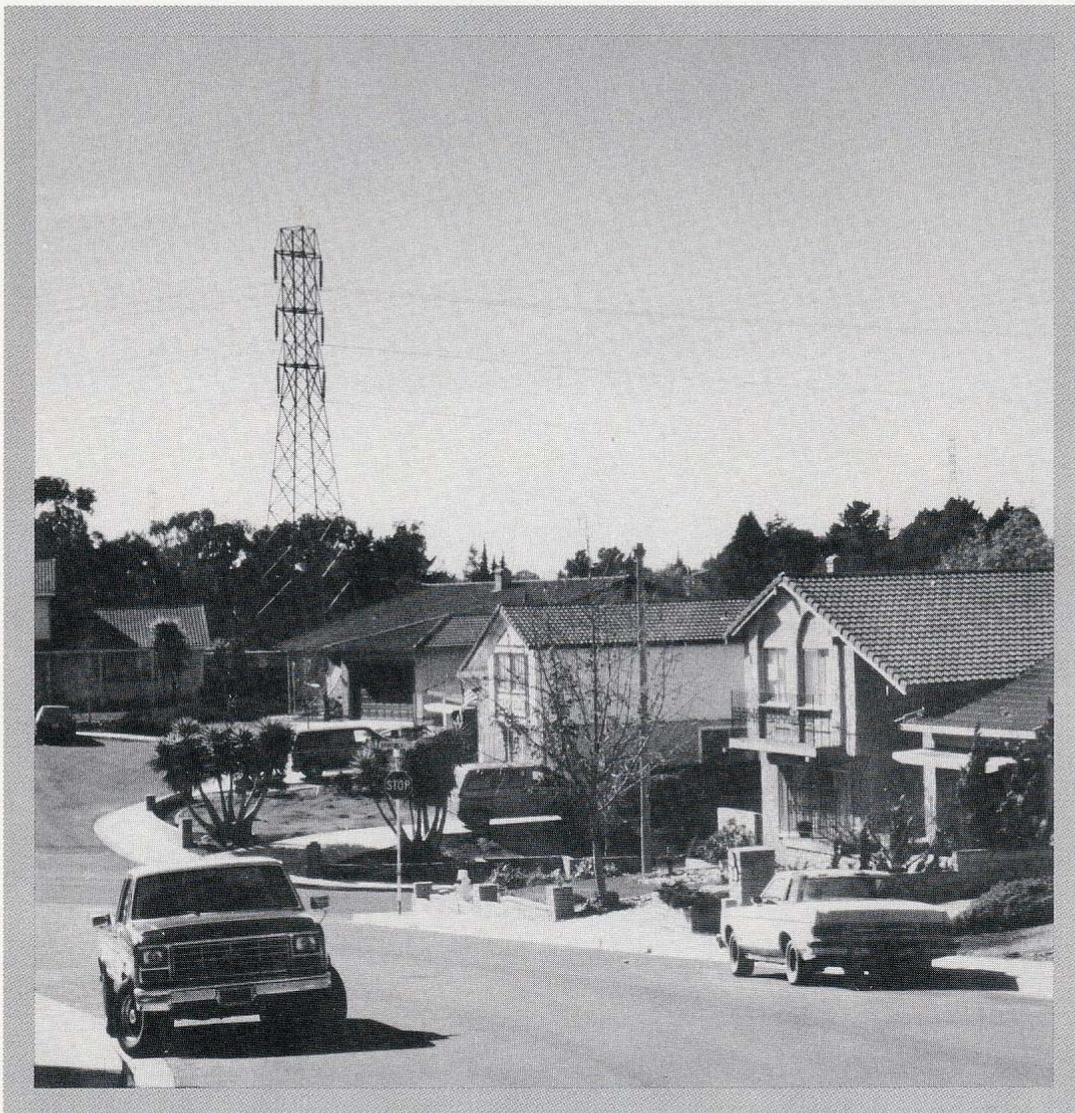


THE EFFECTS OF OVERHEAD TRANSMISSION LINES ON PROPERTY VALUES



A Review And Analysis Of The Literature

Edison Electric Institute Siting & Environmental Planning Task Force

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www.eei.org

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To update the text for internet production, the type face and some of the pagination has changed.
No changes have been made to the content of the report.

THE EFFECTS OF OVERHEAD TRANSMISSION LINES ON PROPERTY VALUES

**Report Prepared For
The Edison Electric Institute
Siting and Environmental Planning Task Force**

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July, 1992

A Review And Analysis Of The Literature

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Acknowledgments

This literature review benefitted from the assistance of many individuals and organizations. The Edison Electric Institute provided funding for the project, with Joel Mazelis acting as project officer. EEI's Siting and Environmental Planning Task Force (SEP) members were generous in their assistance in identifying and obtaining many of the studies reviewed here. In addition, Mary Deming, chair of the SEP, did much of the project administration and read and commented on several drafts of the report. Nancy Wallace, Assistant Professor at the Haas School of Business, University of California at Berkeley, contributed advice and comments on the sections on econometric studies. Tom Spiekerman, graduate student in City and Regional Planning at the University of California, compiled much of the annotated bibliography. Several prominent researchers provided information early in the study and reviewed later drafts of the report, including Peter F. Colwell, of the University of Illinois, Patrice Ignelzi, of Pacific Consulting Services, and William Kinnard, Jr., of the Real Estate Counseling Group of Connecticut. Roger H. Downing, Raymond W. Eyerly, and Richard D. Twark, of the Pennsylvania State University, discussed the organization of the study and research approaches with us early in our work. Many people from utility companies spent time identifying relevant studies, providing background information on their work, and reviewing our research. Among these were Lindsay E. Milton, Ontario Hydro; Pierre Senecal, Hydro-Quebec; Robert Byrd, Duke Power Company; J. Patrick Cairns, United Power Association; Michael A. Chatham, Arizona Public Service Commission; Harry A. Cornell, New York Power Authority; James R. Cornelius, Gulf States Utilities Company; Lu deSilva and Kenneth Richerson, Pacific Gas and Electric Company; Gary Holisko, BC Hydro; Robert L. Pearson, Public Service Company of Colorado; E.G. Pond, Bonneville Power Administration; Normand Rodrigue, Central Main Power Company; Philip W. Simpson, Florida Power and Light; and James R. Torpey, Jersey Central Power & Light Company. The study would have been less rich without the input of these and many other individuals, but any opinions expressed or errors are our own.

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THE EFFECTS OF OVERHEAD TRANSMISSION LINES ON PROPERTY VALUES: A REVIEW AND ANALYSIS OF THE LITERATURE

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EXECUTIVE SUMMARY

Introduction

Research on the effects of overhead transmission lines on property values has expanded over the past fifteen years to include new methods of analysis and more detailed examination of the data. Conclusions as a result of these studies have varied widely, with some authors reporting no effects, others finding small effects, and still others reporting quite large effects. The purpose of this paper is to review and summarize the progress of research over the past fifteen years, to assess the knowledge gained from recent research, and to suggest directions for future studies.

What Questions Are Being Asked?

The studies are generally concerned with the question, "Does the presence of high voltage overhead transmission lines on or near a property affect the value of that property?" Some studies elaborate on this basic question, addressing one or more of the following points:

- a) What is the magnitude of the effect?
- b) What characteristics of the line or right-of-way (e.g. voltage, tower height, right-of-way width, landscaping, distance from nearby residences) lead to the effect?
- c) What types of property are most vulnerable to impacts?

How Are the Questions Examined?

Research has come from several different academic and professional fields. Appraisers have the longest history of examining transmission line impacts. **Appraisal techniques** compare sales prices for matched properties or use descriptive statistics comparing groups of sales, to examine whether properties crossed by or close to overhead transmission lines have lower (or higher) sales prices than unaffected properties. **Attitudinal studies** give a qualitative feel for effects of transmission lines, rather than a quantitative measure of degree of impact. These studies examine how property owners and others involved in property management or sales perceive the effects of transmission lines on sales price of property. **Statistical analyses** draw on data developed through appraisal techniques and other field study methodologies but measure impacts with more sophisticated statistical tools. Comparison of means and multiple regression are the most common

approaches used to look for statistically significant differences between sales of properties encumbered by or close to an overhead transmission line and sales of properties at other locations.

Appraiser Studies

The appraiser studies since 1975 have covered many different places in the United States, examining primarily residential and agricultural property. About half of the studies concluded that transmission lines had not affected property values. Price differentials for residential homes were generally found to be quite small (on the order of 5 percent or less), while price differentials were occasionally much higher (sometimes 20 percent or above) for agricultural property. These findings were based on a large number of studies, but the reliability of the results is nevertheless limited, sometimes by small sample size and frequently by the lack of statistical analysis to verify results.

Attitudinal Studies

Only a small number of attitudinal studies has been completed. Studies have covered places in both the United States and Canada. Methods of approach vary from mailed surveys to face-to-face interviews. Reactions to transmission lines varied widely. In several cases, at least half of respondents were unconcerned about the presence of a transmission line, while in a few cases, three-fourths or more felt the line negatively affected property values. In one case, where the right-of-way was heavily wooded, a significant number of respondents felt the line had a positive effect on property values. Conclusions from attitudinal studies remain tentative because of the small number of studies completed to date.

Statistical Analyses

Drawing heavily from the types of data collected for appraiser studies, several researchers have applied more complex statistical analysis to expand on the interpretation of the data. Since 1975, more than a dozen studies have been completed, covering cases in the United States and in Canada, primarily for residential and agricultural property. As with other research approaches, statistical studies produce widely varying findings. Effects range from no impact to a loss of between 2 and 10 percent for most single family homes and agricultural land, to estimates of losses over fifteen percent for two rural residential cases. The reliability of the findings are limited by the small number of areas and property types studied and by the variations in methodology used.

What Have We Learned?

Although in many ways the research accomplished is still incomplete, a number of findings emerge from recent studies. The most important points are the following:

- 1) Overhead transmission lines have the potential to reduce the sales price of residential and agricultural property.

- 2) The effect, especially for single family homes, is generally small (from zero to 10 percent), but has been estimated to be greater than 15 percent in some specialized cases in rural areas.
- 3) **Other** factors (e.g. neighborhood factors, square footage, size of lot, irrigation potential) are much more likely than overhead transmission lines to be major determinants of the sales price of property.
- 4) Effects are most likely to occur to property crossed by or immediately next to the line, but some impacts have been measured at longer distances.
- 5) Positive impacts may also occur, where the right-of-way is attractively landscaped and/or developed for recreational use.
- 6) Impacts may be greater for smaller properties than for larger properties.
- 7) Impacts may be greatest immediately following construction of a new line (or a major increase in size in an older right-of-way), diminishing over time.

What Next? Future Research Directions

Future research on property value and overhead transmission lines will be most productive if it builds on the work that has already been accomplished. Existing limitations of research suggest several future directions:

- 1) In designing future studies, researchers should be aware of the pitfalls that result from comparing sales over time and over a variety of property characteristics and work towards consistent adjustments to the models or data to account for these pitfalls.
- 2) Research on single family homes would benefit from an expanded, systematized set of studies designed to explore similar issues over a range of geographic areas and transmission line and right-of-way conditions.
- 3) Apply a consistent model structure to studies of agricultural land in several geographic areas.
- 4) Develop a prototype study of multifamily residential property that deals with the greater data complications that arise in studying rental property.
- 5) Design a series of studies to be repeated over time, to capture the effects of changing information and technology on property close to transmission lines.

- 6) Develop a prototype study, combining attitudinal techniques and statistical analysis, to examine the effects of health concerns on the sales price of property close to transmission lines.

At this point in time, **consistency** in model design (within practical limitations) is likely to have a big pay-off, by making it easier to compare studies for different geographic areas, property types and time periods. Communication among researchers involved in transmission line research is essential for producing this consistency.

THE EFFECTS OF OVERHEAD TRANSMISSION LINES ON PROPERTY VALUES: A REVIEW AND ANALYSIS OF THE LITERATURE

I. Introduction

The effects of overhead transmission lines on property values has been of interest to utility companies for many years, to inform the company in planning the routing of rights-of-way and for determining compensation to property owners. Public planning agencies and property owners of affected parcels have also been concerned with understanding the possible magnitude of impacts and the factors leading to changes in property values.¹ Research has been conducted on this issue since the 1950s (see, for example, Crawford 1955, Carll 1956), but over much of this period the research approaches varied widely, research was based on case studies rather than a comprehensive testing of impacts under a range of circumstances, and findings have been ambiguous and sometimes contradictory (see Fridriksson, *et al.*, 1982 and Kellough 1980).

Since 1975, however, researchers at a variety of academic institutions, appraisal firms, and other consulting firms have begun to establish a more systematic body of research on the topic. The purpose of this literature review and analysis is to identify and describe the research that has been conducted between 1975 and 1990, to evaluate the strengths and weaknesses of the research, to assess the current state of knowledge on the topic, and to determine the type of research that could contribute to a better understanding of the issue in the future. The literature reviewed in this study has been identified from earlier review articles, through biographical reference sources, and through telephone interviews with academic researchers, appraisers, and utility company representatives.

¹ Property values in this context refer to the change in market price, as demonstrated by transactions on the open market. They do not include other personal costs an owner may incur in responding to a change induced by a transmission line.

II. A Typology of Literature and Research Methodologies

Figure 1 summarizes the types of reports and articles that have been produced since 1975. We have identified four major categories--reviews of literature, studies using appraisal methods, attitudinal studies, and studies based on statistical analysis.

Literature Reviews

Since 1975, a number of literature reviews and general articles have summarized the material to date and the findings of that material. Some of the earlier literature reviews are quite comprehensive, looking either more generally at the impacts of transmission lines on land use (Butler 1983, Priestley 1983) or specifically at property value impacts (DiMento 1982, Fridriksson 1982, Kinnard 1988 and 1989, and Soleco Consultants, Inc. 1985). These studies summarize overall findings of the literature and often provide annotated citations. Other general articles draw on findings of existing research but are less comprehensive. Two articles by Kellough (1980a and 1980b), for example, look at a variety of different types of impacts (from health and psychological to property value), as examined in Canadian research. Furby *et al.* 1988 assesses findings of some of the key research on property values and discusses legal issues. All of these studies provide useful overviews of the history of research on transmission line impacts, including research predating the period covered in this paper, but are not intended to add new data or analytic material to the field.

Appraiser Studies

A large share of the research on transmission line impacts on property values has been conducted through studies and evaluations by appraisers. Almost all empirical studies prior to 1975 were of this type. Since 1975, although much more sophisticated statistical analyses have been used to address the issue, many utility companies have continued to rely on the evaluations of appraisers to determine whether an impact on property values is likely from an existing or new right-of-way. These studies follow systematic methodology, such as that described in Clark and Treadway 1972, and often use records of sales prices of a large number of properties close to and distant from the transmission line to make their assessment of property value impacts.

Attitudinal Studies

Research on attitudes and perceptions has expanded during the 1970s and 1980s, although it still makes up the smallest share of research on power line impacts. Attitudinal studies are often a part of a larger study on power line impacts, rather than the sole basis for assessing impacts. Attitudinal surveys are occasionally used as one means of assessing property value implications of a power line. The surveys may be addressed to developers, real estate agents, and/or individual property owners. They seek responses on the types of disturbances caused by the line (eg. health, noise, limitations on activities, view) and on the perception of effects, if any, on value. In addition to the questions specifically addressing property value impacts, these studies also provide a basis for identifying factors to consider in statistical analyses of power line impacts.

Figure 1

Typology of Literature on Transmission Line Effects on Property Values

Type of Study	Source of Data	Type of Analysis	Range of Conclusions
Literature Reviews	Other published Studies	Interpretation from existing research	From no impact to some impact; in general critical of research methods used.
Appraiser Studies	Sales records, interviews	Descriptive statistics	Findings range from small positive to large negative effects. Most find no effect.
Attitudinal Studies	Surveys and interviews	Descriptive statistics	Large range shown in concern of respondents with impacts. Professionals may expect greater impact than purchasers.
Statistical Studies	Sales records, tax records	Comparison of means, multiple regression analysis of variance	Range from positive impact in some circumstances to loss of up to 34% in one study.

Statistical Analyses

The greatest advances in research on property value impacts of power lines have come in the statistical analysis of property value data. Prior to 1975, studies relied largely on descriptive statistics to determine if property values were changed by the presence of a power line. Beginning in the mid-1970s, greater attention was paid to determining the "statistical significance" of any differences identified and to assessing the role of a power line in contributing to the value of a parcel of property **taking into account** other factors, such as parcel size, age of improvements, and view from the lot. Several methods have been used for evaluating the significance of property value differences, including difference of means tests (comparing, for example, the average price of encumbered and unencumbered lots), analysis of variance (a more sophisticated comparison of property values among lots of different types), and multiple regression analysis (a technique which allows the researcher to take into account other variations in property characteristics in determining the role of the power line or towers in determining property value).

The expanded research since 1975 has enriched the variety of approaches used in analyzing property value impacts and has broadened the evidence upon which a general assessment of impacts can be made. At the same time, these newer studies leave many issues unresolved and serve to highlight some new issues that have not been well addressed to date. The following section outlines the key issues of concern in this type of analysis. Later sections describe in detail the approach used by different research techniques to address these issues and the findings of existing, recent literature.

III. Key Questions and Parameters Addressed in the Literature

The individual studies that have been undertaken vary widely in the types of questions addressed and the parameters or variables considered in designing the research. Nevertheless, in reviewing the literature as a whole, a set of questions that are of clear concern to utility companies, land planners and property owners emerges (see Figure 2 and discussion below).

The question most frequently explored is **"Is the value of property reduced by the presence of or proximity to an overhead transmission line and right-of-way?"** Those studies that find evidence of negative effects then ask **"What is the magnitude of the impact?"** Many studies stop at this point. However, for findings to be useful for future siting of transmission lines as well as for determining possible compensation levels, a more detailed set of questions is needed.

Some of these questions are developed in the statistical literature. One set of questions is directed toward understanding the circumstances likely to lead to property value decreases from transmission lines. Questions include:

- a) What factors seem to influence the presence or degree of impact on value (Pacific Consulting Services 1991)?
- b) Do impacts vary systematically, according to characteristics of the right-of-way, such as:
 - height of towers
 - design and landscaping
 - width of right-of-way
- c) Are some types of property more vulnerable to transmission line impacts than other types (Woods Gordon 1981)? In other words, do factors such as the type of land use (agricultural, residential, commercial, industrial), density of development, lot size, and initial value influence the degree to which transmission lines and towers affect property values?

The type of property value impact examined varies from study to study. Research may be concerned with:

- a) impacts on land crossed by the right-of-way;
- b) effects on parcels adjacent to the right-of-way; and
- c) effects on nearby non-adjacent parcels.

In addition to changes in the **value** of property, studies may also examine the frequency of sales and the amount of time on the market required to sell a property.

Figure 2

Summary of Key Questions Addressed in Transmission Line -
Property Value Studies

Do high voltage overhead transmission lines affect the value of property crossed by or close to a line?

Is the effect negative or positive?
Of what magnitude?

What factors influence the presence or degree of impact?

Characteristics of the line and right-of-way?

- width
- tower height
- voltage
- landscaping
- distance from nearby property

Characteristics of surrounding property?

- land use
- density
- lot size
- value

How do impacts vary with timing of the sale and of the power line construction?

Do effects diminish over time?

Do effects differ with new lines versus upgrading an existing right-of-way?

Does the level of concern vary among different types of landowners?

- developer with vacant lots
- owner-resident who held property prior to line construction
- owner-resident purchasing property after construction

Other questions relate to how property value impacts may vary as a result of the timing of the sale and the power line construction. With respect to a newly constructed transmission line, "Do impacts to property values diminish over time (see Colwell 1990, Pacific Consulting Services 1991)? If so, why does this occur?" Some studies specifically look at the impacts of a new or upgraded line (Kinnard and Mitchell 1988, Pacific Consulting Services 1991) while others choose to analyze possible impacts of a line long in operation (Kinnard et al. 1988). Timing of ownership may also be significant. Impacts may be viewed differently by a developer with vacant land, by an owner who held the property prior to power line construction (Kinnard et al. 1984, Priestley and Evans 1990) and by an owner who purchased the property when the power line was already in place (Kinnard et al. 1984, Priestley and Evans 1990, Blanton 1980).

Just as the questions addressed vary greatly among studies, so do the factors examined that may be considered in different research approaches (see summary in Figure 3). Most studies continue to be case analyses of limited geographic areas, with examples available from California (Pacific Consulting Services 1991), Illinois (Colwell 1990), Arizona (Ball 1979, 1983 and 1989), Texas (Blanton 1980), Oregon (Oregon 1983), New York (Kinnard and Mitchell 1988 and Kinnard, Mitchell and Webb 1989), Maine (Kinnard et al. 1988), Ontario (Boyer et al. 1978, Mitchell et al. 1976, Woods Gordon 1981), Quebec (Carriere, Chung and Lam 1976, Universite du Quebec a Montreal 1982), and many other states and provinces. A few look at more than one community, although usually still within a quite limited geographic area (Pacific Consulting Services 1991, Carriere et al. 1976, Woods Gordon 1981).

Characteristics of the rights-of-way (e.g. width, landscaping) and transmission lines (e.g. height, voltage capacity), although mentioned in a number of studies, have received little detailed analysis. Most studies look at only one type of right-of-way. A few look at a range of KV levels, which tend to correspond to a range of heights (from 60 to 175 feet high, depending on KV level and the particular line; see Pacific Consulting Services 1991, Woods Gordon 1981, Jensen Management Services 1980 and 1983). None of the studies examined here discuss variations in the right-of-way width, and the few that systematically address such factors as landscaping or recreational use of the right-of-way do so in a very rudimentary way (Pacific Consulting Services 1991).

Most studies address only one property type, the most common being residential property or agricultural land. Very few studies examine commercial or industrial properties. Studies that address more than one land use type (e.g. Kinnard and Mitchell 1988) have not been able to examine whether **impacts of the line** vary by property type (because of data limitations).

The analyses vary greatly by study in terms of timing of sales relative to construction of the line. Some studies examine sales over a period of decade or longer, while others look at a much shorter time frame. Some studies overlap the construction period of the line while others examine a period long after the line has been completed.

Figure 3

Factors Addressed in Transmission Lines Effects on Property Value Studies

Transmission Line Characteristics	Factors Linking Transmission Line and Property Characteristics	Property Characteristics
KV level of transmission line Height of tower Width of right-of-way Length of right-of-way Existence of one vs. multiple KV levels and lines in right-of-way Landscaping in the right-of-way Recreational usage of the right-of-way	Distance from right-of-way View of right-of-way, towers and transmission line Aural impact of line Aesthetic and sentimental value to property owners Timing of property sale: Before, during or after right-of-way filing, easement acquisition, or transmission line construction Length of data analysis period for the property value impact study	Land Use Density of development Lot Size Initial property value Geographic extent of Study Productivity of agricultural, range, and timber land

It is also important to note that **none** of the property value studies purport to address the question of the full costs of new transmission line construction to an existing resident owner of a property. There are some costs that generally are not covered by the price paid for the property (e.g. the sentimental value an owner places on memories of a home, a specific garden layout, interior decorating; see discussion in Furby *et al* 1988). These costs are not identified by either the appraiser-type or statistical studies reviewed here. Some factors of this type are mentioned in attitudinal studies but are not discussed in any depth beyond their possible impacts on property values.

The following four sections of this report examine the approaches and findings of each type of study in more detail. Section IV addresses findings of earlier literature reviews, Section V examines studies by appraisers, Section VI reviews contributions from attitudinal and perception research, and Section VII explores a range of statistical analyses from a wide variety of geographic areas.

IV. Earlier Literature Reviews and Summary Articles

Since 1980, several literature reviews and summary articles have been compiled, providing a useful overview of the history of research on overhead transmission lines (see Figure 4). Some of these, such as Butler 1983, Priestley 1983, and Kellough 1980a examine property value impacts as only one of a number of areas of importance in examine the effects of transmission lines. While these studies do not include some of the more recent literature, they are helpful in providing a context for current property value research, by discussing research on related issues such as the effects of rights-of-way on land use and public perceptions of transmission line impacts. In addition, Butler 1983 and Priestley 1983 provide summaries of a number of articles reviewed here (see notations in the bibliography) and of the major property-value related articles written prior to 1975. Butler does not reach a conclusion on the implications of prior property value research, while Priestley points to the contradictory findings of different studies, where some suggest property value impacts occur and others find no effect. Kellough, reviewing a more limited number of studies, concludes that the studies that find no impacts tend to be quite weak and that both legal precedent and more recent property value studies (1975-1980) suggest that property value and agricultural production may be affected by overhead transmission lines.

Several studies focus in more detail on property value impacts alone (DiMento 1982, Fridrikkson 1982, Furby *et al.* 1988, Kinnard 1988 and 1989, Soleco Consultants 1985). Like the studies they examine, these authors come to differing conclusions.

DiMento bases his conclusions on transmission line studies performed between 1964 and 1981 but also on statistical analyses of the effects of other types of neighboring nuisances or amenities on property values. Drawing from these studies, he concludes that prices can be expected to be affected within 100 feet of the line, but that little effect will be perceived beyond this distance. He also concludes that the magnitude of effects may range between 0 and 10 percent and that impacts should rise with income. However, some of the evidence for these conclusions does not come directly from transmission line research but is the author's interpretation of research into the effects of other types of facilities or neighborhood characteristics.

A literature review by Kinnard, released in two separate publications, emphasizes the opposite conclusion to DiMento's study. Examining both early studies and studies produced between 1970 and 1988, Kinnard concludes that proximity to transmission lines generally does not affect either the highest and best use of the land or the sales price of the property. He notes that exceptions exist, including properties encumbered by easements, some higher priced single family homes within 200 feet of the center of the right-of-way, and price of lots in large tracts of vacant land to be subdivided for residential use in the future.

Figure 4

Summary of General Studies and Reviews

Author/Date ²	Topics Covered	Geographic Area	Conclusions
Butler 1983	Impacts on land use Interactions with public agencies Includes annotated bibliography	United States and Canada (Ontario)	Identifies property value studies but does not evaluate them
DiMento 1982	Effects of transmission lines on residential property values	United States	Prices are affected within 100 ft of line; effects rise with income level and tight housing market; range 0-10%
Fridriksson et al. 1982	Transmission line impacts on land values Includes annotated bibliography	United States and Canada	Legal compensation based on fair market value. Many studies have weak methodologies; findings are ambiguous.
Furby et al. 1988	Legal analysis of basis for compensation for property value lost due to transmission line proximity	United States and Canada (legal discussion, U.S. only)	Good empirical data on effects on sales value does not yet exist; compensation Discussion also must address perceptions.

²Full citations of studies are provided in the bibliography.

Figure 4 (continued)

Author/Date	Topics Covered	Geographic Area	Conclusions
Kellough 1980a	Visual and physical impact of transmission lines	Canada and United States (primary emphasis, Canada)	Both legal precedent and some recent studies show property value and agricultural production may be affected.
Kinnard 1988a and 1989	Effects of high-voltage overhead transmission lines on sales price and market value of real estate	United States and Canada	Proximity to transmission lines generally does not affect value, best use of land. Exceptions exist, in some types of residential development
Priestley 1983	Transmission lines and land use	United States and Canada (Ontario)	Transmission lines do not necessarily affect potential land use; conflicting conclusions are reached on value effects.
Soleco Consultants 1985	Property value impacts of electric facilities	Canada and United States	Results vary because of methodological differences and weaknesses, geographic differences, and small number of studies.

Other literature reviews, generally completed in the early to mid-1980s, emphasize the weakness of research methodology and the ambiguity of findings. Fridriksson et al. 1982 find the existing literature (studies performed between 1956 and 1981) to be inadequate for judging whether transmission lines impact property values. They are concerned with the weakness of the methodology used in many analyses and with the limited number and geographic scope of studies that had been completed by the time of their review. They note that in addition to methodological and scope of study problems, existing research reaches contradictory conclusions on the effects of overhead transmission lines, making generalization to other circumstances impossible.

Soleco Consultants 1985 also emphasize the variability of findings. They point to methodological differences and weaknesses and geographic differences in the case studies as major factors behind the inconclusive findings. They are also concerned with the small number of methodologically sound studies that have been accomplished, and emphasize that further research is needed using cases where the market is well understood, where there is little temporal variation in property prices, where the sample is largely homogeneous, and where the research design controls for as many variables as possible. Even with these improvements, they caution against generalizing from a small number of cases, particularly between geographic areas.

Furby et al. 1988, in their legal analysis of the transmission line property value literature, are also quite critical of existing research (from 1955 through 1983). They feel that research has not provided good empirical data on the effects of transmission lines on sales value. They also criticize the narrow focus of compensation discussions on property values alone, rather than including other types of perceived losses as well.

Since the completion of most of these earlier literature reviews, a number of other methodologically sophisticated studies have been conducted. While the literature still suffers from some of the same weaknesses identified earlier, the body of experience has been widened by newer studies, and a much richer set of methodological approaches is available for examination and analysis. The following three sections draw on both published and unpublished sources to examine the growing body of literature in more detail.

V. Appraiser Studies of Property Value Impacts

Until the mid-1970s, almost all examinations of property value impacts of transmission lines were done by appraisers, using the types of techniques outlined in Clark and Treadway 1972. Appraiser studies have continued to be relied on heavily by utility companies over the past decade and a half as a means of determining whether or not property values have been or will be affected by a transmission line. Figure 5 summarizes the approach and findings of a selection of the appraisal studies performed between 1976 and 1989.³

Methods Used in Appraisal Studies

The techniques used in appraiser studies include:

- a) interviews and surveys of developers, property owners, and management or rental agents (e.g. Ball 1979 and 1983, Jensen Management Company 1980);
- b) comparison of average market transaction sales prices of properties affected by the line with prices of properties away from the line (e.g. Ball 1989, Jensen Management Services 1983); and
- c) paired sales analysis, where properties proximate to the line and away from the line are paired based on characteristics such as square footage and number of bedrooms, basing any comparison of price differences on otherwise relatively homogeneous properties (e.g. C.K. Thompson and Associates 1985, Blanton 1980).

Often more than one approach is combined in a study (e.g. Ball 1989, Oregon 1983, Rasmussen 1976).

The method of analysis of these studies is statistically weak, with conclusions based on descriptive statistics alone, rather than on more sophisticated statistical tests. As a result, the research questions addressed in the studies are quite limited. Most appraisal studies look only at the effects of being directly adjacent to or crossed by the transmission line. Often the study is in actuality a study of the cost of an easement to the property owner. While many studies are quite vague as to the location of the "unencumbered" properties (those away from the line), in many cases these comparison properties are in the same neighborhood and could be quite close to or in sight of the transmission line, although not directly along the right-of-way.

³ A number of the studies referred to here were done on a proprietary basis for utility company clients. To preserve confidentiality of these studies, they are referred to in the text and bibliography by the name of the state in which they were done and by the year of the study.

Figure 5
Summary of Appraiser Studies of Property

Author/Date	Client	Line Features	Geographic Area	Property Type
Ball 1989	Utility Company	69 KV or 230 KV Line (some with 12 KV line, also) 120 ft. easement	Arizona	Developed residential; Undeveloped residential Commercial, industrial; Agricultural
Ball 1979	Independent	69 KV line 230 KV line 500 KV line	Arizona (Phoenix and Tempe)	residential
Ball 1983	Independent	69 KV 138 KV 230 KV	Arizona (Phoenix and Tucson)	mobile home
Blanton 1980	Utility Company	69 KV 138 KV 345 KV	Texas	single family homes
Thompson Associates 1985	Bonneville Power Administration	230 KV (proposed 500 KV line)	Western Montana	suburban and rural residential, improved and unimproved
Oregon 1983	Utility Company	500 KV 175 ft ROW	Oregon/ Idaho border	agricultural (grazing land)
Jensen and Weber 1982	Utility Company	230 KV 400 KV	West central Minnesota	Farm land

Value Impacts

Methodology	Number of Cases and Observations	Conclusions
Comparison of average sales values; paired sales; interview with rental agent (Multifamily only)	8 case studies; Between 4 and 200 sales, depending on case	Mixed. No impact for some residential <5% loss in value for other developed residential. 12+% impact on commercial and industrial from easements. Overall 2% effect on farmland, 44% loss of value for easement area.
Survey of homeowners and sales agents	5 subdivisions Small number of homeowners and agents	Developers gave no discounts for proximity to a power line, even when 3 lines involved.
Survey of mobile home park managers	6 mobile home parks	Managers received no complaints about lines and did not lower prices for sites adjacent to line.
mean difference among matched sales (dollars per square foot); homeowner interviews	3 subdivisions, 39 parcels on the ROW, 351 in subdivision, not on ROW	No set pattern--(values ranged from \$8 less per square foot for ROW homes to \$11 more); no stated concern among homeowners.
Comparison of sales prices among similar properties	2 areas (suburban, rural); 8 homes or sites, total	No adjustment to market price for properties encumbered by or in view of line.
comparison of sales along ROW with sales from previous study; interviews with buyers and sellers	8 sales	Value affected only by amount of land removed by tower, roads; owners perceive effects if potential exists for residential or if lines disrupt irrigation.
Comparison of sales prices of encumbered and unencumbered property	25 encumbered, 57 unencumbered sales	Broad range, from no effect to 20% reduction, depending on amount of disruption to farm operations.

(continued)

Figure 5 (continued)

Author/Date	Client	Line Features	Geographic Area	Property Type
New Jersey 1989	Utility Company	Proposed 230 KV (in existing railroad ROW)	New Jersey	Residential, commercial, industrial, resid-agri. Case studies: residential lots and homes.
Van Court and Company 1988	Public Services Company of Colorado	Upgrade of 115 KV to 230 KV with-in existing easement	Colorado	Residential and open space
Rasmussen 1976	Utility Company	Not stated	North Dakota	Agricultural Land
Jensen and Weber 1979	Utility Company	450 KV, 875 ft ROW (Note: Fee purchase rather than easement; Company allows free use of land)	Manitoba Province (Canada)	Agricultural land
Jensen Management Company 1980	Utility Company	118 KV 230 KV 345 KV 500 KV	West central Minnesota	residential, commercial/ industrial, mobile homes, park, office building
Weber and Jensen 1978	Utility Company	230 KV, 125 ft ROW, built in 1950s	West central Minnesota	agricultural
Earley and Earley 1988	Utility Company	Proposed 230 KV line; comparison with views of 44 KV, 100 KV & 230 KV views only, no ROW cross.	North Carolina	residential lots, single fam homes, condominiums

Methodology	Number of Cases and Observations	Conclusions
Visual inspection of proposed route, survey of home values on similar lines	7 case studies 48 encumbered, 43 unencumbered properties	Because of existing ROW, new line would not impact values. Case studies showed no effects of ROW in most cases (up to a 10% effect in one case, but with few observations).
Market data comparisons	40+ sales	Average price of properties with existing line about 3% below those away from line, but variance high and prices overlap; no further price effect from upgrade.
Sales data and interviews	100 verified sales	Transmission line not significant in prices, respondents rarely mentioned it.
Interviews of property owners Compared sales	6 owners 6 sales	Individuals mentioned inconvenience but no production effects or drop in property values.
interviews	53 interviews	10-25 percent felt the property value was lowered by the line, with residential more concerned than nonresidential.
interviews and sales analysis of encumbered and comparable properties	4 counties 10 encumbered, 20 unencumbered parcels	Owners cited inconvenience but had not paid less; felt it was a "seller's market"
paired sales	5 property types, total of 110 sales	No discernable effect on market value.

Geographic Scope, Land Use Type, and Sample Size

The great majority of transmission line appraisal studies we have identified are for property in the United States. Even the study of impacts in the Canadian province of Manitoba (Jensen and Weber 1979) was conducted by a U.S. firm for a U.S. utility company client. Most of the studies are of residential or agricultural property, but a few also look at commercial and/or industrial property. Most studies are of existing lines, but two studies look at intensified use of an existing right-of-way (New Jersey 1989 and Van Court and Company 1988). The number of observations upon which conclusions are based varies greatly among studies. It is not unusual for conclusions to be based on a sample as small as six or eight sales for each case study (e.g. C.K. Thompson and Associates 1985, Oregon 1983, Jensen and Weber 1979). In other cases 100 or more sales may be examined (e.g. Rasmussen 1976, Blanton 1980).

Findings: Effects Often Very Small or Unapparent

About half of the appraiser studies we reviewed concluded that the transmission line had caused no impacts on property values. Such findings existed for both residential and agricultural property. Where price differentials were identified for residential homes, they tended to be small. Ball 1989 found less than a 5 percent price disadvantage for homes near transmission lines in one area but found no effects on homes in other sites affected by transmission lines. New Jersey 1989 found a 10 percent effect in one case study area (based on a very small sample) but found no significant differential in other case study areas with larger sample sizes. The appraiser on this study concluded that, overall, transmission lines did not lower residential property values.

Agricultural land sometimes showed no negative effect, as well (Weber and Jensen 1978). Ball 1989 found a 2 percent disadvantage overall for agricultural land and a 44 percent decrease in value of land crossed by the right-of-way. Jensen Management Services 1983, in case studies in west central Minnesota found impacts on agricultural land to vary widely, from no effect to a 20 percent reduction in value, depending on the amount of disruption that occurred to farm operations and irrigation. One study of commercial and industrial land found a 12 percent loss or higher, resulting directly from the effects of the easements on the parcel size and shape (Ball 1989).

The results of interviews quoted in these studies are of interest as well. In some cases, agricultural land owners object to the transmission lines and find them inconvenient, but do not necessarily feel that the lines affect property values (Jensen and Weber 1979, Weber and Jensen 1978). In other cases property owners stated indifference or a preference for being close to the line (Blanton 1980). In only two of the studies reviewed here did a significant proportion of owners feel their property was worth less because of the transmission line. In Jensen Management Company 1980 up to one fourth of owners but often far fewer (depending on property type) were concerned with effects. In Oregon 1983, the appraisers concluded that impacts to grazing land were limited to the actual amount lost to towers and roads, but owners were concerned about losses if their land had residential development potential or if the lines disrupted irrigation.

Limitations to Appraiser Findings

The findings of appraisal studies suggest that property values may be but are not always affected by transmission lines. The reliability of these findings is limited by several factors. First, many of the findings are based on very small sample sizes, and in some cases the appraiser had great difficulty finding comparable properties not crossed by the transmission lines (e.g. Oregon 1983).

Second, the studies do not test whether the type of transmission line affects property value impacts. Many of the studies include properties crossed by more than one type of line (sometimes, even on the same property), but studies generally do not systematize findings by size of line, width of right-of-way, or other features. In the two studies that examine a change in the right-of-way (in one case a line upgrade; in a second case the addition of a transmission line to an existing railroad right-of-way), it is concluded that the intensified use will not affect property owners except through temporary disruption from construction activity. The findings are based on the informed judgment of the appraiser, however, interpreting from data on sales occurring prior to the upgrade or change in use, rather than on direct measures of values before and after a right-of-way change.

Third, and most significant, the appraisal technique does not provide statistically reliable results. Even in paired sales analysis, where attempts are made to compare like properties, differences in similar parcels may account for some part of the differences (or lack of difference) perceived between properties near and away from the transmission lines. Statistical techniques for addressing this problem are discussed in Section VII.

VI. Findings of Attitudinal Studies

Nine studies have been identified that include assessments of attitudes towards transmission lines and/or perceptions of transmission line property value effects. These studies, some of their characteristics, and their key property value related findings are summarized in Figure 6. The studies reviewed fall into two major groups: those that focus specifically on property value effects and those that are more general in scope.

The Context for Attitudinal Studies of Property Value Effects

The studies that focus specifically on perceptions of property value effects tend to have been undertaken in conjunction with appraisal and statistical analyses of property value impacts. These studies include the opinions of real estate professionals (Ball 1989, Kinnard *et al.* 1984), and in at least one case, the opinions of local assessors and owners of properties in the study area were also solicited (Kinnard *et al.* 1984). A statistical study of transmission line impacts on the value of agricultural land in Alberta (Thompson 1982) made use of questionnaires that solicited opinions about line impacts on agricultural operations, safety, and aesthetics, as well as beliefs about effects on property values.

The more general studies have involved surveys of people living in proximity to transmission lines, and in a few cases, have also included surveys of "control groups" (people living in nearby areas without transmission lines) (Mitchell *et al.* 1976, Boyer *et al.* 1978) or of the general population (Market Trends, Inc. 1988). The general studies queried their respondents on a broad range of issues, including property values, aesthetics, health, safety, use of their property, and their use of the right-of-way. Two of these studies were undertaken in conjunction with parallel studies of property value effects (Mitchell *et al.* 1976, Boyer *et al.* 1978) and in another case, a general study of perceptions (Priestley and Evans) was followed up with a statistical study of property value effects (Pacific Consulting Services 1991). Four of the studies (Market Trends, Inc. 1988, Rhodeside and Harwell, Ltd. 1988, Economics Consultants Northwest 1990 and Beauregard Conseil, Enr. 1990) evaluated perceptions only, and were not accompanied by parallel or subsequent analyses of actual property value effects.

Survey and Interview Methodology

The most common question posed in these studies was whether the respondent thought that the nearby transmission line affected the value of his or her property. In the case of control group respondents and real estate professionals, the question was framed in terms of whether they thought the subject line affected the value of properties in proximity to it. In most of the surveys, the implicit assumption in these questions was that the effect would be negative, although in a few cases there was a follow-up question asking about the direction of the effect. Only a few surveys asked respondents to indicate the amount by which property value might have been affected. One survey

Figure 6

Summary of Attitudinal

Author/Date	Type of Study	Line Features	Geographic Area	Property Type
Mitchell et al. 1976	Perception study	230 KV, and control area one mile away with no line	Rural area in southern Ontario	Farm land, and rural non-farm
Boyer et al. 1978	Perception study	230 KV, 500 KV, and control areas one mile away with no lines	Rural area in southern Ontario	Farm land, and rural non-farm
Real Estate Counseling Group of Connecticut May, 1984	Perception study: supplement to hedonic model	345 KV line	New York metropolitan region's exurban area	Single family residential

Studies

Methodology	Number of Cases and Observations	Key Property Value Related Findings
Questionnaires administered through face to face interviews	32 respondents	33% of respondents near line believed near line believed line had negative effect on property. 94% in the control area felt that the line had reduced nearby property values.
Questionnaires administered by drop off for mail back and pick up	108 responses	44% near lines said lines were a purchase consideration; 74% near lines thought lines affected property values. 12% near lines considered selling because of power lines. 78% in control area said presence of lines would be a property purchase consideration; 79% in control area thought lines affected property values in vicinity. Opposition to lines peaked in planning/construction phase, diminishing in time. Most lasting impact was perception of negative property value effect.
Questionnaires mailed to town assessors and realtors; In-person and mail questionnaires for property owners within line's vicinity	4 assessors; 21 real estate brokers and appraisers; 47 property owners; 9 long term owners within 300' of line; 58 recent home buyers within 1600' of line	-Assessors: 2 said no effect, 2 said lower value due to line's proximity. -Real Estate Professionals: 90% thought lines often or always reduced sales prices. 86% thought properties close to line sold more slowly. Less than half said financing is harder to obtain for property near line. -Residents Included In Hedonic Study: 60% knew of lines, 7% paid less due to lines. 88% would buy again. 54% said no effect on value. -Post-project Purchasers: 52% knew of lines, 14% paid less due to lines. 56% would buy again; 7% would require reduced price; 26% would require reduced price and good financing if doing this again.

(continued)

Figure 6(continued)

Author/Date	Type of Study	Line Features	Geographic Area	Property Type
Market Trends June, 1988	Opinion survey on line and substation appearance policies	Various	Metropolitan Phoenix, AZ:	Urban and suburban households
Rhodeside and Harwell June, 1988	Perception study	Various	Virginia suburbs and Washington, D.C.	Residential neighborhoods
Economics Consultants Northwest June, 1990 Beauregard Conseil, Enr. July, 1990	Perception study Post-construction perception study	500 KV 450 KV	Western Montana Along the St. Lawrence River, in Quebec	Suburban and rural residences Rural and second home residences
Priestley and Evans December, 1990	Perception study of recently rebuilt transmission line	115 KV and 230 KV	Northern California	Single family residential

Methodology	Number of Cases and Observations	Key Property Value Related Findings
Surveyed households in proximity to existing lines & substations, and random households with no proximity requirement	200 households near lines and substations; 900 surveyed at random	53% of respondents thought proximity to lines and substations reduced property values. Little difference in opinion between those near lines & substations and the general population.
Questionnaire to residents adjacent to existing transmission lines	205 residents; 10 different neighborhoods	57% said no effect on property value; 27% said negative effect; 16% said positive effect due to open space. 74% would buy again. Highly visible line had more likely negative effect; wooded right-of-way had more positive effect. Owners in area before line built more likely to have negative impression of line.
Face to face and telephone interviews	400 residents	50% of respondents within one mile of line felt there was a negative effect on property value; only 5% living one to three miles away said the same.
Focus groups, Questionnaire surveys	20 in focus group within 2 km of river crossing. 202 surveyed with view of river crossing.	12% of respondents concerned with property value impact. 49% were concerned with the line's effect on appearance of the landscape.
Questionnaire Surveys	266 residents within 900' of rebuilt power line	65% thought line had a moderate to large negative effect on property value; 30% said no effect; 5% said positive effect. 8% had strong reservations about buying near line; 39% had mild reservations; 52% weren't influenced; 1% more interested. Higher impact seen by those in area before Rebuild. -Rank of concerns: 1) health/safety 2) property value 3) aesthetic

(Kinnard *et al.* 1984) asked detailed questions about effects of the line on a property's financing and time on the market. Some of the surveys asked respondents how the presence of the line had affected their purchase decision, if the presence of the line had led them to consider moving, or if they would consider buying another home in similar proximity to a transmission line.

All the studies reviewed presented the data in terms of simple descriptive statistics. Many of the studies (Mitchell *et al.* 1976, Boyer *et al.* 1978, Rhodeside and Harwell 1988, and Economics Consultants Northwest 1990) used cross tabulations and tests of significance to identify significant variations associated with differences in context or respondent variables. In addition, the study by Priestley and Evans used scale building, correlation analysis, regression analysis and discriminant analysis to explore the relationships between perceptions, physical conditions and respondent characteristics in greater depth.

Responses Reported in Attitudinal Studies

Figure 7 summarizes the data generated by the studies on the basic question of how respondents think transmission lines affect property values. The data are not directly comparable because the questions were formulated in different ways and addressed to different kinds of samples living in different settings. However, the juxtaposition of the data provides a feel for general patterns. One notable pattern is that in many of the studies approximately 50 percent of the respondents felt that transmission lines had little or no effect on values. In contrast, the percentages indicating perceptions of negative property value effects vary considerably from group to group and study to study. One of the interesting variations is the difference found by the Mitchell study between the percentages of residents of the transmission line corridor perceiving negative impacts (33 percent) versus the percentages of residents in the control corridor who think that property values in the transmission line corridor should be negatively affected (94 percent). It is important to note that in the Boyer study which used a larger, more reliable sample, the differences between the evaluations by the two groups were relatively small (74 percent versus 79 percent). Another interesting contrast appears in the Kinnard study in exurban New York, where 90 percent of the real estate professionals indicated that they thought that the presence of transmission lines generally had a negative effect on sales prices, while only 7 percent of the owners of properties included in the statistical analysis reported paying lower prices because of the presence of the line. The Rhodeside and Harwell study's finding that 16 percent of the respondents think the transmission line has a positive effect on property values may be related to the fact that the area in northern Virginia where the study was carried out is heavily wooded, and in some cases, the transmission line rights of way can be perceived as providing a permanent wooded greenbelt behind the home.

Figure 7
Perceived Impacts on Property Values

Study/Area	Group Studied	Type of Effect Found		
		None	Negative	Positive
Mitchell <i>et al</i> , 1976 Rural southern Ontario	Residents of study corridor		33%	
Boyer <i>et al</i> , 1978 Rural southern Ontario	Residents of study corridor		94%	
Thompson, 1982 Agricultural areas in Southern Alberta	Owners of recently sold agricultural properties crossed by 240 kV lines	33%	67%	
	Randomly selected owners of agricultural properties crossed by 240 kV lines	10%	90%	
	Randomly selected owners of agricultural properties within ¼ to 2 miles of 240 kV line	50%-100%	0%-50%	
Kinnard, <i>et al</i> , 1984 Exurban New York State	Real estate professionals		90%	
	Residents with property included in statistical analysis (paid less because of line)		7%	
	Residents who had bought before line constructed	50%	50%	

(continued)

Figure 7 (continued)

Study/Area	Group Studied	Type of Effect Found		
		None	Negative	Positive
Market Trends, Inc., 1987 Suburban communities around Phoenix, Arizona	Sample of general population (effects of transmission lines and sub-stations)		53%	
Rhodeside and Harwell, Ltd., 1988 Northern Virginia suburbs of Washington D.C.	Residents living adjacent to transmission lines	57%	27%	16%
Economics Consultants Northwest, 1990 Rural and suburban areas in Western Montana	Residents within 1 mile of a 500 kV line Residents between 1 and 3 miles of 500 kV line		50% 5%	
Beauregard Conseil, 1990 Rural and second home areas in Quebec	Residents within view of a 450 kV line crossing a major river		12%	
Priestley and Evans, 1990 Suburban area in northern California	Residents living within 900 feet of a 115/230 kV line	30%	65%	5%

The Thompson study (1982) asked individuals who had recently bought or sold properties crossed by lines whether the presence of the lines had affected the transaction or selling price. Only 23 percent of the respondents indicated that they felt the line's presence had affected the transaction, and only 15 percent indicated they thought it affected sales price. These figures contrast to the finding that 67 percent of these same respondents indicated that they think that transmission lines have an adverse effect on the value of their property.

Only two studies asked respondents if they would buy another home close to a power line. In the Kinnard study, 56 percent of those who had bought their homes in the area after construction of the transmission line indicated that they would be willing to buy another home near a transmission line without any reservation, 7 percent indicated that it would take a price reduction for them to do so, 26 percent indicated that it would take both a price reduction and favorable financing, and 11 percent indicated that they would never do it again under any circumstance. In response to a similar question, 74 percent of those in Rhodeside and Harwell's sample indicated that they would buy another home near a transmission facility.

The Priestley and Evans study went the furthest in relating property value issues to other concerns and in attempting to identify factors predicting how people will evaluate property value effects. It found that the perceived impacts of transmission lines cluster into the three major areas of health and safety, aesthetics, and property values. Of the three, health and safety appear to be the greatest concern, followed by property value concerns and aesthetic concerns. There appear to be some relationships between property value concerns and concerns with aesthetics, but only a weak link between property value concerns and concerns with health and safety. (It is important to point out that the data was collected in 1987 before concerns about electromagnetic fields were very widespread). Negative property value effects were most likely to be perceived by those with higher status employment, and by those who had bought their homes before the transmission line running through the neighborhood was rebuilt with higher towers. This finding is somewhat similar to Rhodeside and Harwell's conclusion that people who had been living in the area when the nearby transmission line was built are most likely to have negative attitudes toward the line and see it as having negative effects on property values.

Limitations

The findings of the research that is now available on perceptions of property value impacts have to be treated with considerable caution. The body of research is small, and much of the work suffers from the fact that it has only been in the past few years that development of hypotheses and research designs in this area has reached any degree of sophistication.

In addition to the limited amount and reliability of the available data, the consideration of the perceptual dimension of property value impacts is made difficult by the complexity of some of the issues involved. For example, there can be discrepancies between actual behavior as measured by means such as econometric analysis and what people say in survey responses about their preferences or concerns. Respondents may have a tendency to overstate the transmission line's

impacts. For example, Priestley and Evans found that in comparing actual views of the transmission line with the view descriptions provided by the respondents, 57 percent of the respondents overestimated how much of the lines they could see. Property value effects may also be overestimated, although the degree to which this occurs has not been tested.

None of the perception studies carried out to date has explored the issue of costs to property owners that may not be recuperated through a sale, such as the value of personalized improvements to a home that an owner may not be compensated for if he or she decides to sell rather than stay in an area where a power line has been built. A somewhat related issue is that the studies of people living around existing lines do not include people who may have already moved because of their objections to living near a line. A related and as yet unanswered question is whether there are enough people unwilling to live near transmission lines to significantly reduce the size of the potential market for homes in areas with lines.

VII. Statistical Approaches to Assessing Property Value Effects

Since 1975, a number of different statistical measures have been applied to the question of identifying property value effects of overhead transmission lines. Some studies take the small but important step of adding simple difference of means tests to matched sales, testing whether any differences in average values are "statistically different from zero" (see Mitchell et al. 1976 and Boyer 1978). Other studies make use of some econometric techniques, combining them with attitudinal surveys (Universite du Quebec a Montreal 1982), case studies (Woods Gordon 1981), or paired sales and difference of means tests (Blinder 1979, Kinnard et al. 1984). Additional studies rely purely on econometric models for the analysis (Pacific Consulting Services 1991, Colwell 1990, Colwell and Foley 1979).

The studies have contributed widely but by no means comprehensively to an understanding of the issues surrounding overhead transmission lines, the complexities of analyzing these issues statistically, and the wide range of impacts that appear. The methodology and structure vary sharply among studies, making it difficult to generalize from the findings. In addition to differences in methodological approach, other major variations include the type of transmission line examined, the variables tested, the land uses considered, and the geographical location of the study area. The way in which the relationship to the power line is defined also varies sharply among studies.

Key Variables--Line Characteristics, Property Type, and Distance

Overhead transmission lines that have been studied through statistical analysis vary in size from 115 KV to 735 KV. Some studies address only one type of line (Blinder 1979, Kinnard et al. 1984 and 1988, Kinnard and Mitchell 1988, Colwell and Foley 1979 and Colwell 1990), while other studies include cases with two or more different sizes of line (Carriere, Chung and Lam 1976, Pacific Consulting Services 1991, Woods Gordon 1981, Universite du Quebec a Montreal 1982). In some cases, the study is conducted many years after the line was built (e.g. Kinnard et al. 1984), while in other cases the study is designed for a region where some of the sales took place before power line construction or upgrade and some sales took place after construction or upgrade (e.g. Kinnard and Mitchell 1988 and Pacific Consulting Services 1991).

Some studies address residential land and improvements only (Blinder 1979, Colwell and Foley 1979, Colwell 1990, Pacific Consulting Services 1991, Kinnard et al. 1984), while others address agricultural land (Mitchell et al. 1984, Woods Gordon 1981) or a mixture of uses including commercial or industrial (Kinnard, Mitchell and Webb 1989, Kinnard and Mitchell 1988). Studies have been performed in California (Pacific Consulting Services 1991), Illinois (Colwell articles), Maine (Kinnard et al. 1988), New York (other Kinnard studies), Maryland (Blinder 1979), Ontario (Boyer et al. 1978, Mitchell et al. 1976, and Woods Gordon 1981), and Quebec (Carriere, Chung and Lam 1976, and Universite du Quebec a Montreal 1982). With the geographic variation comes variations on the part of public governments or utility companies in the ways that easements and rights-of-way are administered which in turn are likely to affect the impacts of transmission lines (e.g. one time versus annual payments, size of payment, uses permitted on the right-of-way).

The relationship of the property to the transmission line is tested quite differently among studies. Some studies define two zones only, a transmission line zone and a case study zone, without distinguishing further among features within zones (e.g. Boyer et al. 1978, Mitchell et al. 1976, Woods Gordon 1981, and Carriere, Chung and Lam 1976). The studies by Kinnard use distance zones, separating impact areas into properties 300 feet or closer to the line, properties somewhat more distant (up to 1600 or 2000 feet away), and control properties (at least 2000 to 4000 feet away from the line). Other studies use continuous distance measures and also look at other line features such as the presence of a tower on or near the property or the presence of an easement on or next to the property (Colwell studies, Pacific Consulting Services 1991, Universite du Quebec a Montreal 1982).

The findings of the various studies are summarized in Figure 8. The discussion below addresses first the studies that use difference of means tests only, and then looks in detail at econometric studies, organized by land use type.

Testing for Difference of Means--Two Canadian Examples

Two Canadian studies conducted in the mid 1970s used difference of means tests to examine whether average differences among properties in transmission-line zones and control zones are significantly different from zero (Boyer et al. 1978, Mitchell et al. 1976). The earlier study was conducted by a geography professor with a group of students. The second study was an extension of the first, conducted as a master of arts project by one of the students.

Both studies look at agricultural properties. They obtain quite different results. The initial Mitchell study, using a total of 81 sales, does not find any evidence that the sales in the two types of zones are significantly different. Concern with the limited sample size and preliminary nature of the study led Boyer (with Mitchell and others) to conduct a more comprehensive study.

Boyer used a sample of over 1000 sales, total, in transmission line zones and control zones (approximately one mile distant). She found that significantly fewer sales occurred among properties in the 500KV line area than among other areas. For both 500 KV and 230 KV lines, property values were significantly lower in the transmission line zone, with an estimated effect of 16 to 29 percent of value, depending on the size category of the property, with properties under 10 acres experiencing almost twice the percentage loss in value of properties over 50 acres in size.

The Boyer findings are clearly of potential concern to utility companies and property owners. However, weaknesses of the basic approach in both these studies make the analyses of limited value. First, both use a difference of means test, which is quite rudimentary compared to other forms of statistical analysis. While Boyer adjusted the analysis by property size, many other significant property variables were not taken into account in either analysis. Two of the most significant were the year of the sale (the sales were over a 10-year time period in Boyer) and the

improvements on the property. Access to transportation was a third factor not accounted for in the model, which could explain regular differences between control and transmission-line zones.

These limitations keep the studies from being conclusive. Interest in the Boyer findings, however, spurred Ontario Hydro to sponsor further research as reported in Woods Gordon 1981 (discussed below).

Econometric Analysis--Some General Comments

Econometric analysis offers an approach to dealing with some of the shortcomings noted in our discussion of appraiser studies and of comparison of means studies. It is an approach that has been applied to the study of property markets for almost two decades (see DiMento 1982, Edelstein 1974, Grether and Mieskowski 1974). However, its use in analyzing transmission line effects has been limited to about a dozen studies (see Figure 8).

Ignelzi and Priestley 1989 provide a generic description of an econometric methodology addressed specifically to evaluating the property value effects of transmission lines. In their methodological paper, they identify the range of factors that have been found to affect property values, concentrating on both characteristics of the property (e.g. size, age, types of improvements) and characteristics of the line. A multiple regression model can include a broader range of factors as independent variables than can appraiser studies or simple comparisons of means.

While an econometric approach offers many advantages to the researcher addressing property value effects, it brings with it disadvantages as well. First, obtaining reliable sales data with sufficient information on housing and line characteristics can be very expensive. Second, the report's audience or client may be unfamiliar with the technique and may misinterpret results. Third, sophisticated statistical techniques have their own pitfalls. For transmission line studies, two of the most serious pitfalls are the complexities of dealing with data that is both cross sectional and time-series and problems arising from the heterogeneity of the data.

In time series data, one of the problems that may lead to inaccurate results is that correlation may exist between a variable and **time** (a condition called serial correlation), so that the characteristics of observations are influenced by the time period in which the observation is made. For example, prices in 1989 may differ systematically from price levels in 1988. This problem does not exist among cross sectional data, although other types of correlation may occur. It is a fairly straightforward process to test for serial correlation in simple time series data, and the techniques for correcting for this problem are also straightforward. With time-series cross sectional data (e.g. a set of individual sales varying over space and over time), identification of the problem and correction for the problem is more complex. Ignelzi and Priestley 1989 discuss one approach, that of adjusting for overall price inflation with a consumer price index. More sophisticated approaches relying on econometric estimations tying price indices to quality changes as well as time are discussed in Case and Quigley 1988 and Meese and Wallace 1991a and 1991b.

Figure 8
Summary of Statistical Analyses of Property

Author/Date	Client	Line Features/Factors Tested	Geographic Area	Property Type/ Time Period
Blinder 1979	State of Maryland	230 KV, 80 ft ROW/ lots abutting ROW, tower behind backyard	Maryland	residential subdivisions 1972-75, 1970-72
Boyer 1976	Royal Commission on Electric Power Planning	230 KV; 500 KV/ in or out of zone with line; before or after 500 KV construction	Ontario	agricultural; 1967-77
Brown 1976	Not stated	72 KV and higher # of lines per Lot	Saskatchewan Province	agricultural 1965-70
Carriere, Chung and Lam 1976	Hydro-Quebec	120 KV, 71' high 735 KV compared sales in transmission line and control zones	Quebec	urban: multi-family Housing urban fringe: -residential/ recreational ("riveraine") -agricultural, and -single family homes

Value Impacts

Methodology	Number of Cases and Observations	Statistical Results R-Squared, Significance*	Conclusions
t-test of means; multiple regression	2 subdivisions 350+ observations	R-Squared 0.57, 0.82 Regression results: (for lots only) about transmission line: significant tower: significant	T-test on means showed no difference in home price; significant (negative) difference in lot price for lots in one subdivision
Chi-squared tests by size category	2 study areas, 1000+ cases	# of sales: 500 KV--significant at > 99% confidence 230 KV--significant only at 80% price: Chi-squared results not described	Fewer sales occurred near the 500 KV line; sales prices were 16 to 29% lower in zones with transmission lines
multiple regression	2 districts 411 quarter section sales, 377 half section sales	R-Squared from 0.55 to 0.71 Number of lines not significant	While transmission lines affect farm productivity in the immediate vicinity, the effect does not appear to be strong enough to lower property values
multiple regression	urban--190 units, 1965-76 urban fringe--91 riveraine 1960-76; agricultural--113, 1960-76; single-family and vacant lots--101, 1971-76	urban--many models, results range from R-squareds of 0.07 to 0.92, TL zone sometimes significant, sometimes not; higher significance for resales	In some cases transmission lines appear to affect property values; in other cases no impact is apparent, although this may in part occur from data limitations (only tested urban area statistically)

(continued)

Figure 8 (continued)

Author/Date	Client	Line Features/Factors Tested	Geographic Area	Property Type/ Time Period
Colwell 1990	Independent (Academic)	138 KV, 50 ft ROW/ distance from line tower on property easement on property effect over time	Illinois	single family homes
Colwell and Foley 1979	Independent (Academic)	138 KV, 50 ft ROW/ distance from line tower on pro- perty	Illinois	single fam- ily homes
Kinnard and Mitchell 1988	New York Power Authority	345 KV distance zones and before/after specific route selected	New York State	Vacant land, residential categories, abandoned ag land, water front, commercial
Kinnard et.al. 1988	Utility Company	345 KV (10 years after construction) distance zones	Maine	single family homes and vacant land 1978-88

Methodology	Number of Cases and Observations	Statistical Results R-Squared, Significance*	Conclusions
multiple regression, exponential model	2 neighborhoods, 200 sales 1968-78	R-Squared 0.77 Several models tested distance from line; always significant at 95% or higher; tower not significant or at 90% only; timing of sale significant at 90 or 95%; easement significant at 95%	The distance from the line affects the price of the home, with the major changes seen in the first 50 ft from line; distance affects property value apart from any impacts of the easement; effects diminish over time
multiple regression, exponential model	2 neighborhoods, 200 sales 1968-78	R-squared 0.75 Distance from line significant; tower behind lot not significant	The distance from the line affects the price of the home with the major changes seen in the first 50 ft from line; no distance effect beyond 200 ft
multiple regression (stepwise regression)	397 sales 1983-87	R-Squared 0.69 distance zones not significant; significant positive effect for sales after route announcement	No evidence that transmission line affects the value of vacant land in the study area.
multiple regression (stepwise regression)	6 towns 305 homes 247 vacant parcels	R-Squared 0.57 No zones significant at 90% or above, although those closest to line have negative signs	No significant effect on property values

(continued)

Figure 8 (continued)

Author/Date	Client	Line Features/Factors Tested	Geographic Area	Property Type/ Time Period
1984	Power Authority	distance zones	State	homes 1972-84
Kinnard, Mitchell and Webb 1989	New York Power Authority	345 KV distance zones and before/after specific route selections	New York State	Vacant land, residential categories, abandoned ag land water front, commercial
Mitchell et.al. 1976	Royal Com- mission on Electric Power Planning		Ontario	agricultural and rural estates 1966-71
Pacific Consulting Services 1991	Southern California Edison	115 KV, 230 KV distance from line # of towers seen crossed by ROW effects of upgrade	California	single family homes

Methodology	Number of Cases and Observations	Statistical Results R-Squared, Significance*	Conclusions
matched sales; interviews; ANOVA, simple and multiple regression	up to 329 sales	R-Squared 0.49 No significant differences among equations by zone. Slope of simple regression analysis showed prices rising faster in areas close to line	No significant effect on property values
multiple regression (stepwise regression); MANOVA	371 sales	R-Squared values up to 0.69; zone variables not significant; after period significant and positive	No negative effect of power line on property values
Chi-Squared tests of difference of means	81 sales	Chi-Squared ranging from 0.245 to 1.491, indicating significance only 10 to 70% of the time.	Property near the power line was neither likely to appeal to a different set of buyers, nor were prices lower near the power line.
multiple regression	7 neighbor- hoods, 1800+ sales 1976-1989	R-squared of 0.84; upgrade has significant negative effect; upgrade effect lessens over time; sign and significance of distance vary by neighborhood; easement has significant negative effect;	The effect of upgrading the line From 60 to 160 ft High is negative, affecting property values by 5% or Less; some evidence That effect reduced With time; ROWs developed for recreational use May have positive effects

(continued)

Figure 8 (continued)

Author/Date	Client	Line Features/Factors Tested	Geographic Area	Property Type/ Time Period
Thompson 1982	Masters Thesis, University of Alberta	64 kV (1952) 240 kV (1969, 1978-80)	Alberta Province	Agricultural land 1976-81
Woods Gordon 1981	Ontario Hydro	230 KV; 500 KV distance towers ROW crossing	Ontario	agricultural land 1969-79
Universite du Quebec a Montreal 1982	Hydro-Quebec	735 KV (built 1975) 120-161 KV (built 1973) distance/visi- bility scale easement	Quebec Province	second homes (vacant land and developed) 1965-81

Methodology	Number of Cases and Observations	Statistical Results R-Squared, Significance*	Conclusions
matched pairs, comparable sales comparisons, multiple regression	74 recorded sales (26 encumbered); 69 questionnaires	R-Squared 0.52 to 0.86; significant effects found when 2 lines crossed the property (at 99% confidence level)	Presence of more than one line reduces property values, especially for land with irrigation potential
Case studies and multiple regression	6 line segments, 1000+ observations	R-Squared not reported; some power line variables significant and negative at the 95 percent level, but only in 2 of 6 cases	Evidence exists of widely varying impacts, from negative effects in areas with residential potential to positive effects in some agricultural areas.
multiple regression	2 regions 946 sales	R-Squared from 0.47 to 0.55; distance/visibility scale significantly negative for all but developed sites; easement significant and positive for all but developed sites	Transmission lines affect the value of land for second homes, with effects up to 34%. Smaller parcels are affected more severely than larger parcels.

* Significance level: Statistical analysis tests whether the estimated parameter is significantly different from zero. A parameter is normally considered significant when the analysis shows that the results would be different from zero in 95 percent of the cases or more (a "95 percent confidence level").

A second problem quite likely to occur in using property value data is that of "heteroskedasticity". Econometric analysis requires the assumption that while observations may fluctuate from their expected value, these fluctuations, or potential "errors," will all be of the same order of magnitude (a condition called "homoskedasticity"). However, when the factors being measured are quite heterogeneous, then potential errors can fluctuate widely. An example would be the variance in property values which may be much greater for large properties than for small properties. Similarly, there is no reason to expect constant variance among different land use types.

Where heteroskedasticity exists, the estimated parameters will still be unbiased, but the confidence intervals (used to determine whether a variable is significant or not) will be narrower than they should be, and a variable may be incorrectly assessed to be insignificant.⁴ Methods of correcting for this condition also exist in the literature (e.g. using price per square foot as the base measure instead of price alone can sometimes correct the problem), but where data on the characteristics of each property is limited, it may not be possible to make the appropriate adjustment.

Some of the studies described below correct for these problems, while others do not. In interpreting the findings of these more statistically sophisticated studies, it is important to keep in mind that sophisticated techniques do not eliminate the possibility of errors in outcome and in interpretation. Results of econometric models are likely to be most reliable if they are tested using homogeneous parcel types (in terms of land use type, parcel size, house size etc.) and if the sales have occurred over a relatively short time period. Realistically, the questions of interest in transmission line research almost always require examination of sales over time, and often of a range of parcel types. Thus, research designs tend to compromise between examining useful questions and technical exactness.

Econometric Analysis--Agricultural Land

Three econometric studies address the impacts of transmission lines on agricultural land. Brown 1976 is an early study that examines the effects of lines on agricultural production and compares these effects to observed impacts on farm land values. Woods Gordon 1981 is a study funded by Ontario-Hydro to further address the property value impact effects brought out by Boyer et al. 1978. Thompson 1982 is a masters thesis completed at the University of Alberta. All three studies are Canadian.

Brown 1976 examined agricultural land sales in the Canadian Province of Saskatchewan over the period 1965 to 1970. He appears to have been looking at the effects of relatively low voltage power lines, and measuring the impacts of the number of lines crossing the parcel. He does not report on other situations, such as the variations due to the amount of acreage covered by lines, distance from or between lines, or parcels close to but not crossed by transmission lines. He adjusted sales prices with a price index and also ran separate regressions for two different size categories. He found that the equations he used explained 55 percent of the variation in prices in one case and 71 percent in the second case. Factors affecting the price of land were primarily

⁴ A more detailed discussion of heteroskedasticity can be found in any basic econometric textbook, such as Jan Kmenta, Elements of Econometrics, Macmillan Publishing Co., Inc, New York, 1971.

productivity levels and distance from shipping points (although in one case one productivity measure did not have the expected sign). The number of power lines was a not significant factor in property prices in either case.

The Woods Gordon 1981 study was of Canadian farmland in the Province of Ontario. The study examined 6 different locations, with land use varying from strictly agricultural to land with potential for residential development. Power line size varied from 230 KV to 500 KV. They included over 1000 observations in the study, with sales occurring over a 10 year period. The parcels included were quite varied in type, based on size, potential land use, and property improvements. They adjust price with a price index and, rather than including separate property characteristics as a variable of each observation, they use a created property improvement index to take into account all improvements on the property. This approach is quite unconventional. While a great deal of care and information went into the creation of the property improvement index, it still leaves room for far more errors than including a greater number of less complex variables in the model, because much of the index is based on arbitrary scales or personal judgment of the analyst.

The use of line variables in the Woods Gordon study is well developed. They test many different model specifications in each area, including as transmission line variables the distance of the property from the line, the number of towers on the property, and whether or not the property is crossed by a right-of-way. The results differ greatly by study area. Areas where there is a greater amount of residential development are found to have statistically significant negative price impacts from the power line, in one case with an average decrease of as much as 16.9 percent. In contrast, areas that are primarily agricultural in two cases show a positive effect from the line and in other cases show no statistically significant effect. One important point made in interpreting these results is that the power company offers free use of the right-of-way to farmers with encumbered land or use at a very low fee to farmers adjacent to utility-owned transmission line corridors. The Woods Gordon team augments the study with case studies of a small number of matched parcels. In general, their findings from the case studies are consistent with the econometric findings.

The Thompson study compares transmission line impacts on land used for dryland farming and land with irrigation potential. The author combines econometric analysis with interview of property owners. The statistical analysis considers only the effects of the presence of a transmission line on the property sales price. The interview portion of the study also addresses effects of proximity to the power line on property values. In all analyses, Thompson adjusts for the price differences over time (his data run from 1976 through 1981). In some cases he adjusts all prices to a 1981 base using appreciation rates calculated from appraiser data or published sources. Less frequently, he uses the date of sale as an independent variable in his statistical analysis.

In his regression analysis, Thompson finds sales prices to be lower for properties crossed by transmission lines. In his comparable sales analysis (where differences are tested using t-statistics but not regression analysis) he finds significant differences only in cases where the land has potential for irrigation. No proximity effects are tested statistically for parcels located close to but not crossed by the line. Interview results show that owners of property adjacent to the line are much more likely to be concerned that impacts may occur than owners of more distant parcels.

The agricultural studies, while of interest, do not produce results that can be broadly applied to other cases. **All** of the statistically based agricultural studies are of Canadian cases. Because utility company policies may vary with respect to ownership and use of rights-of-way, the impacts may be different in other Canadian provinces or the United States. Only one of the econometric case

studies addresses any of the variables in agricultural production that may influence whether or not an impact occurs or not. (A separate study, by Resources International 1979, examines the differing effects of transmission lines on agricultural **production**, depending on crop type and other factors).

Residential Studies

The great majority of econometric studies on transmission line impacts focus on residential properties. This is not surprising, as homeowners and residential developers seem among the most likely to express concern when a new power line is proposed. Our study has identified 8 econometric analyses that deal primarily with residential property. These studies range in geographic area over Canada and the United States, from California to Maine and the Canadian Province of Quebec. They are very varied in the type of property addressed and the type of model used for analysis. The outcome is a set of interesting studies which continue to leave many general questions open. Studies cover a variety of residential property types, including single family homes, residential lots, multi-family units, and second homes. Methods of analysis vary from analysis of variance among simple linear regressions to hedonic price models.

1. Vacant Residential Land

Blinder 1979, Universite du Quebec a Montreal 1982, and Kinnard *et al.* 1988 look at vacant residential land and lot sales (among other topics). Blinder examines lot sales in two subdivisions from a property owner to a developer. In one subdivision, lot premiums were lower for lots abutting the transmission line or with a tower behind the lot. In the second subdivision, no significant difference was found. While Blinder had data on homes, he used paired sales analysis rather than econometrics to examine home sales prices and found no difference in properties abutting or distant from the line or towers. Blinder's study covers a relatively short time period, leading to fewer problems with price adjustments. The market situation he analyzes is a specialized one, in that there was a single buyer, the development company.

The Universite du Quebec a Montreal study includes vacant second (or vacation) home lots (*sites de villegiature*) as well as a much smaller number of developed parcels. They use an econometric model, including as variables a distance/visibility scale related to the transmission line and a dummy variable for the presence of an easement on the lot.⁵ The Universite du Quebec a Montreal group makes a careful effort to adjust for inflationary changes in property over time, by calculating an index using an econometric equation. However, they have little other information on the physical characteristics of the site, using dummy variables to distinguish between different neighborhoods within each area, but no specifics on topography, vegetation, access, or other characteristics. This absence of detailed data does not allow them to adjust for possible quality changes over time. For vacant land, their models explain between 47 and 55 percent of the variation in prices. They find that proximity to and a view of the line has a negative effect on the price of the vacant lot (of up to 34 percent), while the presence of an easement has, surprisingly, a positive effect. They attribute this positive effect to the utility company policy of allowing agricultural use of easements at no charge. They separate the analysis for small and large lots, finding a larger price effect on smaller lots.

⁵ A dummy variable is a variable used to denote the presence or absence of a characteristic. It is usually measured as a value of zero or one. Thus, in this model, if there was an easement across the property, the variable was given the value of one; cases with no easement were given a value of zero for this variable.

As part of a larger study, Kinnard *et al.* 1988 looks at sales of vacant land suitable for residential development in Penobscot County, Maine. This and other Kinnard studies reviewed later are good examples of the combination of appraiser techniques and statistical techniques. Data is gathered on individual sales and is carefully screened. Analysis includes both parcel sales comparisons and multiple regression analysis. In the Kinnard approach, the transmission line component is included in the analysis through separating parcels into distance zones, with the closest zone including parcels located within 300 feet of the transmission line (a 345 KV line). In the 1988 vacant land study, the analysis included close to 250 land sales, with 23 in the zone closest to the line. They conduct separate analyses of sales of smaller parcels (under 5 acres) and larger parcels (over 5 acres). For smaller parcels, the model explains relatively little of the price variation, having an adjusted R-squared of 0.25. The model of larger parcel sales explains about twice as much of the price variation (adjusted R-squared of 0.51). In both models, the parameter for the nearby zone is negative but not significant, indicating that the prices in nearby zones cannot be shown to be significantly lower than prices in other areas.

The Blinder, Universite du Quebec a Montreal, and Kinnard studies reach widely varying conclusions. This may indicate that **transmission lines** affect different areas in different ways, depending on the detailed characteristics of the property. However, some of the difference in results may also proceed from the variations in data characteristics and in the methods of analysis used.

2. Single Family Homes

Studies by Kinnard *et al.* (1984 and 1988), Colwell (1979 and 1990), and Pacific Consulting Services 1991 look at impacts of transmission lines on the values of single family homes. The studies differ widely in methodology and also in findings.

The Kinnard studies look at 345 KV lines in New York and Maine, with rights-of-way 150 to 200 feet wide. Each of the Kinnard studies uses a similar approach to analyzing distance effects, defining property by distance zone (within 300 feet of the line, at an intermediate distance, or beyond 2000 to 4000 feet) rather than as a linear distance from the line. However, the method of analysis differs between the two studies. Kinnard *et al.* 1984 analyzes over 300 sales in New York State over a 12 year period. They analyze effects looking at a combination of matched sales, simple and multiple regression analysis, and analysis of variance. In their econometric analysis, they build a model of the entire market, but test for proximity impacts from the transmission line separately for each zone using a variety of statistical techniques. One example is the creation of separate models for each zone, using analysis of variance to test the difference in parameter values for each zone. This approach would be stronger for a highly homogeneous set of observations. For a data set with a wide time period (1972 to 1984) and probably significant variations in size and quality among homes, some of the impacts may be masked by this analytic approach. In addition, the first distance zone used, up to 300 feet from the line, goes well beyond the impact area found in some other studies (see discussion of Colwell, below). Some impacts to parcels closer to the line may be hidden if the parcels are considered as a group with sales of properties in the less vulnerable range of 150 to 300 feet from the line.⁶

⁶ The authors may have been restricted from creating more sensitive distance zones by the small number of sales occurring very close to the transmission line.

Kinnard *et al.* 1988 uses a more conventional model, comparing properties from all distance zones in a single model. Their impact model includes a relatively small number of property characteristics. (Many more characteristics were included in their initial econometric analysis of the property market and were eliminated because they did not appear to be significant). The zones closer to the line have negative parameters, as would be expected, but none are significant at 90 percent confidence or above. Again the distance of the closest zone is quite wide for expected impacts. However, the authors also conduct a more detailed analysis by separating sales within the closest zone into property intersected by the right-of-way, traversed by the right-of-way, abutting the right-of-way, and all others in zone A. None of these variables showed significant impacts. The results are somewhat weakened by the sample's relatively small number of sales in the zone closest to the line, which may affect the significance level determined by the model.

Colwell 1990 and Colwell and Foley 1979 analyze 200 home sales in two Illinois neighborhoods over an eleven year period. The 1990 study is an extension of the analysis reported in the 1979 study. The transmission line involved is a 138 KV line with a 50 foot right-of-way. Colwell and Foley examine a broader set of transmission line factors than either Blinder or Kinnard. The analysis looks at distance as a continuous variable, rather than a set of zones, at the existence of a tower on the property, at the presence of an easement, and at the trend in impacts of distance from the line and distance from a tower over time. Their model includes much more information on characteristics of the property than do the other studies discussed above, including such factors as presence of a basement, number of bathrooms, and presence of a deck. They find that proximity to the transmission line lowers property values, but that the effect is strongest within the first 50 feet and dissipates quickly after that, disappearing beyond 200 feet. Proximity to the line is found to lower prices even when properties with easements are treated separately. Properties with easements also experience loss in value. However, the presence of a tower on the lot has no additional significant effect on price in most forms of their model. They test the effects on value over time by using the ratio of the month of sale (a measure of when the sale occurred within their study period) to the distance from the line as a variable, and find that this is positive and significant. They interpret this variable as indicating that the negative effect of proximity to the line (measured by 1 divided by the distance) decreases with time.

Although their model explains 77 percent of the variation in property values, it contains some serious limitations. First and most serious, as far as is indicated in the text, they make little adjustment for the effects of inflation over time, even though they are using more than a decade of property sales. While they include the month of sale as an independent variable in the model, this is an inadequate adjustment for inflation, which does not occur evenly over time. Second, the structure of the model appears arbitrary. While it is not unusual for property value models to be of log or semi-log form, there is no explanation in the text for the particular choice of model (log form). Despite these limitations, the Colwell study is one of the more careful and systematic analyses of residential impacts, especially in its treatment of the relationship of the property to the line.

Another study that looks carefully at the relationship of single family home prices to transmission lines was recently completed in California (Pacific Consulting Services 1991). Funded by Southern California Edison, the study looks at sales in 8 different Northern California neighborhoods--6 crossed by transmission lines and two control neighborhoods. The neighborhoods include several with 115 KV power lines, one with a 230 KV line, and one where a 115 KV line was upgraded to 230 KV during the study period. The analysis looks at several types of transmission line effects, including distance from the line, number of towers in view of the property,

whether the property is adjacent to or crossed by the right-of-way, and whether the right-of-way has been landscaped.

The Pacific Consulting Services study covers over 1800 sales during a 14 year period. Price is adjusted over time using the U.S. CPI for home ownership, and dummy variables by year are also included in some forms of the model to account for any local price variations beyond national trends. Detailed information on the property is included, such as the lot size, square footage of the house, street type, steepness of street, panoramic view, view of other transmission lines, and developer (which affected quality of the home). The resulting model explains over 80 percent of price variation. Sales prices in the neighborhoods where the upgrade occurred are consistently found to drop following the upgrade, with a decrease on the order of 5 percent, regardless of distance from the line. The amount of square footage of the right-of-way on the property also negatively affects property values. Being adjacent to the line, however does not have a significant effect on prices, perhaps showing a balance of the negative effects with the advantages of not having a neighbor to the rear of the house. The study finds distance effects to vary sharply by neighborhood, with no overall distance effect apparent. Some neighborhoods show negative effects of proximity to the line, in some forms of the model. The most consistent finding, however, is a positive effect of proximity to the line in a neighborhood where the line is landscaped and developed for recreational use. The analysis also tests for change in the impact of the right-of-way upgrade over time, and finds that the effect drops off sharply several years after the upgrade was completed.

The Pacific Consulting Services study tries to adjust for many of the problems and limitations apparent in other studies, by using a large data set, by conducting extensive field work on home characteristics, type of view and characteristics of the line, and by using price indices and dummy variables for individual years to adjust for broader market characteristics. By covering a 14 year period with a line upgrade occurring in the middle, the analysis offers the opportunity to test for the effects of a major change in a line immediately after completion and at later dates.

Nevertheless, the study highlights some of the difficulties of applying econometric methodology to the property value impact analysis. First, while a great deal of data is available on the homes, other information on the quality of individual homes, on the overall quality of building methods over time, and on financing methods is missing. (It may not be possible to expand such information further in most studies, because of cost and privacy issues). Second, much of the price variation is explained by neighborhood dummies alone, suggesting that many of the characteristics affecting price are not being measured by the typical property characteristics included in the model. Third, the control neighborhoods are not perfect matches for the transmission-line neighborhoods, and in general, there is a great deal of heterogeneity of housing type and socioeconomic characteristics of the population among and within the neighborhoods. All of these factors suggest that errors may exist in the models. More specifically, the model may misestimate some of the price variations due to the transmission lines and may fail to identify cases where further price variations are caused by the line or right-of-way.

3. Multi-Family Homes

In addition to the single family home models, one study has been done on multi-family homes. Carriere, Chung and Lam 1976 look at sales of homes in duplex, triplex and quadruplex development in Sainte-aux-Recollets, an urban area in the Province of Quebec, for the period from 1965 to 1976. They test only for the effects of a property being either within or outside the transmission-line zone. They use a relatively sophisticated price adjustment over time in the model

(based on an econometric estimate), but they have very little information on the property characteristics, except for lot size, of the different types of property included in the study. They report tests of a number of different models, with results varying widely. Some of the models tested explain little of the variation in property value (less than 10 percent) while others explain more than 90 percent. The authors do not discuss any statistical tests they may have made to determine which of these models best explains the characteristics of the property markets. They find significant transmission line effects in some of the models, with the effects being clearest for resales and for the sales price per size of lot (not per square footage of home).

4. Summary of Impacts on Residential Properties

In sum, for residential sales, the effects of transmission lines appear to vary. Study results range from no impacts (in some single family areas) to large effects (in a case with vacation home lots). The studies with the largest data sets and most detailed analyses in terms of both property characteristics and measurements of relationship to the line find some level of negative impact on value, although generally not a large one, and sometimes under limited conditions. Results suggest that many circumstances, ranging from the size of line and right-of-way to the general tightness of market conditions may affect the outcome for residential home and lot prices over time.

Other Property Types

Two Kinnard papers examine the impacts of transmission lines on vacant land that includes nonresidential, nonagricultural lots (Kinnard and Mitchell 1988 and Kinnard, Mitchell and Webb 1989). Both papers report analysis of the same data base, almost 400 sales in New York occurring between 1983 and 1987. The study is of interest because it includes a variety of land types and because changing information on the right-of-way and construction of the transmission line occurred during the course of the time period studied.

The study addresses both the effect of distance zones (defined as previously described) and of changes in information on the right-of-way. At the outset of the period, there was an awareness that a transmission line would be built somewhere within the area, but no specific route had been announced. The route was announced in 1985, and the line built in 1987. This situation complicates the analysis. The authors use simple dummy variables to test for zone effects (A through D, Zone A being closest to the power line and Zone D being a control zone distant from the line) and for sales before or after the 1985 announcement. They find no significant effects of being in the A zone, and find that prices are higher **after** the announcement. This second finding should not be misinterpreted as an indication of the benign effect of power lines. The authors certainly make no such claims. There were very few land sales in zone A before the announcement (only 4), so that the variable really tests the effect of the announcement on properties **away** from the line. If fear of a power line nearby lowers property values, then it would be natural for values to rise once it was known that the location would be distant from most parcels.

Unfortunately, the Kinnard study is unable to disaggregate the effects of power line proximity by property type. Sparsity of data makes it impossible for them to calculate different parameters for transmission line impacts on each property type (including residential, water front, commercial, and abandoned agriculture). Results of the model are also affected by the great heterogeneity of property types, which makes it likely that heteroskedasticity exists in the model. This in turn can make some variables (e.g. location by zone) appear insignificant when they are really significant.

General Findings and Limitations of Econometric Studies

The econometric studies described above are more informational as examples of approaches and limitations to property value research than they are definitive in pointing to effects of transmission lines on property values. The results of these studies suggest that transmission lines almost certainly affect property values in some circumstances, although the size of the effect is not necessarily large, and it is also quite likely that there are circumstances where a transmission line has little effect on property value. While in most cases where impacts occurred they were on the order of 2 to 10 percent of the value of property, in two cases the impact was quite a bit higher (over 16 percent in one Woods Gordon case study and over 30 percent in the Universite du Quebec a Montreal study of second home lots). None of these findings are definitive, but they suggest that further investigation, through a well-designed and coordinated series of studies, would be needed to provide more widely applicable results.

The statistical research that has been accomplished over the past fifteen years also demonstrates that there is still a significant amount of variation in property markets that is not captured by statistical models. Many of the models explain little more than half of the variation in prices. Even those that explain far more rely on unrefined measures of neighborhood differences (such as dummy variables) rather than measures of actual property or neighborhood characteristics (many of which are very difficult or expensive to measure accurately). In the great majority of the models reported here, basic property characteristics explain the great majority of the variation in price, with transmission line measures adding only slightly to the understanding of property value impacts.

In addition to the methodological limitations mentioned throughout the above discussion, the range of studies that have been accomplished is still quite limited. The most frequently examined property type, single family homes, is addressed in only 6 reports and articles (and in only 5 different circumstances, as the Colwell studies both rely on the same set of properties). Most of the other property types are addressed in only one or two studies. This is a very useful beginning, but with a geographic range including all of the United States and Canada, a broader mix of studies using consistent methodologies would be needed to produce widely applicable results.

There is virtually no information from these studies on the impacts of lines on nonresidential, nonagricultural property. Other issues also are explored only preliminarily. One example is the possibility that impacts differ by **value** of property--are expensive homes more sensitive to visual impacts of lines than less expensive homes? Similarly, the issue of diminishing effects over time has been explored only briefly. Furthermore, the type of impact investigated (distance from the line versus view of towers versus presence of a right-of-way or easement) varies so widely among studies that there is little consistent experience from which to make comparisons or draw general conclusions.

In sum, the econometric studies provide information and experience upon which a series of further research studies could be based. However, it is also important to note that design and execution of this type of study is neither simple nor straightforward. To conduct a study adequately, a great deal of information is needed about the properties being sold. The time component of the observations must be thoughtfully dealt with. Practical difficulties are also likely to arise. For example, it is not easy to find a relatively homogeneous set of properties in an area with few topographical or natural variations, that is not also affected by other "nuisance" facilities, such as

other power lines, highways, or even poorly maintained properties. Finally, the studies suggest that a transmission line right-of-way is not necessarily a negative neighbor. Thus, any research should be designed to sort out the possible positive effects of a transmission line (e.g. isolation from neighbors, provision of views or open space) from the negative effects of visual impact, noise, reception interference and health concerns.

VIII. The State of Current Knowledge

Despite the large numbers of new studies that have been conducted since 1975, many of the shortcomings of research on overhead transmission lines noted in Section IV of this report remain. The geographic areas covered are widely dispersed, methods of analysis are often compromised by data limitations, and the questions addressed vary widely from study to study, so that there is little opportunity to confirm the findings from one study with the results of another study.

Nevertheless, the research of the past fifteen years helps to focus our understanding of how overhead transmission lines may interact with the property market. This research also provides very useful experience on the advantages and weaknesses of different methods of approach, on the importance of large, carefully screened data sets, and on the key questions that remain unanswered.

The summary below should be read as being exactly what it states--an evaluation of the state of **current** knowledge. The findings that are presented are based on the best information available today but are open to revision in the future as research is extended in the field and methods of analysis are refined.

Current Knowledge of Impacts

While the findings of the studies reported above vary widely, in sum they suggest a set of findings.

1) There is evidence that overhead transmission lines have the potential to reduce the value of nearby property. The impacts may occur either through the direct effects of an easement on the property or through the impacts on neighboring or nearby property.

2) Where impacts occur, they are often not large. Impacts on single family homes, where they have been measured, are generally in the range of 2 to 10 percent. Many studies of other property types find no effects. The largest impacts identified both in appraiser studies and in econometric research are found in agricultural property and in rural second (vacation) home development. Two of the better-designed studies have found negative effects greater than 10 percent to occur **under some conditions** (Woods Gordon 1981--residential estate properties in agricultural areas, Universite du Quebec a Montreal 1982--second home lots).

3) Overhead transmission lines are generally not the major determining factor of property values. Other factors, such as neighborhood characteristics and characteristics of the land and improvements tend to explain much more of the variation in home prices.

4) The spread of effects outward from the transmission line appear to vary from case to case. Often, the effects appear to be confined to the immediate area around the transmission line (e.g. Colwell 1990). However, in one case, an impact was identified for an entire neighborhood (Pacific Consulting Services 1991). Most of the existing research methods do not distinguish between

effects produced by visibility of the line (which may occur over a long distance) and effects from other physical features of the line (e.g. inconvenience of a right-of-way on the property, noise effects).

5) There is also evidence that overhead transmission lines and their rights-of-way may carry **positive** effects for some property owners. The degree to which this occurs depends very much on the circumstances of the line itself, the neighborhood, and the improvements made to the right-of-way. The finding is most consistent for Canadian cases. In the Canadian studies, the right-of-way is sometimes quite large (over 400 feet in at least one case) and the utility company may allow neighboring farmers to make use of the right-of-way area without charge or for a very low fee. There are characteristics of rights-of-way in the United States, as well, that also lead to improvements of value to neighboring properties. The most frequently mentioned are the advantage of having one less neighbor (e.g. Blanton 1980) and the opportunity to use some rights-of-way for recreational or other purposes (e.g. Pacific Consulting Services 1991). In one attitudinal study, the heavily wooded right-of-way was considered an aesthetic amenity Rhodeside and Harwell 1988).

6) Existing studies provide little evidence that tower height and line voltage are directly related to level of impact. There are cases where relatively small lines affect property values and cases where very large lines do not. However, because of methodological and data limitations, the issue has not been systematically explored.

7) Some studies have found that the impacts of transmission lines are greater for smaller properties than for larger properties. This makes sense intuitively, as it is more difficult to design the property use to minimize impacts on smaller lots.

8) The two studies that address the question of diminishing impacts over time suggest that this may be the case. However, impacts appear to last for several years at least, affecting property owners who expect to sell within the first few years following transmission line construction.

Lessons for Research Methodology

In order to reach more definitive results in the future, it is clear that further statistically sound research is needed. Lessons from recent research can help to inform future research directions.

1) Comprehensive, precise information on the property being studied is essential for reaching reliable conclusions on impacts to property values. Many of the appraiser studies offer good examples of the detailed information which can be obtained from public records. For complete information, it may be necessary to combine the appraiser-type data with accurate field surveys to identify characteristics normally not covered by appraiser studies (see Ignelzi and Priestley 1989).

2) There is a great need for a consistent research methodology. Statistical models, in particular, will produce more meaningful results if the structure of the models is well thought out

and consistently applied in different geographic and land use settings. Attention to the characteristics defining the property and the characteristics defining the impacts of the line is particularly crucial.

3) Certain characteristics of the data normally used in this type of research must be treated with great care. Possible external effects that may change property values over time must be accounted for in structuring the model. Ideally, not only inflation over time but changes in housing quality should be considered. This may require additional econometric modeling to develop accurate price indices and careful attention to data available on property characteristics.

4) While the variation in impacts by property characteristic is an important concern, research design must be careful to account for the problems introduced into the model by heterogeneity of property. This may require indexing data in some way (e.g. a common method is to use price per square foot or per acre) or developing separate models for different property types.

5) In designing research it is also important to consider the possibility that responses to the presence of a transmission line may vary over time. The diminishing effect following initial publicity is just one example. In other cases, research may demonstrate that concern **increases** in periods when more discussion is occurring about the health effects of transmission lines. If this type of variation is occurring, models may need to include a time component to capture such changes, or several separate estimates may be needed instead of a single cross-sectional time-series model.

Unanswered Questions

Not surprisingly, none of the questions posed in Section III of this report have been fully answered by research to date. Some issues have been given extensive attention, as described above, while other important questions have not been answered by existing research design. These include:

- 1) Magnitude of Effects--Several studies have made estimates of the magnitude of effects of transmission lines on property values. However, methodological variety and the **wide** range of findings (from 34 percent loss to a 10 percent gain) leave the question unanswered.
- 2) The source of effects on property next to or near the transmission line, both positive and negative, has not been closely studied--On the positive side, opportunities to make use of the right-of-way or the lack of neighbors are both possibilities, as is the aesthetic landscaping of some corridors. On the negative side, visual impact, fear of health effects, noise, and interference with reception may all be factors. In addition, the publicity surrounding the initial planning and construction of the new or upgraded line may well affect the property market, particularly in cases where the project was contentious and may have led to stigmatization of the affected area.

- 3) The effects by land use type--It would be reasonable to hypothesize that many commercial and most industrial uses differ from residential and agricultural uses in their sensitivity to transmission line effects. There have been no tests of variations in sensitivity by land use type.
- 4) The effects of general surroundings--None of the research that has been accomplished includes much information on the characteristics of the general surroundings. Yet an area with an attractive, open, unurbanized surrounding environment could be affected quite differently than a heavily urbanized area, if the topography, vegetation or background do not provide significant screening of the view of the line.
- 5) The effects of socioeconomic characteristics--Socioeconomic characteristics are often considered to be a factor in affecting property values and also in responses to environmental characteristics. While these have been included in some of the attitudinal studies, they are totally absent in the property value evaluations. (It is unlikely that legally these factors could be considered in determining the level of compensation. However, when an influential factor is left out of an econometric model, all other parameters may be misestimated).
- 6) Health Effects--Recent reports on possible health effects of electro-magnetic fields suggest that concern with health may become more significant as a factor influencing property values close to transmission lines. These concerns are addressed briefly in some attitudinal studies and have not been tied to statistical analyses of property value impacts.
- 7) Changes Over Time--New information, such as the health studies mentioned above or technological improvements in screening transmission lines, may change property owner sensitivity to transmission line proximity over time. Thus, even an excellent study today could fail to address issues that arise in the future.

This last phenomenon suggests the value of designing studies of property value impacts with the intention of repeating the research, using consistent methodology, regularly over time. Such an approach would make it possible to track changes in impacts related to changing public concerns or changing technology.

Future Directions

For future research to extend knowledge further on the question of overhead transmission lines and property values, greater attention to geographic scope, data requirements and analytic techniques will be needed. A set of consistently designed studies of carefully selected property types and geographic areas could significantly improve our understanding of the research questions presented earlier. The following section discusses possible approaches in greater detail.

IX. A Research Agenda for the Future

The preceding discussion suggests several directions for future research. First, systematic examination of some of the inherent problems in research design would help to produce more consistent and comparable studies. Second, a larger number of comparable studies on single family residential property is needed to develop a clearer picture of the range and parameters of impacts. Third, expansion of research on other property types would help direct future siting decisions. Fourth, a longer term agenda is needed for tracking the timing of impacts and for addressing changes in information and technology.

Addressing Methodological Pitfalls

Methodological pieces exist already describing both appraisal techniques (e.g. Clark and Treadway 1972) and econometric techniques (e.g. Ignelzi and Priestley 1989). However, further attention to some of the more problematic aspects of these methodologies could help to strengthen the findings of empirical studies. Further **methodological** research (in addition to or combined with empirical research) would be helpful to set the stage for empirical studies. Five areas of methodological concern remain:

1. Methods for addressing the changing value of property and the changing quality of property over time--Many of the studies reviewed here examined property values over an extended period of time. This was true of most econometric studies and of some appraiser studies as well. Some studies ignore the effects of changes over time, while others adjust prices using a variety of indices. Methodological research could examine alternative approaches to adjusting for changes in quality and value over time. Such research could clarify the choices in research design (e.g. the development and use of price or quality indices, restricting analysis to discrete time periods or quality ranges, or construction of different models for different time periods or quality levels). In general, the inclusion of some variability in time period (and thus inflationary effects) and quality is likely to be desirable for policy analysis, even if it causes complications in research design.
2. Variations in property type (i.e. in existing or zoned use) also cause problems in either appraiser or econometric studies. Further methodological discussion is needed on the alternative approaches for handling different property types (e.g. the use of different models for different property types, the development of different sets of parameters for different property types within the same model, or using one set of parameters for all property types in the same model). In many cases, it may prove desirable to restrict analyses to a single property type.
3. Methods are needed for incorporating variations in attitudes and in personal or social values. For example, price effects may be more apparent in affluent areas, where people can afford to pay for aesthetics. In existing studies, the attitudinal portion of

the study usually is completely separate from the rest of the analysis. Development of a research design to incorporate findings on attitudes into econometric studies of changes in value would strengthen the understanding of the factors leading to property value impacts of transmission lines. McClelland, Schutze and Hurd 1990 provides an example of one such study for hazardous waste sites.

4. Model completeness is important to econometric methodologies as well. Wherever possible, research design should include variables describing characteristics of the property, neighborhood and time period, and characteristics of the transmission line and right-of-way such as distance, height, voltage of line, location of towers, width of right-of-way and treatment of right-of-way.
5. A longer term goal for research could be to develop a model that could be used to simulate impacts of transmission lines on property values in residential or mixed-use neighborhoods. However, this can be achieved only after further empirical work has identified appropriate variables for use in simulation.

Comparable Studies of Single Family Residential Property

The greatest progress has been made in the past 15 years in understanding transmission line impacts in single family home areas. The next step for research on this topic would be to expand and systematize the studies being conducted, to provide a stronger knowledge base for understanding the potential effects of proposed project alternatives. Ideally, a set of studies needs to be designed to compare similar types of residences across a number of geographic areas and transmission line and right-of-way conditions. The studies should incorporate detailed information on property characteristics (e.g. lot size, number of bedrooms, number of baths--see Ignelzi and Priestley 1989). They should also be systematically designed to identify the characteristics of the line that may affect property values (e.g. height, distance from property, etc.), the role of mitigation measures (e.g. landscaping, recreational use) in reducing or reversing impacts, and the timing of the sale with respect to construction of the line. A later extension of this type of study would be to expand the research to a wider range in price and quality.

Attention to Other Property Types

Less information is available from current studies on the effects of transmission lines on most other types of property. The impacts on agricultural land appear to vary widely, while few studies have examined effects on multi-family residential property, on commercial property or on industrial property. Further research appears particularly important for agricultural land (because of its likeliness to be crossed by transmission lines) and multi-family property (because of the increasing tendency to construct multi-family rather than single family residences). Both of these property types, unfortunately, offer more obstacles to study than do single family homes.

Agricultural land covers a very broad category of types of use, quality of land, and availability of resources (such as water). In addition, the number of land sales around a single transmission line is likely to be more limited than for residential property. For agricultural land, it would be useful to apply a consistent model structure to a set of empirical study areas, where parcels in each area are similar in many ways (e.g. in crop type, parcel size, productivity, or potential for future development), but where there is substantial variability among study areas (e.g. areas with large parcel sizes versus areas with small parcels, areas on the urban fringe versus remote locations, etc.). It is highly unlikely that an adequate number of cases can be found for each area if the time period is also restricted. Thus, using consistent methods to adjust for changes in value over time will be important for this area of research.

Research on property value effects for multi-family residences must consider a different set of issues from either single family or agricultural research. First, it may be of interest to look at effects either on sales of buildings, on rental rates, or on unit sales in condominiums. It may be difficult to obtain a sufficient number of observations of building sales to construct an econometric model. Single units turn over more quickly, making a greater number of observations available for rents or single unit sales. However, because rents are not recorded publicly in the way that property sales are, it may be more difficult to obtain rental data rather than sales data. Nevertheless, it is important to look at both rental and for sale property, as occupant sensitivity to transmission lines may be affected by ownership status. As a first step, a prototype study that illustrates some of the issues and alternative approaches to examining multi-family housing would help to provide a framework for further research.

Timing, Information and Technology

In addition to improved models on each property type, over the longer term it will be important to address other factors that may change the direction or level of impacts, such as timing of the sale, changes in information, and technological changes. The timing of sales with respect to line construction can be incorporated straightforwardly into studies of single family home sales and should be considered in designing the set of studies suggested above (as it was in a few of the studies reviewed in Section VII). Some types of information can also be added to single family home studies. For example, it would be useful to make a distinction between sales in areas where publicity and/or public involvement programs accompanied line construction and areas where less information was publicly available. The level of controversy may also be a relevant factor to incorporate in the model. To add this type of information, more than one neighborhood may be needed for the study, or perhaps more than one geographic area.

Changing information on potential health effects of lines needs particular attention. As new information makes health risks of locating close to a line appear more or less serious, the willingness of people to buy homes near transmission lines may change. It would be helpful to be able to link awareness of health risks to sales prices and property values. To do so will require a consistent series of studies over an extended period of time, preferably incorporating both

attitudinal research and econometric analysis. One approach would be to track sales in one or a few selected areas at regular intervals for one or two decades.

In conjunction with changing information, changing technology may also affect attitudes towards and value of property close to transmission lines. Technological changes may evolve to make lines quieter or noisier, more or less visible, or to change the level of perceived health risks. These technological changes may in part be tracked through parallel studies which cover different types of transmission lines. Long term studies of the type suggested above for knowledge of health risks may also be appropriate for tracking the impacts of changes in technology.

Model Limitations and the Role of Other Variables

Any new research in this area should be started with the recognition of the limitations of such research as well as the potential from the research. The problems with recent studies, described in earlier sections, are not the fault of sloppy methodology but of the inherent difficulties in conducting research on real estate topics. The heterogeneity of property quality and type, the unevenness of sales patterns, and the sensitivity of real estate values to many other economic factors imply that a wide margin of error is likely to exist in all studies. This is of particular concern given the relatively small role transmission lines appear to play in determining the price of a home or other property, compared to other factors (such as lot size, neighborhood, and number of bedrooms). Because of this problem, a carefully designed research framework, preferably consistent to other studies, is important if conclusions are to be applicable beyond the individual case.

Some Practical Considerations for a Research Agenda

Of the research topics described in this section, some can be easily begun in the near future while others will need careful structuring and monitoring. Some of the methodological issues should be addressed quite soon, if the work is to influence the shape of empirical studies in the future. A consistently designed set of studies on single family home sales could also be developed shortly. Research on other types of property and on changing information and technology may take more advanced preparation before being instituted.

Further research **can** help to refine our understanding of impacts--for single family home sales and for other property types--and can be used to monitor whether impacts are sensitive to changing conditions over time. The success of these studies will depend on ongoing and open communication among researchers at different institutions and locations and would be enhanced by the availability of financial assistance to overcome data limitations.

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APPENDIX A

**EFFECTS OF OVERHEAD TRANSMISSION LINES ON PROPERTY VALUES:
A REVIEW AND ANALYSIS OF THE LITERATURE**

**BIBLIOGRAPHY OF SOURCES
1976 TO THE PRESENT**

INTRODUCTION⁷

This bibliography is a compilation of recent literature relating to the effects of overhead transmission lines on property values. The bibliography covers all reports and papers completed and published between 1975 and early 1991. It includes all literature reviews completed on the topic since 1975, all econometric studies that we have been able to identify, and a selection of the most relevant methodological pieces, of appraiser-type studies, and of attitudinal studies that investigate the respondents' opinions on property value effects.

The bibliography is organized in four sections. The first section lists literature reviews completed between 1976 and 1990. The second section lists the major general studies related to the topic, including basic works on methodology, and a few empirical pieces on property value effects of factors other than transmission lines. The third section includes related reports and articles on the study of property values in contexts other than transmission lines. The fourth and largest section lists empirical studies of property value impacts, with annotations to indicate the methodology used.

⁷ This bibliography was compiled with the attentive and able assistance of Thomas Spiekerman, Graduate Student, Department of City and Regional Planning, University of California at Berkeley.

PREVIOUS LITERATURE REVIEW CITATIONS

The citations in this section of our bibliography are previous literature reviews of the impact of high voltage electric utility transmission lines on property values. These reviews contain one or more of the following: Annotated bibliographies, detailed reviews and analyses, or simply unannotated bibliographic citations for articles and studies on the impact of transmission lines on property values. In the bibliography of specific articles and studies that we have compiled, these previous literature review sources are included in the citation as described in the following paragraph.

Our bibliographic citations include a category denoted as "**Reviewed In**", followed by an abbreviated cite of the previous literature review source(s) in which the review was contained, if that source contains an annotation or summary review for the citation. If a bibliographic citation without an annotation or summary review was contained in the previous literature reviews cited, the category in our bibliography for the original cite is listed as "**Source of Citation**" rather than as "**Reviewed In**".

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Soleco Consultants, Inc. 1985. Examen de la litterature recente et les avenues de recherche dans le domaine de l'evaluation des impacts des equipements electriques sur la valeur fonciere des proprietes. Rapport final: Novembre.

Title translation: Examination of recent literature and research directions in the area of evaluation of the impact of electric facilities on property value.

GENERAL REPORTS ON THE IMPACT OF HIGH VOLTAGE TRANSMISSION LINES ON PROPERTY VALUES

The citations in this section cover articles which provide background information on the evaluation of transmission line impacts on property values, rather than those which detail specific instances of impacts at a particular study site. The focus of these articles is to explain different types of studies that have been undertaken to evaluate property value impacts of proximity to transmission lines. Some of the sources listed in these citations also review actual case studies of property value impacts of proximity to transmission lines.

GENERAL REPORTS CITATIONS:

Clark, Louis E., Jr., and F. H. Treadway, Jr. 1972. Impact of Electric Power Transmission Line Easements on Real Estate Values. Chicago: American Institute of Real Estate Appraisers of the National Association of Real Estate Boards.

Dempsey, W.E. 1981. "The DUPA Technique for Electric Transmission Line Easement Acquisition". The Appraisal Journal, 49: 382 - 390. July.

Furby, Lita, Robin Gregory, Paul Slovic, and Baruch Fischhoff. 1988. "Electric Power Transmission Lines, Property Values, and Compensation". Journal of Environmental Management. 27: 69 - 83.

Gronhovd, Duane, James A. Knuteson, and William C. Nelson. 1979. Effects of Electrical Transmission Lines on Agriculture. Fargo, North Dakota: Department of Agricultural Economics, North Dakota State University.

Henderson, J. A. et al. 1981. "Economic Impact of High Voltage Transmission Towers on Agricultural Lands", in Tillman, R.E., ed. Environmental Concerns in Rights-of-Way Management: Proceedings of the Second Symposium Held October 16 - 18, 1979. Palo Alto: Electric Power Research Institute.

Ignelzi, Patrice, and Thomas Priestley. 1989. A Methodology for Assessing Transmission Line Impacts in Residential Communities. Prepared for Edison Electric Institute Siting & Environmental Planning Task Force. June.

Kellough, W. R. 1980a. "Impact Analysis of Electrical Transmission Lines: Part I". Right of Way. 46: 50-55.

Kellough, W. R. 1980b. "Impact Analysis of Electrical Transmission Lines: Part II". Right of Way. 47: 19-25.

Resources International. 1979. The Effects of Electric Transmission Lines and Towers on Agriculture. Prepared for Pacific Gas and Electric Company, Fresno, California.

U.S. Department of Energy; Assistant Secretary for Environmental Protection, Safety and Emergency Preparedness. 1983. New England/Hydro-Quebec 450 KV Direct Current Transmission Line Interconnection. Draft Environmental Impact Statement. April.

ARTICLES ON THE ASSESSMENT OF PROPERTY VALUE IMPACTS

This section includes selected background articles on methods of assessing property values and the value of property characteristics. The articles are not specific to transmission lines.

Case, Bradford and John M. Quigley. 1988. Statistical Analysis of Sales Data to Verify Appraisal Information. Working Paper No. 88-150. Berkeley: Center for Real Estate and Urban Economics, University of California, Berkeley. October.

Edelstein, Robert. 1974. "The Determinants of Value in the Philadelphia Housing Market: A Case Study of the Main Line 1967-1969," Review of Economics and Statistics, Volume 56. Pages 319-328.

Grether, D.M. and P. Mieszkowski. 1974. "Determinants of Real Estate Values." Journal of Urban Economics, Volume 1. Pages 127-146.

McClelland, Gary H., William D. Schulze, and Brian Hurd. 1990. "The Effect of Risk Beliefs on Property Values." Policy Analysis, Volume 10. Number 4. Pages 485-497.

Meese, Richard, and Nancy Wallace. 1991. Determinants of Residential Housing Prices in the Bay Area 1970-1988: Effects of Fundamental Economic Factors or Speculative Bubbles? Berkeley: School of Business Administration, University of California at Berkeley, forthcoming.

Rosen, Sherman. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." Journal of Political Economy, Volume 82. Pages 34-55.

BIBLIOGRAPHIC CITATIONS FOR ARTICLES AND STUDIES ON THE EFFECTS OF PROXIMITY TO HIGH VOLTAGE TRANSMISSION LINES ON PROPERTY VALUES

This section contains the main citations of studies of the effects of transmission lines on property values. Previous literature reviews which cited or reviewed these studies are noted, as are descriptions of the types of studies that were conducted for each citation. Studies reviewed or mentioned in this paper are marked with an asterix [*].

The following citations have been categorized into one or more of the groups shown below for the "**Type of Study**" listing for each citation:

1. Econometric - These are the most rigorous statistical studies, including hedonic multiple regression and simple linear regression models.
2. Simple Statistics - These are less rigorous studies which apply statistical methodology such as difference in means tests
3. Appraiser Type - These studies have been conducted by real estate appraisers using traditional appraisal methods such as paired sales and comparables tests. They generally do not include any degree of robust statistical control.
4. Attitudinal Surveys - Attitudinal/opinion surveys are often used in isolation or to supplement empirical property value findings. These surveys usually ask involved parties such as realtors, home buyers, and home sellers their opinions on how property values are impacted by proximity to high voltage transmission lines.

When more than one of these types of study methodologies was applied in a particular citation listed below, each type of study that was used is listed.

For a few citations, where a utility has undertaken studies that it wishes to keep confidential, the utility's name is cited but not the titles of the studies.

BIBLIOGRAPHIC CITATIONS FOR ARTICLES AND STUDIES SINCE 1976:

Arkansas Power and Light Company. 1978. Results and Conclusions from Landowner/Operator Interviews Designed to Determine Effects of Transmission Lines on Crop Production and Costs in Eastern Arkansas (Draft).

Reviewed In: Kinnard, Central Maine, p. A-47

Type of Study: Attitudinal Surveys

Ball, Thomas A. 1979. The Economic Effects of Power Lines Adjacent to Residential Properties in Phoenix and Tempe, Arizona. Phoenix. April. [*]

Reviewed In: Not cited previously

Type of Study: Appraiser Type and Attitudinal Surveys

Ball, Thomas A. 1981. A Study of the Economic Effects of High Voltage Power Lines on Suburban Residential Lots in Little Deer Valley, Maricopa County, Arizona. Tempe. March.

Reviewed In: Not cited previously

Type of Study: Appraiser Type

Ball, Thomas A. 1983. A Study of the Economic and Environmental Impact of High Voltage Transmission Lines on Mobile Home Parks. Tempe. January. [*]

Reviewed In: Not cited previously

Type of Study: Appraiser Type and Attitudinal Surveys

Ball, Thomas A. 1989. A Study of the Economic Affects of High Voltage Electrical Transmission Lines on the Market Value of Real Properties. Prepared for Salt River Project, Phoenix. Tempe. March. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type and Attitudinal Surveys
Baxter, Lyle W. 1978. A Study of the Effect of Electric Transmission Lines on Land Values.
Polson, Montana. August.

Reviewed In: Kinnard, Central Maine, p. A-20

Type of Study: Attitudinal Surveys

Beauregard Conseil Enr. 1990. Rapport Final: Suivi des Impacts de la Traversee du Fleuve par une Ligne Hydro-Electrique Entre Grondines et Lotbiniere sur les Residents de la Region Immediate. Prepared for Vice-Presidence Environnement, Hydro Quebec. [*]

Title Translation: Final Report: Past Project Assessment of the Impacts of the Hydro Line River Crossing Between Grondines and Lotbiniere on the Residents of the Immediate Region.

Source of Citation: Not cited previously

Type of Study: Attitudinal Surveys

Blanton, Herman W. 1979. A Study of the Effect of a 345 KV Highline on Real Estate Values in Grimes County, Texas.

Reviewed In: Kinnard, Central Maine, p. A-28

Type of Study: Appraiser Type

Blanton, Herman W. 1980. A Study of Transmission Line Effects on Subdivisions in Harris County, Texas. [*]

Source of Citation(s): Not cited previously

Type of Study: Appraiser Type

Blinder, Calvin L. 1981. "The Effect of High Voltage Overhead Transmission Lines on Residential Property Values", in Tillman, R. E, ed. Environmental Concerns in Rights of Way Management, Proceedings of Second Symposium Held October 16 - 18, 1979. Palo Alto: Electric Power Research Institute. [*]

Reviewed In: Butler, APA, p. 36
DiMento, BPA Draft, p. 2
Kinnard, Central Maine, pp. A-1 - A-3
Kinnard, EEIW, pp. A-1 - A-3
Priestley, Transmission Lines Bibliography, p. 1

Type of Study: Econometric and Appraiser Type (Stepwise Multiple Regression Analysis, Simple Linear Regression, Comparison of Means, Paired Sales Analysis)

Bonneville Power Administration. Brief studies of the impact of proximity to high voltage transmission lines on property values, performed after 1976, in areas served by this utility.

Source of Citation(s): Not cited previously

Type of Study: Appraiser Type and/or Attitudinal Surveys

Bonneville Power Administration. 1981. "Study of Value Loss in Residential Land".

Reviewed In: DiMento, BPA Draft, p. 2

Type of Study: Unknown, but probably Simple Statistics

Boyer, Jeanette C., Bruce Mitchell, and Shirley Fenton et al.

1978. The Socio-Economic Impacts of Electric Transmission Corridors: A Comparative Analysis. Waterloo, Ontario, Canada: Faculty of Environmental Studies, University of Waterloo. April. [*]

Reviewed In: Fridriksson, Mountain West, p. A-25
Kinnard, Central Maine, pp. A-10 - A-12
Kinnard, EEIW, pp. A-14 - A-16

Type of Study: Simple Statistics and Attitudinal Surveys

Brown, Dean J.A. 1976. "The Effect of Power Line Structures and Easements on Farm Land Values." Right of Way, December, 1975 - January, 1976. [*]

Reviewed In: Kinnard, Central Maine, pp. A-4 - A-5
Kinnard, EEIW, pp. A-4 - A-5

Type of Study: Econometric and Appraiser Type (Multiple Regression Analysis, Paired Sales Analysis, and Capitalization of Income Loss components)

Carriere, Jean, Joseph H. Chung, and Kim Anh Lam. 1976. L'impact des lignes de transport d'energie electrique sur la valeur fonciere. Laboratoire de recherche en sciences immobilieres, Universite de Quebec a Montreal. December. [*]

Title translation: The impact of electric transmission lines on property values.

Source of Citation: Not cited previously

Type of Study: Econometric

Colwell, Peter F. and Kenneth W. Foley. 1979. "Electric Transmission Lines and the Selling Price of Residential Property." The Appraisal Journal, October. [*]

Reviewed In: Butler, APA, p. 50
DiMento, BPA Draft, p. 3
Fridriksson, Mountain West, p. A-7
Kinnard, Central Maine, pp. A-6 - A-7
Kinnard, EEIW, pp. A-6 - A-9
Priestley, Transmission Lines Bibliography, p. 4
Soleco, Examen de la Litterature, p. 8

Type of Study: Econometric (Multiple Regression Analysis)

Colwell, Peter F. 1990. "Power Lines and Land Value." Journal of Real Estate Research. Volume 5, Number 1, pp. 117-127. Spring. [*]

Reviewed In: Kinnard, EEIW, pp. A-8 - A-9
(in unpublished form)

Type of Study: Econometric (Multiple Regression Analysis)

Commonwealth Edison Company. 1978. The Effect of an Electrical Transmission Line Right of Way on Adjoining Property Values. Chicago, Illinois: January.

Reviewed In: Kinnard, Central Maine, p. A-24

Type of Study: Appraiser Type and Attitudinal Surveys

Doane Agricultural Service, Inc. 1977. Doane's Power Line Study.

Reviewed In: Kinnard, Central Maine, pp. A-40 - A-41
Woods Gordon, Corridors' Effect on Rural Property Values,
Bibliography

Type of Study: Appraiser Type and Attitudinal Surveys

Earley, Edward M., and Michael H. Earley. 1988. "Real Estate Market Data Analysis." (For a proposed 230 K.V. Electrical Transmission Line, Transylvania County, North Carolina; prepared for Duke Power Company). Golden, Colorado.

Reviewed In: Not cited previously

Type of Study: Appraiser Type and Simple Statistics

Economics Consultants Northwest. 1990. Garrison-Taft High Voltage Transmission Line Social Monitoring Study. Report Submitted to the Facility Siting Bureau of the Energy Division of the Montana Department of Natural Resources and Conservation and the Bonneville Power Administration. [*]

Source of Citation: Not cited previously

Type of Study: Attitudinal Surveys

Everhart, Marion E. 1977. A Land Economic Study of Transmission Lines and Land Values: Mead-Liberty 345 kV, Maricopa County, Arizona. Scottsdale, Ariz.: M.E. Everhart, MAI.

Reviewed In: Fridriksson, Mountain West, p. A-8
Kinnard, Central Maine, p. A-29

Type of Study: Simple Statistics

Everhart, Marion. 1979. A Land Economic Study of Transmission Lines and Land Values: Prescott-Mesa 230 KV, Maricopa County, Arizona.

Reviewed In: Fridriksson, Mountain West, p. A-9
Kinnard, Central Maine, p. A-30

Type of Study: Appraiser Type

Everhart, Marion E., and Everhart, L. David. 1977. A Land Economic Study of Transmission Lines and Commercial Land Values; Pinnacle Peak-Scottsdale, 69 kV - 120 kV: Scottsdale, Arizona. Scottsdale, Ariz.: M. E. Everhart, MAI.

Source of Citation: Fridriksson, Mountain West, p. B-4
Kinnard, Central Maine, p. B-2

Type of Study: Unknown, but probably Simple Statistics

Hawley, H. R. 1981. The Economic Impact of Electric Transmission Corridors on Rural Property Values. Technical Paper; Canadian Electrical Association, Engineering and Operating Division.

Source of Citation: Soleco, Examen de la Litterature, p. 34

Type of Study: Unknown

Jensen, G.A. & Weber, W.V. 1981. "The Effect of High Voltage Transmission Lines on Agricultural Land Values in Minnesota." Right of Way. Vol. 28, no. 2, pp. 23 - 26. April.

Reviewed In: Butler, APA, p. 34
Kinnard, Central Maine, p. A-34

Type of Study: Appraiser Type

Jensen, Glenn A. and William V. Weber. 1982. High Voltage Transmission Lines and their Effect on Farm Land Value in West Central Minnesota. Luverne, Minnesota: Jensen Management Service, Inc. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Jensen, Glenn A. and William V. Weber. 1979. Study of Farms and Sale of Farms Having High Voltage Powerline Crossings Located in Municipalities of Roster, Woodlands, Rockwood, Manitoba Province, Canada. Luverne, Minnesota: Jensen Management Service, Inc. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Jensen Management Service, Inc. 1980. A Study of the Effect of High Voltage Powerlines on Living and Working Conditions. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Kinnard, William N. Jr., John K. Geckler, Jeffrey B. Kinnard, and Phillip S. Mitchell. 1988. 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, (An Analysis of Real Estate Market Activity in Penobscot County, Maine). Storrs, Connecticut: Real Estate Counseling group of Connecticut. December. [*]

Reviewed In: Kinnard, EEIW, pp. A-17 - A-19

Type of Study: Econometric and Simple Statistics (Hedonic Price Model, Comparisons of Average, Paired Sales, Sale-Resale, Signs Test) and Attitudinal Surveys

Kinnard, William N. Jr., M.B. Geckler, J.K. Geckler, J.B.

Kinnard, and P.S. Mitchell. 1984. An Analysis of the Impact of High Voltage Electric Transmission Lines on Residential Property Values in Orange County, New York. Storrs, Connecticut: Real Estate Counseling Group of Connecticut. May. [*]

Reviewed In: Kinnard, Central Maine, pp. A-8 - A-9
Kinnard, EEIW, pp. A-10 - A-11

Type of Study: Econometric and Simple Statistics (Hedonic Pricing Model, Simple Linear Regression, Paired Sales Analysis, Comparison of Means, and Signs Test), and Attitudinal Surveys

Kinnard, William N. Jr., and Philip S. Mitchell. 1988. Effects of Proximity to Marcy South Transmission Line Right of Way on Vacant Land Sales: Towns of Hamptonburgh and Wawayanda, Orange County, New York, January 1983 - December 1987. Storrs, Connecticut: Real Estate Counseling Group of Connecticut. May. [*]

(Published as an article in Kinnard, Mitchell and Webb 1989, below, and also in Journal of Property Tax Management, July 1990).

Reviewed In: Kinnard, Central Maine, pp. A-13 - A-14
Kinnard, EEIW, pp. A-17 - A-18

Type of Study: Econometric (Stepwise Multiple Regression using model with the best combination of Adjusted R², F-Value, and t-values)

Kinnard, William N., Jr., and Philip S. Mitchell and James R.

Webb. 1989. "The Impact of High-Voltage Overhead Transmission Lines on the Value of Real Property." Paper Presented at the American Real Estate Society Annual Conference, Arlington, Virginia, April. [*]

Reviewed In: Kinnard, EEIW, p. A-19

Type of Study: Econometric (Multiple Regression Analysis)

Lamprey, Stewart. 1985. Economic Impact of Transmission Lines on Property Values in the State of New Hampshire. Vol. 2.

Reviewed In: Kinnard, Central Maine, p. A-21

Type of Study: Appraiser Type

Market Trends, Inc. 1988. Arizona Utility Aesthetics Summary Report. June.

[*]

Reviewed In: Not cited previously

Type of Study: Attitudinal Surveys

Minnesota Power. 1983. Affected Landowner Interviews. Duluth, Minnesota: February.

Reviewed In: Kinnard, Central Maine, p. A-25

Type of Study: Attitudinal Surveys

Mitchell, Bruce, George B. Priddle, and Jeannette Boyer, et. al. 1976. The Long-Term Socio-Economic Impact of an Electrical Power Transmission Corridor on the Rural Environment: Perception and Reality. Waterloo, Ontario: University of Waterloo. [*]

Reviewed In: Butler, APA, pp. 37 - 38
Kinnard, Central Maine, p. 35

Type of Study: Simple Statistics and Attitudinal Surveys

New Jersey. 1990. Study of a transmission line addition to a railroad right-of-way. [*]

Reviewed In: Not cited previously

Type of Study: Appraiser Type

Oetzel, Terrell R. 1977. Study of 765 KV Overhead Transmission Line - Berrien County, Michigan.

Source of Citation: Kinnard, Central Maine, p. B-4

Woods Gordon, Corridors' Effect on Rural Property Values,
Bibliography

Type of Study: Appraiser Type

Ontario Hydro. 1977. The Effects of Hydro Transmission Towers on Farm Operations in Western and Eastern Ontario.

Source of Citation: EPRI Proceedings of Second Symposium, 1979: In Bibliography of Henderson article

Type of Study: Unknown

Ontario Hydro, Environmental Resources Section, and the Ontario Ministry of Agriculture and Food, Horticultural Research Institute. 1977. Economic Effects of Hydro Transmission Towers on Orchard and Vineyard Operations in the Niagra Peninsula.

Source of Citation: Fridriksson, Mountain West, p. B-8
Kinnard, Central Maine, p. B-5

Type of Study: Qualitative Analysis

Oregon. 1983. Study of a 500 KV line in an agricultural area. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Pacific Consulting Services. 1991. A Statistical Analysis of Transmission Line Impacts on Residential Property Values in Six Neighborhoods. Prepared for Southern California Edison, Environmental Affairs. Albany, California. [*]

Source of Citation: Not cited previously

Type of Study: Econometric (Multiple Regression Analysis)

Priestley, Thomas and Gary Evans. 1990. Perceptions of

Transmission Lines in Residential Neighborhoods: Results of a Case Study in Vallejo, California. Study prepared for the Southern California Edison Company. [*]

Source of Citation: Not cited previously

Type of Study: Attitudinal Surveys

Rasmussen, Darrell. 1976. Transmission Line Survey - Five County Area - September 1976. Minot, North Dakota: Appraisal Consultants. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Rhodeside & Harwell, Incorporated. 1988. Perceptions of Power Lines: Residents' Attitudes. Prepared for Virginia Power. [*]

Source of Citation: Not cited previously

Type of Study: Attitudinal Surveys

Sewell, E. Larry. 1989. 230 KV Transmission Lines Real Estate Impact on Marketability Study. Sarasota, Florida: Sewell, Valentich, Tillis, & Thatcher Appraisers.

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Stewart, Young & Mason, Ltd. 1977. Transmission Line Studies, Bruce and Huron Counties. Ontario Hydro.

Reviewed In: Kinnard, Central Maine, p. A-37
Woods Gordon, Corridors' Effect on Rural Property Values,
Bibliography

Type of Study: Appraiser Type and Attitudinal Surveys

Thompson, M. Brent. 1985. Bonneville Power Administration

Market Data Study of Impact on Market Value of Properties Located in the Vicinity of an Existing 230 KV Transmission Line in Missoula County, Montana. [*]

Source of Citation: Not cited previously

Type of Study: Appraiser Type

Thompson, R. R. 1982. The Impact of High Voltage Electric Transmission Lines on Agricultural Land Valuation in Alberta. Master of Science Thesis, Department of Rural Economy, University of Alberta. [*]

Source of Citation: Soleco, Examen de la Litterature, p. 36

Type of Study: Econometric and Attitudinal Surveys

Thompson, R. R. et W. E. Phillips. 1983. "Agricultural Land Value Changes from Electric Transmission Lines: Implications for Compensation". Journal of American Society of Farm Managers and Rural Appraisers, vol. 47, no. 2. October. pp. 33 - 36.

Reviewed In: Soleco, Examen de la Litterature, p. 13

Type of Study: Appraiser Type

Thompson, Robert R. and William E. Phillips. 1985. "Agricultural Land Value Changes from Electric Transmission Lines: Implications of Compensation". Right of Way. December.

Reviewed In: Kinnard, Central Maine, p. A-38

Type of Study: Appraiser Type

Universite du Quebec a Montreal. 1982. Impact de l'implantation des lignes de transport d'energie hydro-electrique sur les va leurs foncieres des sites de Villegiature. Project Hydro-Quebec HA-596-507. Juin. [*]

Title translation: Impact of the location of hydro lines on second home property values.

Source of Citation: Not cited previously

Type of Study: Econometric

**Van Court and Company. 1988. Real Estate Appraisals:
Greenwood-Daniels Park 115/230 KV Conversion--Arapahoe County, Colorado. [*]**

Source of Citation: Not cited previously

Type of Study: Econometric

**Vredenburg, M. Andres. 1980. 765 KV Electrical Transmission
Line Economic Impact Study in the Counties of Franklin and St. Lawrence, State of New
York. Chenago Forks, New York.**

Reviewed In: Kinnard, Central Maine, p. A-44

Type of Study: Appraiser Type

**Weber, William V. and Glenn A. Jensen. 1978. A Study of High
Voltage Power Line Easements and their Effect on Farm Land Values in West Central
Minnesota. Luverne, Minnesota: Jensen Mangement Service. [*]**

Source of Citation: Not cited previously

Type of Study: Appraiser Type

**Woods Gordon (Management Consultants). 1981. Study on the
Economic Impact of Electric Transmission Corridors on Rural Property Values: Final
Report. [*]**

Reviewed In: Kinnard, Central Maine, pp. A-15 - A-16
Kinnard, EEIW, pp. A-20 - A-21
Soleco, Examen de la Litterature, pp. 9 - 11

Type of Study: Econometric (Multiple Regression Analysis) and Appraiser Type