Impact of High Voltage Overhead Transmission Lines on Property Value

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Abstract Title

This paper examines the impact of high voltage overhead transmission lines (HVOTLs) on the prices of detached houses in Eight Mile Plains in Brisbane using hedonic price modelling. Controlled the housing attribution effects the study found that there are significant difference in house prices over the distances from HVOTLs. In particular the houses within 50 meters buffer zone are 15% lower than the median house price in Eight Mile Plains. However, the distance effect diminished over the 200 meter buffer zone. However, the result of hedonic regression model shows that the proximity to HVOTL has little impact on dynamic changes in house prices over time.

Keywords: HVOTL, Externalities, Hedonic Model, Risk Perception, Property Value

Introduction

This paper presents some of the findings of recent research undertaken in Queensland about the impact of High Voltage Overhead Power Lines (HVOTL) on adjacent property value. HVOTL infrastructure can create externalities and perceived threats to the immediate environment and adjoining residents. Their intensity will vary according to individual and community attitudes and expectations. Intertwined with these reactions is the fear of the homeowner's wealth and financial security being impacted with possible reductions in the value of their real estate.

HVOTLs are a familiar and readily-identifiable hazard for homeowners. Previous research (Elliott and Wadley, 2012; Cotton and Devine Wright, 2011) suggests that they presented a symbolically negative image of the industrialised world. Elliott and Wadley (2012), through a series of focus groups undertaken in Queensland, identified that health implications of Electric Magnetic Fields (EMFs) as the most likely HVOTL risk attribute to attract concern and the consequential risk of a possible reduction in property value often became evident in discussions about EMF and, in fact, most other transmission effects. All effects bear directly on the homeowner but EMF risk in particular has the potential to amplify indirectly (i.e. 'ripple') among the community and in the property market in a process known as 'consumption depreciation.' Residential real estate is both a consumption good and

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investment asset and is sensitive to social settings and planning regimes and practices. When HVOTLs are involved, purchase decisions factor in not only a resident's perceived loss of utility in foregone views and compatibility of adjacent land uses, but also in a reduction of investment value if prospective purchasers perceive a place as stigmatised. The environmental stigma arising from HVOTL is the perception of potential buyers and sellers of real estate in proximity to HVOTL who consider that the real estate is compromised in its utility by risk attributes and consequently diminished in value. Numerous factors affect market perceptions of utility.

A criticism of market perception studies in terms of measuring aspects of market behaviour is that they reflect hypothetical rather than actual behaviour of market participants. In many cases it is suggested that they exaggerate the real impacts of HVOTL risk (Kroll and Priestley, 1991). As such, attitudinal research is often considered fraught with potential difficulties with respect to quantifying likely market behaviour by potential buyers.

For this reason, more quantitative studies such as regression analysis are favoured when it comes to measuring diminution of property value. This research contributes to the existing literature in two important ways. First, there is no published literature involving case studies of HVOTL impact on property value in Australia and the findings of this research adds in important ways to those of overseas studies. Recent research findings of international studies on HVOTL have shown that proximity to and the visual encumbrance of HVOTL has a varying negative impact on property values (Rosiers 2002; Sims and Dent, 2005) and it is particularly important to incorporate a visual assessment and measure of impact which HVOTL towers and lines have on homes within their individual surroundings as a variable within the hedonic price model. Actual views of HVOTL from each house are different and they could minimise or maximise its impact on the property value. Google street view is used to assess the visual presence of HVOTLs for all the houses within a 250m zone[3].

Second, there is no published research in Australia into the impact of HVOTL on dynamic changes of house price in terms of capital growth over time. This project investigates the proposition that the presence of HVOTL impacts on the long term capital growth potential of adjacent housing prices.

2. Literature Review

Although HVOTLs have existed for over 100 years, many people, and homeowners in particular, are still wary of them. Research into public reactions to the provision of lines has reinforced the finding of negative perceptions, albeit with substantial variation in intensity caused by measurement differences across studies, as well as disparities in socio-economic status and the choice of environmental variables (Priestly and Evans, 1996). Public perceptions of risk initially focused on aesthetic and engineering qualities. The year 1979 was a turning point, suggesting the first relation of EMF exposure to possible human health effects (Werthiemer and Leeper, 1979). Whilst such a link remains unproven, fears of transmission facilities have since been repeated (WHO, 2007). Issues of safety and

[3] This is a threshold distance to visually identity HVOTL

environmental damage, as well as interference with property rights, abet the negativity (Furby at al., 1988). Proposals of new lines can foster apprehension about local residents' wealth and financial security, due to resumption procedures and associated compensation rights which could appear complex and threatening. The few recorded papers appear amongst studies of 'difficult' industrial landuses (Cameron and Milburn, 1992; Haddad, 1993; and Sullivan, 1998) and other forms of infrastructure (e.g. railways) (Bertolini, 1998) and airports (Freestone, 2009). Some interest has been shown within the real estate journals, where Rosiers (2002) employed a micro-spatial approach to analyse the value of property in the vicinity of HVOTL facilities. Around Glasgow, Scotland, Sims and Dent (2005) revealed that most valuers and realtors perceived negative impacts on HVOTL-affected properties of 3 to 10% of total value. Proximity causes a significant diminution in value, whereas a right of way, created near the rear of the house, can significantly increase value despite the view of the line itself.

The literature relating to this more quantitative approach can be broadly classified into case studies based on statistical techniques such as regression or appraisal or valuation based case studies utilizing relatively small samples of properties. The literature is now relayed in more detail and the links between stigma of place and the processes shaping property price are examined in more detail. An outline of major case studies published in the last 30 years utilising regression analysis is outlined in Table 1.

Table 1: Hedonic valuation studies reported in refereed journals

Study	Decrease in price	Effects observed	Period/Date of study	Date of publication	Powerline capacity	Location and sub market
1. Colwell and Foley	8.8% 3.6%	15m 65m	1963-1978	1979	138KV on steel	Illinois, USA residential
2. Colwell	6.6% 2.0%	15m 65m	1968-1978	1980	138KV on steel	Illinois, USA residential
3. Ignelzi andThomas	1.0-9.0%	100m	1976-1989	1991		USA
4. Kinnard et al	3.0%	65m	1956-1965	1967		Hartford United States
5. Kinnard et al	2.0%	65m	1973-1984	1984		United States
6. Kinnard et al	0.3%	65m	1990-1995	1996		United States
7. Kinnard et al	0.2-4%	65m	1990-1996	1997		United States
8.Hamilton and Carruthers	5.0%	120m	1985-1991	1993		
9.Hamilton and	6.3%	100m	1985-1991	1995	230kv and 500kv on	4 residential suburbs in

Schwann	1.1%	200m			steel	Vancouver, Canada
10.Callanan/ Hargreaves	27.3% 9.1% 2.7%	10m 30m 100m	1983-1993	1995	110kv	Inner city residential Wellington, New Zealand
11.Des Rosiers	5-20%		1991-1996	2002	315kv on steel	Montreal, Canada
12.Dent and Sims	11.5% av	100m	2001-2002	2005		Scotland

Source: Based on Gallimore and Jayne (1999)

From Table 1 it will be noted that negative impacts on property values from HVOTLs more or less range from one to nine per cent, depending on proximity. However, care must be taken in interpretation. Most studies focussed on residential precincts. For example, distances at which the effects are observed vary from study to study with respect to central points or origin. Central points of measurement include the centre of transmission line, the edge of right of way, the centre line of the right of way and the centre point of the right of way. Also, factors such as the topography and nature of landscape will differ. In addition, It is reported that only half these studies produced results which were statistically significant (Gallimore and Jayne, 1999).

Since 1979 a number of other studies have been conducted. Colwell published a further paper in 1990 based on the previous study area and data set. One particular criticism of work was that no account was taken of a possible enhancement in value arising from lots which are contiguous to the easement and therefore have ‘use’ of the greenbelt as in an open view, gardens, swing sets etc. Colwell (1990) accordingly hypothesized that:

- residential selling prices are related both to proximity to the lines and to the towers. It was argued that lines and towers have a large negative impact in close proximity but that it declines at a decreasing rate as distance increases. Additional distance beyond a few hundred metres might make very little difference.

- any impact of the power line and towers might be lessened through time.

In summary, the second study again established that the negative impact of tower lines is large in close proximity, but declines as distance increases. Furthermore, the impact of the lines diminishes with time (Colwell, 1990). Additionally, there can be an additional negative value impact of proximity to towers but it showed no significant signs of diminishing through time.

3. Data and Methods

3.1 Data

The paper uses real estate data (RP Data) which provides detailed property information on property ownership, features and attributes, land size and sales transaction history.. All the sales transactions within Eight Miles Plain for the period between 1st January 2001 and 20th November 2010 were collected, which includes over 5,000 property sales transactions. Some properties have multiple sales within the window timeframe while many of them have no sales history. The analysis of price change as the dependant variable uses only those properties which have recorded repeat sales transactions within the window timeframe in order to calculate the individual price growth rate. Over 460 sold houses have at minimum double repeat sales transactions, 87 of which have triple transactions, 17 with four repeat transactions and 2 houses with 5 repeat transactions within the frame time period of 2001-2010. HVOTL has been constructed within the case study area since the early 1970s and a second double circuit 275Kv tower line was commissioned and constructed in 2003. Community engagement for the second 275kV line occurred during period 1999 to end of 2001

The independent variables used are measured at both the level of the individual house and the HVOTL. The existing literature suggests that a range of housing characteristics may account for differences in the determinant of house price. Previous studies (Priestley and Ignelzi 1989; Colwell, 1990; Callanan and Hargreaves 1995; Bond and Hopkins 2000; Rosiers, 2002; Sims and Dent 2005)) have all considered the impact of HVOTL on property value, including proximity to transmission line, nature of neighbourhood, size of property and date of sale. In this paper we account for these factors using a range of numerical indicators (Table 2). As the focus of this paper is on house price it controls for the effects of individual houses by including variables accounting for the current housing attributes (number of beds, number of bathrooms, number of garage, land size and building age). Finally, in order to account for HVOTL, we include two measures for visual presence and proximity to HVOTL. Table 2 shows some samples of the visual presences of HVOTLs by distance. The visibility of HVOTLs varies over the distance to HVOTL but also affected by topography and landscape. The house of H1 is located within 50m and H2 sits over 100m from HVOTL. However, their visual presences are different by the landscape. Interestingly, in spite of the long proximity (over 100m), HVOTLs from the upper-hill house (H2) is clearly visible. The topography of property location plays an important role in this case.

Table 2: Selected property sample for visual assessment

	Visibility	Actual Image of View
H1 Within 50m	Invisible	
H2 Over 100m	Highly visible	

3.2 Methods

3.2.1 Buffering Analysis

This study examines the impact of high voltage powerlines on residential property prices using a combination of spatial modelling techniques and geographic information system (GIS). We first accessed the RP data base to gain the information on the house prices for individual dwellings over the period 2001-2010. A case study of Eight Mile Plains in Brisbane is selected as a major powerlines coverage area (see Figure 1). The houses with actual sales prices are geocoded by longitude and altitude coordination and present on the satellite image map (refer to Map1). Proximity to HVOTL is measured by Euclidean distance from the powerlines. The dots with different colour scheme represent the five distance buffers: (1) less than 50m; (2) 50 to 100m; (3) 100 to 200m; (4) 200 to 300m and (5) over 300m.

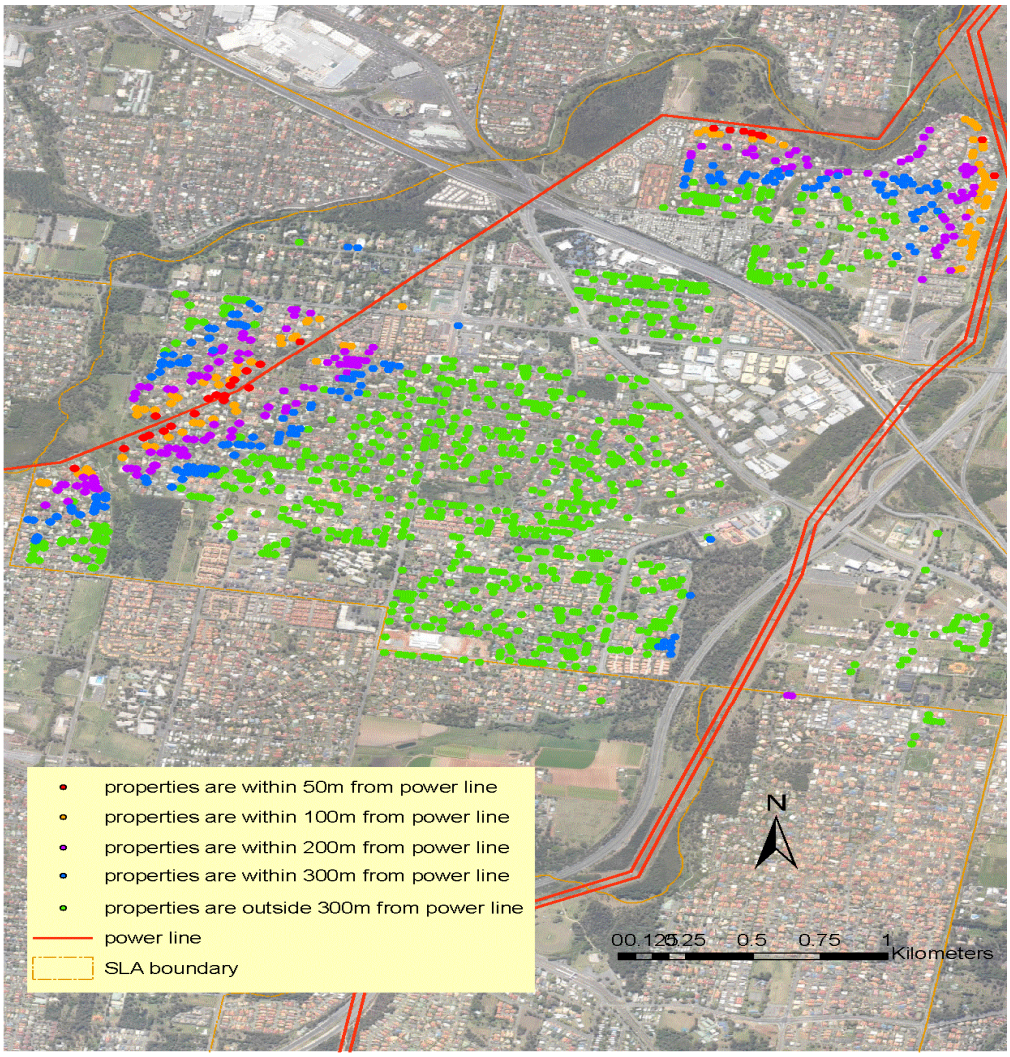

Figure 1: Sold houses in Eight Mile Plains by distance buffers 2001 to 2010

3.2.2 Hedonic Price Model

The hedonic price function (HPF) here refers to market clearing function produced by the interaction of bid functions of households and offer functions of vendors or suppliers as to a market equilibrium. Assuming each individual dwelling is heterogeneous differentiated by a bundle of housing attributes such as the number of beds, toilets and garages, land size, and built year and so on. The hedonic model will determine the value contributions to property with the negative externalities of HVOTL such as visual, safety and health factors. These externalities are measured by two continuous variables of visual impact and actual distance.

P(H) = f (housing characteristics, h1, h2…,hk, HVOTL externalities e1, e2…ek, other factors r1, r2…rk).

This hedonic price equation estimates the change in housing value P(H) that would result from a marginal increase in HVOTL externality E. However, this model does not explain how the externalities negatively or positively contribute to the changes in property price growth or

decline. For instance, if we know that the house price is strongly correlated with the proximity to HVOTL (closer is relatively cheaper) then we would want to know, 'Is the growth rate of house prices nearby HVOTL also lower than that of house far from HVOTL?' The possible externalities of HVOTL on the price change over time can be estimated by:

Price Changes Per Annum ΔP(H)[4] *= f (housing characteristics,* h_1*,* h_2*…,*h_k*, HVOTL externalities* e_1*,* e_2*…*e_k*, other factors* r_1*,* r_2*…*r_k*).*

4. Results

4.1 Descriptive Analysis

A simple descriptive analysis based on median house price has been conducted. Figure 2 shows the median house prices in Eight Mile Plains by four distance buffers. It shows a strong correlation between the proximity to HVOTL and median house price.

There are some basic findings from the buffering analysis which includes:

- The property sale prices within 50m distance from the HVPL (Red marked) show 20% less than the mean house price within Eight Mile Plains.
- The distance between 50 and 100m shows approximately 15% lower than the mean price.
- The mean property price between 100 and 200m is $370,000, around 7% lower than the mean sale price.
- However, it seems that there is little impact on the property prices if distances over 200m

However, this descriptive analysis does not explain the magnitude of this effect on property prices as it does not take account of housing attributes. The following section will estimate the marginal externality of HVOTL with a treatment of housing attributes in the determination of property value.

[4] ΔP(H) is calculated by (first sale price – last sale price)/spell years

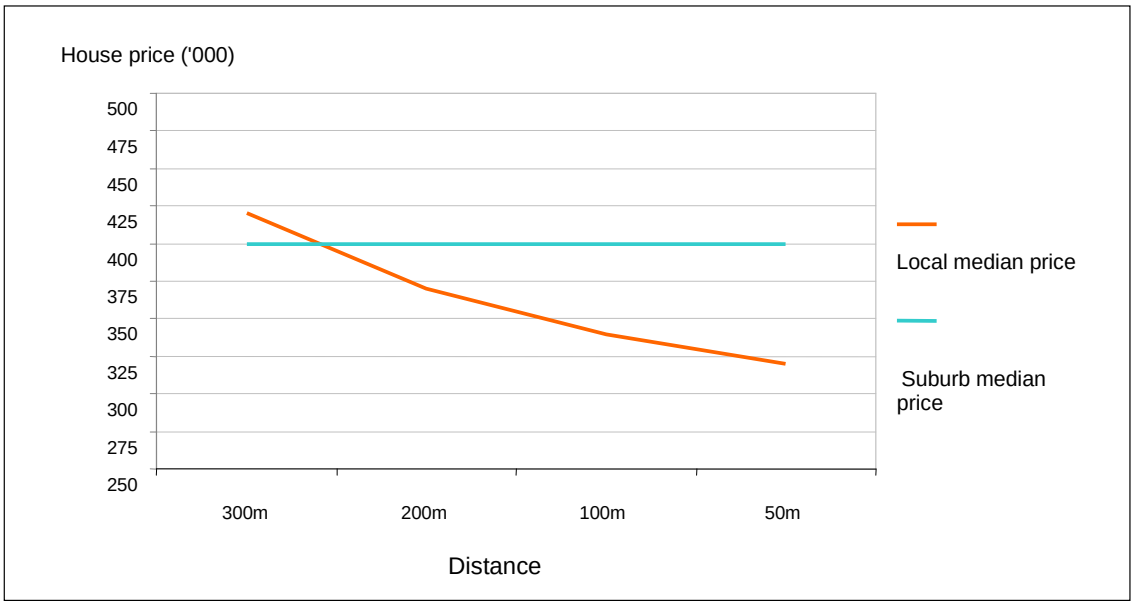

Figure 2: Median house prices by proximity to HVOTL

4.2 Hedonic Price Modelling

The analysis in this paper proceeds from a consideration of externalities of HVOTL focusing only on proximity variable before moving to consider the visual presence of HVOTL. The results of the analysis are presented in Tables 3–4. These tables present the outcomes from the hedonic regressions with the beta coefficients (β) and the robust t-scores. The βs are interpreted in the usual way and illustrate the magnitude of house price determinant in Eight Mile Plains given a particular outcome on the independent variable of house sales price.

The result reveals that all the selected housing attributes contribute to house values and they are statistically significant. The results of the coefficient estimates show that the most important determinant of house prices are the number of bedrooms, land size, sales frequency, number of bathrooms, number of garage and distance to HVOTL in order. It is interesting that the distance to HVOTL still contributes to the property value even if controlled all the housing attributes. When we substitute the proximity to HVOTL to the degree of visual presence the model prediction (r^2) is improved (see Table 4). This finding confirms that the visibility of HVOTL is a more important price determinant than the proximity to HVOTL.

Table 3: Hedonic Regression to House Price with Proximity to HVOTL

	Unstandardized Coefficients		Std. Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-4773525.741	1729792.565		-2.760	.007	-8193418.565	-1353632.916
Beds	28699.736	13687.155	.178	2.097	.038	1639.495	55759.978
Bathrooms	41104.890	15476.251	.227	2.656	.009	10507.510	71702.269

Garages	11923.289	16919.741	.054	.705	.482	-21527.948	45374.525
Area	110.250	50.858	.165	2.168	.032	9.700	210.800
Year_Built	2458.674	873.902	.211	2.813	.006	730.924	4186.424
Dist_PL	69.425	30.019	.166	2.313	.022	10.075	128.774

r^2=.323

Table 4: Hedonic Regression to House Price with Visual Presence of HVOTL

	Unstandardized Coefficients		Std. Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	-4425020.097	1712483.660		-2.584	.011	-7810692.288	-1039347.906
Beds	25834.697	13495.240	.160	1.914	.058	-846.118	52515.511
Bathrooms	42256.341	15067.078	.234	2.805	.006	12467.918	72044.764
Garages	12543.437	16692.318	.057	.751	.454	-20458.172	45545.047
Area	125.137	50.739	.187	2.466	.015	24.825	225.450
Year_Built	2252.657	866.397	.193	2.600	.010	539.742	3965.571
Visual_Ass	34770.677	11447.474	.217	3.037	.003	12138.406	57402.948

r^2=.341

The results from the repeat sales models are presented in Tables 5 and 6 and utilise annual sales appreciation rates of properties as the dependent variable. These models incorporate distance from and view of HVOTL respectively as independent variables and both models perform poorly with respect to r^2. The variables of distance from and view of HVOTL are not significant and do not contribute to changes in price growth, building age being the only significant variable. These results suggest that after the initial impact on property prices of visual encumbrance and distance from HVOTL, possible long term effects of stigma that might arise from HVOTL provision are not present with respect to the future investment value of homes.

Table 5: Hedonic Regression to Price Growth with Visual Presence of HVOTL

	Unstandardized Coefficients		Std. Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	9192044.179	4389834.563		2.094	.038	513105.427	17870982.931
Beds	-41422.121	34735.002	-.120	-1.193	.235	-110095.086	27250.843
Bathrooms	29733.495	39275.334	.077	.757	.450	-47915.951	107382.941
Garages	12346.417	42938.596	.026	.288	.774	-72545.493	97238.327
Area	56.681	129.067	.040	.439	.661	-198.492	311.854
Year_Built	-4570.578	2217.771	-.183	-2.061	.041	-8955.230	-185.926
Dist_PL	44.159	76.182	.049	.580	.563	-106.457	194.775

r^2=.05

Table 6: Hedonic Regression to Price Growth with Visual Presence of HVOTL

	Unstandardized Coefficients		Std. Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	9576714.342	4385709.611		2.184	.031	905930.842	18247497.842
Beds	-43710.490	34561.617	-.127	-1.265	.208	-112040.663	24619.683
Bathrooms	27887.311	38587.130	.072	.723	.471	-48401.518	104176.140
Garages	14130.807	42749.406	.030	.331	.741	-70387.066	98648.679
Area	77.464	129.942	.054	.596	.552	-179.439	334.367
Year_Built	-4802.483	2218.864	-.192	-2.164	.032	-9189.295	-415.670
Visual_Ass	35622.744	29317.241	.104	1.215	.226	-22339.017	93584.505

$r^2=.058$

5. Conclusion

This paper sets out to demonstrate the effect on residential property value of HVOTL at various distances and locations utilising GIS analysis and a case study based on sales transaction data within the suburb Eight Miles Plain, Brisbane Queensland. Findings of the research suggest that proximity and the visual encumbrance of HVOTL are significant variables in determining house price but do not impact detrimentally on the capital appreciation of the property within the various distances and locations set within the case study area. These results suggest that after the initial impact on property prices of visual encumbrance and distance from HVOTL, possible long term effects of stigma that might arise from HVOTL provision are not present with respect to the future investment value of homes.

Using descriptive statistics to determine the impact of HVOTL hazard on selling price at various distances from the line, the results indicate a gradual increase in mean selling price with increasing distance from the HVOTL until a distance of 200 metres or more when there is little or no impact on property price. More specifically, sale prices within 50m distance from the HVOTL (marked by a single red line in Figure 1) show a 20% reduction price when compared to the mean house price within Eight Mile Plains. Prices within the 50 to 100m band show approximately 15% lower than the mean price and approximately 7% within the 100 and 200m distances. These findings reflect those of the most recent overseas studies using hedonic regression techniques. More particularly Sims and Dent (2005) in their UK based case study demonstrated the value of property within 100 metres of the HVOTL is reduced by 6–17 per cent (an average of 11.5 per cent). The presence of a pylon was found to have a more significant impact on value than the HVOTL and could reduce value by up to 20.7 per cent compared with similar property sited 250 metres away. Rosiers (2002) found that overall the price reduction was approximately 10% of mean house value of the global sample and 15%-20% for upper price properties

Limitations of the study include that the RPDATA transaction data used to assess the impact of HVOTL, which were limited to the post HVOTL provision (after 2001). Further research is needed which would compare the growth in property prices of sales transactions both before

and after the period of HVOTL provision. In addition this study has been limited to a specific case study region. Further case studies using hedonic price model techniques could measure differences in possible spatial or environmental effects of various neighbouring suburbs.

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