

**ASSESSING THE IMPACTS OF HIGH-VOLTAGE
TRANSMISSION LINES (HVTL) ON PROPERTY VALUES**

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Determining whether, and to what extent, high voltage transmission lines (HVTL) have an impact on the value of adjacent or nearby residential property by reason of proximity alone is a challenging appraisal assignment. While the literature on the subject is extensive, it is of uneven quality, ranging from anecdotal reports to large, rigorously conducted statistical studies. This paper explains the most common approaches to identifying and estimating that impact, and summarizes the results of the most objective and reliable studies in the published literature.

1.1. METHODOLOGY

The only reliable evidence of the effect of HVTLs on the value of adjacent or nearby residential property must rely on actual arms-length sales of property that lie in close proximity to an existing line. These sales are then compared to other selected transactions involving properties located outside of the potential area of influence. The three most common approaches for performing this comparison are discussed below:

1. Paired Sales Analysis. The first approach attempts to match the characteristics of a subject property within a claimed area of impact (the “Subject Area”) to a single sale of a similar and competitive property outside the area of impact (the “Control Area”). For example, if the subject property, which lies immediately adjacent to a HVTL, sold for \$149,000 and another property with the same value-determining characteristics as the subject property, except for the power line proximity, sold for \$150,000, then the conclusion could be drawn that property value effects of the transmission line are insignificant.

There are several major shortcomings with the Paired Sales approach. The first stems from the availability of sales, and the ability to identify one single sale that can be considered a perfect match to the subject property. For example, not all 3-bedroom 2-bath ranch-style homes are exactly the same. While the subject and comparable properties can share a common style and layout, other factors like age, condition, construction quality, neighborhood, etc. can vary having a measurable impact on value. Similar to the first, the second problem relates to the subjective nature of the analysis. Both the selection of the property and the value adjustments are subjective. It is not uncommon for two appraisers to differ in their opinions as to what constitutes a pair of virtually identical properties, and if not identical, the level of appropriate adjustments. Overall, the Paired Sales approach is highly susceptible to abuse given the reliance on one single sale instead of multiple sales that is standard in most residential appraisals.

¹ See Appendix A for biographical information.

2. Appraisal Based on Control Properties. The second approach recognizes that a perfect match is unlikely and relies on standard residential appraisal sales comparison methodology. Three or four sales of control properties are selected that are as similar to the subject as possible. They are then adjusted to account for differences (other than HVTL proximity) with the subject. This recognizes that there are inevitably going to be differences among the properties and then compensates by making explicit dollar adjustments based on the appraiser's experience in the market in question. For example, if the subject sold for \$149,000 and the value implied by several adjusted comparable sales was \$160,000, there would appear to be some negative influence of the high-voltage line on the value of the subject.

3. Statistical Analysis of Large Numbers of Subject and Control Area Properties
The third approach is to use statistical tools to separate out the effects of the high-voltage line from all the other determinants of value. This is only possible with a relatively large number of sales of subject and control properties. If the sales, property and neighborhood data exist to carry out this approach, it is ideally suited to identifying the independent effect of the transmission line holding the other value-determining factors constant. The tool most commonly used to carry out this analysis is called multiple regression. A multiple regression analysis typically incorporates the following:
 1. Define the area(s) of alleged impact (the "Subject Area"). This can be defined as tiers that are proximate to the alleged area of impact (i.e.- <500 feet, 500 to 1,000 feet, etc.);
 2. Assess format, availability and quality of property and sales data;
 3. Define an area(s) of non impact (the "Control Area");
 4. Define the time frame of the analysis. The time frame generally includes a few years prior to a public announcement, or some other source of public awareness of the proposed right of way or line improvement.
 5. Gather sales data files on all available sales transactions within the Subject and Control Areas. Information captured typically includes market conditions, property and transaction characteristics;
 6. Develop database template for importing data;
 7. Import data and perform logic and quality control checks and apply appropriate filters to data set;
 8. Geo-code sales to pinpoint location and measure proximity;
 9. Run statistical analysis on the data. The strongest models are those that have high levels of explanatory power (R^2), identify statistically significant effects of value determining variables (F-Ratio and t-Values) and give reliable results (Standard Error of the Estimate).

The use of large sets of sales data in multiple regression analysis produces results that are more nearly representative of the patterns of buyers and sellers in the aggregate (i.e. the market) rather than a single buyer and seller as reflected in the Paired Sales approach. In addition, it is the least subjective of the three potential approaches and is the only approach to give explicit measures of reliability which helps the user determine what weight to give the results.

1.2 SUMMARY OF STATISTICAL STUDIES ON THE EFFECT OF HIGH-VOLTAGE TRANSMISSION LINES ON PROPERTY VALUE

The following section highlights the key findings that emerge from multiple regression studies in the published literature.

Over the past 20 years, the literature increasingly recognizes multiple regression analysis as the most reliable technique to investigate whether high-voltage transmission lines impact property values and, if so, to quantify the effect. As explained above, multiple regression has the significant advantage of not relying on the subjective judgment of the appraiser. Rather, it represents an objective reflection of the data together with measures of reliability that attach to the results. As a result, there have been a large number of studies undertaken since about 1980 using large databases and statistical tools to investigate the effect of transmission lines on property value. Sixteen of these studies form the core of the professional literature and are widely quoted and cross-referenced one to the other.² The results of these studies can be generally summarized as follows:

- Over time, there is a consistent pattern with about half of the studies finding negative property value effects and half finding none.
- When effects have been found, they tend to be small; almost always less than 10% and usually in the range of 3-6%.
- Where effects are found, they decay rapidly as distance to the lines increases and usually disappear at about 200-300 feet.
- Two of the studies investigated the behavior of the effect over time and found that, if there were effects, they tended to dissipate over time as well.
- There doesn't appear to have been any change in the reaction of markets to high-voltage transmission line proximity after the 1992 Swedish health effects studies.³

These general conclusions have characterized the appraisal and economic literature throughout the last 20 years and there don't appear to be any new or different trends showing in the data. It is during this period that most of the medical studies on EMF exposure were published, including the oft-referenced Swedish studies that were published in 1992. One of the questions in people's minds, therefore, is the apparent inconsistency between these statistical results and the intensity of opposition that new transmission line corridors generate. How can it be if people are so intensely adverse to the lines that we don't see more of a market effect? This inconsistency is seen clearly when residents along existing high-voltage transmission lines are interviewed. Several studies of this type have been done and are reported on in the next section.

² These 16 studies are summarized in Appendix B.

³ The two referenced 1992 Swedish studies have been widely reported including the following two articles: 1) [Ahlborn and Feychting] - Kolare, Susan, "Power Lines Increase Cancer Risk for Children," *Foirskning & Praktik* (Solna, Sweden: National Institute of Occupational Health), July 1992, p. 387-388, and; 2) [Floderus] Gronkvist, Lars, "Cancers Related to Strong Electromagnetic Fields," *Foirskning & Praktik* (Solna, Sweden: National Institute of Occupational Health), July 1992, pp. 383-385.

1.2. SURVEYS OF RESIDENTS LIVING NEAR HIGH-VOLTAGE TRANSMISSION LINES

Several surveys have been carried out of homeowners living adjacent to, or near, high-voltage transmission lines. While surveys alone are not a recognized valuation tool, when discussed in conjunction with multiple regression analysis they can provide further insight into the findings.

The basic thrust of survey questioning is whether home purchasers were aware of the transmission lines prior to their purchase and, if so, whether their purchase decision or the price they paid was affected by the lines⁴. Like the statistical analyses of sales reported above, the results of these survey studies are quite consistent with one another. Their findings can be summarized as follows:

- A high proportion of the residents were aware of the lines at the time of purchase.
- Between one-half and three-fourths of the respondents have negative feelings about the lines.
- The negative feelings center on health effects, aesthetics and property value effects.
- Of those who have negative feelings about the lines, the vast majority (67-80%) report that their purchase decision and the price they offered to pay was not affected by the lines.

In summary, the relatively small effects on property value attributed to HVTL proximity in the literature does not mean that the direction of the effect of transmission lines on property values is not negative. Our general interpretation is that, even though transmission line issues have been a prominent concern in most of the communities studied, and even though the direction of effect on real estate value is clearly negative, their presence is apparently not given sufficient weight by buyers and sellers of real estate to have had any consistent, material effect on market value.

⁴ Five studies are prominent in the literature and are summarized in Appendix C.

POSITION

Principal, Chalmers & Associates, LLC

EDUCATION

Ph.D. - Economics, University of Michigan - 1969

B.A. - Economics, University of Wyoming - 1963

EXPERIENCE

I. ECONOMICS

Broad range of experience in quantitative economic analysis and problem solving applied to regional and urban growth issues, public planning, economic modeling, fiscal analysis, industry economics and socioeconomic impact assessment.

II. REAL ESTATE

Experienced in applying economic and financial analysis together with relevant market data to real estate development, investment counseling, asset management, and real property valuation. Projects include large, urban, mixed-use projects, single use projects of all types, and large master-planned community studies.

III. ENVIRONMENTAL DAMAGES QUANTIFICATION / REAL PROPERTY VALUATION

Have applied real estate and economics background to litigation oriented engagements focused on environmental damages in the context of valuation of contaminated property, valuation of property affected by hazard or risk, natural resource damages and value of real property in the context of eminent domain.

PROFESSIONAL AND BUSINESS HISTORY

Chalmers & Associates, LLC, Principal, 7/02 to present.

PricewaterhouseCoopers LLP, Principal, Financial Advisory Services. 7/98 to 6/02.

Coopers & Lybrand L.L.P. Principal, Financial Advisory Services. 1990 to 6/98.

Mountain West: 1974 to 1989. President and Economic Consultant.

Arizona State University: 1972 to 1979. Faculty of Economics, College of Business.

Rockefeller Foundation: 1970 to 1972. Special field staff at Thammasat University, Bangkok, Thailand.

Amherst College: 1966 to 1970. Faculty of Economics.

CERTIFICATIONS

Arizona: General Real Estate Appraiser #30487

PUBLICATIONS***Books Published***

One Hundred Centuries of Solitude - Redirecting America's High-Level Nuclear Waste Policy (with James Flynn, Doug Easterling, Roger Kasperson, Howard Kunreuther, C.K. Mertz, Alvin Mushkatel, K. David Pijawka and Paul Slovic) Westview Press (1995).

Economic Principles: Macroeconomic Theory and Policy (with Fred R. Leonard) MacMillan (1971).

Selected Articles Published

“Recent Developments in Natural Resource Damage Claims: Smoke or Fire?” (with Suzanne M. Stuckwisch), Environmental Compliance & Litigation Strategy, Vol. 15, No. 10, March 2000.

“Creating Value--and Profits--from Contaminated Real Estate” (with William V. Trefethen), Workouts & Asset Management, Vol. 5, No. 1, October 1996.

“Risk Factors in the Appraisal of Contaminated Property” (with Thomas O. Jackson), The Appraisal Journal, Vol. 64, No. 1, January 1996; 44-58.

“The Emerging Market in Contaminated Real Property,” California Environmental Compliance Monitor, Vol. 5, No. 24, 320-322, October 16, 1995.

“Quantifying Contamination's Effects on Residential Property Values” (with Sue Ann Adams), Environmental Compliance & Litigation Strategy, September 1995; 4-6.

“Valuation Issues - Assessing Value of Environmentally Impaired Properties” (with Jeffre Beatty and Robert Ecker), as a chapter in Environmental Aspects of Real Estate Transactions, published by the ABA Section of Natural Resources, Energy and Environmental Law, 1995.

“Supporting Appropriate Adjustments in Large Scale Condemnation Actions” (with Daniel Sorrells), The Appraisal Journal, October 1994.

“Property Value Diminution: Residential and Commercial Cases Demand Different Approaches” (with Jeffre B. Beatty), Environmental Compliance & Litigation Strategy, February 1994; 4-7.

“Issues in the Valuation of Contaminated Property” (with Scott A. Roehr), The Appraisal Journal, Vol.61, No.1, January 1993; 28-41.

“Perceived Risk, Stigma, and Potential Economic Impacts of a High-Level Nuclear Waste Repository in Nevada” (with Paul Slovic et al), Risk Analysis, Vol. II, No. 4, 1991; 683-696.

"A Methodology for Valuing Contaminated Property" (with Steve Pritulsky, Scott Roehr, and Dan Sorrells), Land Rights News, November 1991.

“Contributions of Real Estate Economics to Right-of-Way Acquisition and Valuation” (with S. Pritulsky and D. Sorrells), Right-of-Way, June 1991; 8-13.

“Impacts of Nuclear Generating Plants on Local Areas” (with D. Pijawka), Economic Geography, Vol. 59, No. 1, January 1983; 66-80.

“Evaluation of Underutilized Resources in Water Resource Development” (with J.R. Threadgill), Water Resources Research, 1981.

“Integrating Planning and Assessment through Public Involvement” (with James L. Creighton and Kristi Branch), Environmental Impact Assessment Review, Vol. 1, No. 4; 349-353, April 1981.

“An Empirical Model of Spatial Interaction in Sparsely Populated Regions” (with E.J. Anderson, T. Beckhelm, and W. Hannigan), International Regional Science Review, Vol. 3, No. 1, Fall 1978.

“Some Thoughts on the Rural to Urban Migration Turnaround” (with M.J. Greenwood), International Regional Science Review, Vol. 2, No. 2, Spring 1978.

“The Role of Spatial Relationships in Assessing Social and Economic Impacts of Large-Scale Construction Projects,” National Resources Journal, Vol. 17; 209-222, April 1977.

“Shift and Share and the Theory of Industrial Location” (with T. Beckhelm), Regional Studies, Vol. 10; 15-23, 1976.

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APPENDIX B: TRANSMISSION LINE STATISTICAL STUDIES REVIEWED

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STATISTICAL ANALYSIS OF SALES – CALLANAN 1995	
Author	Callanan, Judith and R.V. Hargreaves
Title	“The Effect of Transmission Lines on Property Values: A Statistical Analysis”
Source	<i>New Zealand Valuers Journal</i> , June 1995
Study Area	Suburb of Newlands in the city of Wellington, New Zealand
Transmission Lines	Two sets of high-voltage transmission lines transecting a suburb: i) Takapau line was erected in 1924 and upgraded in 1983 (runs through east side of town), and ii) Hayward line erected in 1931 and upgraded in 1981 (runs along south east corner of town). Both lines are a prominent part of the suburb. There is no ROW in New Zealand. Pylons are located on private property and the lines run over private properties.
Sales Data	330 sales of properties within 300 meters of the transmission lines over a 10-year period from 1/1/83 to 1/31/93. ¹
Distance Zones	Distance, both to the lines and to the pylons, is a continuous variable.
Hypotheses Tested	Any effect on property values due to proximity to transmission lines or pylons?
Functional Form	Linear model ²
Independent Variables	Floor area, lot size, time, condition, neighborhood, panoramic view, age and proximity variables
Results	<ul style="list-style-type: none"> ➤ R² of 74% ➤ No effect of proximity to lines; for properties directly under the lines, an effect of less than one percent ➤ Consistent negative effect for proximity to pylons; for Hayward line, decrease in property values of 2.7% at 100m, 5.4% at 50m and 13.6 % at 20m ➤ Less of an effect of pylon proximity on the Takapu line

¹ Ultimately, only 5 years worth of data was used in the study.

² The dependent variable is represented in terms of inflation-adjusted sales price.

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STATISTICAL ANALYSIS OF SALES – COLWELL 1990	
Author	Colwell, Peter F.
Title	“Power Lines and Land Value”
Source	<i>Journal of Real Estate Research</i> , Spring 1990
Study Area	Decatur, Illinois
Transmission Lines	Double-circuit 138 kV lines with lattice steel towers; ROW consists of a 50’ easement
Sales Data	200 sales over a period from 1/1/68 to 10/31/78; all properties are within 400 feet of the centerline
Distance Zones	Continuous distance to transmission line variable
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value due to proximity to line? ➤ Any effect on value due to easement (holding distance constant)? ➤ Any effect on value due to proximity to towers? ➤ Any change in effects over time?
Functional Form	Log-Log Model ³
Independent Variables	Distance to line, distance to tower, easement on property, time, neighborhood, lot size, building size, number of bathrooms, basement, garage size and deck variables
Results	<ul style="list-style-type: none"> ➤ R² of 77% ➤ Negative proximity effect of approximately 6% at 50 feet from center line; declining rapidly to about 2% at 200 feet ➤ Over a 10-year period, negative proximity effect dissipated⁴ ➤ No evidence of effect due to proximity to tower ➤ There is evidence of a negative effect associated with the easement as well as a distance effect. That is, a property 50 feet from the line with the easement would be more affected than a property at the same distance without an easement.

³ Both dependent and continuous independent variables are in natural logarithms. The Log-Log transformation models the tendency of the dependent variable to change by Beta percent when a continuous independent variable (holding all other independent variables equal) changes by one percent.

⁴ The lines were constructed well before 1/1/68, so this is simply a decay in the market effect over time (perhaps due to vegetative growth or familiarity) not a before/after comparison.

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STATISTICAL ANALYSIS OF SALES – COLWELL 1979	
Author	Colwell, Peter F. and Kenneth W. Foley
Title	“Electric Transmission Lines and the Selling Price of Residential Property”
Source	<i>The Appraisal Journal</i> , October 1979
Study Area	Decatur, Illinois
Transmission Lines	Double-circuit 138 kV lines with lattice steel towers; ROW consists of a 50’ easement
Sales Data	200 transfers over a period from 1/1/68 to 10/31/78; all properties are within 400 feet of the center line
Distance Zones	Continuous distance to transmission line variable
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value due to proximity to line? ➤ Any effect on value due to tower on property?
Functional Form	Log-Log Model
Independent Variables	Distance to line, tower on property, time, neighborhood, lot size, building size, number of bathrooms, basement, garage size and deck variables
Results	<ul style="list-style-type: none"> ➤ R^2 of 75% ➤ Negative proximity effect; about 9% at 50 feet from the center line declining rapidly to about 3% at 200 feet ➤ No evidence of tower effect

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STATISTICAL ANALYSIS OF SALES – COWGER 1996	
Author	Cowger, J.R., Steven C. Bottemiller and James M. Cahill
Title	“Transmission Line Impact on Residential Property Values: A Study of Three Pacific Northwest Metropolitan Communities”
Source	<i>Right of Way</i> , September/October 1996
Study Area	Portland, Oregon; Vancouver and Seattle, Washington
Transmission Lines	16 Bonneville Power Authority high voltage transmission lines varying between 115 kV and 500 kV. One line with concrete poles, one line with H-frame wood structures, and 14 lines with lattice steel towers. Either the structures or the conductors were clearly visible from the subject properties.
Sales Data	281 residential sales abutting the BPA lines over a period from 1990 to 1991 and a matched sale for each subject sale.
Distance Zones	Sales were categorized as either subject (abutting the transmission lines) or control (unaffected by proximity to transmission lines)
Hypothesis Tested	Any effect of transmission lines on value as evidenced by matched pairs of subject and control sales?
Functional Form	Statistical analysis of a large number of matched pairs
Independent Variables	Control matches for the subject properties were selected based on time, market, sale terms, lot size, residence size, condition, age, number of bedrooms, number of bathrooms, number of rooms, garage size, landscaping, other improvements and zoning variables
Results	<ul style="list-style-type: none"> ➤ Portland: mean of subject sales was 1.46% greater than control sales ➤ Vancouver: mean of subject sales was 1.05% less than control sales ➤ Seattle: mean of subject sales was 1.00% less than control sales ➤ None of the subject means were significantly different from the control means at the 95% level ➤ Differences between individual pairs of subject and control showed no relationship to distance of the subject from the transmission line

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STATISTICAL ANALYSIS OF SALES – DES ROSIERS 2002	
Author	Des Rosiers, Francois
Title	“Power Lines, Visual Encumbrance and House Values: A Micro-Spatial Approach to Impact Measurement”
Source	Accepted by <i>Journal of Real Estate Research</i> , January 2002
Study Area	Brossard, located in the Greater Montreal area, Canada
Transmission Lines	315kV transmission line running through center of three distinct neighborhoods. Corridor is two miles long and 200 feet wide with “Improved Visual Appearance” conical steel pylons reaching, in most cases, between 155 and 175 feet in height.
Sales Data	507 sales of single-family homes over a period from 2/91 to 11/96
Distance Zones	Sales were categorized by distance from the easement, distance from the line, distance from the pylons, view of the pylon (limited, moderate or pronounced and rear, side or front) and view of the line.
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Does proximity to the line or easement affect value? ➤ Does proximity to a pylon affect value? ➤ Does view of the line or pylons affect value? ➤ Is there any apparent effect on value of publication of the Swedish leukemia studies?
Functional Form	Log-linear and linear Regression Models
Independent Variables	Age, lot size, living area, basement area, siding, landscaping, cabinets, floors, air conditioning, kitchen features, pool, garage, door, house style, neighborhood, property tax rate, service area, view and distance variables
Results	<ul style="list-style-type: none"> ➤ Direct view of a pylon can have a significant negative effect on value. The effect averages 10% with greater effects where the setback to the tower is narrow and greater with higher value homes ➤ Similarly, a direct view of the conductors will reduce value by 5-10% ➤ Rear or side views on the other hand tend to increase value due to greater view corridors. Net effects are negative and max at 5-12% of value at 165-325 feet and tend to disappear beyond 500 feet. ➤ No effect of the Swedish studies was observed

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STATISTICAL ANALYSIS OF SALES – HAIDER 1999	
Author	Haider, Murtaza
Title	“Influence of Power Lines on Freehold Property Value in the Greater Toronto Area”
Source	University of Toronto, Series in Spatial Econometrics, Jan. 2000
Study Area	Greater Toronto Metro Area
Transmission Lines	All HVTL’s in the Toronto Area were used
Sales Data	A total of 27,400 sales in calendar 1995
Distance Zones	Zones around all HVTL in the Toronto metro area were established at 100m intervals out to 500m, and at larger intervals out to 3000m.
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Considerable emphasis on comparing ordinary least squares specification with spatial auto-regressive specification. ➤ Basic question was effect of proximity to HVTL’s on home values.
Functional Form	Semi log model with spatial auto-regressive specification
Independent Variables	Number of rooms, bedrooms, bathrooms, parking capacity, distance from CBD, average income in CT, spatial autoregressive variable, fireplace, air-conditioning, detached, multiple story
Results	<ul style="list-style-type: none"> ➤ OLS results showed 4-6% decrease in value, with no effects beyond 500m ➤ The spatial autoregressive model seems to produce better results in general. The only reported result for a distance zone is a 3.1% decrease in value in the 0-100m zone relative to property more than 3000m from a line.

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STATISTICAL ANALYSIS OF SALES – HAMILTON 1993	
Author	Hamilton, S.W. and Cameron Carruthers
Title	“The Effects of Transmission Lines on Property Values in Residential Areas”
Source	Research Paper, April, 1993
Study Area	Five residential neighborhoods in Vancouver, British Columbia
Transmission Lines	Coverdale – Two 500kV and one 230kV lines on lattice steel structures in a 140m ROW: <ul style="list-style-type: none"> ➤ Newton (East/West) – Same lines as Coverdale ➤ Newton (North/South) – Two transmission lines ➤ Walnut Grove – 60kV line on wood poles ➤ North Vancouver – Two 230kV lines on lattice steel structures
Sales Data	15,663 transfers of single-family detached units over the period 1/1/85 to 12/31/91. Of these, 2,698 sales are within 270m of the transmissions lines, 171 are within the ROW, and 289 are adjacent, but not in the ROW.
Distance Zones	Sales were categorized 0-120, 121-170, 171-220, 221-270 and greater than 270 meters. ⁵
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value by distance? ➤ Any effect on value by distance zone? ➤ Any effect on value by visibility? ➤ Any diminishing effects on value over time?
Functional Form	Log-Log Model
Independent Variables	Continuous distance variable, distance zones, property in or adjacent to ROW, line or structure visible, number of structures visible, age, living area, lot area, number of rooms, baths, bedrooms, fireplaces, pool, garage, sidewalks, corner lot, time and neighborhood variables
Results	<ul style="list-style-type: none"> ➤ R² of 84% ➤ Negative proximity effect of 3-4% in zone 1, and 1-2% in zone 2 compared to Zone 5 ➤ In general no statistical effect in Zones 3 and 4 ➤ No effect of adjacency, beyond the distance effect ➤ Properties within the ROW showed less of a negative effect than zone 1

⁵ The Zones are observed in 50-meter bands. The first Zone includes the 50-meter band and the 70-meter average distance from the center of the right of way to its boundary.

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STATISTICAL ANALYSIS OF SALES – HAMILTON 1995	
Author	Hamilton, S.W. and Gregory M. Schwann
Title	“Do High Voltage Electric Transmission Lines Affect Property Value?”
Source	<i>Land Economics</i> , November 1995
Study Area	Four neighborhoods in Vancouver, BC
Transmission Lines	Two neighborhoods have a 140m ROW with two 500 kV lines and a 230 kV line, all on steel towers. One neighborhood has two lines, each on steel towers and one neighborhood has a 60 kV line on wood poles.
Sales Data	All sales of single-family detached residences over the period 1985-1991 in the four neighborhoods. This resulted in a total of 12,907 sales of which 426 were adjacent to the ROW and 2364 were not adjacent but within 200m of the ROW.
Distance Zones	Distance was measured as a continuous variable from the property to the centerline of the ROW
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect of tower visibility on property value? ➤ Any effect of distance to transmission lines on value? ➤ Any combined effect of tower visibility and proximity?
Functional Form	Extensive discussion of appropriate functional form; ultimately used a Box-Cox model
Independent Variables	Distance, abutting ROW, within ROW, towers visible, lines visible, garage, pool, curb, corner lot, age, # of fireplaces, basement rooms, bedrooms, full baths
Results	<ul style="list-style-type: none"> ➤ Adjacent properties suffer a 5.7% decrease due to tower visibility and 5.8% from proximity or 6.3% in combination ➤ Properties non-adjacent but within 200 m of the lines suffer no visibility effect from the towers but a small decrease due to proximity. The combined visibility and proximity effects are about 1%

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STATISTICAL ANALYSIS OF SALES – IGNELZI 1991	
Author	Ignelzi, Patrice C. and Thomas Priestley
Title	“A Statistical Analysis of Transmission Line Impacts on Residential Property Values in Six Neighborhoods”
Source	Southern California Edison – Environmental Affairs, 1991
Study Area	Eight neighborhoods in Vallejo and other communities, Solano County, California
Transmission Lines	Study focused on the before and after effects of upgrading a 115 kV line to a combined 115/230 kV line. The 115 kV line was on 60’ lattice steel towers while the new line was on 165’ steel poles. The ROW varied in width but was generally 100’ but the extent of landscaping, fencing and use varied considerably from area to area.
Sales Data	There were six new neighborhoods plus two original neighborhoods yielding a total of 1,816 sales from 1976 through December 1989. The sales data were inflation adjusted.
Distance Zones	Five distance zones: 0-300’, 301-600’, 601-900’, 901-1500’, and over 1500’
Hypothesis Tested	<ul style="list-style-type: none"> ➤ Are there effects on value of proximity to the line? ➤ Is there an effect on value due to number of towers visible? ➤ Is there an effect, independent of proximity if the ROW crosses a property? ➤ Is there an effect on value associated with upgrade of the line?
Functional Form	Linear
Independent Variables	Lot size, living area, street type, steepness of street, panoramic view, proxy for house quality
Results	<ul style="list-style-type: none"> ➤ R² of 84% ➤ Upgrading effect is negative affecting value by 4-9% at 300’ from centerline ➤ Evidence that the upgrading effect diminishes over time and is gone in 4-5 years ➤ Sign and significance of distance to line vary by neighborhood. ROW’s developed for recreational use may have positive effects ➤ Easement on property has negative effect ➤ No significant effect on value of line or tower visibility

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STATISTICAL ANALYSIS OF SALES – KINNARD 1997: NEVADA STUDY	
Author	Kinnard, William N., Mary Beth Geckler and Jake W. DeLottie
Title	“Post-1992 Evidence of EMF Impacts on Nearby Residential Property Values”
Source	Real Estate Counseling Group of Connecticut, April 1997
Study Area	Sun City, Nevada
Transmission Lines	138 kV line with 3 double circuits on 90’ concrete poles. Line is in the middle of an arterial street about 35’ north of Sun City boundary. Lines and poles are visible throughout Sun City. The line was completed in August 1991.
Sales Data	4,269 transfers of single-family residences from 1989 to 1996
Distance Zones	Sales were categorized by distance zones: 0-200’, 201-400’, 401-800’, 801-1320’, 1321-2640’ and greater than 2641’.
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value before /after construction 8/1/91? ➤ Any effect on value before/after Swedish health effects study 1/1/93? ➤ Any effect on value by distance zone?
Functional Form	Log-Log Model
Independent Variables	Age, living area, lot size, garage size, number of baths, distance zone, fairway lot, greenbelt lot, cul-de-sac Lot, fireplace, community entrance lot and time variables
Results	<ul style="list-style-type: none"> ➤ High R² ➤ One Model shows a 1% effect on value of homes 0-200’ relative to homes greater than 2,641’ ➤ No apparent effect due to construction or due to Swedish studies ➤ Trends for distance zones show no negative effects of proximity

APPENDIX B

STATISTICAL ANALYSIS OF SALES – KINNARD 1997: MISSOURI STUDY	
Author	Kinnard, William N., Mary Beth Geckler and Jake W. DeLottie
Title	“Post-1992 Evidence of EMF Impacts on Nearby Residential Property Values”
Source	Real Estate Counseling Group of Connecticut, April 1997
Study Area	Portions of St. Louis and St. Charles Counties, Missouri
Transmission Lines	Four study areas were centered on substations. A fifth study area surrounded a 138 kV line on 90’ steel poles. These facilities were only visible to portions of the study areas and all were built before 1/1/90.
Sales Data	1,377 residential sales over the period 1990 to 1996
Distance Zones	Sales were categorized by distance zones: 0-200’, 201-400’, 401-800’, 801-1,320’ and 1,321 or greater
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value of visibility of lines or substations? ➤ Any effect on value before/after Swedish health effects study 1/1/93? ➤ Any effect on value by distance zone?
Functional Form	Appears to be a Log-Log Model
Independent Variables	Age, living area, lot size, garage, number of baths, distance zone, warm air, number of stories, basement, visibility of structures, time variables, distance variables and frame type.
Results	<ul style="list-style-type: none"> ➤ High R² ➤ No effects of visibility, proximity or Swedish studies.

APPENDIX B

STATISTICAL ANALYSIS OF SALES – KINNARD 1989	
Author	Kinnard, William N., Phillip S. Mitchell and James R. Webb
Title	“The Impact of High Voltage Overhead Transmission Lines on the Value of Real Property”
Source	Research Report, April 1989 (seems to be the same basic research as Study 3)
Study Area	Orange County, New York: Hamptonburgh and Wawayanda
Transmission Lines	Marcy South 345kV overhead transmission lines running between East Fishkill and Marcy extending 200 miles
Sales Data	371 transfers of vacant land over the period 1/1/83 to 12/31/87.
Distance Zones	Sales were categorized 0-300’, 301-1600’, 1601-2000’ and 2001 to 4,000’
Hypothesis Tested	Does proximity to the transmission line have any measurable impact on inflation adjusted value per square foot of vacant land subsequent to October 1, 1985 when final approval for construction was obtained?
Functional Form	Linear
Independent Variables	Lot size, school district/town, land use, distance zone and time variables
Results	<ul style="list-style-type: none"> ➤ No evidence that proximity had any impact on price-per-acre ➤ Post-announcement values appear to be higher than pre-announcement values, holding distance to the line constant

APPENDIX B

STATISTICAL ANALYSIS OF SALES – KINNARD 1988	
Author	Kinnard William N., Mary Beth Geckler, Kinnard and Phillip S. Mitchell
Title	“Effects of Proximity to High-Voltage Electric Transmission Lines on Sales Prices and Market Values of Vacant Land and Single-Family Residential Property: January 1978-June 1988”
Source	Real Estate Counseling Group of Connecticut, 1988
Study Area	Penobscot County, Maine
Transmission Lines	345 kV line, 10 years after construction.
Sales Data	305 residential property sales and 247 vacant property sales.
Distance Zones	
Hypothesis Tested	Is there an effect of proximity to the line on property value?
Functional Form	
Independent Variables	
Results	<ul style="list-style-type: none"> ➤ R² of 57% ➤ No distance zones with significant negative sig ➤ No evidence of significant negative effects of the line on value

APPENDIX B

STATISTICAL ANALYSIS OF SALES – KINNARD 1984	
Author	Kinnard, William N., Mary Beth Geckler, Kinnard and Phillip S. Mitchell
Title	“An Analysis of the Impact of High Voltage Electric Transmission Lines on Residential Property Values in Orange County, New York”
Source	Real Estate Counseling Group of Connecticut, 1984
Study Area	Orange County, New York: Hamptonburgh and Wawayanda
Transmission Lines	345 kV line
Sales Data	329 inflation adjusted sales of single-family homes over the period 1972-1984
Distance Zones	
Hypothesis Tested	
Functional Form	
Independent Variables	
Results	<ul style="list-style-type: none"> ➤ R² of 49% ➤ No statistically significant proximity effects

APPENDIX B

STATISTICAL ANALYSIS OF SALES – MITCHELL 1996	
Author	Mitchell Phillip S. and William N. Kinnard
Title	“Statistical Analysis of High-Voltage Overhead Transmission Line Construction on the Value of Vacant Land”
Source	<i>Valuation</i> , June 1996.
Study Area	Hamptonburgh and Wawayanda, Orange county, New York
Transmission Lines	345 kV Marcy South electric transmission line runs from Marcy, New York to East Fishkill, New York traversing 200 miles and through 37 townships. Route announced in September, 1985
Sales Data	376 transfers of vacant land over the period 1/1/83 to 12/31/87.
Distance Zones	Sales were categorized by distance zones: 0-300’, 301-2000’ and 2001 or greater.
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Any effect on value per acre by distance zone? ➤ Any effect on appreciation rates before/after line construction?
Functional Form	Linear model ⁶
Independent Variables	School district, land use, lot size, distance zone and time
Results	<ul style="list-style-type: none"> ➤ R² of 70% ➤ No effects of proximity ➤ Appreciation rates were higher after line construction than before

⁶ The dependent variable is represented in terms of inflation-adjusted sales price per acre.

APPENDIX B

STATISTICAL ANALYSIS OF SALES – WOLVERTON 2003	
Author	Wolverton, Marvin L., and Steven C. Bottemiller
Title	“Further Analysis of Transmission Line Impact on residential Property Values”
Source	<i>The Appraisal Journal</i> , July, 2003
Study Area	Portland, Oregon and Vancouver and Seattle, Washington
Transmission Lines	16 BPA high voltage transmission lines varying between 115 kV and 500 kV. One line with concrete poles, one line with H-frame wood structures and 14 lines with lattice steel towers.
Sales Data	712 sales occurring over the period 1989-1992 of which 300 sales abutted a transmission line.
Distance Zones	Sales were characterized as either subject (abutting the transmission line) or control (not abutting a transmission line right-of-way)
Hypotheses Tested	<ul style="list-style-type: none"> ➤ Is there a negative effect on value for homes abutting a transmission line right-of-way? ➤ Are there adverse appreciation effects for abutting relative to non-abutting properties?
Functional Form	Both semi-log and linear regression models
Independent Variables	Date of sale, site and site improvement variables, location variables, building improvement variables, and abutting transmission line variable
Results	<ul style="list-style-type: none"> ➤ No evident price sensitivity to abutting a high voltage transmission line right-of-way ➤ No evidence of differential appreciation over time for properties abutting transmission lines compared to non-abutting properties

APPENDIX C: HOMEOWNER SURVEY STUDIES REVIEWED

KINNARD 1967 1
PRIESTLY 1990 2
KUNG 1992..... 3
BOND 1996 4
MITTENESS 1998 5

APPENDIX C

HOMEOWNER SURVEY STUDY – KINNARD 1967	
Author	Kinnard, William N.
Title	“Tower Lines and Residential Property Values”
Source	<i>The Appraisal Journal</i> , April 1967
Study Area	17 subdivisions in 9 towns around Hartford in central Connecticut
Transmission Line	Multiple lines including both lattice steel and wooden H-frame towers
Data	377 property owners responded, all being within 200’ of the transmission line ROW (R^2 of 46%)
Results	<ul style="list-style-type: none">➤ 79.9% of respondents aware of transmission lines at time of purchase➤ 76.3% report no effect of lines on purchase decision or on price

APPENDIX C

HOMEOWNER SURVEY STUDY – PRIESTLY 1990	
Author	Priestly, Thomas and Gary Evans
Title	“Perceptions of a Transmission Line in a Residential Neighborhood: Results of a Case Study in Vallejo, California”
Source	Southern California Edison Environmental Affairs Division, December 1990
Study Area	City of Vallejo, Solano County, California
Transmission Line	115 kV line on 60’ lattice steel towers upgraded to 115 kV/230 kV on 160’ steel poles in a 100’ wide ROW
Data	270 households within 900’ of line including homes built both before and after line was upgraded; survey was administered in 1987 (R ² of 60%)
Results	<ul style="list-style-type: none"> ➤ Most respondents see TL’s as a negative element ➤ Those living in the area when the TL was built are more likely to see it as negative ➤ Factors predicting opposition include distance, line-view and higher occupational status ➤ Many respondents overestimated how much of the line they could see ➤ Health and safety issues are of greatest concern followed by property value concerns and aesthetic concerns ➤ The more the respondents use the ROW, the less their concerns

APPENDIX C

HOMEOWNER SURVEY STUDY – KUNG 1992	
Author	Kung, Hsiang-te and Charles F. Seagle
Title	“Impact of Power Transmission Lines on Property Values: A Case Study”
Source	<i>The Appraisal Journal</i> , July 1992
Study Area	Memphis and Shelby Counties, Tennessee
Transmission Line	Various high voltage transmission lines in the two-county area
Data	47 responses (R ² of 59%)
Results	<ul style="list-style-type: none">➤ 53% of respondents considered TL’s an eyesore, remaining 47% did not➤ None of the survey respondents considered it a health hazard➤ Of the 53% who considered the lines an eyesore, 72% said the price they were willing to pay was unaffected

APPENDIX C

HOMEOWNER SURVEY STUDY – BOND 1996	
Author	Bond, S.G.
Title	“The Impact of Transmission Lines on Property Values”
Source	ARES Twelfth American Real Estate Society Conference, South Lake Tahoe, March 1996
Study Area	Newlands, a suburb of Wellington, New Zealand
Transmission Line	Study area is crossed by two 110 kV lines on 26m steel pylons located on private property; two distance zones: i) 0-50m (close), and ii) 51-300m. Most of the development occurred subsequent to the construction of the lines.
Data	Approximately 460 respondents (R^2 of 58%)
Results	<ul style="list-style-type: none"> ➤ 25.5% of respondents have very negative feelings about HVTL’s, 37.6% have somewhat negative feelings and 32.8% have no strong feelings one way or the other ➤ Concerns are aesthetics, noise, and health and safety ➤ The HVTL’s created reservations about buying with 29.5% of the respondents while 70.6% of those responding indicated no influence or increased interest in buying ➤ Impact on price was suggested by 19.9% while 80.1% maintained that there was no effect on purchase price

APPENDIX C

HOMEOWNER SURVEY STUDY – MITTENESS 1998	
Author	Mitteness, Cheryl and Steve Mooney
Title	“Power Line Perceptions: Their Impact on Value and Market Time”
Source	College of Business, St. Cloud State University, 1998
Study Area	Brooklyn Park and Maple Grove, Minnesota
Transmission Line	Various
Data	67 respondents living adjacent to right-of-way or crossed by transmission lines (R^2 of 35.6%)
Results	<ul style="list-style-type: none"> ➤ 49% considered the TL’s in making their purchase decision, 51% did not ➤ Of those who considered it, 36% lowered their offering price, while for 64% offering price was unaffected ➤ Of those who indicated an adjustment in their offering price, the mean adjustment was 4%