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## Impact of Highway Improvements on Property Values in Washington State

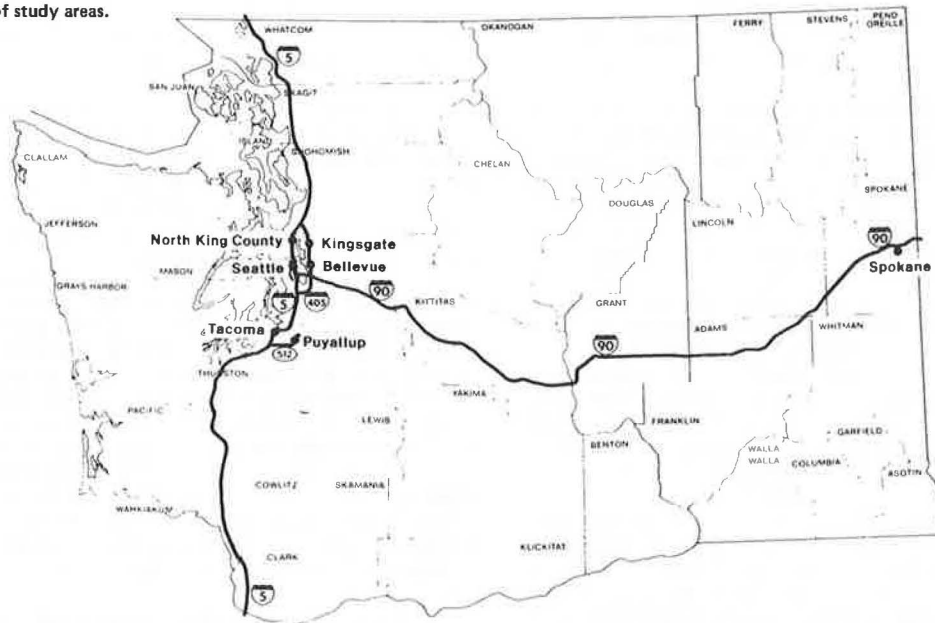
RAYMOND B. PALMQUIST

The purpose of the study is to examine the effects of major highways on the value of surrounding properties. The study applied several tested theoretical techniques to a data base derived from 9359 sales records and interviews with owners of homes and businesses. In each of five study areas, hedonic pricing techniques, with all variables kept constant except those under examination, produced a quality-adjusted price index. This index for the years during which a highway was opened was then compared with an index for a comparable area not affected by highway change. Owners' perceptions concerning highway impacts, gained from 383 interviews, were also analyzed. Improved access to residential areas provided by highway construction resulted in property appreciation 15-17 percent greater than comparable properties that lacked such access advantage. Even where highest noise level readings occurred, accessibility-induced property appreciation more than offset noise-induced depreciation. Highway noise had little effect on commercial, industrial, or residential properties greater than 600 ft from the highway. Extensive care ensured accuracy and data reliability. For example, each property sale was investigated to exclude any invalid transactions or sales where extensive improvements

might influence appreciation. Validity to the 95 percent confidence level was the norm for hedonic regressions and related statistical computations. The results provide an accurate, reliable method for predicting the potential access benefits and noise costs in terms of relative changes in property value. This evidence will provide facts for detailed discussion during project planning.

The purpose of this study is to measure the effects of limited-access highways on property values. Transportation improvements of all kinds are being evaluated more carefully than ever during the planning stages. This attention to detail is well justified because the implications of such projects transcend the engineering disciplines and have environmental, social, and economic effects of major importance. In the economic area, one of the im-

Figure 1. Location of study areas.



pacts that is of great concern to the public is the effect of a highway on property values. This important issue arises in the preparation of the environmental impact statement and in the public discussions characteristic of our open planning process. Comparisons of beneficial and adverse effects require their quantification in terms of effects on property values. A major objective of this study is to isolate the factors of improved accessibility and of highway-generated noise from the myriad of factors that influence property values. Several theoretical developments allow refinement of previous studies and validation of their results. Reference is made to the studies by Anderson and Wise (1), Boyce and others (2), Gamble and others (3), Langley (4,5), Nelson (6), and Vaughn and Huckins (7). The research was designed to apply new theoretical techniques yet overcome difficulties noted in previous investigations.

#### OVERVIEW

This study analyzed the effects of a highway on the values of surrounding properties. Analysis of more than 9350 property sales provided real estate price trends in areas where a highway was constructed. These trends were then compared with those in similar areas that did not experience highway changes. A total of 383 in-depth interviews were conducted with residents of residential areas and business operators in a commercial and industrial study area (see Figure 1).

Where improvement in the accessibility of an area was substantial, property values appreciated significantly more rapidly. In Kingsgate, Interstate 405 resulted in a 12 percent appreciation; in the north King County study the appreciation that resulted from I-5 was 15 percent. In both areas, most residents used the highways for commuting to work and realized significant time savings. On the other hand, in Puyallup, few of the residents used WA-512 for commuting, so there was little or no effect of highway benefits on property values.

Unfortunately, some of the houses closest to the highways also suffer some negative effects because of adverse environmental influences. Highway noise levels caused a partly offsetting decrease in property values for those houses closest to the high-

way. This effect increased as the noise level increased above that in the surrounding neighborhood. The magnitude of this effect ranged from 0 to 7.2 percent in the areas studied, depending on the noise level and the character of the neighborhood involved. As incomes increase, people are willing to pay more for quiet surroundings and thus noise damages increase.

The net effect of these adverse and beneficial influences was positive for the areas where both effects could be quantified. This means that all houses in the areas appreciated because of the highway, but those closest to the highway did not appreciate to the same degree. A related study was done on the length of time involved in selling properties next to the highway and those further removed. There was no statistically significant difference in the amount of time houses were on the market prior to sale in the two locations.

In a study of commercial and industrial property, values were found to have appreciated almost 17 percent more than in a control area that was not influenced by highway change. Interviews in this area showed that the managers of the firms in the area were, for the most part, well aware of the benefits provided by the highway. The owners of land in the area tended to underestimate the appreciation in property values due to the highway.

Interviews were also carried out in residential areas. In general, residents' perceptions of both the benefits and adverse effects of the highway were fairly accurate. However, those people who live closest to the highway were not as aware of beneficial effects of the highway, and these people also estimated that the negative effect of noise on property values was almost twice as large as it actually was.

#### METHODOLOGY

Two courses of action are available to determine any beneficial access effects from a highway. It is possible to carry out a cross-sectional study of residences in significantly different locations and relate the various property values to some measure of the accessibility of the location. The alternative is to examine time-series data of property values in a particular area for a number of years, be-

fore and after a highway is opened, and compare the trends with those in an area that is relatively unaffected by changes in the highway system during the same period.

The former method requires a measure of accessibility such as the percentage of employment within a given travel time to the central business district (CBD) as postulated by many urban models. This is a reasonable measure of accessibility only where all employment is in the CBD. For more realistic urban areas, it is necessary to use more complex measurements of accessibility that take into account the attractiveness between various zones as well as the travel costs between these zones. Because of the large area that must be included in studies of this type, expense may rule out studies of individual houses and force studies of census tracts. Finally, the necessary measurements of accessibility are generally only available at wide intervals, and this makes prediction of the accessibility effects of a particular highway improvement difficult.

The alternative method, which was selected for this study, examines the time pattern of property values based on hedonic pricing. This technique evaluates quality changes in products by separating a commodity into its various characteristics and studying the contribution of each characteristic to the object's value. Dummy variables, variables that take a value of one in a particular year and zero otherwise, are the key to developing hedonic regressions that span several years. The use of data on individual houses makes possible the simultaneous consideration of localized adverse highway effects such as noise or air pollution. Not only just the final effect on property values is observed but also the pattern of change before the values again stabilize. Finally, this method examines property values in the period before the highway is opened. This allows the researcher to check the specification of the model before the major change of the highway was introduced and to see if anticipation of the highway's opening caused property value to increase.

There are numerous different causes of property value changes when a highway is constructed. These various effects can work in opposite directions and can occur over different areas and times. In this study the beneficial effects are measured by examining the trends in property value in the affected area over a 10-year period starting considerably before the highway's opening. These trends are then compared with a general residential real estate index for comparable property, or an index in a control area, to discover any differences. The trends within the study area are first established by using multiple regressions to separate the value of a house into the value of the various components of that house. Once this is done, it is possible to establish the price trends when all the characteristics of a house are kept constant. Thus, price is a function of these characteristics, and multiple-regression techniques are used to find the effect that changing one feature has on price when all other aspects of the property are held constant.

The accuracy of the price measurements developed by this method depends on the accuracy of the specification of the regression equation that establishes the component prices. The specification used in this study avoids several problems that have hampered some recent studies. Nonetheless, it was desirable to check the specification of the regression equation by comparing the measurements generated with those created by a different method. Such an alternative method was provided by examining repeat sales on the same houses. By this means the various characteristics other than depreciation were con-

stant, and the pure price changes could be measured. The results of the analysis of repeat sales were then compared with the prior measurements to ensure their reliability for the study area. Both of these were then compared with a control real estate price index to see if the highway had influenced the values of nearby homes. An improvement in accessibility due to the new highway was reflected in an increase in property values. A substantial increase in accessibility for the area raised property values by 12-15 percent.

A less desirable effect on property values is created by adverse highway influences that may affect certain houses. Noise is the most important of such adverse effects. Noise monitoring was done throughout the study areas. By using these data, hedonic regressions revealed that property values were hurt by noise. An alternative means of estimating property value damages without noise measurement is carried out by using more easily collected data on distance and elevation with respect to the highway and vegetative cover. Negative effects on property values must be compared with the positive effects of improved accessibility to discover the net effect.

A number of criteria were used to select the residential study areas. Areas that have a large number of houses in close proximity to a limited-access highway were considered essential for this study to enable assessment of any negative environmental effects. Also, it was desired that the houses be distributed so that they extended back from the highways about 1 mile. By using such areas, some houses are adjacent to the highway and others are sufficiently removed that they experience no negative effects but do enjoy the benefits of accessibility. To increase the reliability of the regressions, the houses should be single-family dwellings and relatively homogeneous. The houses should not be influenced by nonhighway negative environmental effects. The highways should have been opened fairly recently but should have been open long enough to allow property values to reach equilibrium. The study area should lie within a single political jurisdiction to avoid possible fiscal differences that may affect property values.

#### Kingsgate Study Area

The first study area selected, Kingsgate in King County, is located on the east side of Lake Washington across from Seattle, just north of the communities of Kirkland and Redmond and just south of Bothell. It is traversed by I-405, which was opened to traffic in this area toward the end of 1970. The direct distance of the houses from the nearest lane of traffic on I-405 ranges from a minimum of less than 100 ft to a maximum of 5900 ft. There is an interchange at the north boundary of the study area and another just south of the south study area boundary. The minimum street distance of a house from the nearest interchange is 2000 ft and the maximum distance is 11 000 ft. The gently rolling terrain varies a little more than 200 ft in elevation but with no undevelopable steep slopes. Some of the houses are completely exposed to the highway, and others are screened by trees. The area is predominantly occupied by single-family dwellings in the middle to upper-middle price range. The oldest houses in the platted areas studied were built in 1962. The major building expansion was begun in 1965. The Kingsgate data were collected from the following sources: (a) excise tax records, (b) assessor's records, (c) direct measurement, and (d) published indexes.

### Excise Tax Records

In King County there is an excellent source of information on sales prices and dates since the 1-percent excise tax on real estate transactions is cross-indexed by location. Crucial information on prices and dates of sales was obtained from the excise tax affidavits that indicate the seller's payment of the 1-percent excise tax on all real estate transactions in Washington. This excise tax was established in 1951, so the affidavits were available for all relevant sales. The affidavits record not only the price and date of the sale but also the type of deed involved and the parties to the sale. This information assisted in restricting the sales obtained to those that were representative of the value of the property. This was done by eliminating all sales where the conveyance was neither a warranty deed nor a real estate contract. Sales between parties with the same last name were also eliminated. All valid sales between 1962 and July 1976 were obtained. This provided a data base of 4785 sales for the analysis that follows. The mean price in 1967 dollars was \$23 012 with a range from \$11 064 to \$33 728.

### Assessor's Records

Data collection centered around the real property records of the county assessor's office. For each piece of property, county assessor's records contain an extensive description of the lot and house. As explained earlier, a priori expectation dictate many of the variables to be collected here. These include the areas on the various floors, the year built, and the number of bathrooms. For others of the variables shown, the question was whether or not they were relevant in this particular area. Empirical evidence was used to make this decision. The qualitative variables were made amenable to the regression analysis by transformation into dummy variables. In addition, the assessor's records contain information on the sales that had taken place on each particular piece of property. The remaining data were collected directly through the use of assessor's maps and visits to the site.

### Direct Measurement

Various attributes determined from the assessor's maps included the following:

1. The distance to the highway measured from the center of the lot to the nearest lane of traffic,
2. Interchange and other important distances,
3. Elevation with respect to the highway,
4. The presence of trees between the house and the highway, and
5. Whether or not the house was in a plat that provided swimming pools and recreation facilities in return for mandatory dues.

Thirty noise-monitoring stations were selected to provide a representative sampling for the area. Readings were taken at various distances from the highway, at different elevations with respect to the highway, and with varying vegetation covers. At least three readings were taken at each station during peak traffic hours. The mean of these readings was then recorded on assessor's maps and used to construct contour lines to represent equal noise levels. This allowed the determination of the noise level within 2.5 dB(A) at the center of each of the lots.

### Published Indexes

The final group of variables represent temporal ef-

fects on prices. The consumer price index is derived by the U.S. Bureau of Labor Statistics to represent the trend in prices of all consumption goods for urban wage earners and clerical workers. The other price indexes are published by the Seattle Real Estate Research Committee (SRERC) and represent real estate price trends within the Seattle-Everett standard metropolitan statistical area, defined by the U.S. Bureau of the Census, and also within the more limited area on the east side of Lake Washington. Finally, the date of the opening of the Totem Lake Shopping Center was included because many residents expressed the belief that this factor had influenced their property values.

The data on prices, sales dates, and property characteristics were used to develop real estate price indexes for the study areas to measure access benefits. To assess the impact of the highway on property values, it was necessary to know the general trend in real estate prices during these years. Within King County SRERC computes price indexes for single-family residential properties in various areas. The SRERC index for properties on the eastside of Lake Washington was most comparable for the Kingsgate area--approximately the same distance from Seattle and the same age.

### Data Analysis

The primary method of analysis used on the collected data involved regressions. This technique required selection of the variables that make a significant contribution to explaining the observed market prices. Variables such as the various floor areas and the age of the houses were selected on theoretical grounds. The empirical work later substantiated these choices. For other variables the choice was made empirically. Where the coefficient of the variable was not significantly different from zero, it was not included.

After the opening of I-405, the properties affected by the freeway appreciated in value at a considerably faster pace than did the average of other properties on the eastside of Lake Washington. Between the opening of the highway and 1975 the houses in the study area appreciated by an average of 12 percent more than did houses elsewhere on the eastside. (Tests show this to be best expressed as a percentage of the house value rather than an absolute amount that applies to all houses.) The full effect of the highway did not seem to take place immediately, but property values increased over several years. Also, increases in property value do not seem to anticipate the opening of the highway.

### North King County Study Area

The second study area bordered I-5 north of Seattle. This relatively homogeneous lower-middle class neighborhood contains homes that are an average of 25 years old. I-5, which in this section has six through lanes with two more lanes in connection with exits or entrances, was opened in late 1965. Thus, most of the houses were built before the highway location was announced.

Although there is some undeveloped land in the area, the study was restricted to platted land with single-family residences. Highway access is provided at either end of the study area and at a midpoint NE 175 Street. As in Kingsgate, the terrain is gently rolling with less than 200 ft of elevation difference.

All valid sales beginning in 1958 and continuing through 1976 were collected. These yielded a data base of 2823 observations. Similar techniques were used to measure property value trends for this study

area. SRERC has an index that represents real estate trends in north Seattle, north King County, and southern Snohomish County. This control index represents the general location and type of homes in the study area.

After the highway opened, homes near the highway appreciated considerably more rapidly than did those represented by the control index. Resale values dipped between 1969 and 1973. This aberration is easily accounted for because these are the years of the Boeing Company reductions in employment. Many Boeing Company workers choose to live in Kingsgate and in the north King County area because these locations are central between Everett and Renton, where the company has plants.

Such houses command a premium because of the accessibility that the highway affords. When Boeing cut its employment by well over half and there were substantial secondary employment cuts, many of the residents of such areas were forced to sell, and the premium for accessibility was reduced. After the slump the differential was reestablished. The differential, with the exception of the years of the downturn, appears to have been about a 15 percent appreciation because of the accessibility benefits. This appreciation does not appear to have taken place on the announcement of the highway but rather on the opening of the highway. The improvement in accessibility in this area was comparable to that in the Kingsgate area. The same destinations to the north and south are available, and similar time savings are allowed by the highway. It is encouraging that the results in the two areas are quite close.

#### Spokane Study Area

Another study area was selected along I-90 through Spokane. Here a major urban freeway passes through an area of older houses that were built long before the highway was opened. The average age of the houses is 50 years, but the highway was only opened in early 1959 to carry the traffic that had previously used Sprague Avenue. This was only one of a number of changes that may have affected property values in this area over the years. Nonetheless, this area of lower-class homes provided an increased range of socioeconomic neighborhoods being studied. A total of 745 observations were available for the study of negative proximity effects. The absence of a control index prevented analysis of access benefits for the Spokane area.

#### Puyallup Study Area

The final residential study area to be discussed is located in the southeast corner of Puyallup, where WA-512 has recently been built. Much of this area is still relatively undeveloped, with farm land or small residential acreages scattered among the more densely developed residential areas. The northwest part of the study area is older and more uniformly developed than the rest of the study area. WA-512 is a limited-access four-lane highway that was opened in December 1973. One of the main reasons for the study was to examine whether or not the houses located to the southeast of the highway appreciated more slowly because they had been isolated from the main part of the city. This was a concern that was frequently expressed prior to the construction of the highway.

Data were collected for sales that took place between 1965 and 1976. This provided a data base of 838 sales. In the Puyallup study area the property value trends derived were compared with a countywide index based on mean sales prices and with the trends in a control area in Puyallup. Both techniques in-

dicated that, although study area properties may have appreciated slightly more rapidly than the control indexes, there was no statistically significant difference. This coincides with the interview data where few of the residents indicated that they used WA-512 to commute to work. Because the time savings for residents would thus be small, it is not surprising that the property value effects were not large.

#### Access Benefits

The results from these study areas seem to indicate that improvements in accessibility and time-savings can be reflected in residential property values. However, the magnitude of this effect depends on the magnitude of the improvement in accessibility, especially with respect to work trips. Where the improvement was substantial, such as when I-405 or I-5 were opened, property values increased by 12 percent or more. But when few of the residents saved time in their commuting trips, as with WA-512, property values appreciate little, if at all, because of the highway. In making forecasts of the effect of a change in the highway system, the accessibility improvement must be estimated. The forecast could then be estimated as equal to that in the study area with a comparable improvement or as an interpolation of the results in two study areas if the improvement lies between that in the two study areas.

#### Noise Damages

In addition to the access benefits described above, the residential studies also allowed estimation of any negative proximity effects. The measured noise levels were used to assign a noise reading to each house as described above. The effect of this noise on property values was then isolated from the effects of other differences in properties. There was sufficient noise data to obtain this estimate for Kingsgate, North King County, and Spokane. In Kingsgate the 12-percent appreciation due to accessibility improvement more than offsets the 7.2-percent reduction due to noise at the noisiest houses.

Tests indicated that in each of the study areas the effect of noise was best expressed as a percentage of the value of the home rather than a fixed, absolute amount. In addition, tests were performed to examine whether or not a given increase in noise had the same effect at different noise levels. The A-weighted decibel scale was designed to approximate human perception of noise, but it is possible that it might not approximate the level of annoyance caused by that noise. Alternative forms for the noise variable were tried, but the linear form proved superior in all three study areas.

It might be expected that wealthier individuals would be willing to pay more for quiet in their residences. The studies confirm this, because not only are the damages a percentage of the value of the house, but also the magnitudes of the percentages increase with increasing income (see table below). The result of this study could be used to forecast the effect in an area where a new highway was proposed.

<u>Study Area</u>	<u>Avg Reduction for Each 2.5 dB(A) Increase in Noise Above Ambient (%)</u>	<u>Highest Noise Reading [dB(A)]</u>	<u>Avg Reduction from Highest Reading (%)</u>
Kingsgate	1.20	70	7.2
North King County	0.75	75	6.0
Spokane	0.20	80	2.0

Several other factors were tested for possible relations to distance from the highway, including the following:

1. Length of time on the market,
2. Sales terms, and
3. Greater than average decline in sales price during downturns in the real estate cycle.

Careful analysis of data obtained from multiple listing records provided no evidence of any effects of the highway on adjoining properties taking the form of changes in price or of longer periods on the market.

#### Commercial and Industrial Study Area

The effects of a highway on property values in a commercial or industrial area were also studied. It was much more difficult to find acceptable study areas for several reasons. First, commercial and industrial establishments generally have such definite transportation requirements that it is almost impossible to find such areas where access is not good. This makes it difficult to find a study area that predated the construction of a highway.

It is also necessary to control for the difference in the structures on the land to isolate the highway effects. Specification of the regression equation is considerably more difficult than in the residential case. The data on characteristics are difficult to obtain due to considerations of confidentiality. The selected alternative was to find an area where there was a mixture of commercial and industrial establishments and vacant land. This portion of the study could then examine trends in undeveloped land prices without considering structural characteristics. Interviews with established firms obtained the owners' perceptions of the effect of the highway. However, selection of study area sites remained difficult because this mixture of vacant and developed land is uncommon in commercial and industrial areas. A final problem is the lack of commercial and industrial real estate price indexes to serve as a control. For this reason, an actual control area was necessary. Unfortunately, to be useful a similar mixture of undeveloped and developed land was required. Also, the control area had to be similar to the study area in location and character.

The study area that seemed to meet these restrictive conditions best was in Bellevue, east of I-405. This section of I-405 was opened in June 1972, but commercial and industrial establishments were already in the study area at this time. The study area contains a business park, numerous automobile dealers, and other extensive commercial development. Safeway and Coca-Cola are the two largest establishments in the area in terms of both area and dollar volume. Most of the manufacturing businesses are located in the northern part of the study area. Much of the northwest portion of the study area is served by several railroad sidings to the Burlington Northern line. A substantial amount of vacant land remains throughout the area.

The control area selected was further south along I-90. This Interstate highway provides transportation access to the area, but there were no major changes in the highway during the period studied. The control area is similar in character, with small shopping centers, light industry, and vacant land.

Due to the restrictions of confidentiality on assessor's records, data on the prices and dates of property sales were collected from the monthly publications of Monitor Real Estate Corporation of Seattle. Monitor records all sales in King County

for which the legally required excise tax is paid. Sales are classified by type of zoning and vacant or nonvacant land. All sales of vacant land within the study and control areas between 1965 and 1977, inclusive, were collected. This provided 268 observations. Zoning information was obtained from the Bellevue Planning Department, and land areas and access information were obtained from assessor's maps. A majority of the land was zoned for either manufacturing or for retail and wholesale use, although three other general classifications accounted for approximately 20 percent of the sales. There was a wide range of land areas from about 20 000 ft<sup>2</sup> to more than 650 000 ft<sup>2</sup>.

After controlling for parcel size, zoning, railroad and street access, and the year of the sale, the properties in the study area were shown to have appreciated significantly more than those in the control area after the highway was opened. In fact, the differential was 16.7 percent. The improved access for incoming goods and customers for the commercial establishments and incoming and outgoing goods for manufacturers and warehousing provides the motivation for the firms' location here. This results in the appreciation of property values. Noise did not appear to have any adverse effects on these properties. As before, in using these results for forecasting the effects of a new highway on property values, one must consider the degree of accessibility improvement that is anticipated.

#### Surveys

Another phase of the study involved personal interviews with the residents to discover their perceptions of the beneficial and adverse effects of having a major highway located nearby. Perceived effects were then compared with those revealed by the real estate market.

These interviews were conducted in person by a team of interviewers. This method was selected to obtain the desired high return rate and to ensure hearing the opinions of those residents who were disgruntled with the highway. It was desirable to have any residents present who commute to work and, where possible, to have both husband and wife present. For these reasons, a majority of the interviews were conducted on weekends and at night. Attempts were made to interview at least one adult in every house that abutted the highway and in a sample of houses more removed from the highway.

The first set of interviews was done in the Kingsgate area, where 240 interviews were conducted, 114 at abutting properties. The major portion of the interviews concerned potential beneficial and adverse effects of the highway on the residence. The first questions of this part referred to the awareness of highway benefits. The distribution of responses to the general question, "Are there benefits to you from having a highway nearby?" was quite revealing. In the impact area within 600 ft of the highway the interviewers explained that this question referred to benefits from having the highway in the area and not necessarily from having it within 600 ft. In spite of this clarification, impact zone residents reported benefits less frequently than did those who lived in the study zone more than 600 ft from the highway. In the impact zone, 82.5 percent thought there were benefits, which seems to be a substantial proportion until it is compared with the study zone, where 99.2 percent mentioned benefits. Since the locations of work and distance to highway access did not differ substantially between the areas, it appears that the same benefits were present for the two groups. Yet, the adverse effects in the impact zone were preventing approximately one-

Table 1. Residents' overall rating of freeway based on living conditions.

Rating	Study Zone (n=126)		Impact Zone (n=114)		Total Sample (n=240)	
	No.	Percent	No.	Percent	No.	Percent
Very good	62	49.2	11	9.6	73	30.4
Good	52	41.3	47	41.2	99	41.3
Neutral	11	8.7	33	28.9	44	18.3
Bad	1	0.8	21	18.4	22	9.2
Very bad	0	0.0	2	1.8	2	0.8
Percentage of sample		53		47		100

fifth of those interviewed from being aware of such benefits.

The next questions in the interview concerned perceived adverse effects. The questioning was divided into two parts. First, people were asked which adverse effects, if any, they noticed, and then they ranked the importance of these effects. For this part of the interview no suggestions of possible effects were made by the interviewers. Second, the respondents were asked to evaluate the importance of effects suggested by the interviewer. Questioning here concerned the effects both inside and outside the dwelling.

Noise was the one adverse effect mentioned extensively. Within the impact zone, approximately three-fourths of those interviewed cited noise as the most-important adverse effect. Those further removed from the highway in the study area still mentioned noise in one-fourth of the cases. Air pollution was the other problem mentioned with the next greatest frequency, but noise was mentioned almost 10 times as often.

The questions to this point only revealed which effects were mentioned and not the relative severity of the problems. The next part of the interviews sought relative evaluations of the different effects. The first point about these responses is that the highway seems to have few adverse effects for those residents more than 600 ft from the highway, which agrees with the noise-monitoring results reported earlier. Only one respondent found any of the effects annoying inside the home. Less than 16 percent even notice the noise, and they did not find it annoying. Outside the home the results were comparable except for noise where about 5 percent now found the noise annoying. Thus, the measure of the adverse effects used earlier in this study appears to coincide fairly well with the responses.

The responses in the impact zone were perhaps surprising in that many people did not find the effects annoying. Inside the houses only about 5 percent of the residents found effects other than noise to be annoying or objectionable. Within the house, 16.7 percent found the noise annoying and 3.5 percent found it objectionable. Most respondents found the effects other than noise "not noticeable" and noise "noticeable but not annoying". Outside the home the effects were more important. The noise was annoying or objectionable to 35.1 percent of those interviewed, and 7 percent felt that way about air pollution. The other effects were perceived to be the same as those indoors.

The interviews then had the residents evaluate the beneficial and adverse effects together to find an overall rating of the highway's effect on their living conditions. For the entire sample the median and the mean of the responses were in the category good. In the study area the most common response was very good; however, the mean was half way between very good and good. In the impact area the most common response was good, but the mean was be-

tween good and neutral. There is a statistically significant correlation between measured noise level and overall highway rating, so noise is an important factor in people's evaluation of the highway. It is of special interest that those people who bought their houses without knowing of the highway plans rate the highway significantly worse (bad was the most frequent answer) than did those people in the impact zone who bought their houses knowing of the plans (see Table 1).

The part of the interviews that related most closely to the main body of this research concerned the perceived effects of the highway on property values. In the study zone, 46.8 percent thought that the highway had increased their property values compared with what they thought would have happened if the highway had not been constructed. No effect was expressed by 37.4 percent, and less than 2 percent thought that property values had been decreased by the highway. In the impact zone, 36 percent thought values had been hurt, 31.6 percent thought there was no effect, 19.3 percent were uncertain, and only 13.2 percent thought values had increased. Next, the residents were asked if they could estimate the dollar value of these property value effects. Only about two-thirds expressed their opinions, but this was a high enough response rate to allow some generalizations. The residents believed that the damages were approximately twice as large as those found in actual sales. This indicates that in evaluating highway impacts it is important to consider not only the anticipated actual effects on property values but also the anticipated perceptions of those effects.

Interviews were also conducted with the residents of the Puyallup study area. In many respects the results were comparable to the results in Kingsgate. Noise was considered to be by far the most significant adverse effect, and once again people's ratings of the adverse effects correlated well with the actual noise readings. However, few of the people interviewed used WA-512 to commute to work. Thus, the evaluation of the benefits of the highway was significantly lower than in Kingsgate. This fact also lowered the overall ratings of the highway in Puyallup.

As part of the Bellevue commercial and industrial study, the managers of a representative sampling of business firms were interviewed. A majority of the interviews were at retail establishments, but interviews were also conducted with all the large wholesale and manufacturing establishments. A majority of the firms chose to locate in the area because of transportation availability or customer accessibility. More than 72 percent of those interviewed thought that I-405 helped customer accessibility, and 45 percent thought it improved goods accessibility for their firm. More than 65 percent stated that highway use had increased the gross sales of the firm, and 55 percent thought that the highway also resulted in lower operating costs. A significant number of firms (27.6 percent) indicated that they would not have chosen to locate in the area if I-405 had not been in existence. The overall rating of the highway was between good and very good, and a majority of the firms thought that the effect had been major.

To examine people's perceptions of the effect of the highway on property values, interviews were also conducted with the owners of the vacant land in the area. Half of these individuals thought that I-405 had influenced the value of the property. Although there was great uncertainty as to the magnitude of this effect, the estimates averaged 7.5 percent, which underestimates the actual effect estimated from real estate sales. These individuals thought

that the increases could be attributed for the most part to improved customer and employee accessibility.

#### APPLICATIONS

Possible applications of these results are many. The most-important use is in connection with impact statements and public involvement programs. This application provided the original motivation for the study. The results of this study have quantified the property value effects of a limited-access highway. This information can be used for generally assessing property value effects in similar locations when a highway is constructed. The effects on property value are a great source of public concern. This evidence will provide facts for detailed discussions on this topic.

There has been interest in partly financing highway construction by capturing part of the accessibility benefits through property taxes. The property value effects are caused by the user benefits from the highway and do not represent an additional benefit. If existing taxes on highway users are at an appropriate level, then an additional tax on property is not called for. If additional taxes are indicated, they could take either form with similar long-run effects. A related point is that care must be used in applying the results of the benefit side of this study to benefit/cost analyses. Double-counting would result if user benefits were fully evaluated and property value effects were added.

These same considerations do not apply to the adverse property value effects of noise. Noise represents an externality that must be considered in benefit/cost analysis in order to make efficient decisions. The distributional effects of these externalities might also provide a basis for the payment of compensation to the residents affected. Such compensation should be paid to the house owners at the time of the highway effects origination but not to those who purchase the house after the effects take place. Currently, the Federal Highway Administration requires that controls such as noise barriers be used to reduce highway noise to 70 dB(A) in residential areas unless exceptions are granted. This study might be used to show that, in some cases, compensation would prove less costly than the construction of noise-abatement devices.

Finally, this study might prove useful in making decisions between various transportation modes. Such a choice between modes must be based on all of the effects of the construction of each mode.

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## Some Conventional and Not-So-Conventional Views of Congestion

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The purpose of this paper is to explore the extent to which the conventional treatment of highway congestion, as developed in the economic analysis of road pricing, provides an acceptable theoretical or practical foundation for policy. The conventional theory is first outlined, and it is emphasized that, although it is probably technically sound, it relates to highly abstract circumstances. The main body of the paper then develops two themes. First, a number of arguments are put forward that imply that, in quantitative if not qualitative terms, the conventional analysis of congestion seems unlikely to

provide an adequate basis for the proper formulation of policy. Second, some reasons for regarding congestion as an effective allocative mechanism in its own right are given. Although the arguments in the paper are not developed sufficiently far to reach firm conclusions of an operational kind, there are clear indications that traffic management and related policies aimed at securing efficient use of existing highway facilities should proceed with care when valuing congestion savings and when assessing optimal congestion levels.