other interesting issue contained in the article is that according to the City's Annual Quality of Life survey showed that homeowners under the flight path 'were generally happier than homeowners elsewhere in Minneapolis' in that they felt like they lived in a 'good' neighbourhood.

In 1989 the Star-Tribune Newspaper of the Twin Cities Minneapolis –St Paul reported on another compensation action by three home owners who were affected by aircraft noise. Much of the discussion centred on the admissibility of evidence of noise levels.

The Star Tribune (Doyle, 2012) reported on a landmark case whereby landowners were entitled to compensation for nuisance and loss of property value resulting from the new runway built at the Minneapolis-St Paul International Airport. The case appears to be unique and involved a significant landholding which was within close proximity to the new runway. The basis of the claim was the loss in value of the developed product and increased development costs of developing the site to allow for noise abatement measures.

There was media coverage of a public gathering to discuss the impact of aircraft noise from the T.F. Green Airport on the school at Hoxie in The Provincial Journal (DePaul, 1998). The complaints were largely based around routine breaches of a voluntary curfew, windows shaking and pictures falling off walls when aircraft use reverse thrust to slow down following landing. In this instance the Airport Corporation had allocated $11.5 million to noise insulate local houses. A secondary discussion reported in the article was the potential impact on local property values.

Further discussion of the future of the T.F. Green Airport was evident in The Providence Journal (Zainyeh, 1998) as criticism of its expanding market share to include international flights. Despite the economic benefits that airport expansion can bring, expansion of the airport was considered to be a negative factor. The article states:

> 'While economic prosperity can result from an airport, its unintended side effects are erosion of residential property values and decay in the community's social structure. In urban areas across this nation, intense airport operations have resulted in community frustration with airport noise and concern over its impact on young children. The consequence is exodus of residents seeking a better environment in which to raise their families. What remains is a diminished quality of life for those who choose to reside and a steady decrease in residential property value impacting the municipal budget.'

The suburb of Oakhaven which has been impacted by the Memphis International Airport was the subject of an article that appears in the Commercial Appeal Memphis (Maxey, 1996). The report discusses a class action from residents in Shelby County and DeSoto County neighbourhoods who are seeking a buy out or compensation for noise, pollution and related inconveniences. The article does not mention a reduction in property values as a result of noise pollution.

Similarly there is a report of a class action by residents living Witham Field Airport seeking compensation for the cost of insulation of their homes and reduction in property value as a result of airport traffic, in the Palm Beach Post (Modzelewski, 2004).

The St Petersburg-Clearwater Airport has also been the subject of attention in the media. In response to an article written by Steinle (2003) in the St Petersburg Times entitled 'Noise is in the ear of the beholder', Galbraith (2003) submitted a letter to the editor which was published by the newspaper. The letter called for a more serious study to be undertaken concerning all airport issues including, finances, road and traffic impacts and property value impacts. The letter went on to describe some of the negative consequences of living under the flight path of the St Petersburg-Clearwater International Airport.

An newspaper report in the St Petersburg times on 28 April, 2003 whereby the Pinellas County Commissioner Susan Latvata commented that she had not received any complaints about aircraft noise from the St. Petersburg-Clearwater International Airport resulted in six Letters to the Editor being published in the newspaper. Generally these letters focused on noise, infringement of property rights through noise nuisance and the introduction of curfews. Only one letter mentioned a potential reduction in property value as a result of the airport. Bauer (2003) states '*the property value of my home is also at serious risk. I have been informed that Realtors are required to disclose the fact that our home is in the flight path of the airport – not exactly an enticing upgrade.*'

Lester (1994) had a Letter to the Editor published in the Cincinnati Post which discussed amongst other things the impact of Cincinnati-Northern Kentucky International Airport expansion plans. The letter claims '*if the airport wants unlimited growth, it should be prepared to pay people a just price for the property and property value they have ruined by their inept handling of the airport's growth*'. The letter offers no justification for the claim that property values will be reduced.

A further three letters to the editor were published in the Los Angeles Daily News on 27 June 1997. These letters generally focused around a concern regarding noise in the San Fernando Velley and Santa Monica Mountains as a result of an increase in jet traffic. The views expressed were very varied concerning the increased air traffic and noise. One letter Neveu-Beaghan (1997) stated, *'I can only see the decrease in my property value with each jet departure, and that stress, coupled with the pain and anguish suffered as a result of constant noise made by these monster airplanes, is quite overwhelming. Enough is enough.*' Whereas, another local resident made comment that the airport generates significant employment opportunities. Neuys (1997) said, '*Yet again, the irresponsible homeowners of Encico are looking to improve their proerpty values and their pocketbooks at the expense of working-class folks. At the first hint of work that would create 100 new jobs right here in the Valley, so people don't have to commute, they are up in arms, doing their best to stamp out the project.*'

A Joint Land Use Study recommendation to identify an 'Airport Overlay District', a one mile in radius from the airport runway was criticized in The State Journal, Frankfort (2014). The planning scheme would identify the district that is likely to be subject to increased noise, vibration and the risk of accident. The article raised potential breaches in property rights and in particular identified the impact to rental opportunities, property value, ability to finance and obtain property insurance.

CANADA

The debate surrounding the impact of airports on local residents including the impact on property values also exists in Canada. An opinion piece by Thomas (1999) submitted to the Kitchener-Waterloo Record made a statement that residents in communities neighbouring airports is one of 'bitter resentment'. To counter the argument that a regional airport in the Waterloo Region is responsible for economic growth in the area Thomas states

> 'Waterloo Region has been and continues to be one of the fastest growing areas in the country. Our economic growth has resulted from a skilled workforce, highly regarded universities and colleges, an enviable quality of life, a strategic geographical location in southern Ontario and the availability of Person and Hamilton airports, which are within an hour's drive. It did not happen here because of our regional airport.'

Thomas states that a full study should be undertaken to determine the impact of the Waterloo regional airport on quality of life and property values.

UNITED KINGDOM

England

The Guardian newspaper (Vidal, 2015) reported the outcome of a survey undertaken by the Department of Environment, Food and Rural Affairs. It was found that people are becoming increasingly intolerant of noise pollution including 'loud music, barking dogs, noisy neighbours, road traffic and aircraft noise'. According to the study '48% of the 2,750 people surveyed in England and Wales felt that their home life was being spoilt by noise, with one in five saying it kept them awake at night'. In 2012, 72% of people reported that they regularly heard noise from aircraft, airports and airfields. However, the most common sources of noise were road traffic (83%) and neighbours and other people nearby (83%).

Despite the negative aspects of being situated under a flight path this does not always mean that properties will be without value. A newspaper article in the Daily Mail, Australia (Webb and Crossley, 2014) reported that Myrtle Avenue, Hounslow, one of the closest streets to Heathrow and frequented by plane spotters still retains an 'estimated average' of 276,946 pounds due to its proximity to London.

SCOTLAND

The topic of aircraft noise impacting property value has been raised in the Evening Times (Leadbetter, 2008) where it raised that passengers flying out of Glasgow Airport should each pay 1 pound to compensate those living under the flight paths. One resident (Gary Donaghy) is reported as saying '*We are going to sell up but the property value has dropped since the airport announced its expansion plan…. You are trapped in your house because you can't open a window*'.

ISRAEL

An article appearing in the Israel Business Arena (Margalit, 2010) once again reported on the outcome of litigation concerning residents taking action against an airport for general nuisance and loss of property value as a result of airport noise. In this instance, despite the proposition being put forward that property values would not be impacted by more than 5%, the residents who lived close to the Ben Gurion Airport were successful in taking action against the Israel Airports Authority. This was due to a beach of local planning and building law relating to environmental justice. It was considered that the local residents should not bear the price of environmental degradation and loss in property values from the expansion of an airport.

3.4 CONCLUSIONS

The initial stage of the literature review focused on academic literature that reported studies concerning the impact of aircraft noise on property values. These studies, while largely the result of econometric modelling were peer reviewed and retained a level of academic rigor. The outcomes of these studies are fundamentally that

Stage 2 of the literature review focused on newspaper articles, opinion pieces, blogs and on-line forums. The results from Stage 2 of the literature review showed that in some instances assertions were made as to the impact of the airport operations on property value of impacted properties. These claims ranged from 1% or 20% of value. These claims were opinion based and with no empirical evidence offered to support claims. Opinions as to a reduction in value were frequently made by those with a vested interest in the debate such as real estate agents or homeowners. There were also an equal number of articles that stated that the impact of aircraft noise was not identifiable because affected properties had increased in value. In some cases increases in value were outside of what would be expected considering the broader property market.

Many articles discussed the balancing of all outcomes from airport expansion including the increase commercial activity that would result from living near to an airport transit centre.

The online forums and blogs and some newspaper articles appeared to have a very balanced debate about all of the factors that are of interest when selecting a location to invest or reside. One factor that is considered is aircraft noise with the others being proximity to shops, established schools, beaches, the CBD and high streets. Of the negative factors that were considered aircraft noise was considered to be of lesser consideration than traffic noise and noisy neighbours.

Some of the discussion surrounding airports internationally focused on planning schemes and their appropriateness. In some instances the planning schemes created onerous requirements upon development in affected zones and seemed to be more limiting to property value than the aircraft noise they were seeking to guard against.

The media attention on the topic in the USA and Israel focused largely on the litigation surrounding residents and other landholders taking legal action against government or airport authorities for diminution in value of their property and general nuisance. Despite there being some legal precedent in Australia for a low flying light airplane creating an action for nuisance this precedent does not extend to commercial flight operations. In addition the conceptualization of private property rights in the USA and Israel is vastly different to that of Australia. By virtue of the system of land tenure in Australia ownership of private property is by virtue of a grant from the Crown. In addition, the Crown also retains rights over any privately owned parcel of land.

More broadly location seems to be the driving factor in any real estate decision including proximity to services particularly the CBD and beaches. This was particularly the case in the discussion surrounding the Sydney airport due to its close proximity to the CBD. It is clear from the literature that the tolerance to noise generally varies from individual to individual. The impact of airport operations would be one of many positive and negative factors that would be balanced in any decision to reside or invest in a particular residential property location.

4 Study Areas

4.1 INTRODUCTION

This section of the project identifies the various suburbs and areas that will be analysed in the study and explains the rationale for the selection of the study areas. The degree of analysis for each of the various selected locations will vary depending on the specific factors impacting on each of the areas.

A number of aspects have been the drivers for the various locations selected and these comprise:

- Current flight path locations
- Proposed flight paths on completion of the new parallel runway
- Locations currently affected by aircraft noise
- Locations that will be subject to aircraft noise on completion and startup operation of the proposed runway
- Locations that will have a reduced aircraft traffic movements on completion and startup of the proposed runway
- Locations with significant numbers of complaints from aircraft noise
- Locations where there are minimal or no complaints relating to aircraft noise
- Locations within ANEF Contour 20 (Existing runway)
- Locations immediately adjoining ANEF Contour 20 (Existing runway)
- Locations within ANEF Contour 20 (Proposed runway)
- Locations immediately adjoining ANEF Contour 20 (Proposed runway)

These locations cover a wide range of suburbs and locations within Brisbane and will provide a full comparison of residential property performance data for the study.

4.2 STUDY AREA LOCATIONS

The following details the various locations that have been selected for this study and the specific streets that will be analysed to determine the impact of aircraft noise on residential property markets in the Brisbane area. The selection of the suburbs has been based on:

- Location under existing and proposed flight paths,
- Location within and adjoining ANEF 20 Contours for the existing and proposed runway
- Degree and extent of noise complaints to Air Services Australia
- Distance from the Brisbane Airport land boundaries (suburb locations to the south, west and north/west of the airport) under existing and new flight paths
- Suburbs that are not impacted by airport operations in anyway.

In a number of cases, such as Hendra, Clayfield and Wooloowin, these suburbs are not under flight paths but their location can result in visual exposure to aircraft movements, despite not been directly under an existing or proposed flight path.

ANEF 20 CONTOUR STREET LOCATIONS (EXISTING RUNWAY)

All residential streets located in the ANEF 20 contour have been identified and matched with an equal number of residential streets in the same location that adjoin the affected streets. The actual streets to be analysed are shown in Table 4-1.

Table 4-1: Affected Streets: Morningside, Cannon Hill, Seven Hills

Within ANEF 20 Contour			
Junction	Gatling	Mornington	Asquith
Wattle	Shrapnel	Bridgewater	Britannia
Cedar	Nordenfeldt	Cardiff	Fleetway
Bunya	Grenade	Avon	Greendale
Maxim	Bingara	Lang	Lysander
Portwine	Armstrong	Princess	Pinedale
Emerald	Joshua	Duke	Hillsdale
Village	Aeroplane	Goolara	Oberon
Krupp	Derringer	Imperial	D'arcy
Bent	Brock	Montfort	Domitia
Whitworth	Barina	Bonar	Aventis
Moncrief	Rossiter		

Table 4-2: Adjoining Streets: Morningside, Cannon Hill, Seven Hills, Norman Park, Murrarie

Adjoining ANEF 20 Contour			
Amelia	Brussels	Southgate	Baringa
Appia	Paris	Winton	Deviney
Majestic	Erica	Carnarvon	Kates
Ferguson	Dahlia	Tomahawk	Key
Pattison	Camelia	Governor	Moore
Dante	Aster	Jericho	Gary
Salaria	Marsh	Cooper	Jersey
Phalerum	Keats	Barwon	Ayr
Windemere	Shelley	Beelarong	Fraser
Blackwood	Bombery	York	Elwell
Molloy	Andrews	Algoori	Paramount
	Corporate	Elaroo	

Table 4-3: ANEF 20 Affected and Adjoining Streets: Balmoral

Balmoral	
Within ANEF 20 Contour	**Adjoining ANEF 20 Contour**
Suvla	Thynne
Bexley	Walkers
Ryan	Manton
Fifth	Dilkera
Bolan	Pollock
Taylor	Fishermans Bend
Thorpe	Kuranda
Baldwin	Tugulawa
Yonga	Grant
Olive	Riddell
Wentworth	Cambridge
Carbeen	Bevis
Karthina	Walkers
Michael	Parry
Hood	Wambool
Myuna	Main
Andrew	Vista
McIlwraith	Cecile
Barton	Aloomba

ANEF 20 CONTOUR STREET LOCATIONS (PROPOSED RUNWAY)

A similar methodology has been applied to the selection of the streets that will be affected by the proposed runway. In this case the affect is across two suburbs on opposite sides of the Brisbane River.

Table 4-4: ANEF 20 Affected and Adjoining Streets: Ascot

Ascot			
Within ANEF 20 Contour		**Adjoining ANEF 20 Contour**	
Alison	Jackson	Allen	Mein
Hilda	Lamington	Balowrie	Lilley
College	Hopetoun	Kent	Harding
Windsor	Onslow	Stevenson	Manson
Oxford	Buxton	Dobson	Nudgee
Winchester	Silva	Beatrice	Newmarket
Mordant	Long	Norman	Goodwood
Raceview	School	Duke	Flemington
Blackburn	Grant	Magdala	Olive
O'Sullivan	Hamilton	Napier	Hedley
Ure	Williams	Vine	Navigator
Clarke	Crescent	Charlton	Pleystow

DIRECT FLIGHT PATH STREET LOCATIONS<4500FT (EXISTING SOUTHERN FLIGHT PATH)

The following tables are based on a sample of residential streets in locations that are subject to significant aircraft movements and located within the flight paths with aircraft below 4,500ft. These are also locations that attract some noise complaints but not at the same ratio as those locations in the ANEF 20 Contour. A number of locations have been selected and all streets selected are within the same suburb. These suburbs include existing flight paths. The first Table represents streets that are within 1 to 3 kms from the ANEF 20 contour, with the subsequent Tables representing suburbs at a further distance from the ANEF 20 contour.

Table 4-5: Existing Flight Path: Camp Hill

Camp Hill	
Martha	Doyle
Newman	Chatsworth
Waverley	Wellstead
Norfolk	Duling
Illidge	Kelsey
Donald	Lingard
Lavington	Gristock
Castor	Albert

Table 4-6: Existing Flight Path: Coorparoo

Coorparoo	
Eastwell	Geera
Norfolk	Lancaster
Mackay	Rutland
Emlyn	Leigh
Howard	Durham
Trundle	Woodhill
Kenneth	Shire
Verry	Halstead
Welwyn	Leicester
Regal	Amelia
Mona	Arvon
Brae	York

Table 4-7: Existing Flight Path: Tarragindi

Tarragindi		
Kogarah	Turramurra	Arunta
Barmore	Coromandel	Kuring-gai
Lisle	Queensthorpe	Prior
Monkton	Belvedere	Bramston
Chadwick	Ferrand	Pope
Hexham	Monash	Windmill
Garioch	Chamberlain	Strathfield
Marieander	Heathwhite	Woolton
Pozieres	Pring	thornycroft

Table 4-8: Existing Flight Path: Mount Gravatt East

Mount Gravatt East		
Panorama	Clausen	Carrara
Bakewell	Eyre	Wunulla
Archiva	Hawkwood	Dunbar
Kentia	Gatton	Heyford
Crewe	Tarrant	Pond
Lymm	Camlet	Foxglove
Leyland	Margate	Oakfield
Hoff	Kentish	Floral
Grenfell	Gilliver	Boambillee

DIRECT FLIGHT PATH STREET LOCATIONS<4500FT (EXISTING NORTHERN FLIGHT PATH)

Table 4-9: Existing Flight Path: Bulimba

Bulimba	
Quay	Johnston
Coutts	Melrose
Portside	Harrison
Parklane	Byron
McConnell	Cowper
Merry	Tennyson
Kenbury	Shakespeare
Thompson	Wordsworth
Bulimba	Lang

Table 4-10: Existing Flight Path: Gordon Park

Gordon Park	
Burnaby	Richmond
Glebe	Khartoum
Highland	Gordon
Alva	Hamilton
Victoria	Rose
Beaconsfield	Cowper
Bedford	Haig
Stirling	Lambert
Willis	McCord
Barron	Tindal
Shamrock	Archer
Kate	Montrose

Table 4-11: Existing Flight Path: Albion

Albion	
Marne	Lucy
Bridge	Gore
Grove	Crosby
Wakefield	Collingwood
Bale	Tate
Madden	Elliot
Amelia	Fox
Store	Burdett
Little	Bogan
Lever	Pedder
Ellen	Wallace

Table 4-12: Existing Flight Path: Chermside West

Chermside West	
Mayfield	Marban
Pacific	Valiant
Gilmour	Fairlane
Graymond	Safari
Kanofski	Kurago
Toomey	Buran
Lawrence	Mugara
Ashley	Bigi
Castlehaven	Gibum
Sika	Birra
Fallow	Covey
Basnett	Felsman
Ben	Packer

DIRECT FLIGHT PATH STREET LOCATIONS, <4500 FT (PROPOSED)

The following Four tables (Tables 4-13 to 4-16) identify streets in four suburbs that are currently free from aircraft noise but will have impact once the new runway is in operation

Table 4-13: Proposed Flight Path 2020: Stafford

Stafford	
Minimine	Balal
Waroon	Balerang
Leiper	Turrana
Collier	Ryena
School	Canonbar
Crawford	Barokee
Clifford	Dunedoo
Lutana	Harold
Buddina	Victor
Wayland	Rueben
Lennon	Pateena
Jardine	Guntur
Winnam	Gabon

Table 4-14: Proposed Flight Path 2020: Annerley

Annerley	
Victoria	Chester
Clydesdale	Rigby
Avondale	Ferndale
King	Lothian
Emperor	Bower
Prince	Real
Ealing	Gustavson
Junction	Lewisham
Gowrie	Gibson
Waldheim	McIvor
Dudley	Lambton
Ekibin	Stephens
Waterton	Jopp

Table 4-15: Proposed Flight Path 2020: Hamilton

Hamilton	
Comus Ave	Perry
Comus St	Markwell
Hipwood	Cooksley
Mikado	Lawes
Pine	Riverview
Joynt	Kent
Royal	Balowrie
Queens	Allen
Castleton	Charlton
Killara	Circe
Rossiter	Sparkes
Langside	Lynell
Annie	Eldernell

Table 4-16: Proposed Flight Path 2020: New Farm

New Farm	
Heal	Abbott
Annie	Samuel
Browne	Terrace
Villiers	Clay
Merthyr	James
Welsby	Hawthorne
Sydney	Kent
Lamington	Beeston
Alford	Gibbon
Lower Bowen	Davidson
Mark	Chermside

NO FLIGHT PATH AND NIL OR LIMITED NOISE COMPLAINTS

The following tables show a selection of streets located in suburbs that are not subject to direct flight path and have not recorded any or very minimal noise complaints to Air Services Australia. Again a similar number of streets for each of these locations have been chosen to match the sample sizes for the affected locations. Although a number of these locations are not directly under an existing or proposed flight path, residents would be able to see aircraft movements depending on location within the suburb.

Table 4-16: Brisbane Suburbs with Limited Aircraft Noise Exposure

Wooloowin	Mansfield	Mitchelton
Bertha	Casmaria	Marshall
Henry	Handon	Chewton
Emma	Linfield	Chessom
Nelson	Mingera	St Helens
Lodge	Koumala	Grace
Dawson	Cresthaven	Keylar
Stewart	Morialta	Glenholm
Lydia	Colington	Pascoe
Jimbour	Valentia	Skyring
Woobye	Dirkala	Blackwood
Frances	Menkira	McConaghy
Brook	Lorinya	Andover
Rawson	Danina	Mimosa
View	Coolmunda	Glen Retreat
Kedron	Kiparra	Princess
Hamley	Condong	Irvine
Price	Mirang	Frasers
Park	Togar	Union
Judge	Aminya	Suez
Clark	Silex	Taylors
Thorpe	Trident	Parkview
Hunter	Luprena	Cranbrook

SUBURB COMPARISON

In addition to the matched street comparisons listed above, an analysis of the residential property markets on a full suburb basis will also be undertaken, with the Brisbane median house price movement assessed as the basis for comparisons. These suburbs selected for this part of the research project have been based on:

» Their inclusion as matched street analysis

» Degree of aircraft noise complaints recorded

» Location in respect to existing and future flight paths

Table 417: Brisbane Suburb Comparison

High Noise Complaints	Low Noise complaints	No/minimal noise complaints
Morningside	Gordon Park	Annerley
Coorparoo	Northgate	Mitchelton
Camp hill	Bulimba	New Farm
Cannon Hill	Mount Gravatt East	Mansfield
Tarragindi	Balmoral	Virginia
Seven Hills	Clayfield	Chelmer
Tingalpa	Ashgrove	Sherwood
Norman Park	Chapel Hill	Jindalee
Holland Park West	Wynnum	Forest Lake
The Gap	Fairfield	Kenmore
Murarrie	Hawthorne	Graceville
Belmont	Ascot	Hamilton

4.3 NEXT STAGE

With the study areas now identified, data will be collected to carry out the full analysis of the residential property market sectors. The area selection will allow a long term trend analysis and comparison across a range of airport operation and aircraft noise issues in relation to residential property markets.

The analysis will address property performance aspects including:

» Median house price trends over time

» Median unit price trends over time

» Average house price trends over time

» Average unit price trends over time

» Price differential comparisons

» Average annual capital returns

» Volatility of average annual capital returns

» Risk Return ratios

» Rental trends for houses and units

5 Research Methodology

5.1 INTRODUCTION

This analysis will be based on all sales transactions that have occurred in the study areas over the period from January 1, 1988 to December 31, 2013. This twenty six year period covers a range of Brisbane residential property cycles and represents a comprehensive coverage of both periods of residential property booms and falls. The study areas comprise a range of socio-economic sectors and geographic locations around the Brisbane Local Government Area. Complete sales transaction data has been accessed for 36 Brisbane suburbs for the 26 year period. A socio-economic classification of these selected suburbs shows that all the suburbs in the HNC category are lower, middle and upper middle socio-economic suburbs and classified as inner middle ring suburbs of Brisbane. The MNC suburbs include six suburbs that are classified as mid to high; high socio-economic suburbs and 6 low to high middle socio-economic suburbs. The NNC suburbs comprise 4 mid to high middle socio-economic suburbs; 3 high socio-economic suburbs and 4 high lower socio-economic suburbs of Brisbane. In all cases the high socio-economic suburbs are inner ring suburbs of Brisbane, with the upper low socio-economic suburbs being outer middle ring suburbs of Brisbane. There are no outer ring Brisbane suburbs in the study areas.

In addition a selection of individual streets were analysed across 21 Brisbane suburbs, covering the existing northern, southern flightpaths, as well as suburbs that will be subject to the new flight paths following the introduction of the new parallel runway. Concentrating the analysis on specific streets, located directly under the current and proposed flight paths limited factors that can vary significantly even in a specific suburb. Three suburbs with no current or future exposure to aircraft noise were also included in the analysis. In all, streets in 39 Brisbane suburbs have been studied. The transaction data covers both residential freestanding houses and residential strata title property, including home units/apartments, townhouses and villas for the full suburb analysis. For the selected street analysis, the limited number of unit/townhouse/villa sales transactions limited this analysis to freestanding residential houses only.

To assess the impact of aircraft noise on rental property the volume of annual bonds lodged and median rental values for 2 bedroom units (the predominant building type in the Brisbane unit market) have been collected for the same 36 Brisbane suburbs. However, the data for this section of the study is limited to the period 1994 to 2013.

In total the study database consists of 181,524 sale transactions comprising 126,262 house sale transactions and 55,262 strata title sale transactions.

5.2 DATA SOURCES

Sales transaction data has been accessed from Pricefinder and RP Data, two commercially available real estate transaction databases currently used by property professionals. These two databases are based on the sale transfer data provided to the Queensland Government on settlement of all residential property sales. These databases provide details on the date of sale, sale price and property type. All sales were filtered to remove all same name transactions so that only true market value sales were included in the analysis.

The rental data was obtained from the Queensland Rental Tenancies Authority, which records all rental bonds and weekly rental rates, providing data on the number of rents negotiated each quarter for each of the majority of suburbs, towns and regions in Queensland for a range of property types and building size. For the purposes of this study the rental property analysis has been based on the number and rental value for 3 bedroom houses and two bedroom units/townhouses, as this was considered to be the main residential property types across the majority of suburbs in the study area.

The various suburb and street locations were selected based on the data and mapping provided in the Brisbane Airport Corporation Current and Future Flight Path and Noise Information Booklet (2014). This data allowed the identification of Brisbane suburbs that are exposed to both current runway flight paths, as well as the new flight paths that will be in operation once the new parallel runway is in operation.

5.3 DATA ANALYSIS

All sales transactions have been entered into Microsoft Excel for analysis. Microsoft Excel functions have been used to determine annual price variations, average annual capital returns, capital return volatility and the correlations between the annual movement in sales volume, median house and unit prices and average house and unit prices.

The data has been analysed to determine:

- The number of sale transactions for each identified study area (refer to Tables 4-1 to 4-17)
- Change in annual sales volume for each of the identified study locations
- Correlation between sales transaction numbers across the identified study areas
- Annual trend in the median and average price for each of the suburb and street locations
- Annual change in price for each of the property types and locations identified in the study
- Average annual capital returns for each of the property types and locations in the study
- Volatility of annual property prices for each of the property types and locations identified
- Property investment risk/return comparison for the various property types and locations
- Correlation analysis for the each of the specific study locations
- Annual and average annual price variation between residential property types in high noise suburbs (all middle socio-economic suburbs) compared to middle socio-economic suburbs in moderate and no aircraft noise locations.
- Brisbane Local Government Area median house price
- Brisbane Local Government Area median unit price
- Brisbane Local Government Area average weekly rental rates for houses and units

This comprehensive analysis will provide the most extensive study of the impact of aircraft noise on residential property prices (values) and rents over a 26 year period. As identified in Chapter 1, previous studies on the impact of aircraft noise on residential property markets have been based on limited time periods as little as 6 to 12 months.

Although this current study covers the period 1988 to 2013, the data will be updated annually until the new Brisbane parallel runway has been constructed and in operation for a number of years.

The analysis compares a range of suburbs with high to no aircraft noise and will allow residential property prices to be tracked for both existing suburbs that are currently affected by aircraft movements (and possible less affected with the operation of the new runway) and suburbs that have limited affectation from aircraft movements or will be affected by aircraft noise once the new runway is operational.

Commencing the study in 1988 covers the time period from the commencement of operations on the current Brisbane runway in 1988, the development and upgrades of the current domestic and international terminals and the increasing number of aircraft movements over the past 26 years.

This extensive base study provides a sound platform to assess property prices across an extensive range of Brisbane locations as the new runway at Brisbane airport is developed and commences operations, based on the actual market response to previous changes in aircraft noise levels, movements and flightpaths.

6 Results and Discussion

6.1 INTRODUCTION

This section of the study will present the analysis of the sales transactions for a range of Brisbane suburbs and streets from January 1988 to December 2013. The discussion of the results will start on a suburb basis comparing the real estate performance of suburbs with high volumes of noise complaints per month (HNC) to suburbs with moderate noise complaints (MNC) and suburbs with no or minimal noise complaints (NNC). This suburb analysis covers both houses and units.

The second stage of the results compares the real estate performance of the HNC suburbs to the middle socio-economic suburbs in the MNC and NNC locations. This is then followed by the analysis of the rental market for houses and units in the HNC, MNC and NNC suburbs

Following the rental analysis the various street/suburb analysis is discussed based on flight path locations. The street analysis starts with the streets currently under the existing runway flight paths, including those streets within ANEF 20 and a matching number of streets adjoining the ANEF 20 contour, as well as the streets that will be within the ANEF contour for the new runway and matched streets adjoining this contour. A further study compares streets in the existing southern and northern flight paths but at varying distances to the Brisbane airport. A similar street analysis is then discussed based on suburbs that will be subject to aircraft movements on completion of the new parallel runway. In addition, the results compare the average analysed data for the streets that are currently not and in the future will not be subject to aircraft noise from the existing and future runway at Brisbane airport. The final results compare the average of each of the real performance of the streets in the suburbs under the southern, northern and new flightpaths to the non-flight path locations.

With each study scenario the various price trends and investment performance analysis will be compared to the Brisbane median house price for the same period. All median and average house prices are shown in units of $0,000s (Thousands).

6.2 SUBURB COMPARISON

SUBURB COMPARISON (HIGH, MODERATE AND MINIMAL/NO NOISE COMPLAINTS)

A total of 36 Brisbane suburbs were identified for the study based on the number of noise complaints to Air Services Australia and reported on their website. The suburbs were grouped according to high level of noise complaints (HNC), moderate levels of noise complaints (MNC) and suburbs that have not recorded any noise complaints or very limited occasional noise complaints over the past two years (NNC). The high noise complaint suburbs were located on the southern flight paths and within 14kms from the existing main runway at Brisbane airport (southern end of the runway proper). The moderate MNC suburbs covered a range of locations to the south, west, north and east of the Brisbane airport and are all inner ring or middle ring Brisbane suburbs and within a 5-10km radius from the current Brisbane Airport main runway (southern end)s. The NNC suburbs were also geographically diverse including inner ring, middle and outer middle ring suburbs of Brisbane.

Figure 6-1: Suburb Comparison: Sales Volume 1988-2013

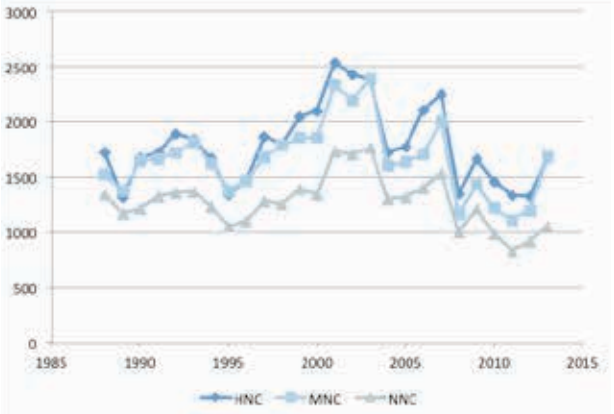


Figure 6-1 shows the volume of house sale transactions for the HNC, MNC and NNC suburbs for the period 1988 to 2013. The numbers of sales for the HNC and MNC locations were higher than the NNC suburbs, with the HNC suburbs having a high of 2,539 sales in 2001 and a low of 1,168 sales in 2008. However, this was expected as the majority of suburbs in the HNC classification locations are in the middle socio economic locations of Brisbane, which traditionally have a higher rate of sales compared to the higher socio-economic suburbs of Brisbane. The interesting findings from these suburb comparisons is the fact that despite the variation in the number of sales per annum, the actual trend in sales has been consistent across all the noise complaint areas, especially for the HNC and MNC suburbs, with all classifications showing increasing and decreasing rates of sales over each year of the 26 year period. This is also confirmed in Table 6-1, which shows the correlation between the number of annual sales across the three suburb classifications. This table shows the correlation co-efficients are very highly positively correlated at r = 0.90 (HNC, MNC), 0.89 (HNC,NNC) and 0.91 (MNC,NNC). The very high significance of these correlations are evidenced by the fact that a significant co-efficient at the 5% level is r = +/-0.37. These results show that the location of a suburb under a flight path has no impact on the volume of residential house sales at any point in time compared to suburbs that have some or no exposure to flight paths and aircraft noise. Ownership of a property under a flight path and subject to aircraft noise in Brisbane does not affect the ability to sell that house compared to moderate or non-affected houses.

Table 61: Correlation: Suburb Comparison: Sales Volume: 1988-2013

	HNC	*MNC*	*NNC*
HNC	1.00		
MNC	*0.90	1.00	
NNC	*0.89	*0.91	1.00

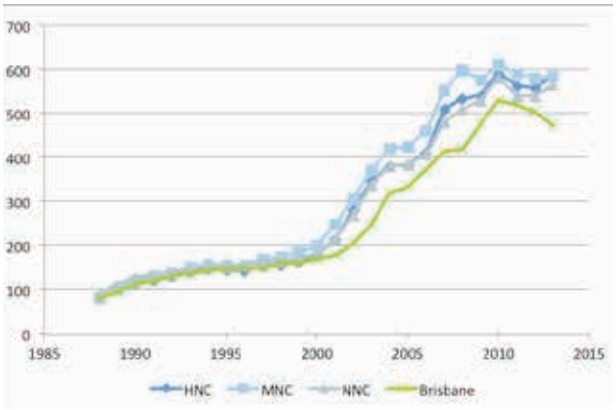
**Significant at the 5% level*

Figures 6-2 and 6-3 show the annual trend in median and average house prices for the 36 suburbs from 1988 to 2013. Particular years of note when comparing these trends in median and average prices are:

1988	World Expo Brisbane
1989	Australian airlines pilots strike and the significant impact on tourism and South East Queensland
2000-2007	Brisbane property boom
2008-2010	Global Financial Crisis
2011	Brisbane floods

From the period 1988 to 2000, there was limited movement in median house prices across all the 36 suburbs in Brisbane, with the HNC, MNC, NNC and Brisbane LGA median house prices increasing at a similar rate, with all classifications showing 100% increases in median prices over this 13 year period (Refer to Figure 6-2)

Figure 6-2: Suburb Comparison: Median Price ($ thousands): 1988-2013



However, from the year 2000, there has been a significant difference in the median price of the suburbs in the HNC, MNC and NNC suburbs compared to the Brisbane median house price. This is due to the fact that over the period 2000 to 2013 much of the growth in housing supply in Brisbane has been in the outer middle and outer Brisbane suburbs, with limited increases in housing supply in the suburbs in the inner and inner middle ring suburbs. The other major finding from this analysis of the median house prices in the suburbs that are subject to high to moderate aircraft noise is that the trend in house prices has been very similar and the higher median house prices in the MNC suburbs is based more on the fact that half the suburbs in this noise classification are high socio-economic suburbs as described above. This figure also shows that the trend in price movement from year to year has been virtually identical for the suburbs in the HNC classification compared to the suburbs in the NNC suburbs. This indicates that residential property prices in HNC suburbs of Brisbane are not adversely affected by aircraft noise compared to locations that have less or minimal aircraft noise issues and in a number of years the more convenient location of these suburbs to the Brisbane CBD and services has resulted in the median price being higher than non-affected locations.

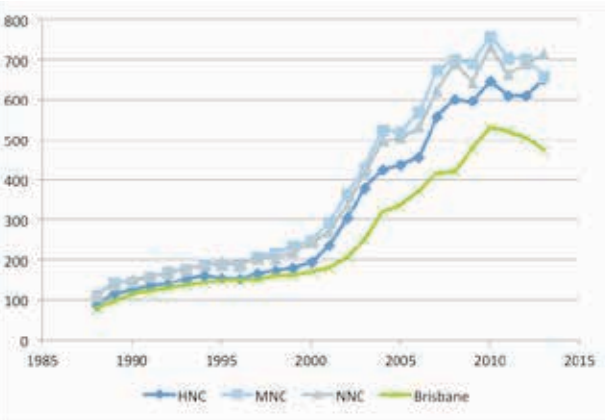
Table 6-2: Correlation: Suburb Comparison: Median Price: 1988-2013

	HNC	*MNC*	*NNC*	*Brisbane*
HNC	1.00			
MNC	*0.95	1.00		
NNC	*0.96	*0.93	1.00	
Brisbane	*0.62	*0.62	*0.69	1.00

**Significant at the 5% level*

Table 6-2 also supports the strong correlation between house price movements across the suburbs in the study. The annual change in median house prices between houses in the HNC to houses in MNC and NNC suburbs are highly positively correlated with correlation coefficients of r = 0.95 (HNC,MNC) and r = 0.96 (HNC, NNC). These extremely high correlation coefficients state that over the 26 year time period the movement in house prices across the suburbs in the high, moderate and no aircraft noise complaint suburbs have been identical, regardless if the suburb is located close to the airport or under the various flight paths for the current Brisbane airport runway.

Figure 6-3: Suburb Comparison: Average Price ($ thousands): 1988-2013



Again, Figure 6-3 shows that over the full 26 years of this study the trend in annual changes in average house prices have been very similar, however the average prices for the HNC suburbs has been less on a yearly basis compared to the MNC and NNC suburbs, but all the research study suburbs had an average annual house price higher than the Brisbane median house price. The actual trend in house price change per year has been very similar for suburbs in the HNC, MNC and NNC suburbs. All these suburbs experienced their highest average price in 2010, when prices dropped in 2011 and 2012, before an increase in 2013. Since 2010, the median price for houses in Brisbane has been declining. Table 6-4 also shows that the correlation between the average annual change in house prices between the HNC, MNC and NNC suburbs in Brisbane have also been extremely highly positively correlated HNC to MNC (r=0.89), HNC to NNC (r= 0.87), with these suburbs also being significantly positively correlated with the Brisbane median house price (HNC and Brisbane r = 0.59)

Table 6-3: Correlation: Suburb Comparison, Average Price: 1988-2013

	HNC	*MNC*	*NNC*	*Brisbane*
HNC	1.00			
MNC	*0.89	1.00		
NNC	*0.87	*0.85	1.00	
Brisbane	*0.59	*0.71	*0.64	1.00

**Significant at the 5% level*

The investment performance of the HNC, MNC and NNC suburbs and the Brisbane Median house price are shown in Table 6-4. This Table shows that over the 26 year period the average annual capital return based on median house prices for HNC suburbs under the southern flight path has been 8.66%. This capital return has been greater than the average annual capital return for MNC suburbs (8.52%) and NNC suburbs (7.93%). All the HNC, MNC and NNC suburbs returned a higher average annual capital return compared to the Brisbane median capital return of 7.72%

The HNC suburbs also had the highest volatility at 9.49%, with the NNC suburbs having a very similar volatility to the Brisbane median volatility and the MNC suburb volatility. On a risk return basis based on median price change over the study period, each of the noise affected and non noise affected suburbs have a very similar risk return ratio ranging from 1.04 (MNC), 1.07 (NNC), 1.08 (Brisbane) and 1.09 for HNC suburbs. This again shows that the investment performance and risk for houses in high aircraft noise suburbs is no different to the investment performance of the moderate and no noise suburbs with similar location characteristics.

Table 6-4: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise	8.66	9.49	1.09
Moderate Noise	8.52	8.87	1.04
No/Low Noise	7.93	8.47	1.07
Brisbane LGA	7.72	8.35	1.08

Table 6-5: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise	8.77	9.71	1.11
Moderate Noise	7.80	9.43	1.21
No/Low Noise	7.90	8.52	1.08
Brisbane LGA (median)	7.72	8.35	1.08

Based on the average annual price changes for the 26 year period in Brisbane, the HNC suburbs have also shown the highest investment returns with an average an capital return of 8.77%, well above the average annual return for MNC suburbs (7.8%) and NNC suburbs (7.9%). This table also shows that on an average price basis the volatility for MNC suburbs has been closer to the volatility of the HNC suburbs, predominately due to the higher volatility of the higher value properties in the higher socio-economic suburbs. Due to these similar levels of volatility in between the HNC and MNC suburbs, the risk/return ratio based on average prices is higher for the MNC suburbs (1.11 to 1.21).

SUBURB COMPARISON: HOUSES (HIGH NOISE COMPLAINT SUBURBS V MIDDLE SOCIO ECONOMIC SUBURBS)

The suburb comparisons above are based on levels of noise complaints with the HNC suburbs comprising the middle socio-economic suburbs on the southern flight path ranging from 2 to 14 kms from the current Brisbane airport runway (southern end). The MNC and LNC suburbs comprised a mixture of upper low, middle and high socio-economic suburbs. To compare the price difference between noise affected and moderate to non-noise affected suburbs, the 12 HNC suburbs were matched with 12 middle socio-economic suburbs in the MNC and LNC categories. This has allowed a comparison of median and average house prices for affected and non-affected suburbs to be assessed to determine average price differences for the period 1990 to 2013. If the variation in price is similar in each case than the main determinant of value in these matched socio-economic suburbs would be locational based rather than actual exposure to aircraft noise.

Figure 6-4: Suburb Comparison: HNC v Middle Socio-economic: Median Price ($ thousands): 1988-2013

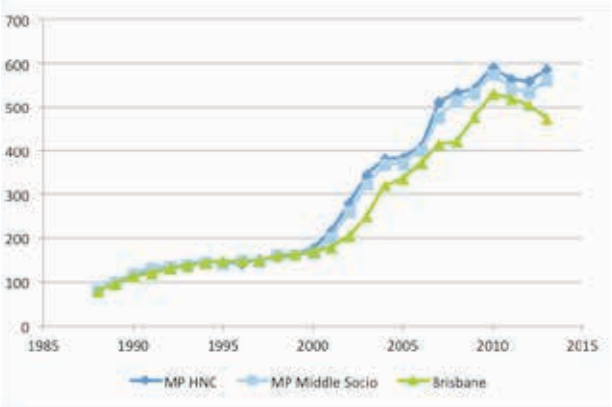


Figure 6-4 shows the trend in median prices movement for the period 1988 to 2013 based on the comparison of middle socio-economic suburbs in the HNC suburbs to the middle socio-economic suburbs in the MNC and NNC locations. This figure shows that from the period 1988 to 2000, the annual trend in the movement of median house prices for the HNC suburbs was virtually the same for middle socio economic suburbs in inner and middle ring locations of Brisbane, as well as the median price for houses in Brisbane. From 2000 to 2010 the median house price for the HNC and middle socio-economic suburbs has been higher but followed a similar trend to the Brisbane median house price. While the median house price in Brisbane showed a decline from 2010, this was not the case for the HNC suburbs from 2012 to 2013. This figure also shows that the change in annual median prices for HNC suburbs has been very similar to the middle socio-economic suburbs in the MNC and NNC locations and over a number of years has actually been higher.

Again, the very highly positive significant correlation between the movement in house prices in the HNC suburbs to middle socio-economic suburbs in Brisbane is confirmed in Table 6-6, with the correlation coefficient for HNC v Middle socio-economic r = 0.86 (significant coefficient at 5% level r= 0.37). The correlation between the HNC and middle socio-economic suburbs is stronger than the correlation with the Brisbane median house price.

Figure 6-5: Suburb Comparison: HNC v Middle Socio-economic: Average Price: ($ thousands): 1988-2013

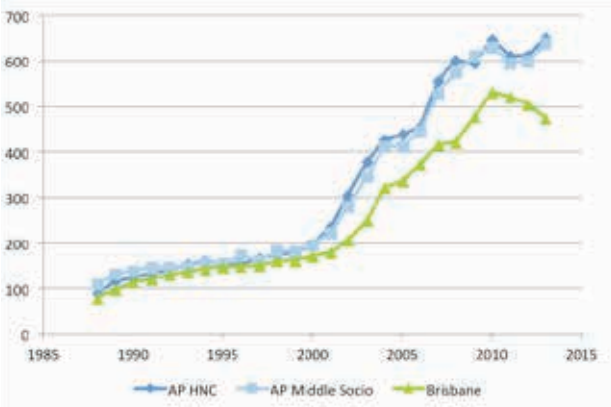


Figure 6-5 represents the trend in the average house price HNC v middle socio-economic suburbs, with the same trend being reflected in both these housing sectors and again well above the Brisbane median house price. In the case of the average house price the correlation between HNC and middle socio-economic suburbs is again very highly positively correlated at r = 0.78, with the average price in the middle socio-economic suburbs being higher from the period 1988 to 2000, but after 2000, the average price for houses in the HNC suburbs was higher than the middle socio-economic suburbs.

Tables 6-7 and 6-8 again show that over the full 26 year period of this study both the median and average house price in the southern flight path suburbs subject to the highest number of aircraft noise complaints and under the main southern flight path has shown a higher average annual capital return compared to middle socio-economic suburbs and the overall Brisbane housing market, with very similar volatility and risk/return ratios.

Table 6-6: Correlation Analysis: Median and Average Prices 1988-2013

	MP HNC	*MP Middle Socio*	*AP HNC*	*AP Middle Socio*	*Brisbane*
MP HNC	1.00				
MP Middle Socio	*0.86	1.00			
AP HNC	*0.97	*0.84	1.00		
AP Middle Socio	*0.75	*0.89	*0.78	1.00	
Brisbane	*0.62	*0.67	*0.59	*0.66	1.00

**Significant at the 5% level*

Table 6-7: Capital Return and Investment Performance: Median Price 1988-2013: HNC v Middle Socio-economic Suburbs

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise Suburbs	8.66	9.49	1.09
Middle socio Economic Suburbs	8.43	9.54	1.13
Brisbane LGA	7.72	8.35	1.08

Table 6-8: Capital Return and Investment Performance: Average Price 1988-2013: HNC v Middle Socio-economic Suburbs

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise Suburbs	8.72	9.68	1.11
Middle socio Economic Suburbs	7.66	8.87	1.16
Brisbane LGA	7.72	8.35	1.08

With this very similar trend in the movement in annual median and average house prices between the HNC suburbs and middle socio-economic suburbs in Brisbane, the percentage difference in the median and average house price for each of the 26 years are shown in Table 6-9. This Table also shows the average annual median and average house price over the period 1988 to 2013. From the median house price results, there have been 4 years during the period 1988-1992 where the median price for middle socio-economic suburb houses were higher than houses in the HNC suburbs, with the HNC suburbs recording a higher median price for each of the years from 1993 to 2013. On an average annual basis the median price for houses in the HNS suburbs was actually 2.11% higher than the median price for houses in the middle socio-economic suburbs. However, on an average price basis there have been 9 separate years where the average price for houses in the middle socio-economic suburbs has been higher than the HNC suburbs (17 years where the reverse has been the case). Again this difference has been most prominent in the period 1988 to 1999. Much of this early price difference can be attributed to the location of the HNC complaint suburbs all being located in South Brisbane and the middle socio-economic suburbs in the study being predominately inner city and northern suburbs. Until the early 2000s, there had been a price premium for houses located in Brisbane's northern suburbs compared to the south Brisbane locations and this is confirmed in the results shown in Table 6-9.

Table 6-9: Annual % Variation between HNC Suburbs and Middle Socio-economic Suburbs: Median Price and Average Price

Year	Median Price Comparison (%)	Year	Average Price Comparison (%)
1988	-1.23	1988	-19.27
1989	3.06	1989	-12.88
1990	-2.54	1990	-10.79
1991	-6.92	1991	-8.90
1992	-3.70	1992	-4.76
1993	1.45	1993	3.40
1994	0.69	1994	2.55
1995	2.13	1995	0.00
1996	-6.00	1996	-11.05
1997	4.83	1997	3.73
1998	-4.91	1998	-5.46
1999	0.00	1999	-1.10
2000	7.27	2000	0.00
2001	7.50	2001	5.86
2002	7.69	2002	8.57
2003	6.81	2003	9.57
2004	3.54	2004	3.41
2005	3.51	2005	6.31
2006	2.50	2006	2.48
2007	7.37	2007	5.50
2008	3.70	2008	4.53
2009	1.89	2009	-2.46
2010	3.15	2010	2.54
2011	3.88	2011	2.52
2012	4.70	2012	2.00
2013	4.46	2013	2.04
Average Annual Difference	+2.11	**Average Annual Difference**	-0.45

Over the past 26 years the middle socio-economic average annual price differential compared to the HNC suburbs has been 0.45% higher. However, from 2000 to 2013 the price difference has been greater in the HNC suburbs (3.77% per year).

A further sub period analysis of these capital return comparisons is shown in Table 6-10. On a sub period basis the median house price for houses in middle socio-economic suburbs subject to high levels of aircraft noise and complaints has been consistently higher than similar suburbs that have moderate or minimal aircraft noise. On a median price basis the greatest difference has been the sub sector time periods of the last three and 15 year periods, where the difference between the median house price in the HNC suburbs has been on average 4.35% and 4.53% higher, the period where this difference has been the lowest (but still higher) was the last 25 years, indicating that over recent times, despite an increase in actual aircraft movements, these high noise suburbs have been attracting higher house prices than similar Brisbane suburbs not subject to the same levels of aircraft noise.

Table 6-10: Analysis of Variation between HNC Suburbs and Middle Socio-economic Suburbs: Median Price and Average Annual Price Differences

Period	Median Price Difference	Average Price Difference
Last 3 years	4.35%	2.19%
Last 5 years	3.62%	1.33%
Last 10 years	3.87%	2.89%
last 15 years	4.53%	3.45%
Last20 years	3.24%	2.08%
last 25 years-	2.24%	0.30%

Although the variation in the average price for houses for HNC suburbs and MNC and NNC suburbs was not as high as the median price analysis, in all sub periods the HNC suburbs had a higher average annual price compared to the other middle socio-economic suburbs. Again the highest price percentage difference was the last 15 years with an average annual higher price difference of 3.45%. Removing the price difference for 1988 actually results in all sub time periods showing a higher average annual price.

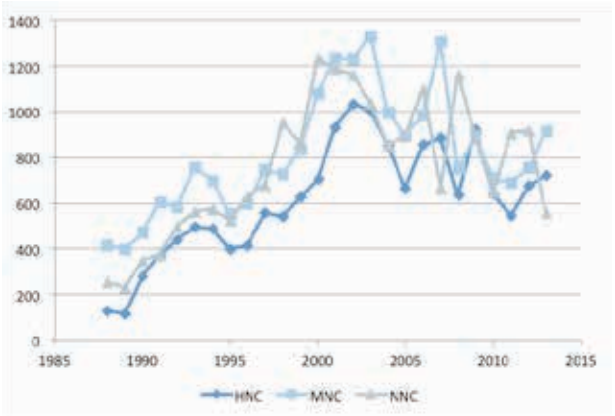
The only explanation for these results is that aircraft noise is not the determining factor for value in these locations and a convenient location the Brisbane CBD, good schools, services and transport are more likely drivers of house prices for suburbs under the existing flight paths, as is the case for Brisbane suburbs currently not currently affected by aircraft noise or located under flight paths.

SUBURB COMPARISON (HIGH MODERATE AND MINIMAL/NO NOISE COMPLAINTS): UNITS

A similar analysis has also been carried out for units in the HNC, MNC and NNC suburbs identified in this study. Again, these results are also compared to the median unit price for the Brisbane LGA.

Figure 6-6 and Table 6-11 show that the trend in actual sales per year for units in the HNC and MNC suburbs were similar in trend and average annual percentage change in sales volume, with a correlation coefficient of r = 0.56. Although there was a positive correlation between HNC suburbs and NNC suburbs, this correlation was not significant, with a negative correlation between MNC suburbs and NNC suburbs.

Figure 6-6: Suburb Comparison: HNC, MNC, NNC Units: Sales Volume 1988-2013



The unit market in Brisbane is predominately in the inner suburbs and inner middle ring suburbs. The middle ring suburbs predominately comprise detached housing and units have only been a significant percentage of total housing stock over the past 10 years.

Table 6-11: Correlation Analysis Units: Suburb Comparison on Sales Volume 1988-2013

	HNC	*MNC*	*NNC*
HNC	1.00		
MNC	*0.56	1.00	
NNC	0.20	-0.20	1.00

**Significant at the 5% level*

The trend in median unit prices across the various suburbs in this aircraft noise study has not been as similar as the trend in freestanding houses. Although the general trend has been somewhat similar the median unit price for the NNC suburbs has been consistently higher than the HNC and MNC suburbs; however all have been generally higher than the Brisbane median unit price.

Figure 6-7: Suburb Comparison: HNC, MNC, NNC Units: Median Price: ($ thousands): 1988-2013

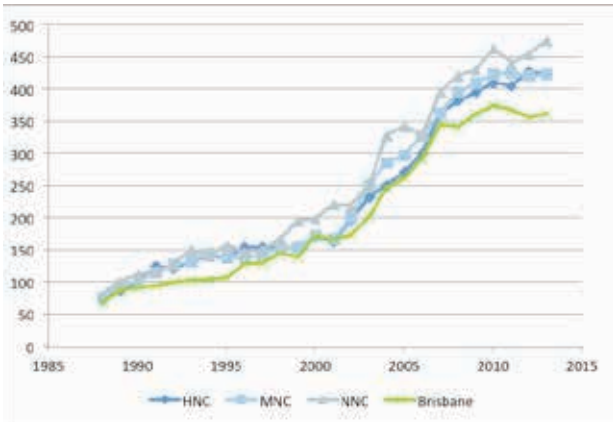


Table 6-12 confirms that the price movement trends for units in the HNC and MNC have been similar with a very significant positive correlation of r = 0.71. The correlations between HNC and MNC with the NNC suburbs are not significant. However it is interesting to note that both the HNC and MNC suburbs have a very significant positive correlation with the Brisbane median price unit, but not the NNC suburbs.

Table 6-12: Correlation Analysis: Units Suburb Comparison: Median Price 1988-2013

	HNC	*MNC*	*NNC*	*Brisbane*
HNC	1.00			
MNC	*0.71	1.00		
NNC	0.12	0.27	1.00	
Brisbane	*0.52	*0.60	0.34	1.00

**Significant at the 5% level*

Table 6-13: Correlation Analysis: Units Suburb Comparison: Average Price 1988-2013

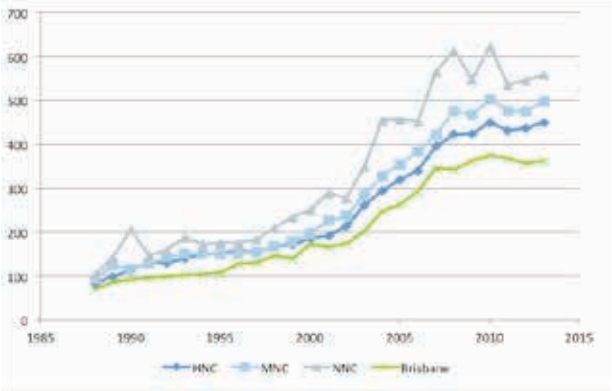
	HNC	*MNC*	*NNC*	*Brisbane*
HNC	1.00			
MNC	*0.56	1.00		
NNC	*0.47	*0.41	1.00	
Brisbane	*0.63	*0.51	*0.42	1.00

**Significant at the 5% level*

When the average price per year is compared there is a more significant correlation in annual price movements for all of the suburb classifications, with the NNC suburbs unit prices also being significantly correlated with the HNC, MNC and Brisbane median unit price. Again these correlations are significant but not at the same very high level of significance as shown in the Brisbane housing market (Refer to Table 6-13 and Figure 6-8). Figure 6-8 also confirms the general similarity in the trend for unit prices in the HNC and MNC suburbs compared to the NNC suburbs.

Unlike the housing analysis, the average capital returns for home units in the various suburb locations based on changes in annual unit prices was highest in the NNC suburbs (7.66%), followed by the units in the suburbs most affected by aircraft noise (7.66%). Both these were higher average annual capital returns compared to both MNC and the Brisbane units overall. The high capital return for the NNC units also resulted in the highest volatility of 9.87%, higher than the level of volatility for HNC and MNC suburbs (Refer to Tables 6-13 and Figure 6-8).

Figure 6-8: Suburb Comparison: HNC v Middle Socio-economic: Average Price: ($ thousands): 1988-2013



This has resulted in the NNC suburbs having the worst risk return ratio for the study at 1.26, well above the risk return ratios for MNC and MNC (1.13 and 1.09 respectively). The overall risk return ratio for Brisbane units for the period 1988 to 2013 was also higher than the HNC and MNC suburbs. Despite the effect of aircraft noise these suburbs have shown a better investment performance compared to the Brisbane unit market overall and the suburbs with limited aircraft noise affectation. Table 6-15 compares the capital return, volatility and risk/return ratio for the various levels of aircraft noise affectation based on the average price of units in each classification. Again, the suburbs with the least impact of aircraft noise have shown the highest average annual capital return, but also at the highest level of risk. On the average unit price basis the risk return ratio for the NNC suburbs was 2.02, more than double the risk/return ratio for the HNC suburbs at 0.98, again showing the safer investment performance of the unit market in areas located under the existing southern flight path (Refer to Table 6-15).

Table 614: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise	7.66	8.67	1.13
Moderate Noise	7.40	8.06	1.09
No/Low Noise	7.86	9.87	1.26
Brisbane	7.18	8.80	1.23

Table 615: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise	7.22	7.09	0.98
Moderate Noise	7.28	8.78	1.21
No/Low Noise	8.29	16.75	2.02
Brisbane	7.18	8.80	1.23

SUBURB COMPARISON: UNITS (HIGH NOISE COMPLAINT SUBURBS V MIDDLE SOCIO ECONOMIC SUBURBS)

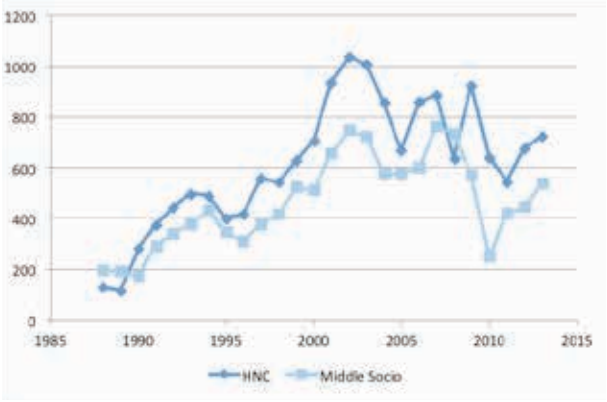
As was the case with the housing analysis based on a suburb basis, a further analysis of the various Brisbane unit markets has been carried out comparing the HNC suburbs to the middle socio-economic suburbs. Figure 6-9 shows the similar trend in median unit sales volume over the period for units in the HNC and middle socio-economic suburbs, although the volume of sales on an annual basis has been greater in the HNC suburbs. Both locations saw a peak in annual sales in 2002, with a significant fall in sales in the middle socio-economic suburbs from 2008 to 2010 and a similar drop in sales for the HNC suburbs one year later from 2009 to 2011. The variation in the volume of sales and the trend in annual sales is also reflected to the positive but non-significant correlation between the two unit markets, with a correlation coefficient of only r = 0.11, well below the 5% level of significant correlation of r = 0.37

Table 6-16: Correlation Analysis Units: Sales Volume HNC Suburbs v Middle Socio-economic Suburbs

	HNC	*Middle Socio*
HNC	1.00	
Middle Socio	0.11	1.00

**Significant at the 5% level*

Figure 6-9: HNC Suburbs v Middle Socio-economic Suburbs: Units Sales Volume 1988-2013



Figures 6-10 and 6-11 show the trend in median and average unit prices for the HNC and middle socio-economic suburbs. These figures show that the trend for median and average unit prices from 1988 to 2013 have been relatively similar for the HNC suburbs and middle socio-economic suburbs but differ to the overall median unit price for the Brisbane LGA.

Table 6-17: Correlation Analysis Units Median Price: HNC Suburbs v Middle Socio-economic Suburbs

	HNC	*Middle Socio*	*Brisbane*
HNC	1.00		
Middle Socio	*0.66	1.00	
Brisbane	*0.48	*0.70	1.00

**Significant at the 5% level*

The median price trend similarity is also supported by Table 6-17 that shows a very significant correlation coefficient of r = 0.66 for the middle socio-economic suburbs and the HNC suburbs. This Table also shows a very significant correlation between the middle socio-economic suburbs and the Brisbane median unit price (r = 0.70) but a lower coefficient for the HNC suburbs and the Brisbane median unit price (0.48).

Figure 6-10: HNC Suburbs v Middle Socio-economic Suburbs: Units Median Price: ($ thousands): 1988-2013

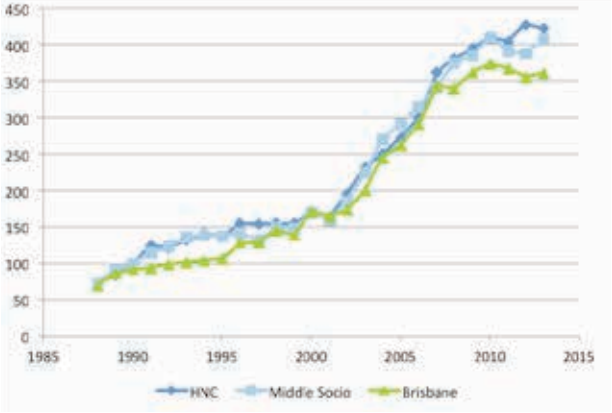


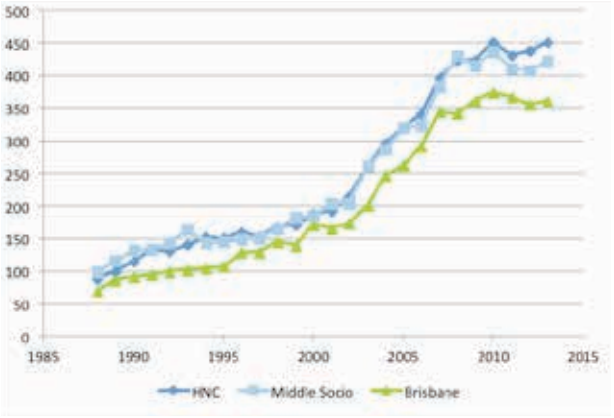
Table 6-18: Correlation Analysis: Units: Average Sales: HNC Suburbs v Middle Socio-economic Suburbs

	HNC	*Middle Socio*	*Brisbane*
HNC	1.00		
Middle Socio	*0.61	1.00	
Brisbane	*0.59	*0.39	1.00

**Significant at the 5% level*

Again, the overall trends in the average price of units in the HNC suburbs and the middle socio-economic suburbs have been relatively similar for the three unit classifications. However, the relationship between the percentage changes in unit average prices are slightly less on the average price basis compared to the median price for the HNC and middle socio suburbs. Despite this slight decrease from 0.66 to 0.61 they are still very highly correlated, again showing that any change in price is not directly related to the location of the HNC suburbs under the current Brisbane airport flight path.

Figure 6-11 HNC Suburbs v Middle Socio-economic Suburbs: Units Average Price: ($ thousands): 1988-2013



Tables 6-19 and 6-20 show the investment performance of these market sectors over the 26 year study period. In the case of the analysis based on median unit prices, units in the HNC suburbs have outperformed both the middle socio-economic suburbs and the Brisbane LGA unit returns. Not only did the HNC outperform on an average annual capital return basis but also at a lower volatility, which also resulted in a better risk return ratio of 1.12 compared to 1.15 for the middle socio-economic suburbs and 1.23 for the Brisbane units

Table 6-19: Capital Return and Investment Performance: Median Price 1988-2013: HNC v Middle Socio-economic Suburbs: Units

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise Suburbs	7.65	8.58	1.12
Middle socio Economic Suburbs	7.50	8.63	1.15
Brisbane	7.18	8.80	1.23

Table 6-20: Capital Return and Investment Performance: Average Price 1988-2013: MNC v Middle Socio-economic Suburbs

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
High Noise Suburbs	7.00	6.78	0.97
Middle socio Economic Suburbs	6.36	8.72	1.37
Brisbane	7.18	8.80	1.23

On an average price basis the HNC suburbs again outperformed the middle socio-economic suburbs on a capital return basis. Although the average annual capital return based on average unit prices decreased to 7.00% for the HNC suburbs and 6.36% for the middle socio-economic suburbs, the volatility for the HNC suburbs was also much lower at 6.78%, resulting in a risk/return ratio of 0.97.

As was the case with the house market analysis, the annual differences in median and average prices were calculated as a percentage to determine the difference in price for units in these suburbs on both an annual and overall average annual basis. These results are shown in Table 6-21 below. These results have tended to mirror the results seen in the house analysis. The price for units in the middle socio-economic suburbs was higher in the years 1988 to 1993 based on both median and average prices. In the case of the median price analysis, the unit median price in the years 2004 to 2006 was lower in the HNC suburbs. In all other years the median price percentage difference each year was positive for the HNC suburbs. In total there were 7 years where the percentage difference in price was negative for the HNC suburbs but 19 years where it was positive, resulting in an overall average annual positive difference of 1.97%. As was the case with the housing analysis there was an overall negative average annual percentage price difference of -0.12% between the average price of units in the HNC suburbs compared to units in the middle socio-economic suburbs. However this average annual price percentage was much lower than the housing results. These results again show that the location of units under the main southern flightpath has no impact on the median price for units in Brisbane compared to units that are somewhat or not affected by aircraft noise. The results also show that on an average price basis there are more years over the period 1988 to 2013 when the price differential favoured the units in the HNC suburbs and overall the average annual price differential was less than 1%.

A further sub period analysis of these capital return comparisons are shown in Table 6-22. On a sub period basis the median unit price for properties in middle socio-economic suburbs subject to high levels of aircraft noise and complaints have been consistently higher than similar suburbs that have moderate or minimal aircraft noise. On a median price basis the greatest difference has been the last three and five year periods where the difference between the median unit price in the HNC suburbs has been on average 5.77% and 3.98%% higher respectively. The period where this difference has been the lowest (with HNC still higher) was the last 15 year period, indicating that over recent times, despite an increase in actual aircraft movements these high noise suburbs have been attracting higher unit prices than similar Brisbane suburbs not subject to the same levels of aircraft noise.

Table 6-21: Annual % Variation between HNC Suburbs and Middle Socio-economic Suburbs: Median Price and Average Price: Units

Year	Median Price Comparison (%)		Average Price Comparison (%)
1988	0.00	1988	-11.22
1989	-8.70	1989	-14.66
1990	-1.01	1990	-12.98
1991	8.70	1991	-0.75
1992	-1.63	1992	-9.09
1993	-2.94	1993	-14.11
1994	1.44	1994	5.59
1995	0.00	1995	4.17
1996	9.93	1996	6.71
1997	15.79	1997	2.00
1998	4.03	1998	1.82
1999	4.73	1999	-6.04
2000	0.00	2000	1.08
2001	1.88	2001	-5.42
2002	5.41	2002	4.41
2003	3.11	2003	0.00
2004	-7.41	2004	2.79
2005	-6.85	2005	0.00
2006	-4.76	2006	5.59
2007	5.85	2007	3.39
2008	1.87	2008	-1.63
2009	2.60	2009	2.42
2010	0.00	2010	3.21
2011	3.32	2011	4.87
2012	10.31	2012	7.11
2013	3.69	2013	6.64
Average Annual	1.97	**Average Annual**	-0.54

Table 6-22: Analysis of Variation between HNC Suburbs and Middle Socio-economic Suburbs: Median Price and Average Price Differences

Period	Median Price Difference	Average Price Difference
Last 3 years	5.77%	6.21%
Last 5 years	3.98%	4.85%
Last 10 years	0.86%	3.44%
last 15 years	1.58%	1.87%
Last20 years	2.75%	2.44%
last 25 years-	1.97%	-0.12%

Although the variation in the average price for units in HNC suburbs and MNC and NNC suburbs was not as high as the median price analysis, in all sub periods the HNC suburbs had a higher average annual price compared to the other middle socio-economic suburbs. Again the highest price percentage difference was in the last three and last five year periods with an average annual higher price difference of 6.21% and 4.85% respectively. Removing the price difference for 1988 actually results in an increase in the price difference across all sub period analysis, with the 25 year period showing a decrease from a lower percentage difference from -0.54 to -0.12.

Again, as is the case for median house prices, the only explanation for these results is that aircraft noise is not the determining factor for value in these locations and a convenient location to the Brisbane CBD, good schools, services and transport are more likely drivers of unit prices for suburbs under the existing flight paths.

SUBURB COMPARISON RENTAL COMPARISONS: HOUSES

The previous analysis has focused on the price differences between houses and units located in suburbs of Brisbane with varying exposure to aircraft noise. This section of the report will carry out a similar analysis based on the median rent for both three bedroom houses and two bedroom units across the same suburbs. This analysis will look at both the number of rental bonds that are registered each year and the median rents for those particular suburbs for the period 1994 to 2013 only.

Figure 6-12: Suburb Comparison: Volume of Rent Bonds 1994-2013

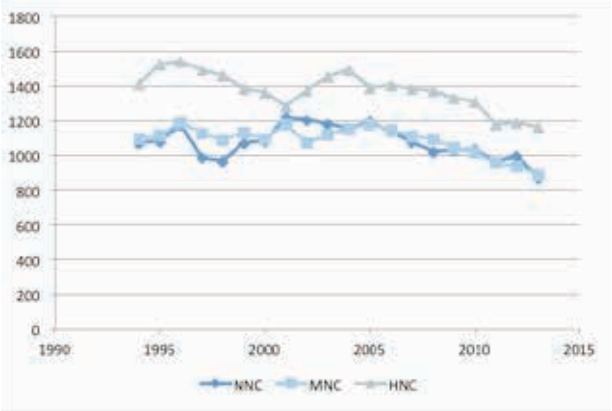


Figure 6-12 shows the number of rental bonds registered for houses for each of the years from 1994 to 2013 for the HNC, MNC and NNC suburbs of Brisbane. Unlike the sale trends, the rental trends for houses across the study locations has been varied from 1994 through to 2005, but the overall trend in rent bonds has been similar across the three classifications since 2005. This figure also shows that the highest numbers of properties for rent are in the HNC suburbs and the rental volume trends have been more similar in the MNC and NNC suburbs. This is confirmed in Table 6-23 which shows the correlation between these three locations. During the period 1994 to 2013 there has been a significant correlation between the change in annual rental bonds for houses in the HNC and MNC suburbs but only a slight non-significant negative correlation between rental bond numbers in the HNC and NNC suburbs. There was also no significant correlation between the MNC and NNC suburbs.

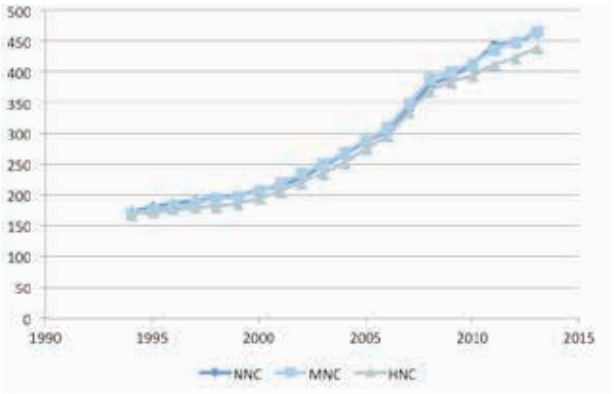
Table 6-23: Correlation Analysis: Rental Bond Volume: Houses 1994-2013

	NNC	*MNC*	*HNC*
NNC	1.00		
MNC	*0.68	1.00	
HNC	-0.04	0.01	1.00

**Significant at the 5% level*

In relation to average weekly rentals in the three suburb classifications, Figure 6-13 shows that the trend in all suburbs has been relatively similar, with the average weekly rental in the MNC and NNC suburbs virtually identical over the 20 year period. From 1994, the weekly rents in the HNC suburbs were slightly lower than the other two classifications through to 2008, with this gap widening in the period from 2008 to 2013. This difference in average weekly rents can be explained by the fact that the HNC suburbs are all middle socio-economic suburbs, whereas the NNC and MNC suburbs have a greater proportion of high socio-economic suburbs and several of these suburbs also have a higher proportion of high value homes for rent.

Figure 6-13: Suburb Comparison: Rental Rates of 3 Bedroom Houses 1994-2013



Although the NNC and MNC suburbs have shown a higher average weekly rent compared to the HNC suburbs, Table 6-24 confirms that the actual change in rental values from year to year are extremely highly correlated between the three suburb classifications (HNC, MNC r = 0.95; HNC, NNC r = 0.88). This level of correlation shows that the location of rental property under the existing main southern flightpath, which attracts the highest level of noise complaints, has a rental market increasing at the same percentage as properties not located under an existing flightpath.

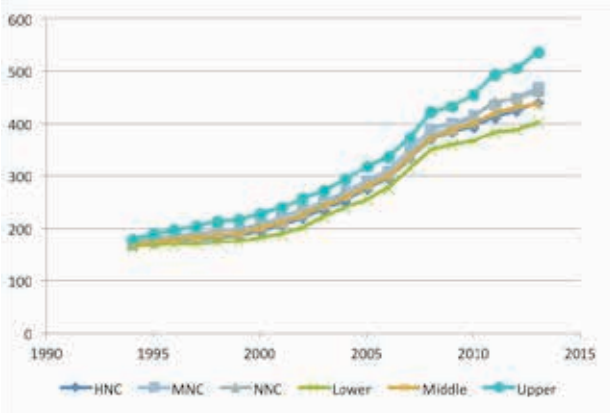
Table 6-24: Correlation Analysis: Average Weekly Rents: Houses 1994-2013

	NNC	*MNC*	*HNC*
NNC	1.00		
MNC	*0.93	1.00	
HNC	*0.88	*0.95	1.00

**Significant at the 5% level*

Figure 6-14 compares the average weekly rental for Brisbane based on both levels of aircraft noise and socio-economic status. This figure shows that the trend in rent increases over the period 1994 to 2013 have been very similar regardless of the location of the property. The highest weekly rental values are in the high value suburbs and the lowest in the lower value suburbs.

Figure 6-14: Comparison Rental Rates: Noise Complaint v Socio-economic Status

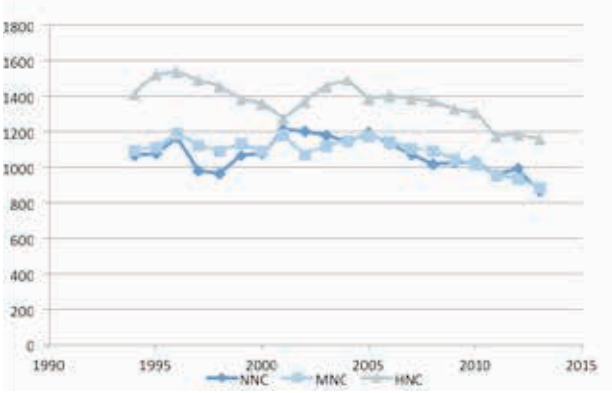


It is interesting to note that the weekly rentals for houses in the HNC suburbs have increased at virtually identical levels as the middle value suburbs. As stated previously, all the suburbs in the HNC classification are middle socio-economic suburbs. This again indicates that the location of a rental property under a flight path and subject to aircraft noise will achieve very similar rental rates per week as a similar property in a non-affected location

SUBURB COMPARISON RENTAL COMPARISONS: UNITS

Where there was a very similar trend in the movement and volume of rental bonds for houses across the three suburb classifications, this has not been the case with 2 bedroom units in the same suburb locations. Figure 6-15 shows that the HNC suburbs have had the highest number of rental bonds recorded for each of the years 1994 to 2013. For the period 1994 to 2005, there was a marked difference in the volume of rentals and the trend in rentals across the three noise classification suburbs. However, since 2005, although the volume of rentals has continued to be higher for the HNC suburbs, the actual trend in new rentals has been more similar to the MNC and NNC suburbs.

Figure 6-15: Suburb Comparison: Rent Bonds Volume 1994-2013



This variation in rental volumes is further evidenced in Table 6-25, which shows that there is no significant positive correlations between unit rental volume across the three suburb classifications. These results do not reflect the same trends as house rentals in the same suburbs.

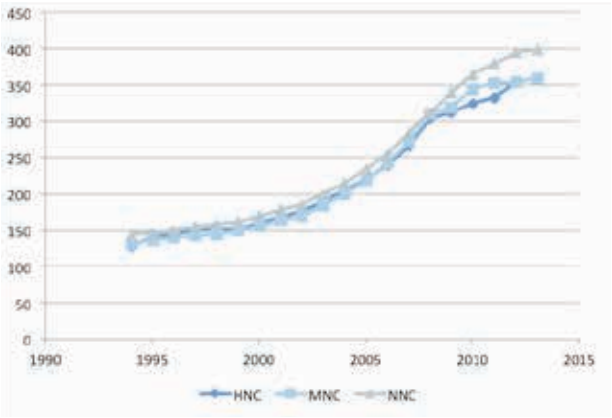
Table 6-25: Correlation Analysis: Suburb Comparison Units 1994-2013

	NNC	*MNC*	*HNC*
NNC	1.00		
MNC	0.05	1.00	
HNC	-0.04	-0.15	1.00

**Significant at the 5% level*

Figure 6-16 records the changes in average weekly rentals for the period 1994 to 2013 for 2 bedroom units in the HNC, MNC and NNC suburbs. This figure again shows that the highest weekly rents for units has been in the NNC suburbs, again reflecting the higher socio locations of some of the suburbs in this aircraft noise classification. It is interesting to note that from the period 1994 through to 2008, the average weekly rental rates per year were very similar for the HNC and MNC suburbs.

Figure 6-16: Suburb Comparison: Rental Rates: 2 Bedroom Units 1994-2013



However, during the period from 2008 to 2012, there was a noticeable difference in the average weekly rental for the MNC suburbs compared to the HNC suburbs. This difference was actually 5.5% in 2010 and 5.6% in 2011. After 2011, the actual average weekly rental for these two aircraft noise suburb classifications has been identical. Table 6-26 also confirms the strong positive correlation between the average weekly rental movements in the HNC and MNC suburbs (r = 0.83) and the NNC suburbs (HNC r = 0.58 and MNC suburbs r = 0.79). Although there are a greater number of rental properties in the HNC suburbs each year, this is not reflected in the increase in rental prices over the period 1994 to 2013, with all markets moving at similar rates per year.

Table 6-26: Correlation Analysis: Rental Rates 2 Bedroom Units 1994-2013

	HNC	*MNC*	*NNC*
HNC	1.00		
MNC	*0.83	1.00	
NNC	*0.58	*0.79	1.00

**Significant at the 5% level*

STREET COMPARISONS

The previous analysis has been based on entire suburbs in locations that are affected by varying degrees of aircraft noise based on the number of complaints that are received. Although all the suburbs in the HNC and MNC suburbs were subject to aircraft noise, this following analysis has identified streets that are directly under the various Brisbane airport flight paths. This has been carried out to limit other value drivers in these specific residential property sectors. The following analysis is based on matched streets in suburbs on the following basis:

- Streets with recognised aircraft noise within ANEF 20 (existing runway operations)
- Streets with recognised aircraft noise adjoining ANEF 20 (existing runway operations)
- Streets with recognised aircraft noise within ANEF 20 (proposed runway operations: south flight path)
- Streets with recognised aircraft noise adjoining ANEF 20 (proposed runway operations: south flight path)
- Streets with recognised aircraft noise within ANEF 20 (proposed runway operations: north flight path)
- Streets with recognised aircraft noise adjoining ANEF 20 (proposed runway operations: north flight path)
- Streets under the flight path (existing runway: Southern Suburbs) at varying distance from Brisbane airport
- Streets under the flight path (existing runway; Northern Suburbs) at varying distance from Brisbane airport
- Streets under the proposed new Brisbane runway at varying distance from Brisbane airport
- Streets in suburbs that are not under any flightpaths; current or proposed

To provide a realistic real estate investment performance analysis, the number of streets in the various study locations ranged for 16 to 48, providing sufficient data to analyse these residential property sectors. Again, the Brisbane median house price has been included to demonstrate the level of performance for these actual street locations to the overall Brisbane residential property market.

STREET COMPARISON: WITHIN AND ADJOINING ANEF20 (EXISTING RUNWAY)

Streets within and adjoining ANEF 20 contour are the locations in Brisbane that have the most recognised exposure to aircraft noise. In relation to ANEF 20 contour, the streets within ANEF 20 contour are located in the suburbs of Morningside, Canon Hill and Camp Hill, with the adjoining streets to this contour including streets located in Morningside, Canon Hill, Camp Hill, Seven Hills and Murrarie.

Figure 6-17 shows the annual sales transaction for houses within ANEF 20 contour and those streets outside ANEF 20 contour in the same suburb locations. From this figure it can be seen that there has been a greater number of sale transactions in the streets adjoining the ANEF 20 contour compared to sales within the ANEF 20 contour, although the trend in the number of sales per year has been relatively similar. Over the 26 year period the peak in sales in the adjoining streets occurred in 1999 and 2007, while the years for maximum sales within the noise contour were 2006 and 2007

Figure 6-17: Comparison Sales Volume Within and Adjoining ANEF 20: Existing; Southern Suburbs

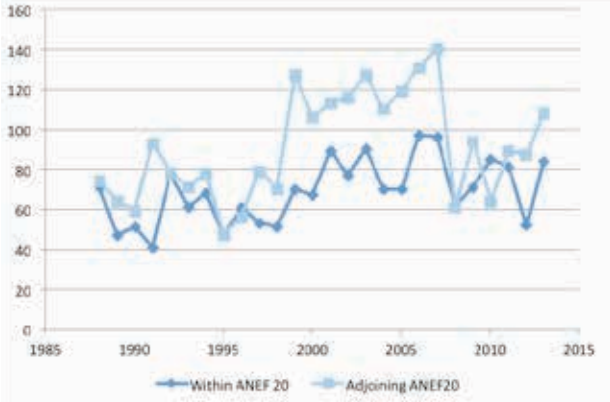


Figure 6-18 shows the trend in median house prices for these house locations subject to the higher aircraft noise levels within and adjoining the ANEF 20 contour. This figure shows that from 1988 through to 2003, the median house price for both sectors were very similar moving from $69,000 in 1988 to $360,000 (Within) and $370,000 (adjoining) in 2003. Since 2003, the trend in changing median house prices has been similar in both locations, with the streets adjoining the ANEF 20 contour showing a higher median price per year, apart from 2011 when the median price for houses within the ANEF contour was higher than the adjoining streets. The Brisbane median house price is also compared in Figure 6-18 and shows that until 2000, the Brisbane median house price was higher than the median house price for the streets within and adjoining the ANEF 20 contour for the southern flight path. However, since 2000, both the houses directly under ANEF 20 contour and adjoining have shown a higher median house price for these noise affected properties, with the median house price difference between the houses under the ANEF 20 contour and the Brisbane median house price ranging from the ANEF 20 contour houses being $35,000 higher in price at the lowest difference in 2010 to a higher difference of $110,000 in 2013. Despite the high levels of aircraft noise, these streets have outperformed the Brisbane median house price for the last 13 years despite increasing aircraft movements.

Figure 6-18: Median Price Comparison: Within and Adjoining ANEF20: Existing Runway: ($ thousands): 1988-2013

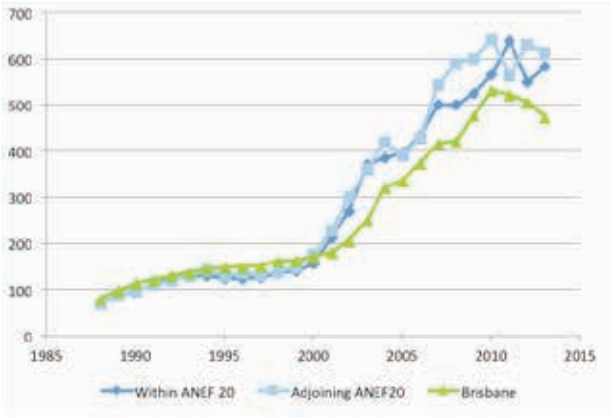


Figure 6-19 shows a similar result when the comparisons are made on an average price basis. Again, the average house price for the houses within and adjoining the southern runway ANEF 20 contour, have shown a higher average annual price compared to the Brisbane median house price for the period 2000-2013. Over the 26 years of this analysis the average annual median price difference for the adjoining streets compared to the streets within the ANEF 20 contour has been +4.33%, with the average annual median price for houses in ANEF 20 contour being +4.48% higher than the Brisbane median house price.

On an investment performance basis, the average annual capital return over the period 1988 to 2013 has been considerably greater for the streets within and adjoining the ANEF 20 contour compared to the Brisbane median house price return. Tables 6-23 and 6-24 also show that houses in streets within and adjoining the ANEF 20 contour returned an average annual capital gain of 9.45% and 9.72% respectively based on the annual change in median price. These returns are significantly higher (21.78% and 25.25% respectively) than the average annual capital return for the Brisbane median house. Although the overall volatility for the ANEF 20 houses was higher than the Brisbane median house volatility, the risk return ratios were similar at 1.24 (Within ANEF 20); 1.21 (Adjoining ANEF 20) and 1.08 (Brisbane median)

Figure 6-19: Average Price Comparison: Within and Adjoining ANEF20: Existing Runway: ($ thousands): 1988-2013

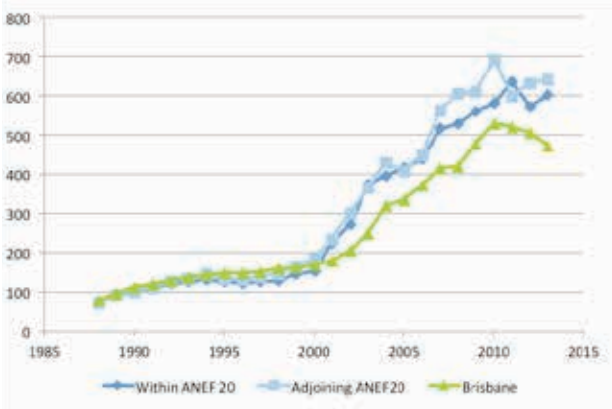


Table 6-28 shows that on an average price basis houses within the ANEF 20 contour have performed slightly lower; and with a higher volatility compared to the average annual return performance of the houses in the streets adjoining the ANEF 20 contour. This suggests that houses directly under the most recognised noise locations have a slightly reduced price and average annual capital growth compared to similar properties not directly under the recognised aircraft noise affected areas, with this difference in average annual capital return being 2.92% based on median prices and 3.79% based on average prices. These results are significantly lower than the academic studies identified in the literature review of this study.

Tables 6-29 and 6-30 provide the results of the correlation analysis between these three housing sectors. The results confirm the very strong significant positive correlation between the movement in both median and average house prices in the streets within and adjoining ANEF 20 contour (r = 0.64 median price and r = 0.69 average price). Both locations have a positive significant correlation to the change in the Brisbane median house price.

Table 6-29: Correlation Analysis: Median Prices 1988-2013

	In ANEF 20	*Adj ANEF 20*	*Brisbane*
In ANEF 20	1.00		
Adj ANEF 20	*0.64	1.00	
Brisbane	*0.48	*0.54	1.00

**Significant at the 5% level*

Table 6-30: Correlation Analysis: Average Prices: 1988-2013

	In ANEF 20	*Adj ANEF 20*	*Brisbane*
In ANEF 20	1.00		
Adj ANEF 20	*0.69	1.00	
Brisbane	*0.40	*0.60	1.00

**Significant at the 5% level*

Table 6-27: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	9.45	12.00	1.24
Adjoining ANEF 20	9.72	11.72	1.21
Brisbane LGA	7.76	8.35	1.08

Table 6-28: Capital Return and Investment Performance: Average Price 1988-2013

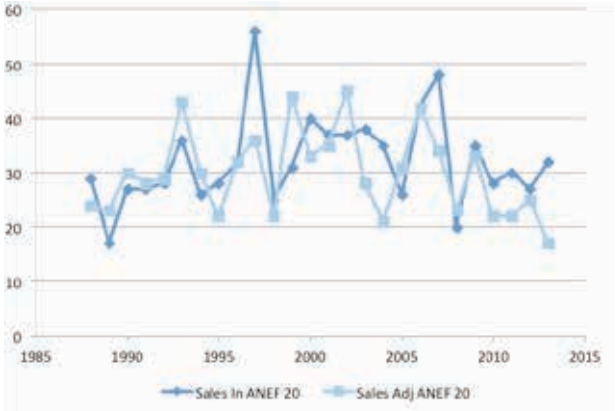
Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	9.37	12.36	1.32
Adjoining ANEF 20	9.74	10.96	1.12
Brisbane LGA (median)	7.76	8.35	1.08

STREET COMPARISON: WITHIN AND ADJOINING ANEF20 (PROPOSED RUNWAY: BALMORAL)

The following analysis has adopted the same approach as the street analysis above. However in this case the identified areas are based on the houses located in streets that will be within and adjoining the ANEF 20 contour for the new parallel runway at Brisbane airport. The first section of this new runway analysis is based on the suburbs on the southern side of the Brisbane River covering the suburb of Balmoral, with the second ANEF 20 contour analysis covering the suburbs on the northern side of the Brisbane River covering the suburbs of Ascot and Hendra. Although not currently affected by the proposed runway flight paths, details of the runway and flight paths have been accessible to the public and potential home buyers since 2004.

The sales transaction figures for the streets that are currently not directly affected by the existing Brisbane airport runway are shown in Figure 6-20.

Figure 6-20: Comparison Sales Volume: Within and Adjoining ANEF20: Proposed Flight Path; Southern Suburbs



From this figure it can be seen that the volume and trend in sales for the streets in Balmoral are very similar regardless of whether they are located within or adjoining ANEF 20. Important dates to consider for this analysis are the first announcement of the new runway plans in 2004 and the official Government approval in 2007. Since 2007 there have been regular Brisbane Airports Corporation updates on the project, as well as extensive print and electronic media coverage. On this basis, it is most likely that the residential property sector in these specific study locations would have some knowledge of the runway development.

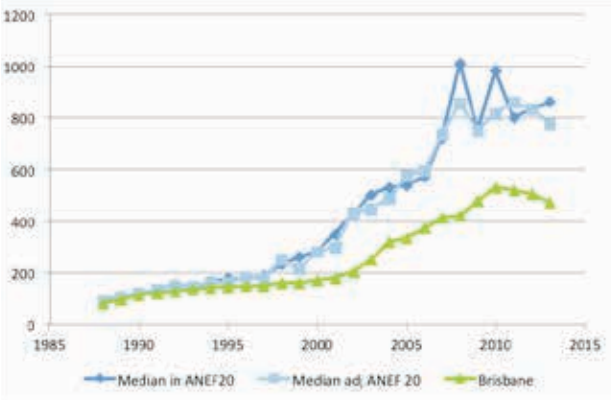
Table 6-31: Correlation Analysis: Within and Adjoining ANEF 20: Sales Volume 1988-2013

	Sales In ANEF 20	*Sales Adjoining ANEF20*
Sales In ANEF 20	1.00	
Sales Adjoining ANEF20	*0.47	1.00

**Significant at the 5% level*

Table 6-31 again confirms the significant positive correlation between the annual sales volume for residential houses in the streets within and adjoining the new ANEF 20 contour (r = 0.47).

Figure 6-21: Comparison Median Price: Within and Adjoining ANEF 20: New Flight Path South: ($ thousands): 1988-2013



The analysis of the median price trends for these streets within and adjoining the ANEF 20 contour for the new runway show that the potentially noise affected streets median prices have been very similar, especially in the period 1988 to 2008. Since 2008 there has been more volatility in annual median prices. This can be explained by this suburb's location on the Brisbane River and the flood impact of 2011 and the impact of the GFC on higher value residential property in Brisbane. The median house price for residential property both within and adjoining the proposed ANEF 20 noise contour has been higher than the Brisbane median house price, particularly from 1997, when there was a greater demand for and gentrification of inner ring property in the south Brisbane suburbs.

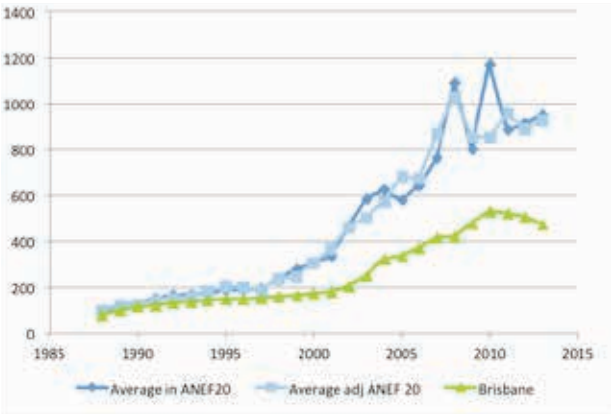
Table 6-32: Correlation Analysis: Within and Adjoining ANEF 20: Median Price 1988-2013

	MP In ANEF20	*MP Adj ANEF 20*	*Brisbane*
MP In ANEF20	1.00		
MP Adj ANEF 20	*0.44	1.00	
Brisbane MP	0.18	0.25	1.00

**Significant at the 5% level*

This similarity in median prices are also confirmed by the significant positive correlation (r = 0.44) between the two housing sectors (Refer to table 6-32). Both these locations in Balmoral have no significant correlation with price change movements compared to the Brisbane median house price.

Figure 6-22: Comparison Average Price: Within and Adjoining ANEF 20: New Flight Path South: ($ thousands): 1988-2013



A similar relationship between the residential property within and adjoining the ANEF 20 contour also resulted when the average residential property prices are analysed. Figure 6-22 again shows a very similar trend in average house prices for the period 1988 to 2009, with more volatility in the period 2009 to 2011. Table 6-33 also confirms the significant correlation between average annual price movements for these two residential housing sectors.

Table 6-33: Correlation Analysis: Within and Adjoining ANEF 20: Median Price 1988-2013

	AP in ANEF20	*AP Adj ANEF 20*	*Brisbane*
AP in ANEF20	1.00		
AP Adj ANEF 20	*0.42	1.00	
Brisbane MP	0.30	0.16	1.00

On a capital return basis, the Balmoral streets that will be under the proposed flight [path ANEF 20 contour have shown a higher average annual capital return based on both median and average house prices. For houses within the ANEF 20 contour the average annual capital returns based on median and average prices have been 10.70% and 11.72% respectively, with houses in streets adjoining showing a slightly lower average annual capital return of 9.73% and 9.99%. These returns are well above the average median capital return for the Brisbane LGA. These higher capital returns reflect the higher socio-economic status of Balmoral, and is in line with the overall suburb results for the higher socio-economic suburbs that have been analysed in the previous sections of this report. The higher returns also reflect the higher volatility of the change in house prices for both these two sectors, especially for the streets within the ANEF 20 contour based on average prices. This volatility can also be explained by the variation in houses in this particular area ranging from very high value direct riverfront properties to more modest housing away from the Brisbane River.

Table 6-34: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	10.70	14.50	1.36
Adjoining ANEF 20	9.73	14.43	1.48
Brisbane LGA	7.72	8.35	1.08

Table 6-35: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	11.72	18.60	1.59
Adjoining ANEF 20	9.99	11.84	1.19
Brisbane LGA (median)	7.72	8.35	1.08

Both the streets within and adjoining the noise contours in Balmoral have shown a significantly higher risk/return ratio compared to the Brisbane median house price for the 26 year period. This difference is more pronounced for the streets within the ANEF 20 noise contour (Refer to Tables 6-34 and 6-35). This difference in risk/return ratios between the Brisbane median house price and the return performance for houses within the ANEF 20 contour is greater for the average price analysis but on an average price basis the houses in the adjoining streets have a better risk/return compared to the risk/return performance based on median prices. A review of the location of these streets indicates that a large number of the streets within the ANEF contour are actually close to major military and industrial sites, which may have as much effect on the current residential property market in this location as potential aircraft noise, especially compared to the adjoining streets without that same proximity to non-residential uses. A large proportion of the military land directly under the new runway southern flight path has been recently designated for redevelopment to mixed residential use.

STREET COMPARISON: WITHIN AND ADJOINING ANEF20 (PROPOSED RUNWAY: ASCOT/HENDRA)

A similar analysis based on the proximity of streets to the new runway ANEF 20 Contour has also been carried out for the potentially affected and adjoining streets located on the northern side of the Brisbane River. These streets are actually located closer to the existing Brisbane airport runway, and subject to greater levels of aircraft noise compared to Balmoral, where the residential streets are slightly further away from the airport. In the case of this comparison of streets, the streets within the ANEF 20 noise are predominately in the suburb of Hendra, with the Ascot suburb streets being the lower lying streets close to Doomben Racecourse. The adjoining streets are predominately in the suburb of Ascot and comprise a generally higher value residential property sector compared to the streets within the ANEF 20 contour. This socio-economic difference is also reflected in the median and average house prices over the 26 year study period. Although Hendra is not directly under a flight path, the close proximity to the Brisbane Airport boundary results in a very physical exposure to aircraft and airport activity.

Figure 6-23: Comparison Sales Volume: Within and Adjoining ANEF 20: North Ascot/ Hendra 1988-2013

Although there has been a greater number of sales in the streets adjoining the northern section of the ANEF 20 contour, compared to sales in the streets within the contour, Figure 6-23 shows that the actual trend in the change in annual sales has been reasonably similar, with the highest volume of sales in the period 1997 to 2003 and the lowest volume of sales occurring in 1996, 2004 and 2005 for both street classifications. There were only 12 sales for the streets within the ANEF contour in 1996 and the lowest number of sales transactions for the adjoining streets was 16 in 2008.

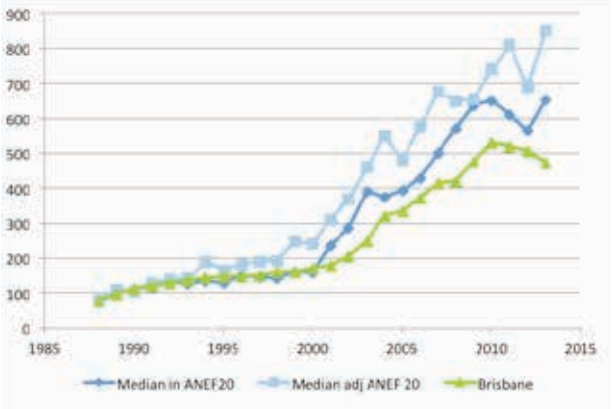
Table 6-36: Correlation Analysis: Within and Adjoining ANEF 20: Sales Volume 1988-2013

	In ANEF 20	*Adj ANEF 20*
In ANEF 20	1.00	
Adj ANEF 20	*0.63	1.00

**Significant at the 5% level*

Table 6-36 also confirms the similarity in sales volume movement on an annual basis with the correlation between the two street classifications being very highly positively correlated at r = 0.63.

Figure 6-24: Comparison Median Price: Within and Adjoining ANEF 20: Proposed Flight Path: ($ thousands): 1988-2013



The median price for streets in Ascot/Hamilton, adjoining the ANEF 20 contour for the proposed runway, has been significantly higher than the median house price for the streets that will be within the ANEF contour, particularly since 1998 to 2013 where the median price for houses in the adjoining streets has increased from $192,000 to $852,000 in 2013. The median price of houses within the ANEF 20 contour has also increased but from $142,000 to $653,000 over the period. Much of this variation is based on the differing socio-economic status and quality of the houses in the two sectors. Again, the Brisbane median house price is included in the Figures and both these locations have outperformed the Brisbane median house price, particularly for the period 2000-2013. Although median house prices have been higher in the Ascot based streets, the actual trend in annual median price movements has been similar across both the streets within and adjoining the proposed ANEF 20 contour.

Table 6-37: Correlation Analysis: Within and Adjoining ANEF 20: Median Price 1988-2013

	In ANEF 20	*Adj ANEF 20*	*Brisbane*
In ANEF 20	1.00		
Adj ANEF 20	*0.57	1.00	
Brisbane MP	0.30	0.29	1.00

**Significant at the 5% level*

The similarity in median house price change from year to year is evidenced by the very significant positive correlation coefficient of r = 0.57, well above the correlation coefficient comparisons for the Brisbane median house price which were not significant at the 5% level.

The difference between the quality and size of houses within and adjoining the ANEF 20 contour for the new runway is also evidenced in the average annual house price for the two sectors. Again the trend in average house prices has been higher for the streets adjoining the ANEF 20 contour compared to those streets that will be within the ANEF 20 contour. On an average price basis houses in the ANEF 20 contour increased from $79,000 in 1988 to $709,000 in 2013. Over the same period the average price for houses in the streets adjoining the ANEF 20 contour increased from $104,000 to $1,018,000. Again, on an average price basis, both these sectors outperformed the Brisbane median house price.

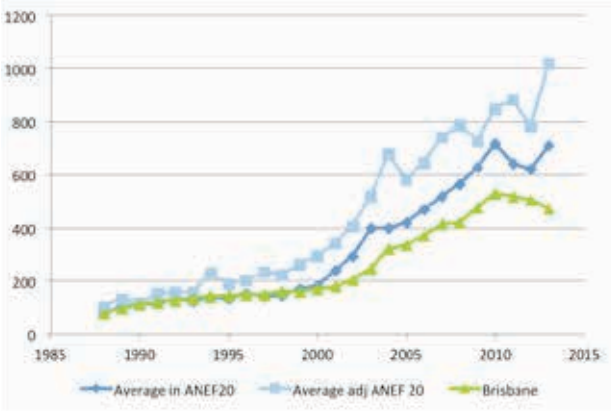
Table 6-38: Correlation Analysis: Within and Adjoining ANEF20: Average Price 1988-2013

	in ANEF20	*Adj ANEF 20*	*Brisbane*
In ANEF20	1.00		
Adj ANEF 20	*0.44	1.00	
Brisbane	*0.40	0.23	1.00

**Significant at the 5% level*

Although the actual average price for houses within ANEF 20 contour was lower on an annual basis, overall the annual change in average house prices was very similar. Table 6-38 shows that the correlation between annual house price movements have been positively significant at the 5% level (r = 0.44), with the houses within the ANEF 20 contour also having a slightly lower significant correlation with the Brisbane median house price movement over the period 1988 to 2013.

Figure 6-25: Comparison Average Price: Within and Adjoining ANEF 20: New Flight Path North: ($ thousands): 1988-2013



Tables 6-39 and 6-40 show the average annual capital returns for the houses in the streets within and adjoining ANEF 20 based on both median and average house prices, as well as the average annual capital returns based on the Brisbane median house price.

At this point in the development of the new parallel runway, the houses within and adjoining ANEF 20 contour in the suburbs of Ascot/Hamilton/Hendra have shown an average annual capital return from 10.09% to 10.85% based on median prices and 10.08% to 10.85% based on average prices. As has been shown in the previous analysis, these higher value suburbs have returned a higher capital return compared to both the middle value suburbs and the Brisbane median house price. These higher average annual capital returns are also subject to greater levels of volatility, resulting in higher risk/return ratios. For houses within the ANEF 20 contour, the risk/return ratio is better, based on the average house price (1.27), compared to the median house price (1.45). The reverse situation has occurred for the adjoining street sector.

FLIGHT PATH COMPARISONS

The following analysis compares the investment performance of houses that are subject to a range of flight path scenarios and at varying distances from Brisbane airport. In each case there are a selected number of streets in each of the selected suburbs, which cover the following locations:

- Southern suburbs under the existing flight path
- Northern suburbs under the existing flight path
- Northern suburbs that will be under the proposed runway fight path
- Suburbs that are not under either the existing or proposed flight paths.

All street locations chosen for this section of the analysis are outside the ANEF 20 contour and the adjoining streets that have been discussed previously in this chapter. The streets closer to the airport would be subject to higher levels of aircraft noise compared to the streets in suburbs further away such as Chermside West, East Mt Gravatt and Stafford. However, all the street locations selected are currently or potentially subject to aircraft noise.

Table 6-39: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	10.09	14.65	1.45
Adjoining ANEF 20	10.85	12.79	1.27
Brisbane LGA	7.72	8.35	1.08

Table 6-40: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Within ANEF 20	10.08	14.85	1.27
Adjoining ANEF 20	10.72	16.29	1.52
Brisbane LGA (median)	7.72	8.35	1.08

SUBURB STREET COMPARISON: SOUTHERN FLIGHT PATH: VARYING DISTANCES

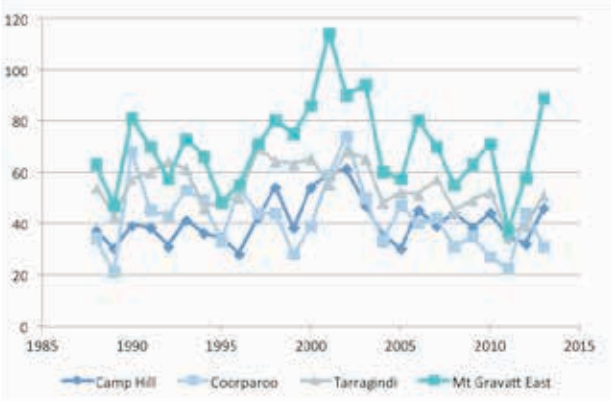
The first comparison covers four southern suburbs currently subject to aircraft noise from the existing flight paths. These suburbs range from 10.5 km from the airport (Camp Hill) to 14.5 km distance (Mt Gravatt East). Again both the median and average prices per annum are also compared to the Brisbane median house price.

The annual numbers of house sale transactions for each of the street locations under the existing flight path are shown in Figure 6-26 and the correlation coefficients are shown in Table 6-41. The highest numbers of sales over the period 1988 to 2013 has been in the suburbs of Mt Gravatt East and Tarragindi. These are lower middle to mid middle socio-economic suburbs of Brisbane and have a greater proportion of freestanding residential houses compared to the more inner city areas of Camp Hill and Coorparoo, which have a greater concentration of townhouses and units compared to freestanding residential property. In all cases, the highest volume of house sales occurred in the period 2001 to 2002, with the lowest volume of house sales being in 2011, following the major Brisbane flood event in January 2011.

Table 6-41 confirms that the movement in annual sales volume has been very similar in Mt Gravatt East and Tarragindi (r = 0.58), Mt Gravatt East and Coorparoo (r= 0.61) and Mt Gravatt East and Camp Hill (r=0.64).

Although Camp Hill and Coorparoo are nearly adjoining suburbs the correlation between the volume of annual sales is positive but not significant at r = 0.19.

Figure 6-26: Comparison Sales Volume: Existing Flight Path 1988-2013



Annual median house prices for the selected streets in the four suburbs under the southern flight path are shown in Figure 6-27. Again, these median price results are compared to the Brisbane median house price for the period 1988 to 2013. The inner city suburbs of Camp Hill and Coorparoo have had a higher annual median house price compared to the inner middle and outer middle ring suburbs of Tarragindi and Mt Gravatt East. Despite the various differences in location form the Brisbane CBD and the Brisbane Airport, the general trend in the increase in median prices across the 26 year study period has been relatively similar, with relatively flat growth across all suburbs from 1988 to 2000 and significant annual growth in median house prices from 2001 to 2013.

Table 6-41: Correlation Analysis: Sales Volume Existing Flight Path

	Camp Hill	Coorparoo	Tarragindi	Mt Gravatt East
Camp Hill	1.00			
Coorparoo	0.19	1.00		
Tarragindi	*0.45	*0.39	1.00	
Mt Gravatt East	*0.64	*0.61	*0.58	1.00

**Significant at the 5% level*

Figure 6-27: Comparison Median Price: Existing Flight Path: ($ thousands): 1988-2013

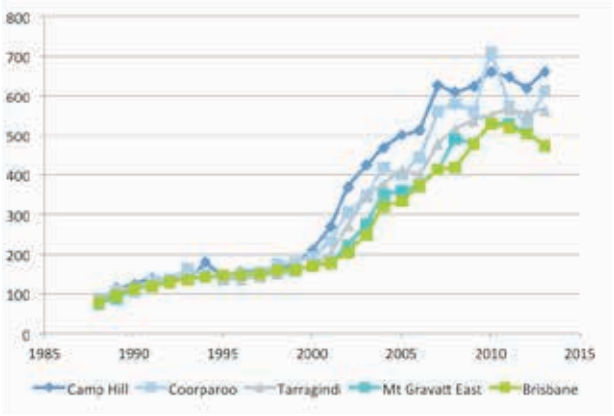
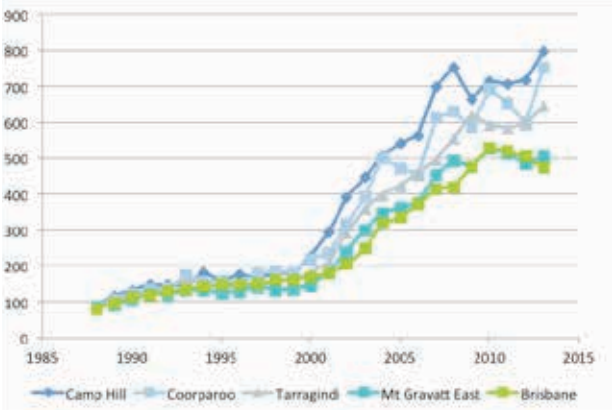


Figure 6-28: Comparison Average Price: Existing Flight Path: ($ thousands): 1988-2013



This has been particularly the case with Camp Hill, where median house prices have increased from $82,000 in 1988 to $661,000 in 2013. This growth in median house prices has been despite the location close to Brisbane airport and the impact of aircraft noise.

Mt Gravatt East is the furthest distance from the airport compared to the other suburbs in this section of the analysis and is classified as a lower middle socio-economic suburb. The median house price trend for Mt Gravatt East has been very similar to the Brisbane median house price for the same 26 year period, including the decline in median house price from 2010 to 2013, when prices in streets for the other three suburbs were generally increasing.

Table 6-42 again shows the very high significant positive correlations between median house price movements across the selected streets in the four suburbs. Over the period 1988-2013, the highest correlations were Camp Hill and Tarragindi (r=0.79); Mt Gravatt East and the Brisbane Median price (r=0.79) and Tarragindi and Mt Gravatt East (r=0.62). All correlations were positively significant at the 5% level, again indicating that house price increase over the 26 year period was very similar regardless of actual distance from the Brisbane airport.

A similar trend across the four suburbs occurs based on average house prices. As is the case with previous analysis across the streets in the ANEF 20 contour affected streets, the average house price has tended to be higher on an annual basis compared to the median house price. Based on average prices, houses in the Camp Hill streets have outperformed the other suburbs with the average house price increasing from $84,000 in 1988 to $798,000 in 2013. Although, based on average house prices, Mt Gravatt East houses had a lower average price than the Brisbane median price from 1988 to 2000. From 2001 to 2010, the average house price in Mt Gravatt East has actually been slightly higher. Generally the trend in house price increase has been relatively similar across the four suburbs. This is again illustrated in Table 6-43 with all locations under the southern flight path having very highly positive significant correlations ranging from r=0.71 (Coorparoo and Mt Gravatt East) to r=0.47 (Coorparoo and Camp Hill).

Table 6-42: Correlation Analysis: Median Price Existing Flight Path: 1988-2013

	Camp Hill	Coorparoo	Tarragindi	Mt Gravatt East	Brisbane
Camp Hill	1.00				
Coorparoo	*0.57	1.00			
Tarragindi	*0.79	*0.57	1.00		
Mt Gravatt East	*0.39	*0.43	*0.62	1.00	
Brisbane	*0.42	*0.46	*0.57	*0.79	1.00

**Significant at the 5% level*

Table 6-43: Correlation Analysis: Average Price Existing Flight Path: 1988-2013

	Camp Hill	Coorparoo	Tarragindi	Mt Gravatt East	Brisbane
Camp Hill	1.00				
Coorparoo	*0.47	1.00			
Tarragindi	*0.49	*0.59	1.00		
Mt Gravatt East	*0.61	*0.71	*0.64	1.00	
Brisbane	0.35	*0.46	*0.50	*0.48	1.00

**Significant at the 5% level*

Table 6-44 Capital Returns and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Camp Hill	9.52	13.75	1.44
Coorparoo	9.09	13.48	1.48
Tarragindi	8.58	10.49	1.22
Mt Gravatt East	7.93	9.63	1.21
Brisbane LGA	7.72	8.35	1.08

The high correlation between the median and average house prices between streets in Mt Gravatt East and Brisbane is also reflected in the capital returns for these two classifications (7.93% Mt Gravatt East; 7.72% Brisbane median). All other suburb street locations under the southern flight path have shown a higher capital return based on median house prices compared to the Brisbane median house price. As the suburbs move closer to the Brisbane airport, the average annual capital returns based on median house prices have increased from an annual return of 8.58% for Tarragindi to 9.52% for Camp Hill. These average annual capital returns are also higher than the average returns based on the HNC suburbs, discussed earlier in this section of the study.

Based on average house prices across these southern flight path streets, the average annual capital returns are higher in Tarragindi, Camp Hill and Coorparoo but slightly lower in Mt Gravatt East. In the case of streets in Coorparoo the average annual capital return increases from 9.09% (median price) to 10.12% (average price). Again, the house price in the streets subject to varying levels of aircraft noise under the southern flight path has been significantly greater than the returns for the median Brisbane house market.

The higher average annual returns have also resulted in higher levels of volatility in house price movements over the study period, with the streets in Tarragindi having the better risk/return ratio of 1.20, compared to the investment return performance in Coorparoo and Camp Hill.

NORTHERN SUBURB STREET COMPARISON: EXISTING FLIGHT PATH: VARYING DISTANCES

The northern flight path study area comprises suburbs exposed to two flight paths and at varying distances from Brisbane airport. This includes the inner city suburbs of Bulimba, Bardon and Albion and the middle ring suburbs of Gordon Park, Ashgrove and Chermside West. Distances of these suburbs from Brisbane airport ranges from 6.5km and 7km for Albion and Bulimba, to 12 and 13 kms for Bardon and Ashgrove.

In addition to variances in location and distance from the Brisbane airport, these suburbs have variations in socio-economic status. Bulimba, Ashgrove and Bardon are classified as higher socio-economic suburbs, with Gordon Park and Chermside West being middle socio-economic suburbs and Albion, although an inner city suburb, is a lower middle socio-economic housing suburb due to the large concentration of industrial property in this suburb.

Table 6-45: Capital Return and Investment Performance: Average Price 1988-2013

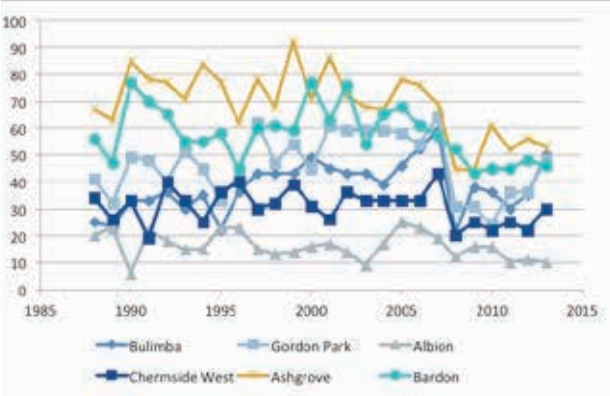
Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Camp Hill	9.92	13.12	1.32
Coorparoo	10.12	14.75	1.46
Tarragindi	8.98	10.78	1.20
Mt Gravatt East	7.90	10.44	1.32
Brisbane LGA	7.72	8.35	1.08

Table 6-46: Correlation Analysis: Sales Volume Existing Flight Path: 1988-2013

	Bulimba	Gordon Park	Albion	Chermside West	Ashgrove	Bardon
Bulimba	1.00					
Gordon Park	*0.44	1.00				
Albion	-0.05	-0.22	1.00			
Chermside West	0.28	0.13	-0.24	1.00		
Ashgrove	0.23	0.33	-0.10	0.03	1.00	
Bardon	0.08	0.22	-0.16	0.07	0.33	1.00

**Significant at the 5% level*

Figure 6-29: Comparison Sales Volume: Existing Flight Path 1988-2013



The industrial nature of Albion is also reflected by the lower volume of annual sales transactions compared to the other streets in the five suburbs in this section of the aircraft noise study. Figure 6-29 also shows the similarity in annual sales trends for the two middle socio-economic areas of Chermside West and Gordon Park. The sales volume per annum for the higher value suburbs of Ashgrove, Bardon and Bulimba has been significantly different, with Ashgrove having the highest number of house sales per annum for all but three years between 1988 and 2013 (2000; 2002 and 2008).

Unlike the correlation analysis based on the suburbs under the southern flight path, there is very limited correlation between the annual number of sales per year across the suburbs under the northern flight path of the existing Brisbane airport runway. Table 6-46 shows that the only significant positive correlation between annual sales is Bulimba and Gordon Park (r=0.44). In the analysis of these streets in the six northern Brisbane suburbs there were a number (six) of negative correlations, with the more significant being Albion and Chermside West (r=-0.24).

Figure 6-30 shows the median prices for these streets in suburbs under the northern flight path, together with the Brisbane median house price. The figure confirms the higher median price for the house sales in the high value suburb of Bulimba, however these higher median prices were also subject to significant volatility, especially during the years from 2007 to 2013. In relation to the other suburbs, the trend in median price movements between the adjoining suburbs of Bardon and Ashgrove was very similar for the 26 year period, increasing from $100,000 in 1988 to $763,000 and $820,000 respectively. It is also interesting to note the similarity between median price movements in the middle value suburb of Chermside West and the Brisbane median house price. During the study period streets in Chermside West have seen an increase in median price from $80,000 to $473,000, identical to the 2013 Brisbane median house price. Gordon Park is a higher value middle socio-economic suburb of Brisbane and this is reflected by the higher annual median price compared to Chermside West and a similar median price trend to Ashgrove and Bardon.

Figure 6-30: Comparison Median Price: Existing Flight Path: ($ thousands): 1988-2013

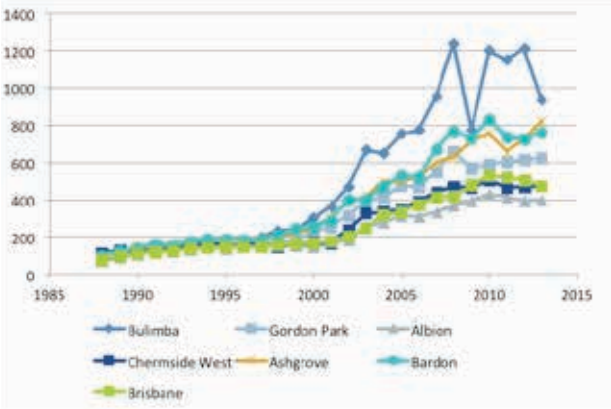
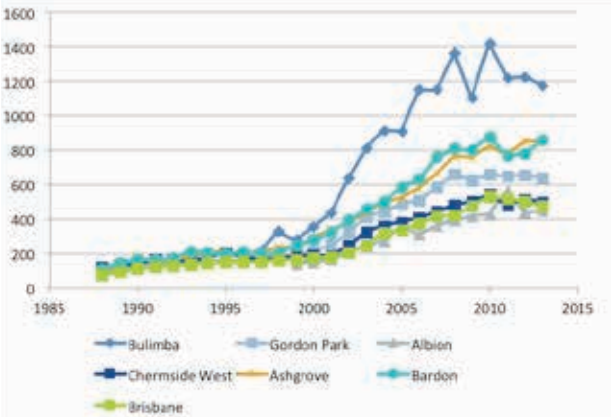


Figure 6-31: Comparison Average Price Existing Flight Path: ($ thousands): 1988-2013



The correlation analysis between annual median house price movements for streets in the six northern suburbs plus the Brisbane median house price are shown in Table 6-47. In general there have been a number of significant positive correlations with some of the northern suburbs, but not to the same extent as the correlations shown for the suburbs under the southern flight path. Bulimba has very high significant positive correlations with Gordon Park (r=0.66) and high significant positive correlations with Chermside West and Bardon (r=0.48 and r=0.45 respectively). Gordon Park also had high significant positive correlations with Bardon, Albion and Chermside West (r=0.64, r=0.46 and r=0.51 respectively). There was also a significant correlation between the adjoining suburbs of Ashgrove and Bardon (r=0.58). The only streets in the northern suburbs that had a significant positive correlation with the Brisbane median price were Albion, Chermside West, Ashgrove and Bardon, with the highest correlation being Albion (r=0.54).

Figure 6-31 also shows that based on average annual prices houses in the Bulimba streets have been significantly higher than the other suburbs and less volatility compared to the median house price. Again, the streets in the suburbs of Ashgrove and Bardon have shown a very similar trend in average price movements across the period 1988 to 2013; both achieving an average price of $863,000 in 2013. On an average price basis the trend in annual prices between Albion and Brisbane median house price is also very similar across the full study period.

On an average price basis there has been slightly less correlations across the 6 suburbs compared to the analysis based on annual median house prices. Table 6-48 shows that based on average annual house prices the highest being Gordon Park and Bardon (r=0.64) and Gordon Park and Chermside West (r=0.57). Again the least significant positive correlations were the streets in Albion, where the change in average annual house prices were positive but not significant with any other suburb.

Table 6-47: Correlation Analysis: Median Price Existing Flight Path: 1988-2013

	Bulimba	Gordon Park	Albion	Chermside W	Ashgrove	Bardon	Brisbane
Bulimba	1.00						
Gordon Park	*0.66	1.00					
Albion	*0.39	*0.46	1.00				
Chermside W	*0.48	*0.51	0.19	1.00			
Ashgrove	0.08	0.30	*0.40	0.22	1.00		
Bardon	*0.45	*0.64	0.28	*0.49	*0.58	1.00	
Brisbane	0.25	0.32	*0.54	*0.42	*0.51	*0.39	1.00

**Significant at the 5% level*

Table 6-48: Correlation Analysis: Average Price Existing Flight Path: 1988-2013

	Bulimba	Gordon Park	Albion	Chermside W	Ashgrove	Bardon	Brisbane
Bulimba	1.00						
Gordon Park	*0.51	1.00					
Albion	0.34	0.36	1.00				
Chermside W	0.36	*0.57	0.04	1.00			
Ashgrove	*0.57	*0.51	0.31	0.23	1.00		
Bardon	0.33	*0.64	0.17	0.30	*0.45	1.00	
Brisbane	0.37	*0.55	0.36	*0.51	*0.48	*0.43	1.00

**Significant at the 5% level*

Table 6-49: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Bulimba	12.44	20.01	1.61
Gordon Park	9.34	9.18	1.05
Albion	8.23	17.11	2.08
Chermside West	6.46	11.92	1.85
Ashgrove	9.20	9.96	1.05
Bardon	9.02	11.34	1.26
Brisbane LGA	7.72	8.35	1.08

Table 6-49 and 6-50 show the average annual capital returns, volatility and risk/return ratio based on the median and average house prices for the selected streets in the six northern suburbs under the existing flight path. As has been the case with all the previous analysis, the higher value suburb of Bulimba, Ashgrove and Bardon have also had the highest capital returns based on average and median house prices.

The surprising result for the six northern suburbs analysis was the capital return performance for Gordon Park. This middle socio-economic value suburb is also closer to the airport runway than a number of other suburbs in this analysis but has also recorded a significantly higher capital return at a relatively low volatility resulting in one of the lowest risk/return ratios of 1.05 (median price) and 1.02 (average price), which is lower than any other suburb or street analysis in this full study.

Another surprising result was the low capital return performance for houses in Albion. Despite this suburb being an inner city classified location, the average annual capital return has been the lowest recorded in the study and the only suburb subject to aircraft noise with an annual capital return less than the Brisbane median house price average of 7.72%. As previously discussed the high proportion of industrial property in Albion appears to have a greater impact on house price performance in this suburb, rather than the impact of aircraft noise under the northern flight path.

The risk/return performance of Ashgrove has also been considerably better than some of the other suburbs analysed in this study. The high average annual capital return based on both median and average prices at 9.20% and 9.05% respectively and volatility of 9.96% and 10.06% respectively. This has resulted in a risk/return ratio of 1.05 based on the median price for Ashgrove houses and 1.13 based on average house prices. These risk/return ratios are in line with the returns from the lower performing suburbs of Brisbane.

These results also indicate that the location of a suburb under the northern flight path and subject to aircraft noise has not had any significant impact on median and average house prices in those locations compared to suburbs not affected by aircraft noise. Location closer to the Brisbane CBD appears to be a more significant driver of property prices than aircraft noise.

Table 6-50: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Bulimba	12.15	18.21	1.50
Gordon Park	9.35	9.51	1.02
Albion	8.33	16.88	2.03
Chermside West	6.59	11.28	1.71
Ashgrove	9.05	10.06	1.13
Bardon	9.30	11.17	1.20
Brisbane LGA	7.72	8.35	1.08

SUBURB STREET COMPARISON: PROPOSED FLIGHT PATH.

To determine the actual impact of the new parallel runway at Brisbane airport and the new flight path associated with the new aircraft movements when full operations commence; a number of streets in three suburbs that currently are not under any flight paths but will be in the future have been identified. These streets are in the suburbs of Hamilton; a high socio-economic inner city suburb in close proximity to the Brisbane airport; New Farm a high value inner city suburb on the northern side of the Brisbane River; Stafford a middle value socio-economic middle ring northern Brisbane suburb (8.5km from Brisbane airport) and Annerley an inner ring upper middle socio-economic southern suburb of Brisbane (11km from Brisbane airport).

The current analysis will allow a base line to be set for these suburbs to assess if additional information on the new runway has a positive, neutral or negative impact on residential property prices in these suburbs and to also monitor house prices once the new runway is in full operation.

Figure 6-32: Comparison Sales Volume: Proposed Flight Path 1988-2013

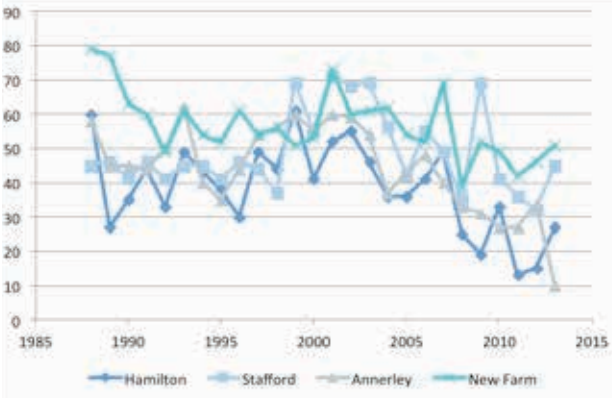


Figure 6-32 again shows the annual volume of sales across the selected streets in these three suburbs. As these suburbs differed in relation to location, distance from the airport and socio-economic status, it was expected that sales volume would vary to a greater extent to the northern and southern flight path analysis. This figure shows that the streets in Annerley recorded the highest volume of house sales from 1988 to 1998; however, since 1999 Stafford has recorded the highest volume of house sales, as was the case with the existing flight path analysis above, the higher value suburbs such as Hamilton recorded less sales per annum compared to the middle socio economic suburbs of Brisbane.

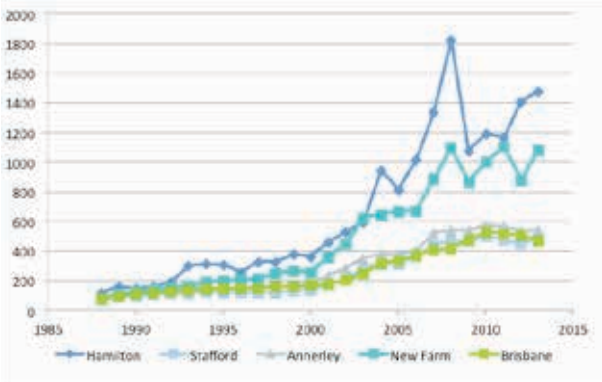
Table 6-51: Correlation Analysis: Sales Volume Proposed Flight Path: 1988-2013

	Hamilton	Stafford	Annerley	New Farm
Hamilton	1.00			
Stafford	0.17	1.00		
Annerley	0.00	-0.02	1.00	
New Farm	0.23	*0.42	0.06	1.00

**Significant at the 5% level*

The variation in annual house transactions across the full study period between these varying socio-economic suburbs is demonstrated in Table 6-51 that shows that there is only one significant correlation in respect to annual movement in sales volume (Stafford and New Farm r=0.42).

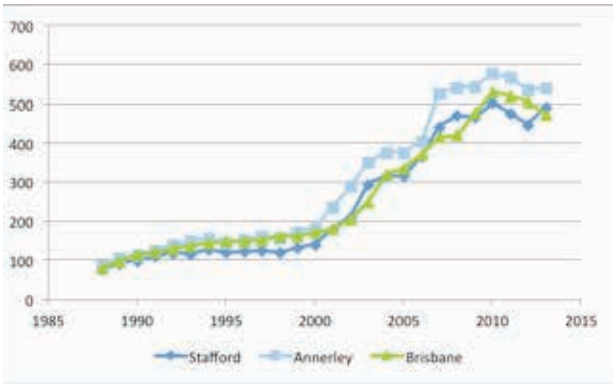
Figure 6-33: Comparison Median Price: Proposed Flight Path: ($ thousands): 1988-2013



The significant difference in these four suburbs is also reflected in the trend in median house prices across the study period.

With the previous suburb analysis, there were very minor differences in the median house price from 1988 through to 1997, at which time period the median price differences increased significantly based on location to the Brisbane CBD and socio-economic status. Figure 6-33 shows that the house prices in the Hamilton and New Farm streets have been considerably higher than the other two suburbs in this comparison from 1988, with Hamilton increasing from $120,000 in 1988, peaking at $1,820,000 in 2008 and achieving a median price of $1,475,000 in 2013. During the same period, the median house price for the New Farm streets has increased from $83,000 in 1988 to $1,082,000 in 2013, with a peak of $1,100,000 in 2011. The volatility in this housing market can be driven by years where the low volume of sales is based on the higher value properties in that location. This figure also shows that over the period 1988 to 2013, the median house price trend for Annerley and Stafford have been very similar and this is supported by Table 6-52 and Figure 6-34 that shows the extremely high significant positive correlation between the median house price movement in these suburbs (r=0.86). Stafford also had a very significant positive correlation with New Farm (r=0.71). Although there was a significant correlation between Annerley and Hamilton (r=0.39), there was no significant positive correlation in median house price movement with Hamilton with both Stafford and New Farm.

Figure 6-34: Comparison Median Price: Proposed Flight Path: ($ thousands): 1988-2013 (Ex Hamilton and New Farm)



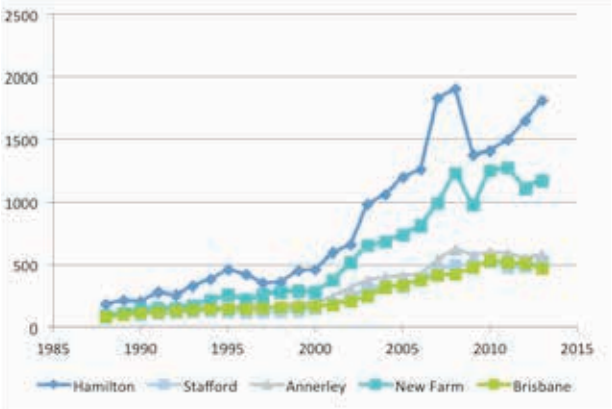
Both Stafford and Annerley house price movements per year have been positively correlated to the Brisbane median house price; this was not the case with Hamilton and New Farm with a non-significant correlation coefficient of r = 0.23 (Hamilton) and r=0.26 (New Farm).

Table 6-52: Correlation Analysis: Median Price Proposed Flight Path: 1988-2013

	Hamilton	Stafford	Annerley	New Farm	Brisbane
Hamilton	1.00				
Stafford	0.27	1.00			
Annerley	*0.39	*0.86	1.00		
New Farm	0.34	*0.74	*0.71	1.00	
Brisbane	0.23	*0.49	*0.46	0.26	1.00

**Significant at the 5% level*

Figure 6-35: Comparison Average Price: Proposed Flight Path: ($ thousands): 1988-2013



Based on average annual house prices, Hamilton and New Farm again have shown significantly higher average prices compared to the middle socio-economic suburbs of Annerley and Stafford. The average price for houses in Hamilton increased from $185,000 in 1998 to $1,814,000 in 2013, with New Farm average house prices increasing from $96,000 to $1,174,000 for the same period. During this same period the average price for houses in Annerley increased from $84,000 to $574,000 (Refer to figure 6-35)

The average annual price movement for Stafford and Annerley was very similar for the period 1998 to 2000; with the average price for houses in Annerley increasing from $85,000 to $187,000; with the increase for Stafford for the same period being $73,000 to $149,000 increasing to $523,000 in 2013.

Based on average house prices there has still been a very high significant positive correlation between house price movements in Annerley and Stafford (r=0.86) and Annerley and New Farm (r=0.71). There was not a significant correlation between Hamilton and Stafford; nor Hamilton and New Farm based on average house price movements.

The investment performance of these housing sectors based on both median and average house prices are shown in Tables 6-54 and 6-55.

The capital return performance for these three suburbs that are currently unaffected by flight paths but will be with the new runway have shown very similar capital returns to the southern and northern flight path suburbs. The higher socio-economic suburbs of Hamilton and New Farm haves recorded the highest average annual capital return based on median house prices of 12.83% (Hamilton) and 12.41% (New Farm). Based on average house prices these returns fell slightly to 11.00% and 12.06% respectively.

Table 6-53: Correlation Analysis: Average Price Proposed Flight Path: 1988-2013

	Hamilton	Stafford	Annerley	New Farm	Brisbane
Hamilton	1.00				
Stafford	*0.51	1.00			
Annerley	*0.58	*0.76	1.00		
New Farm	*0.45	*0.59	*0.53	1.00	
Brisbane	0.12	*0.47	0.32	0.35	1.00

**Significant at the 5% level*

Table 6-54: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Hamilton	12.83	22.41	1.75
New Farm	12.41	16.54	1.33
Stafford	8.45	11.20	1.33
Annerley	8.23	10.31	1.25
Brisbane LGA	7.72	8.35	1.08

Table 6-55: Capital Return and Investment Performance: Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Hamilton	11.00	18.07	1.61
New Farm	12.06	15.59	1.29
Stafford	8.74	11.35	1.30
Annerley	8.67	13.14	1.52
Brisbane LGA	7.72	8.35	1.08

Average annual capital returns for Stafford and Annerley have been very similar at 8.45% and 8.23% respectively based on median house prices and 8.74% and 8.67% based on average prices. All four suburbs have recorded higher average annual capital returns compared to the Brisbane median prices returns.

These higher returns have also been achieved at considerably higher levels of volatility, with the volatility for Hamilton house price returns being 22.41% (median prices) and 18.07% (average prices); with New Farm also having high volatility levels of 16.54% (median prices) and 15.59% (average prices). The volatility for Annerley and Stafford was also relatively high at 13.14% and 11.35% respectively based on average house prices, with slightly lower volatility for Stafford based on median prices and significantly lower volatility for Annerley based on median prices, with a fall from 13.14% to 10.31%. The risk/return ratios for Hamilton were the highest for these three suburbs, with all suburbs showing higher risk/return ratios compared to the Brisbane median house price.

SUBURB STREET COMPARISON: NO FLIGHT PATH.

The final street and suburb analysis in this study is based on streets in three Brisbane suburbs that are currently not affected by aircraft noise and are not under current or proposed flight paths for the existing or on completion of the new runway at Brisbane airport. These suburbs have been chosen based on their location and socio-economic status. Wooloowin is a high middle socio-economic northern suburb of Brisbane, within close proximity to the CBD and with access to good rail transport. Mitchelton is a middle socio-economic northern suburb of Brisbane, located approximately 12km from Brisbane airport. Mansfield is also a middle socio-economic suburb and is located 11km south of Brisbane airport and to the east of the suburb Mt Gravatt East. The selection of streets in these particular suburbs will allow a comparison based on level and impact of aircraft noise from nil to severe.

Figure 6-36: Comparison Sales Volume: No Flight Path 1988-2013

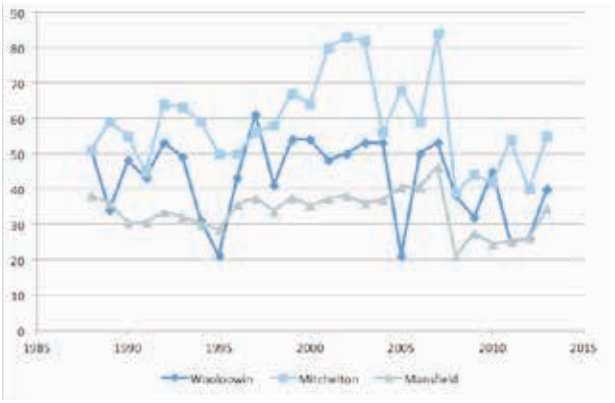


Figure 6-36 again demonstrates the variation in annual house sales across a range of streets in these three suburbs. Wooloowin and Mitchelton, both suburbs on the northern side of the Brisbane River, both had more sales per annum than Mansfield. Wooloowin saw a significant decrease in annual sales from 1992 to 1995 from 53 sales to 21 sales in 1995. Mansfield has been the most consistent in regards to the volume of sales. All suburbs had a peak in sales in 2007 (Mitchelton 84 sales; Wooloowin 53 sales and Mansfield 46 sales).

Based on the correlation coefficients shown in Table 6-56, the no flight path suburbs with the most significant positive correlations are Mansfield and Mitchelton (r=0.66). These are highly significant correlations and in line with the other suburb comparisons, especially in relation to middle socio-economic suburbs. There was no significant correlation between sales volume in Wooloowin compared to the other no flight path suburbs and this can be attributed to the difference in socio-economic status.

Table 6-56: Correlation Analysis: Sales Volume No Flight Path: 1988-2013

	Wooloowin	Mitchelton	Mansfield
Wooloowin	1.00		
Mitchelton	0.01	1.00	
Mansfield	0.28	*0.66	1.00

**Significant at the 5% level*

Again, the trend in annual median house price movement for the streets in this suburb selection is shown in Figure 6-37, including the overall Brisbane median house price trends for the period 1988 to 2013. Although the house price for Wooloowin has always been higher than Mansfield, the actual movement trend has been very similar from 1988 to 2010 and is supported by the very high significant correlation coefficient of r=0.60 (refer to Table 6-57).

Both New Farm and Mansfield have consistently outperformed the Brisbane median house price for the full 26 years of the study. This has not been the case for the median house price for streets in Mitchelton, which has only outperformed the Brisbane median house price from 2001 to 2013. Mitchelton is classified as a middle to lower middle socio-economic suburb and from Table 6-57 it can be seen that there is a very significant correlation between these two sectors (r=0.52). This is not the case for either Wooloowin or Mansfield.

Figure 6-37: Comparison Median Price: No Flight Path: ($ thousands): 1988-2013

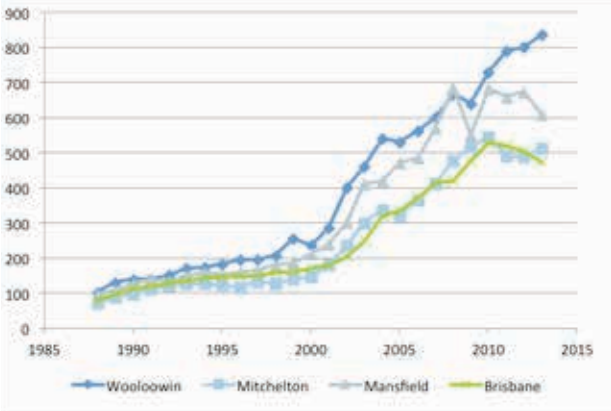


Figure 6-38 shows the trend in the average house price for streets in the three suburbs that are not subject to any aircraft noise or under any existing or future flight paths. Again, the houses in the higher middle socio-economic value suburb of Wooloowin have been consistently higher than houses in the middle socio-economic suburbs. It is interesting to note that on an average price basis, house prices in Mansfield have been declining over the period 2010 to 2013, in line with the general decline in the Brisbane median house price. However, the average house price in Wooloowin has been increasing significantly from 2009 to 2013. Mitchelton saw a decline in average house prices from 2010 to 2012 and an increase in the average house price in 2013. Two suburbs had a peak in average house prices in 2010 (Mansfield $765,000 and Mitchelton $530,000) and Wooloowin house prices achieved their highest average in 2013 ($835,000).

On an average price basis, streets in all three suburbs have shown an overall average price per annum greater than the Brisbane median price.

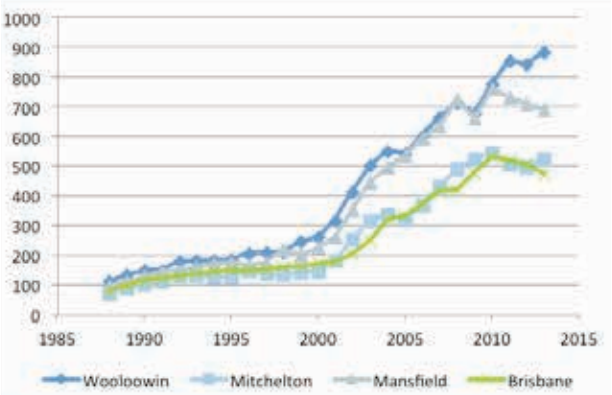
Based on average house prices there is an even stronger significant positive correlation between the change in annual average house prices in Wooloowin and Mitchelton (r=0.80) and a slightly lower significant positive correlation between annual house price movements between Mansfield and Mitchelton (r=0.51) (refer to Table 6-58).

Table 6-57: Correlation Analysis: Median Price No Flight Path: 1988-2013

	Wooloowin	Mitchelton	Mansfield	Brisbane
Wooloowin	1.00			
Mitchelton	*0.60	1.00		
Mansfield	*0.41	*0.48	1.00	
Brisbane	0.38	*0.52	0.35	1.00

**Significant at the 5% level*

Figure 6-38: Comparison Sales Volume: No Flight Path: ($ thousands): 1988-2013



Tables 6-59 and 6-60 show the investment performance of the streets in the no flight path housing suburbs over the period 1988 to 2013. The common theme across all the suburbs in the study also applies in the no flight path streets with the higher value suburbs having outperformed the middle socio-economic suburbs on a capital return basis. However, these substantially higher capital gains have been at higher levels of volatility. The average annual capital returns for Mitchelton and Mansfield are similar on both a median and average price basis.

On a median price basis, Mitchelton has an average annual capital return of 8.67% at a volatility of 10.67%, below the volatility of Mansfield with a lower capital return. Mansfield also had the worst risk/return ratio of these three suburbs at 1.44 based on median price; however this ratio improved to 1.28 based on average prices. Mitchelton had the worst risk/ return ratio of the group based on average prices.

Wooloowin has shown a higher average annual capital return based on both median (9.19%) and average (8.99%) house prices over the 26 year period, with lower volatility compared to Mansfield and Mitchelton. Wooloowin also has the lowest risk return ratios of 1.15 (median) and 1.00 (average) well below the other suburbs in this study based on average house prices.

Table 6-58: Correlation Analysis: Average Price No Flight Path: 1988-2013

	Wooloowin	Mitchelton	Mansfield	Brisbane
Wooloowin	1.00			
Mitchelton	*0.80	1.00		
Mansfield	*0.45	*0.51	1.00	
Brisbane	*0.39	*0.49	*0.53	1

**Significant at the 5% level*

Table 6-59: Capital Return and Investment Performance: Median Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Wooloowin	9.19	10.55	1.15
Mitchelton	8.67	10.67	1.23
Mansfield	8.28	12.06	1.44
Brisbane LGA	7.72	8.35	1.08

Table 6-60: Capital Return and Investment Performance Average Price 1988-2013

Location	Average Annual Capital Return (%)	Average Annual Volatility (%)	Risk return Ratio
Wooloowin	8.99	8.95	1.00
Mitchelton	8.92	11.88	1.33
Mansfield	8.75	11.19	1.28
Brisbane LGA	7.72	8.35	1.08

7 Result Comparisons

7.1 INTRODUCTION

The final section of this study will compare the housing capital return and investment performance of the various suburbs and street analysis based on the socio-economic status of the suburb, level of aircraft noise complaints and geographic location in Brisbane and location under current and new or no flight paths.

7.2 HIGH SOCIO ECONOMIC SUBURBS

A number of high value suburbs of Brisbane have been identified throughout this study and they are the inner city suburbs, close to the Brisbane CBD and located on the Brisbane River or overlooking the CBD and Brisbane River. These suburbs are Bulimba, Balmoral, New Farm, Hamilton and Ascot.

Table 7-1 compares the capital return performance of each of these suburbs and shows that over the period 1988 to 2013 there has been very little difference in the growth in house prices across these high value suburbs regardless of location and exposure to aircraft noise. One of the best performing suburbs on an average annual capital return basis has been Bulimba which is under an existing flight path and subject to moderate levels of noise complaints. These capital returns for Bulimba are slightly higher than for New Farm which is not under any existing or future flight paths and not subject to any aircraft noise complaints. The highest average annual capital returns in this study have been for Hamilton at 12.83%, a suburb with no or minimal noise complaints and not subject to any current flight paths, but will be subject to aircraft movements when the new runway is in operation. This higher average annual capital return is only a difference of 0.39% per annum. The capital returns for Ascot and Balmoral, which are currently not under a flight path, are less than Bulimba. The higher return suburbs also have the highest volatility and risk/return ratios.

Based on these figures it can be assumed that the location of a high value suburb under a flight path and subject to moderate noise complaints does not suffer any long term impact in relation to house price movements and capital growth.

7.3 HIGHER VALUE MIDDLE SOCIO-ECONOMIC SUBURBS

These higher value middle socio-economic suburbs are all outer inner ring or inner middle ring suburbs of Brisbane and are all conveniently located to the Brisbane CBD. Three suburbs are located south of the Brisbane River and four suburbs located north of the Brisbane River.

Table 7-1: Comparison: Capital Return and Investment Performance High Value Suburbs: 1988-2013

Suburb	Flight Path	Average Annual Capital Return	Volatility	Risk/Return Ratio
Bulimba	Existing Flight Path South MNC	12.44%	20.01%	1.61
Balmoral	Proposed Flight Path South MNC	10.22%	14.46%	1.42
Ascot	Proposed Flight Path North MNC	10.55%	12.79%	1.27
Hamilton	Proposed Flight Path North NNC	12.83%	22.41%	1.75
New Farm	Proposed Flight Path North NNC	12.41%	16.54%	1.33

Table 7-2: Comparison: Capital Return and Investment Performance High Middle Value Suburbs: 1988-2013

Suburb	Flight Path	Average Annual Capital Return	Volatility	Risk/Return Ratio
Camp Hill	Existing Flight Path South HNC	9.52%	13.75%	1.44
Cannon Hill	Existing Flight Path South HNC	9.72%	11.72%	1.21
Coorparoo	Existing Flight Path South HNC	9.09%	13.48%	1.48
Gordon Park	Existing Flight Path LNC	9.34%	9.18%	1.05
Ashgrove	Existing Flight Path MNC	9.20%	9.96%	1.05
Bardon	Existing Flight Path NNC	9.02%	11.34%	1.26
Hendra	Proposed + Existing Flight Path MNC	10.09%	14.65%	1.45
Wooloowin	No Flight Path NNC	9.19%	10.55%	1.15

The actual impact of aircraft noise on long term housing market performance is also demonstrated in Table 7-2 based on higher value middle socio-economic suburbs of Brisbane. The variation in average annual capital returns for these seven suburbs range from 10.09% to 9.02% per annum. Two of the highest average annual capital returns for the 26 year period were achieved in the suburbs under the main southern flight path and subject to the highest number of noise complaints (Camp Hill 9.52% and Cannon Hill 9.72%). The highest average annual capital return for this suburb classification was Hendra at 10.09% per annum. This suburb is not currently under a flight path but actually adjoins Brisbane airport. Again the suburbs with the higher average annual capital returns also had the higher price volatility and risk return ratios. Of interest with these high value middle socio-economic suburbs is the high return for Gordon Park and Ashgrove but relatively low volatility at 9.18% and 9.96% respectively resulting in the lowest risk/return ratios across the full study locations and less than the Brisbane median house risk return ratio of 1.08. Both these suburbs are under existing flight paths and subject to low and moderate aircraft noise complaints.

These results again confirm that houses located under existing flight paths in Brisbane and subject to high levels of noise complaints have achieved capital growth over the past 26 years equivalent or higher than areas not affected by aircraft noise.

7.4 MIDDLE VALUE MIDDLE SOCIO-ECONOMIC SUBURBS

Again, these suburbs are classified as middle socio-economic and cover suburbs to the south and north of the Brisbane River. All are middle ring suburbs of Brisbane, apart from Albion. Albion can be classified as an inner ring suburb close to the Brisbane CBD, however it is a suburb with a significant industrial property sector.

This table again shows the similarity in capital growth and investment performance when suburbs are compared on a like to like basis. For these middle socio-economic suburbs the average annual capital growth over the period 1988 to 2013 has ranged between 8.67% and 8.23%. If Albion is excluded the volatility has been relatively consistent compared to the analysis above for the higher value residential property sectors, ranging from a low of 10.31% for Annerley to a high of 12.06% for Mansfield. The best risk/return suburb has been Tarragindi with an average annual capital return of 8.58% and a volatility of 10.49%. This investment performance is for a suburb under the main southern flight path and subject to high aircraft noise complaints. This residential investment performance for Tarragindi is actually better than Mansfield and Mitchelton that are not subject to any existing or future flight paths and any aircraft noise complaints.

These results also indicate that the change in median price for houses in these suburbs is driven by factors other than aircraft noise.

Table 73: Comparison: Capital Return and Investment Performance Middle Value Suburbs: 1988-2013

Suburb	Flight Path	Average Annual Capital Return	Volatility	Risk/Return Ratio
Tarragindi	Existing Flight Path HNC	8.58%	10.49%	1.22
Albion	Existing Flight Path MNC	8.23%	17.11%	2.08
Stafford	Proposed Flight Path NNC	8.45%	11.20%	1.33
Annerley	Proposed Flight Path NNC	8.23%	10.31%	1.25
Mansfield	No Flight Path NNC	8.28%	12.06%	1.44
Mitchelton	No Flight Path NNC	8.67%	10.67%	1.23

Table 7-4: Comparison: Capital Return and Investment Performance Lower Value Suburbs; 1988-2013

Suburb	Flight Path	Average Annual Capital Return	Volatility	Risk/Return Ratio
Mt Gravatt East	Existing Flight Path MNC	7.93%	9.63%	1.21
Chermside West	Existing Flight Path NNC	6.46%	11.92%	1.85
Brisbane Median		7.72%	8.35%	1.08

7.5 LOWER VALUE MIDDLE SOCIO-ECONOMIC SUBURBS

There are only two suburbs analysed in this study the fall into the socio-economic classification of lower middle socio-economic. Mt Gravatt East and Chermside West are classified as outer middle ring suburbs of Brisbane, with Chermside West located north of the Brisbane River and Mt Gravatt East south of the Brisbane River. Both these suburbs are under the existing runway flight paths and subject to moderate aircraft noise complaints (Mt Gravatt East) and minimal aircraft noise complaints (Chermside West). Residential property in these two suburbs would be more typical of the Brisbane median price house.

The average annual capital return for houses in these two suburbs has been considerably lower than the other sectors discussed above. Chermside West has recorded the lowest average annual capital returns for all suburbs in the study and is the only suburb that has a lower capital return than the Brisbane median house price. This low return and relatively high volatility also results in houses in this suburb also recording one of the higher risk/return ratios of 1.85. Although this suburb is under the existing northern flight path, its location does not result in any significant levels of aircraft noise complaints. Mt Gravatt East is located under the southern flight path and is subject to moderate aircraft noise complaints but the average annual capital return for the past 26 years for houses in this suburb have been greater than the Brisbane median house price capital return

These results also confirm that a housing suburb in Brisbane has its value and price determined by a range of factors and not only aircraft noise and the location of a property under a flight path will have minimal if any impact on the investment performance and capital growth of that property.

8 Conclusions

THIS STUDY OF AIRCRAFT NOISE AND FLIGHT PATH IMPACT ON RESIDENTIAL PROPERTY VALUES IN BRISBANE COVERS ONE OF THE MOST EXTENSIVE TIME PERIODS FOR A STUDY OF THIS TYPE. THE DATA FOR THIS PROJECT COMPRISED ALL RESIDENTIAL HOUSE AND UNIT SALES FOR THE SELECTED SUBURBS AND STREETS IDENTIFIED IN THE RESEARCH AREA. IN TOTAL THERE WERE OVER 181,000 SALES ANALYSED IN THE STUDY OVER THE PERIOD FROM 1988 TO 2013.THIS PERIOD COVERS THE FULL PERIOD OF OPERATIONS OF THE CURRENT AIRPORT AND RUNWAY. THE TIME PERIOD ALSO COVERS A RANGE OF SIGNIFICANT NATURAL AND ECONOMIC EVENTS THAT HAVE A DIRECT IMPACT ON A RANGE OF RESIDENTIAL PROPERTY SECTORS. THESE EVENTS INCLUDE THE RESIDENTIAL PROPERTY BOOM FROM 2001 TO 2007, THE GLOBAL FINANCIAL CRISIS AND THE 2011 BRISBANE FLOODS. THIS TIME PERIOD ALSO COVERS THE EXTENSIVE PUBLIC CONSULTATIONS, MEDIA RELEASES AND WEBSITE INFORMATION PUBLISHED AND BROADCAST IN RELATION TO THE APPROVAL OF THE NEW RUNWAY AT BRISBANE AIRPORT, UPDATES ON THE VARIOUS STAGES OF CONSTRUCTION AND DETAILS OF THE VARIOUS FLIGHT PATHS AND EXPECTED AIRCRAFT MOVEMENTS.

Residential property buyers and tenants have been aware of the location of the existing flight paths prior to 1988, with the first works on the existing runway commencing in 1980 and this information readily available for all interested residential property buyers and renters. As this study covers the full period of existing airport operations, the results of this detailed study provide an extremely accurate analysis of residential property buyers behaviour in relation to houses and units in these flight path locations.

OVERALL FINDINGS

Overall this analysis shows that during the period from 1988 to 1992 the median price for houses under the existing flight paths for the Brisbane airport runway (opened in 1988) was lower than houses not affected or minimally affected by aircraft noise. However, since 1993 the reverse has been the case, with median house prices being higher in suburbs subject to aircraft noise compared to those with minimal or no noise affectation. Houses in Brisbane locations subject to aircraft noise have shown similar and in most cases higher average annual capital returns compared to non-affected properties and their price and performance is linked more closely to socio-economic status than aircraft noise impact. Location of residential property under Brisbane flight paths has not had any significant effect on the ability to rent residential property or resulted in any differences in weekly rental rates across any of the various socio-economic residential property locations. These results confirm that in Brisbane, the decision to purchase a residential property in any given location is based on a range of factors, and exposure to aircraft noise is offset by other factors associated with suburbs located under aircraft flight paths, resulting in similar and often higher prices and capital growth despite this exposure to aircraft noise.

SIGNIFICANT RESULTS

The major findings from this study are:

» Based on the analysis of 42 Brisbane suburbs subject to varying levels of aircraft noise and aircraft noise complaints there was no difference between the annual movement in actual houses and units sold in these suburbs. The trend in sales volume from year to year over the period 1988 to 2013 was virtually identical, regardless whether the suburb was located directly under current flight paths or not subject to any aircraft noise. The actual number of sales per annum did vary but this was more a factor of available housing stock rather than location under a flight path. This is confirmed by the extremely high positive correlation coefficients based on sales volume movement from year to year. Based on the number of years in this study a significant positive correlation coefficient at the 5% level would be $r = 0.37$, this analysis shows the correlation coefficient between suburbs with high levels of noise complaints had a correlation coefficient of $r=0.90$ with the moderate noise complain suburbs and $r=0.89$ with the minimal and no noise complaint suburbs. On these results the effect of aircraft noise on the number of properties sold in affected areas is not a major factor, if at all.

» Where there was an extremely high significant correlation between the change in sales volume from year to year across the various suburbs with high to minimal aircraft noise, this relationship was even stronger when the annual movement in median house prices for each of the suburb rankings based on degree of aircraft noise was compared. The correlation between the change in the median house price across the high aircraft noise complaint suburbs to the moderate and

minimal or low noise complaint suburbs was virtually identical over the 26 year period with the respective correlation coefficients being 0.95 and 0.96. This indicates that houses under a flight path and subject to high aircraft noise levels will increase or decrease in median price at the same levels as houses in suburbs with moderate or no aircraft noise impact.

» The analysis of the average annual capital return based on both the median price and average price for houses across the 42 suburbs has shown that not only have the house prices in the high noise suburbs matched the price growth compared to less or not affected suburbs but have actually outperformed these suburbs in relation to capital growth over the 26 year period.

» All the suburbs in the high aircraft noise complaint locations are classified as middle socio-economic suburbs. When the median and average price per year for these suburbs are compared to middle socio-economic suburbs that have no or less impact from aircraft noise, from 1988 to 1992 the median price was lower in suburbs subject to aircraft noise, particularly from 1988 to 1991 where the percentage difference in price was up to 6.92% less on a median price basis and 19.27% less on an average price basis. However, since 1992 the houses in the high noise complaint suburbs have actually achieved a higher average and median price compared to similar middle socio-economic suburbs moderately or not affected by aircraft noise. Based on median prices, after 1992, there are only two years when the HNC affected suburbs had a median house price less than the MNC and NNC affected suburbs; with 18 years when the median prices was higher. Overall, across the full period, on a median price basis, the difference between noise affected houses and non-affected was 2.11% higher. This again supports the fact that aircraft noise is only one factor that house buyers consider when purchasing a property and in the majority of cases is not resulting in a lower house price, nor discounts at levels stated in the academic literature review. The sub period analysis confirms that the higher difference in median house prices for the affected suburbs has been greater over the past 15 years, which also reflects the increasing house prices in the southern Brisbane suburbs that had been lagging behind the northern Brisbane suburbs up to the late 1990s.

» Sales transactions volume across the 36 suburbs for units has differed significantly to the house analysis. One of the major reasons for this difference is the varying proportion of home units, townhouses and villas across these suburbs. The proportion of home units in total housing stock is greater in the inner city, high value suburbs of Brisbane, with the middle ring suburbs having a lower percentage of units in the total housing stock. These variations in total units in suburbs have resulted in the highest volume of sales being in the NNC suburbs and the lowest volume per year in the HNC suburbs. Based on the change in volume from year to year, the only positive significant correlation for unit sales in Brisbane was between HNC suburbs and MNC suburbs (r=0.56). Unit median prices in all these 36 suburbs in the aircraft noise study were higher than the Brisbane median unit price across all years of the study. Although there was only one significant correlation between these three unit markets based on median unit prices (HNC and MNC r=0.71). However on an average price basis there were two significant correlation co-efficients and all the noise complaint study suburbs had a positive significant correlation with the Brisbane median unit price. Although the capital return performance for units in Brisbane has not been as strong as the growth in house prices, the median price average annual returns for units in the HNC, MNC and NNC suburbs have been very similar ranging from a high of 7.86% (NNC) to 7.40% for MNC and HNC units 7.66%. Just as was the case with houses, in these three noise classification suburbs, there are no significant differences in the growth and annual change in the median price of units based on the level of aircraft noise. If aircraft noise was the major value driver in these suburbs there would be a significant variation in prices from the HNC suburbs and the NNC suburbs. Based on a comparison of the variation in the annual median price of HNC units and middle socio-economic units in the MNC and NNC suburbs, there is a much greater significant positive correlation based on both median and average prices, with the trend in price movement being very similar and average annual capital returns being virtually identical across the 26 year period. Also, like the house price analysis based on this comparison, the median and average price for units in the HNC suburbs was up to 14% lower than the middle socio-economic units in the MNC and NNC suburbs from 1988 to 1993. However since 1994 to 2013, in all but three years the average and median unit price in the HNC suburbs has been higher. This again supports the fact that aircraft noise is not the main factor that drives unit values in these suburbs of Brisbane.

» A similar result to the discussion above has been replicated in the analysis of rents in these suburbs. Despite varying levels of aircraft noise the volume of houses and units rented in the HNC and MNC suburbs are very similar but this is not the case in the NNC suburbs. The actual growth in weekly house rentals across the period from 1988 to 2013 has been very similar, as evidenced by the extremely significant correlation across the three sectors with correlation co-efficients ranging from r=0.88 to 0.95. There were also very significant correlations in relation to the weekly rental rates for units in the three suburb classifications. As was the case with house and unit prices, the same relationships applies based on weekly rentals for houses and units with the degree of aircraft noise affectation and proximity under flight paths not having any impact on the ability to rent a property in the HNC and MNC suburbs nor the weekly rental that can be achieved.

» Houses directly located under the ANEF 20 contour and subject to the most recognised levels of aircraft noise do show a lower volume of sales per year but the trend in sales volume is very similar to houses outside this

noise contour. Being located in such high aircraft noise locations does not result in a residential property being unsaleable. Although the median house price for these aircraft noise affected houses is slightly lower compared to the adjoining locations, the actual movement in the price of houses from year to year have been similar, as has the average annual capital return and volatility, with these streets recording average annual return in excess of 9%, well above the Brisbane median house return of 7.72%.

» The differences in house prices for the comparative streets for houses that will be subject to the higher levels of aircraft noise when the proposed runway is in operation are in high value and upper middle value suburbs of Brisbane. At present the areas south of Brisbane that are located under or adjoining the ANEF 20 contour for the proposed runway are in high value areas and there is currently very little difference in median and average house prices, despite the fact that it is common knowledge that these streets will be subject to aircraft noise. Houses in the streets that are under the ANEF 20 contour at this location have actually shown a higher average annual capital return over the full 26 year period, as well as the past 5 years. The location of many of these streets on or close to the Brisbane River appears to be a major value driver for residential property. The streets that are under or close to the ANEF 20 contour north of the Brisbane River have also shown the same trend in sales volume over the study period, with the houses adjoining the contour exceeding sales in the streets within the contour. Although the median price for houses within the contour was less than the streets adjoining, this is more related to the suburb status rather than the location to the airport. The adjoining streets in this particular location are predominately in the suburb of Ascot, a high value residential suburb of Brisbane, while the streets within the new runway ANEF 20 contour are predominately in the suburb of Hendra, a lower value suburb compared to Ascot.

» Streets in the four selected suburbs subject to the highest volume of aircraft movements are middle to high value middle socio-economic suburbs of Brisbane. The analysis of sales in these streets indicate that median house prices are higher than the Brisbane median house price across all 26 years of the study and that these streets have recorded higher average annual capital returns compared to similar value middle socio-economic suburbs in Brisbane. These higher returns were not at significantly higher levels of volatility in median and average house price movements. The various median and average price fell as the distance from the airport increased, despite the aircraft noise levels also decreasing as distance from the airport increased. This again shows that the location of a street subject to aircraft noise has its value determined more by distance to the Brisbane CBD rather than aircraft noise levels.

» When the analysis is based on northern suburbs of Brisbane subject to the existing runway operations, the results mirror the situation in the southern Brisbane suburbs. The streets in the inner city residential suburbs (Albion is excluded due to its large industrial property profile) have consistently outperformed the streets in the suburbs located further away from the CBD. This applied whether the suburb was affected by existing or proposed aircraft noise.

» The price and price movement for residential streets in the suburbs that are not currently affected by aircraft noise from the existing runway but will be under the proposed flight path again have shown a very similar trend and overall capital return performance to those suburbs that are affected by aircraft noise. There was no premium evident for the fact that the suburb was not affected by aircraft noise. Again, the dominant value factor appears to be proximity to the CBD and services driving these residential property sectors, with both median prices and capital returns decreasing as the distance from the Brisbane CBD increases. The available information on the location of flight paths and potential aircraft movements that have been published widely since the announcement of the new runway have not seen any discounting of residential house prices in these areas to date.

» The analysis of the residential properties in the suburbs that are not subject to any flight paths or aircraft noise both now and in the future again showed very little difference in median and average house prices and capital growth when compared to similar socio-economic suburbs that were currently under flight paths or would be under flight paths when the new runway operations commence.

» When each of the various suburbs in this overall study were compared on a socio-economic basis from low middle socio-economic through to high socio-economic suburb status, the investment performance over the period 1988 to 2013, was virtually identical, whether the suburb was under a flight path, subject to higher levels of aircraft noise or in close proximity to the airport.

FURTHER RESEARCH

This is an on-going research project and all the various suburb and street analysis will be updated annually for the full development period of the new parallel runway at Brisbane airport and for a number of years following the introduction of aircraft operations at the airport on completion of the runway. This continuing study will determine any impact of the new runway information, as the runway project progresses, may have on the various Brisbane residential property locations and any possible impact on these residential property markets once the new runway is in operation.

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