

# HIGHWAY RESEARCH RECORD

Number 96

## Indirect Effects of Highway Location and Improvements 5 Reports

Presented at the  
44th ANNUAL MEETING  
January 11-15, 1965

SUBJECT CLASSIFICATION

- 15 Transportation Economics
- 53 Traffic Control and Operations
- 83 Urban Land Use

HIGHWAY RESEARCH BOARD

of the

Division of Engineering and Industrial Research  
National Academy of Sciences—National Research Council  
Washington, D. C.

1965

## *Department of Economics, Finance and Administration*

Guilford P. St. Clair, Chairman  
Chief, National Highway Planning Division  
U. S. Bureau of Public Roads, Washington, D. C.

### DIVISION OF ADMINISTRATIVE AND MANAGEMENT STUDIES

W. L. Haas, Chairman  
Highway Management Associates  
Madison, Wisconsin

David R. Levin, Vice Chairman  
Deputy Directory, Office of Right-of-Way and Location  
U. S. Bureau of Public Roads, Washington, D. C.

### COMMITTEE ON LAND ACQUISITION AND CONTROL OF HIGHWAY ACCESS AND ADJACENT AREAS

(As of December 31, 1964)

David R. Levin, Chairman  
Deputy Director, Office of Right-of-Way and Location  
U. S. Bureau of Public Roads, Washington, D. C.

Frank C. Balfour, Founder—National Coordinator, American Right-of-Way  
Association, Los Angeles, California

Archie H. Christian, Right-of-Way Engineer, Texas Highway Department, Austin  
J. Arnold Cobley, Chief Right-of-Way Agent, Washington Department of Highways,  
Olympia

Rudolf Hess, Chief Right-of-Way Agent, California Division of Highways, Sacramento

Robert L. Hyder, Chief Counsel, Missouri State Highway Department, Jefferson City

Daniel R. Mandelker, Professor of Law, Washington University School of Law,  
St. Louis, Missouri

LeRoy C. Moser, Chief, Right-of-Way Division, Maryland State Roads Commission,  
Baltimore

J. Allyn Preston, U. S. Bureau of Public Roads, Washington, D. C.

DIVISION OF ECONOMIC STUDIES

R. G. Hennes, Chairman  
Department of Civil Engineering  
University of Washington, Seattle

Carl C. Saal, Vice Chairman  
Chief, Traffic Systems Research Division  
U. S. Bureau of Public Roads, Washington, D. C.

COMMITTEE ON INDIRECT EFFECTS OF HIGHWAY IMPROVEMENTS

(As of December 31, 1964)

Sidney Goldstein, Chairman  
Economic Adviser, Office of Planning  
U. S. Bureau of Public Roads, Washington, D. C.

Floyd I. Thiel, Secretary  
Acting Chief, Socio-Economic Research Branch  
U. S. Bureau of Public Roads, Washington, D. C.

William G. Adkins, Research Economist, Texas Transportation Institute, Texas A and M University, College Station

H. W. Bruck, Deputy Director, Long Range Plan, Penn-Jersey Transportation Study, Philadelphia, Pennsylvania

Kenneth Cook, Virginia Council of Highway Investigation and Research, University of Virginia, Charlottesville

R. Kirk Dansereau, The Pennsylvania State University, University Park

William L. Garrison, Department of Geography, Northwestern University, Evanston, Illinois

Edgar M. Horwood, Professor of Civil Engineering, University of Washington, Seattle

David R. Levin, Deputy Director, Office of Right-of-Way and Location, U. S. Bureau of Public Roads, Washington, D. C.

Walter C. McKain, Jr., Head, Department of Rural Sociology, University of Connecticut, Storrs

Leon N. Moses, Professor of Economics, Northwestern University, Evanston, Illinois

William C. Pendleton, Associate Professor of Economics, University of Pittsburgh, Pittsburgh, Pennsylvania

Jerome P. Pickard, Director of Research, Urban Land Institute, Washington, D. C.

Matthew Platt, D. C. Department of Highways and Traffic, Washington, D. C.

James M. Smith, Wilbur Smith and Associates, Columbia, South Carolina

Paul Staffeld, Deputy Commissioner, Minnesota Department of Highways, St. Paul

## Foreword

Highway researchers have been active for a number of years in studying the influence that highway improvements have on adjacent areas. Since 1956, a great deal of literature has been developed which is concerned with various socio-economic aspects of this influence. This research has been performed mainly by university personnel, although in a few instances consulting firms or state highway department personnel have themselves carried out the research. A large segment of this literature has been concerned with the land value impact of highways or their impact on highway-oriented businesses. Some of the studies have been conceptually oriented but most are "before" and "after" data analyses. These earlier studies have sought to evaluate the economic and social effects of different types of highway improvements on business and industrial activity in small towns and in parts of larger urban areas. In more recent years, though, these studies have been broadened to a considerable degree as interest has developed in understanding the effects of a transportation improvement on the entire community.

The group of papers included in this Highway Research Record reflect this broader concern. Such community impact can take many forms and may range from the economic to the psychological, sociological and aesthetic effects of highways on the individual, social groups and business activities within a community. Highway administrators, planners, engineers, and public works officials, in general, will find considerable useful information in this volume.

The report by Professor Edgar M. Horwood, a city planner and engineer at the University of Washington, seeks to evaluate the state-of-the-art in this entire area of community impact research and suggests a number of new approaches to community analysis. Professor Walter C. McKain, Jr., a sociologist of the University of Connecticut, analyzes the implications of the Connecticut Turnpike on a depressed socio-economic fabric and the "ribbon of hope" that it furnished. Those interested in this type of research may also wish to consult a summary analysis of all highway impact studies through 1961 and a list of all such studies in progress in 1964 in the cooperative U. S. Bureau of Public Roads-state highway department research program that has just been published by the U. S. Government Printing Office. It is entitled "Highways and Economic and Social Changes."

There is one aspect of highway influence that has been given considerable attention in the past few years. City planners, transportation planners, right-of-way specialists, land and area development specialists, and local governments have all been concerned with the significance of highway interchanges to their communities. Since these interchanges have tended to become centers of activity, attention has focused on the development of research tools for predicting this development, for predicting land sales and values, implications to local tax rolls, and for recommendation of land-use controls to facilitate orderly development.

Floyd I. Thiel, an economist with the U. S. Bureau of Public Roads, who has in recent years spearheaded research in this field, summarizes and evaluates the work in the paper "Interchange Area Development." He describes both findings made and methods used and then makes some pointed observations on the adaptation of land-use controls to promote effective land development at interchanges. Mark C. Flaherty, a planner for Duluth, Minn., pays particular attention to the development and pre-



diction of highway service areas in connection with the urban transportation planning process. Roger H. Ashley and William Berard of the Michigan State Highway Department describe the types of land use, values and the extent of development along the length of I-94 in that state. They present a history of such development along the 180-mile stretch of highway, relate business experience to distance from the interchange and to the value of the business site, and draw right-of-way and land acquisition implications from their research.

It is expected that future activities sponsored by HRB Committee on Indirect Effects of Highway Improvements will deal with various indirect effects that have not been subjected to systematic economic analyses, such as (a) the external aspects of highway improvements, including smog and noise, (b) the comparison of indirect benefits methods used in other public works programs that may have applicability to highway research, (c) attitudinal studies of the effects of highways on communities and development of attitudinal scales for the evaluation of these effects, and (d) the study and prediction of the regional impact of highways on depressed areas and entire corridors of activity, as well as the statewide impact of highways.

# Contents

## COMMUNITY CONSEQUENCES OF HIGHWAY IMPROVEMENT

Edgar M. Horwood .....	1
Discussions: Robert D. Pashek; Edgar M. Horwood .....	2

## COMMERCIAL HIGHWAY SERVICE DISTRICTS AND THE INTERSTATE: Their Proper Relationship in an Urban Setting

Mark C. Flaherty .....	8
------------------------	---

## COMMUNITY RESPONSE TO HIGHWAY IMPROVEMENT

Walter C. McKain .....	19
------------------------	----

## HIGHWAY INTERCHANGE AREA DEVELOPMENT

Floyd I. Thiel .....	24
----------------------	----

## INTERCHANGE DEVELOPMENT ALONG 180 MILES OF I-94

Roger H. Ashley and William F. Berard .....	46
---	----

# Community Consequences of Highway Improvement\*

EDGAR M. HORWOOD, University of Washington

## ABRIDGMENT

This paper, as presented at the 44th Annual Meeting of the HRB, was the summary of findings of one year's research project sponsored by the National Cooperative Highway Research Program (Project 64-2-2). Since the summary volume of this project is expected to be published elsewhere in the Highway Research Board literature, only an abridgment is given here to facilitate interpretation of the commentary by Pashek and reply by Horwood.

The project's objective was to correlate and evaluate existing studies of highway economic impact and other community consequences, to develop guidelines for the determination of such consequences, and to specify the aspects of indirect effects of highways in most need of further research.

Studies of bypasses and urban radial and circumferential freeways were found to be numerous and were subjected to correlative analysis. Lack of uniformity as to methodology and selection of variables made statistical correlations difficult. Therefore, it was necessary to resort to crude averages and ranges to derive numerical values with guideline utility. It was found that bypasses have differential effects on communities, with least benefit generally derived by towns of less than 5,000 population and by highway-oriented businesses. Greater benefit accrued to the larger centers and to the nonhighway-oriented business sector, presumably due to decreased congestion, greater pedestrian amenity in shopping areas, and an enlarged trade area. Small towns without central place importance may suffer substantially from a highway bypass.

The circumferential freeway studies revealed the propensity of industrial and commercial land uses to develop along beltway routes. Land values usually rise concomitantly in proximity to the circumferentials. Urban radial freeways generally have the effect of temporarily increasing the values of land, especially undeveloped land, very near the route, though the benefit derived falls off rapidly with distance from the facility.

Evaluation of the studies analyzed revealed a number of methodological shortcomings which tended to decrease their utility for comparison and prediction as well as for understanding of the long-term consequences of highway developments. Utility of the studies, as determined by interviewing cognizant highway officials and researchers in a sampling of the states most active in nonuser impact research, reveals that they were made mainly to alleviate public relations problems by countering adverse public opinion with factual information.

Gaps in knowledge requiring research, as expressed by interviewees, were of three types: (a) specialized impacts of highways, especially as they affect currently protesting special interest groups; (b) refined methodological approaches to impact research; and (c) miscellaneous areas of analysis representing operational problems of highway agencies (e.g., interchange congestion, frontage road needs, and air rights evaluation).

---

\*An abridgment of a paper presented at the 44th Annual Meeting of the Highway Research Board under the sponsorship of Committee on Indirect Effects of Highway Improvements. The paper reports a portion of the work done under Project 64-2-2 of the National Cooperative Highway Research Program. A report of the full project is expected to be published by HRB in the report series of NCHRP.

Synthesizing these findings, three areas of future community consequences research were proposed: (a) spatially localized studies, i. e., tactical studies intended to enhance public relations or to solve particular agency problems of an operational nature; (b) spatially integrated studies, or areally comprehensive strategic planning studies which add to basic knowledge and provide feedback on interrelated user and nonuser effects useful in making decisions on future use of highway systems and route locations; and (c) theoretically oriented models, mathematical representations of economic or settlement impacts of highways useful in testing alternative regional land-use and transportation patterns, thereby aiding policy and plan decision making.

The general conclusions drawn from the research are:

1. There will be a continued need for the operational types of studies made in the past, although future ones should be made with more sophistication in the selection of variables, indices of change, control areas, identification of exogenous influences, etc.
2. There is an emerging need for a research program of spatially integrated studies which examine community consequences in the larger context of the metropolis or region, identify a spectrum of economic and social effects, integrate user and nonuser aspects (benefit transference, land use, traffic, etc.), and are justified by their utility in expanding basic knowledge, suggesting useful theoretical constructs and aiding in the determination of highway plans and policies. The particular objective must be to gain a better understanding of the systems effect of urban highway development, including the iterative impacts of freeway and land-use developments on each other.

## *Discussion*

ROBERT D. PASHEK, The Pennsylvania State University—Mr. Horwood has provided a valuable report on a research project concerned in part with the correlation and evaluation of the existing body of literature on the economic impact of highway improvements. Other stated general objectives of the project are the development of "guidelines for highway agencies to follow in considering the community consequences of highway improvements and to specify those aspects of the problem requiring further study."

The following comments will be confined largely to the analysis of bypass studies and to some proposals presented by Mr. Horwood as a policy guide for future research efforts.

The analysis of bypass studies must have been a very frustrating experience with different classification of variables, different universes, and nonuniformity in research design. Mr. Horwood should be highly commended for his clear presentation of the few strengths and many weaknesses of the various reports. Acknowledgment must be given to the finding that "a bypass has distinctly different effects on towns of 5,000 persons and on cities over 5,000 population" with the implication that the former were adversely affected and the latter remained unchanged or were favorably affected. This reviewer raises the question, however, as to whether or not the emphasis on a population classification may obscure the basic reasons behind the findings. For example, I would suggest that, regardless of population, the extent to which the community serves as a market or shopping center for the surrounding area and its geographical relationships with competing market and shopping centers would be two of the basic factors. The introduction of a bypass for the community could result in the community becoming a more attractive market and shopping center through the reduction in congestion and an increase in "pedestrian amenities." Population differences among communities need not provide an indication of these factors.

This reviewer would also like to raise the question as to whether or not a substantial bias may be present by the very nature of the universe studied, i. e., the available bypass studies. What type of a sample do these studies represent of all bypassed com-

munities? Were the communities studied chosen because they did provide some unique situations?

The statement is made by Mr. Horwood that "It is highly probable that many small communities are adversely affected by highway bypasses when travel times are changed to permit a greater accumulation of goods and services in a larger neighboring community." The reviewer recognizes the importance of travel time but suggests that the travel time from a studied community to neighboring communities is not changed by the introduction of a bypass. A change in travel time is only likely to occur when the bypass is at an intermediate point between the origin and destination points, not when the bypass is at the origin point itself. What may have happened in many situations is that the bypass was constructed along with a general improvement of the highway to neighboring communities. The travel time was thus affected by the improved highway link and not by the bypass.

In general, the specific recommendations made by Mr. Horwood for future bypass studies are commendable and strongly supported by this reviewer with two modifications. There is agreement on the recommendation that "The same spans of time before and after opening the bypass should be used in all studies." However, there is not agreement that 2 years before and 2 years after is an appropriate standard for measuring the impact of the highway. In some instances the impact of the bypass may not become evident for 4, 6, or more years. An important variable in this situation would appear to be nearness to an important urban center. It is recommended that a limit of 2 years not be imposed but that the impact be measured uniformly at 2-year intervals.

A question may be raised with regard to the recommendation that such data as electricity usage, telephone installations, bank deposits, and employment be discarded in future studies since they are subject to many extraneous factors and are not reliable indicators of highway impact. There is no disagreement with this statement as it stands, but elsewhere Mr. Horwood makes an impressive plea for control areas. Would not this type of data be important in the measuring of changes in levels of economic activity between the community being studied and the control areas, especially when no better indicators were available?

The reviewer believes that the analysis of bypass studies is an important step in the continued development and refinement of highway impact research. It is also felt that the major contributions of such studies have been attained. It would seem that such additional isolated case studies of the type undertaken in the past regarding bypasses can contribute little new knowledge in the area of predictive techniques and provide little additional aid to the decision-making entities.

Mr. Horwood concludes his paper with a general appraisal of highway impact research efforts which is followed by some proposals that could serve as a policy guide for future research efforts. He states, "it appears that three types of studies must be conducted in the future." These are (a) spatially localized studies which are a public relations-oriented, limited objective type of field studies, (b) spatially integrated studies which examine phenomena comprehensively in terms of space, and (c) theoretically oriented models "which may lead to the development of models of economic activities or settlement from which policy decisions may ensue."

This reviewer fully supports Mr. Horwood's general appraisal of highway impact research and the specific proposals for future study. This reviewer does take issue, however, with the implication that this classification would provide an adequate policy guide for future research efforts. The proposed classification, as defined and developed by Mr. Horwood, is criticized on the basis that it presents a misleading picture and that it is unduly narrow in scope or range of vision.

For example, Mr. Horwood presents "the impact of land-use changes at interchanges" as a gap in knowledge under the spatially localized study classification. Remember, by definition, the spatially localized study proposals are public relations oriented. At the present time, we have a study nearing completion at Penn State dealing with land-use changes at 105 interchanges in Pennsylvania. The study is examining a host of variables such as age of interchange, traffic flows, topography, distance from other interchanges, distance from market centers, population, and other indicators



of economic activity. The objectives of the study include the development of tools and knowledge for the prediction of change so that plans may be designed for highway protection, better planning in the future, and controls of land use. I am certain that the econometrician in charge of the study would be horrified to find his efforts classified as public relations oriented.

Let us look at Mr. Horwood's second classification, "spatially integrated studies." His definition of this classification states that "space may be either the total urban region or space in some linear context such as a regional development along a river valley or freeway." The restriction of studies to urban regions and developments along a river valley or freeway actually states what has been done in the past and not necessarily what needs to be done in the future. This is an unduly restrictive and extremely narrow approach. I would suggest that studies should involve economic regions, regardless of whether they are urban or rural. I would also suggest that studies of systems or networks of highways rather than an individual freeway might provide findings of greater value to Mr. Horwood's studies for "strategic planning purposes." How would a study for a road program to aid distressed areas such as might be found in President Johnson's proposed Appalachia Program fit into Mr. Horwood's classification?

This reviewer must also raise a question with regard to the statement that "these also tend to be studies for strategic planning purposes rather than tactical studies needed to answer field-oriented problems." I would suggest that many of these studies could provide a base and important ingredients for tactical studies needed to answer field-oriented problems. "Spatially integrated studies" and field-oriented problems are not mutually exclusive.

Although the classifications proposed are not acceptable to this reviewer, this section of the paper has many valuable suggestions. It serves a function in pointing out specifically many gaps in knowledge that need additional study. Mr. Horwood is to be commended for this contribution.

As a conclusion to these remarks, it might be well to add some comments regarding what is absent in the report rather than further comments on material in the report. This is limited to two items—one a question and the other a suggestion.

Mr. Horwood has at different places in his paper mentioned the urban transit and urban regional studies. Would not the analysis and evaluation of the relevant portions of the CATS, PATS, and Penn-Jersey studies, among others, be an important addition to this report?

Mr. Horwood has alluded to research horizons in his concluding statement. I would suggest that this horizon would include the development of studies concerning both the direct and indirect impact of highway improvement on the income and employment of a community. Highway impact research efforts have been primarily directed towards the impact on what may be called fixed assets such as land values and land use. Little attention has been given to the next step in the research process; i. e., what impact does the change in fixed assets such as land use have on the income and employment of the community? Some important developments are occurring in this area. The Pennsylvania Regional Analysis Group at Penn State, using input-output analysis, developed a transaction matrix of economic activity for Clinton County. It so happens that a segment of the Interstate system (the Keystone Shortway) will cross this county with three interchanges. Information concerning probable changes in fixed assets such as land use at the three interchanges was fed into the transaction matrix, and it could clearly be seen what the impact of the highway improvement was likely to be on the income and employment of the area. A report on this procedure will be available in July. It is suggested that this type of flow analysis can be a most powerful guide for new highway construction and constitutes a portion of the new horizons.

Edgar M. Horwood, Closure—Mr. Pashek raises the question as to whether or not the emphasis on a population classification may obscure the basic reasons behind the

findings. This is always a risk, of course, in the stratification of any data. The population class increments of 5,000 people were used as a simple first-order scale, mainly because no other numerical classification seemed appropriate. This treatment should not be thought of as an emphasis, although the reader may easily carry away this impression because of the many observations that appear to be differentiated by the 5,000 population value level. Figures are also given for the cities in all population classes so that the reader may judge for himself as to the validity of the 5,000 population level as a criterion.

On this same point, Mr. Pashek's remarks are well taken in that the bypass may result in a community becoming a more attractive market through the reduction in congestion and increase in pedestrian amenities. In fact, amenity improvement may even justify either a drop in some economic indicators or the shift from one set of economic benefits to another. It seems unlikely, though, that highway departments could reasonably explain the justification for any reduction of economic indicators based on projected improvement in pedestrian amenity to a community.

Mr. Pashek raises a question as to whether or not a substantial bias may be represented by the fact that only the studies of bypassed cities were analyzed. It is a valid statistical observation that the studies themselves constitute a biased sample of the total universe of bypassed communities; however, they were the only evidence available short of a massive effort such as the financing of the study did not anticipate. It would also seem that because the bypassed cities were selected without bias, the sample itself is not too biased and probably represents a reasonable simulation of the universe.

This writer is confused over the statement that the "reviewer (Pashek) recognized the importance of travel time but suggests that the travel time from a study community to neighboring communities has not changed by the introduction of a bypass." This is undoubtedly true if no transportation improvement has been made between the bypassed community and its neighbors. Invariably, however, the bypassed community is connected to other communities by the new facility which bypassed it. In fact, because typical settlement patterns run along highways, it is most probable that the bypassed community is one of a series of "beads" along the transport link. The remark by Mr. Pashek suggests that controlled communities must include those along the improvement as well as those unconnected by the improvement. When considered in this context, his point is very well taken and represents an aspect of economic impact analysis that was not emphasized per se in the basic study. It must be observed, however, that only one of the existing studies probes this question, and even then not too comprehensively.

Concerning time sequences for analysis of economic impact, there is nothing magic about the 2-year before-and-after span. It is usually difficult to anticipate improvement and develop before studies much in advance of 2 years. Specific routes are not generally known and it takes some time to develop interest in the before portion of a before-and-after study. Naturally, the continuation of economic impact analyses at 2-year increments after the construction of a facility would be admirable, and hopefully some studies may be refunded or originally funded with a long-term analysis in mind. Most fiscal arrangements make it difficult to extend financing of the study beyond 2 years.

My suggestion that electricity usage, telephone installations, bank deposits and employment be discarded in future studies as they are subject to many extraneous factors may have been stated a little too strongly, in retrospect. The implication behind the presentation of this statement is that these measurements are associated with many other things than highway improvement itself and substantial problems are raised in relating them to highway improvement.

This writer accepts as a valid criticism the charge that spatially localized studies must be substantially more than public relations oriented. In fact, his criticism should have extended beyond bypass studies to all of the others mentioned under this classification. There is no doubt in my mind, however, that most of the spatially localized studies conducted through 1964 have been public relations oriented. A more appropriate wording for the report would have been that these spatially localized studies include those which are public relations oriented. It is felt at the same time, however, that



Mr. Pashek's remarks that the proposed classification in its entirety is "misleading" is not substantiated. Although Mr. Pashek has suggested the inclusion of a few important types of studies that could very well be added to the list presented, he does not substantially support a basic attack on the classification system itself. In fairness to him, however, his remarks have been designed to point out deficiencies and not to counter with new structures for analysis.

Mr. Pashek makes a claim that the "restriction of studies to urban regions and developments along a river valley or freeway actually states what has been done in the past and is not necessarily what needs to be done in the future. This is an unduly restrictive and extremely narrow approach." He states in addition the need for analysis of economic regions, urban or rural, and systems of networks of highways rather than an individual freeway. He further refers to the need to study programs in relation to aids to distressed areas, as typified by Appalachia.

Besides emphasizing the fact that the research report makes a substantial plea for analysis of urban freeway systems and their total economic impact rather than individual freeways, the author feels that the merits of these remarks cannot be disputed, although they beg the question as to priorities of analyses as well as the concerns of those who commission highway economic impact studies. This raises very broad questions as to the future nature of highway economic impact research, especially as may be funded by state and federal agencies.

Mr. Pashek undoubtedly has a sense of the broad-scale and social consequences of highway developments and the need for analysis along these lines which is shared by the author. Mr. Pashek would be shocked, however, to read the review committee report of NCHRP Project 2-2, which presents an extremely circumscribed point of view of highway economic impact analysis. Highway administrators, as this report indicates, are not substantially concerned with broad economic analysis. They are trying to solve rather specific problems, or what they believe are specific problems, in regard to state highway developments, mostly relating to freeways. Highway administrators are looking for relatively simple and quick answers, not a general education on economic impact.

Perhaps a failure of the concluding section of the research report is that it does not emphasize specifically the fact that the direction of highway economic analysis suggested for future analysis implies what the author believes to be of the highest priority and most significance. As a long-time student of highway economics, this writer has been close to some of the most comprehensive research done in the country, that in the State of Washington in the early 1950's which dealt with highway economic benefits in relationship to economic regions and highway networks. A basic risk of this kind of analysis is that it is hard to tie down in specific terms for those who commission it. It is inevitable that when highway development is analyzed in terms of local or economic regional viability, many of the benefits are of a negative nature. Highway administrators and legislators do not want to see any negative results. There is as great a chance that the current highway program in Appalachia will drain off what economic viability remains in that region (except for recreation) as that it will not. In fact, history implies there is a greater chance that transportation improvement will confer greater benefits to the areas of greater viability when it connects regions of greater and lesser economic strength. This is the history of the railroads in the western areas of this nation. Gateway cities such as Chicago and St. Louis precluded economic development of western cities as the railroads moved west.

Mr. Pashek poses a very significant challenge for the inclusion of relevant portions of the Urban Region Transportation Studies along with other traditional studies dealing with highway economic impact. This thought crossed the mind of the research group at one point and was dismissed as being highly relevant from the standpoint of the specific scope of work programs presented in the research prospectus. The realization that highway economic impact studies must examine the works coming out of regional transportation studies came about at a time when the funding would not permit the broadening of the study. For one thing, the urban region studies do not present the findings in traditional terms as related to highway economic impact analysis, and for another the interpretations of the economic aspects of these studies are as yet

extremely difficult to assess. Studies such as those developed as part of the Penn-Jersey program delve deeply into regional economics and open a very much broader door than highway administrators are traditionally thinking about. Mr. Pashek probably did not have available other volumes of the NCHRP 2-2 report which discussed the urban metropolitan region highway economic evaluation problem, such as arose from the key study of Los Angeles.

In conclusion, I believe that Mr. Pashek has identified some very important points that were not sufficiently underscored in the summary report of the series. It seems difficult, on the other hand, to reconcile these broadening questions of highway economic impact with the operational needs of highway programmers and current thinking in highway agencies. Highway economic impact analysis is a subject much like the proverbial elephant, which appeared as seven different artifacts to the seven blind men who examined it. These different orientations are discussed in the section of the report dealing with interpretation, appraisal and application.

The utility of highway economic impact studies logically covers the gambit from public relations to highly complex studies dealing with regional and interregional economic events. It is difficult to draw a line as to what is a highway economic impact study and what is a study of a highway planning nature that will deal intelligently with the cycle of user and nonuser impacts over time. In the opinion of one observer who comments in the final report on NCHRP Project 2-2, "The contractors have trespassed into the provinces of the traffic engineer and the urban planner in worrying about developing a method of estimating future traffic volumes." Such thinking would certainly take a constrained view of the breadth which Mr. Pashek suggests, although this writer is sympathetic to his point of view.

The field of highway economic impact analysis lies between the extreme poles of broad educational findings and specific points relating to specific route locations. What is practical may stem from either end of the spectrum, although the highway administrator may not be looking for education in the search for practical solutions to what he believes are practical problems. These polemics seem to suggest a differentiation in terms. Conceivably the term "community consequences" could be used for a more restrictive type of analysis than the term "highway economic impact analysis."

# Commercial Highway Service Districts And the Interstate

## *Their Proper Relationship in an Urban Setting*

MARK C. FLAHERTY, Senior Planner, Department of Research and Planning,  
City of Duluth, Minnesota

A method is suggested by which local officials can better guide land-use development opportunities available as a result of Interstate highway construction. The question of location near interchanges of commercial highway service districts is examined from the point of view of interchange function and design, traffic conditions, user costs and land-use environment. Indices are suggested to guide decisions on locating service districts. A method for determining the amount of land that should be made available in service districts for highway-oriented uses is presented. This method is based on the assumption that there exists a relationship between the amount of land for highway-oriented uses and the volume of traffic associated with arterial streets serving such uses. An association through time was made along selected arterial strips and yielded a correlation coefficient of 0.81. Also demonstrated are the differences in land development occurring when highway-oriented land-use planning principles are recognized and followed or when they are ignored.

•IMPACT IS a totally overworked term in the jargon of the Interstate highway researcher today. Conversely, the work opportunity has not been sufficiently used. How many times has the question been asked, "What impact will the Interstate have in my community?"

Actually the Interstate per se will have absolutely no impact on urban communities. What does occur is that a range of opportunities are available to urban communities because Interstates are located within them. However, the actual effect or impact which results is directly dependent on the policies of the local community toward this transportation media. If a community seeks to make optimum use of the opportunities as a stimulus for guiding carefully conceived land-use development plans, then beneficial accomplishment of broad community goals will result. If, however, the community looks with a jaundiced eye at the Interstate and fails to take responsible interest in its ultimate development, then indeed trying days are ahead for that community.

A major question facing urban America today is whether or not local officials and agencies will assume this responsible interest. Emphasis must be placed on the responsible role which local officials must play in the unfurling drama of our developing Interstate Highway System. The role I refer to is not the harassment of state and Federal officials for additional design features or schedule changes, but is the preparation of sensible land-use development plans for those areas immediately adjacent to the new



highway facilities. Naturally, these plans should become an integral part of the community's overall plan. In addition, the local officials are also responsible for developing and adopting the appropriate land-use controls which will systematically guide the orderly implementation of land-use development while protecting effective and efficient movement of traffic between the Interstate and local street systems.

The immediate focus of the problem inherent in relationships between land-use development and traffic movement lies within those confined areas where arterial streets function as mediators or adaptors between the high-capacity Interstate system and the local urban street system. The reason for the problem is that land uses are not alike in their generation or attraction of trip movements. In fact the range of differences is drastic. The following information developed for land uses in the Duluth study sharply focuses this statement (1):

1. Residential uses produced 6 to 10 vehicle trips per dwelling unit per day.
2. Industrial uses produced 20 to 30 vehicle trips per acre per day.
3. Highway-oriented uses produced 200 to several thousand vehicle trips per acre per day.

As development increases around interchanges, the traffic on the Interstate and the intersecting arterials increases; thus, the vehicular capacity of the interchange area becomes more critical. It is obvious that the location of highway-oriented uses will aggravate this situation far more than most other uses. It is also obvious that the highway-oriented uses greatly desire such locations. It is inherent to their very nature that they locate in response to the presence of large traffic volumes.

This point is effectively brought out in a study carried on along a major circumferential highway in the Twin Cities (Minneapolis-St. Paul, Minn.) Metropolitan Area (2). It was found when studying a 16-mi stretch of this highway that 56 percent of all highway-oriented uses were located within 1,000 ft of eight major intersections with the highway and 91 percent of all highway-oriented uses were located within 2,500 ft of these same intersections. Clearly portrayed here is the attractiveness of interchanges for highway-oriented uses. As a solution, it would be sheer folly to suggest that local land-use control ordinances simply ban the highway-oriented uses from these areas. This is either postponing, shifting or evading the problem; it is not facing the problem. Even though the highway-oriented uses are extreme traffic generators, their location in an interchange area is necessary to provide adequate service to road users. The amount of land property devoted to such uses as the specific location of such uses is a very delicate problem since three interests must be served simultaneously. They are the general public, the abutting property owner, and the road user. The public's substantial investment in a new highway facility demands that it operate efficiently and its purpose not be negated by indiscriminant land development. The abutting property owner must have the opportunity to develop his land to the fullest potential consistent with the well-being of his neighbors and community. The road user must be able to obtain needed service without endangering life and property because of confused or congested traffic conditions.

It is, however, possible to balance these interests when local officials assume their responsibility of evaluating the interchange areas, developing prudent land-use development plans, and establishing positive controls which will guide and promote development of such plans. Truly such responsible action embraces the very spirit of the 1962 Highway Act, for it develops a cooperative effort on the part of state and local officials and it coordinates, in the most critical areas, comprehensive land-use and transportation planning.

#### COMMERCIAL HIGHWAY SERVICE DISTRICT

Local communities should consider the addition of a special commercial highway service district zoning classification to their ordinances. In general, this district (also termed service district) is an established and defined land-use area in which land is available and used for the specific purpose of servicing the needs of persons and vehicles traveling the highways. It should cater to the needs of the road user. Only busi-

nesses which directly serve the road user should be permitted as a "use by right" in these service districts. All others are better suited in other locations. The businesses which directly serve the road user fall into three basic groups, which are as follows:

1. Automotive service—a complete line including auto and truck service stations, auto and truck repair garages, tire service and repair stations, and all other automotive services of this general nature;
2. Highway-oriented retail service—curio and novelty gift stores, sporting goods and bait stores, fruit and produce stands, and other similar highway-oriented retail establishments; and
3. Highway-oriented personal service—restaurants, tea rooms, confectioneries, motels, drive-in restaurants, drive-in confectioneries, drive-in dispensing machines, drive-in receiving and pick-up stations, and other similar highway-oriented personal service establishments.

Various protective regulatory standards to guide proper site development should be established specifically for these districts. In addition to the usual specifications, such as ample lot area, adequate setback and yard areas, sufficient off-street and loading spaces, it is essential that a traffic control plan accompany every request for a permit in these districts. No permit should be issued until after the submitted traffic control plan is approved. Such a plan should be reviewed promptly by the local traffic engineer and the district office of the state highway department. The plan should show the location and extent of proposed: (a) street easements and surfaced portions of all public thoroughfares adjacent to property; (b) ingress-egress to property; (c) internal traffic circulation; (d) off-street parking and loading; (e) structures, islands and miscellaneous traffic barriers; and (f) traffic control devices and signs, including channelization.

One overriding factor should be made sufficiently clear at this point. In spite of how much care is taken in the drafting of specific protective regulatory standards, it is imperative that the service district be properly located and sufficiently large in area. Unless such is the case, it will be ineffective and will not provide adequate service.

#### LOCATION OF COMMERCIAL HIGHWAY SERVICE DISTRICT

When considering locations for such a district in West Duluth (1) the following factors were appraised, scaled and analyzed: interchange function, interchange design, traffic conditions, user costs, and land-use environment.

##### Interchange Function

Streets do not all have the same function; they are generally classified according to their general function. Interchanges also vary in function and it is necessary that they also be classified. This is particularly important when considering the establishment of service districts because, as will be seen from examples later in this paper, the ultimate function of the interchange is a major determinant in the actual physical location of the service district.

In simple practical terms, interchanges function at three levels. Some basically transmit road users from one road system to another for purposes of continuing their trip. These might be termed express interchanges. Others carry the dual function of exchanging traffic between two road systems and providing access to arterial streets which immediately service important abutting land uses. These might be termed arterial interchanges. A third type has the principal function of providing convenient service for road users, and secondarily of serving both important abutting land uses and traffic exchange purposes. This might be termed a service interchange. Table 1 illustrates these respective functions.

##### Interchange Design

Although this paper does not purport to examine exhaustively interchange design as related to service districts, a few observations are in order. Ideally, the desirable

TABLE 1  
INTERCHANGE FUNCTION

Interchange	Service		
	Traffic	Land	Road User
Express	x	-	-
Arterial	x	x	-
Service	x	x	x

location for a service district is adjacent to the frontage roads connecting the two halves of a split-diamond interchange. Such location permits road users to leave an express facility, secure needed services (gas, food, lodging) and return to the express facility without increasing travel distance, with a minimum of turning, and with a retention of the driver's sense of direction. In other words, unnecessary traffic congestion is held to a minimum. As is shown later in this paper, the distance necessary between the ramp termini of the two half diamonds is proportional to the volume of traffic to

be served. However, it is not practical to allow this distance to be less than 800 ft nor greater than 3,200 ft.

Generally the least desirable location for a service district in a dense urban setting is in the vicinity of a diamond interchange. When such a district must be placed in conjunction with a diamond interchange, it is then recommended that at least 400 to 800 ft, measured along the intersecting arterial, separate the district from the terminus of the nearest interchange ramp.

### Traffic

Traffic conditions comprise a third factor requiring extensive evaluation. A careful appraisal must be made of elements such as total vehicular volume and capacity of the interchange and the connecting arterials, conflicts arising from cross streets and turning movements (particularly left-hand turns), the physical disposition function and capacity of local streets in the interchange area, positioning and numbers of mid-block ingress-egress points along the arterial street leading to the interchange, and site distance involved. All of these elements must be assimilated and analyzed under varying conditions of land-use trip generation rates when considering the advisability of various possible locations for the service district.

### User Costs

A fourth consideration is a comparison and projection of the actual cost accruing to the road user when seeking service at different service district locations. Such a comparison between three specific interchanges was made in the West Duluth study (1) by means of the following equation:

$$NC = X (\$0.137) - Y (\$0.093) \quad (1)$$

where

X = distance via local streets from Interstate ramp egress point to center of commercial highway service district to Interstate ramp ingress point;

Y = distance via Interstate from a point on a direct line with this egress point to a point on a direct line with this ingress point;

\$0.137 = operating cost per mile on local street;

\$0.093 = operating cost per mile on Interstate; and

NC = net cost of seeking service by one road user.

After the cost of seeking service by one road user has been determined for each interchange, only a simple expansion (NC times the number of such trips per day times the time interval desired) is required to determine comparative cost figures for each interchange. Table 2 shows the specific comparison of these interchanges surveyed in the West Duluth study.



TABLE 2

## TWENTY YEAR USER COST ENCOUNTERED BY SERVICE SEEKING ROAD USERS

Interchange	Distance (mi) <sup>a</sup>		Operating Cost (\$) <sup>b</sup>			20-Yr User Cost (\$) (7, 300 days)
	Via Inter- state	Via Local Streets	Inter- state	Local Streets	Diff.	
Cody St.	1.93	1.93	180.00	260.00	80.00	584,000.00
Central Ave.	0.00	0.33	0.00	50.00	50.00	365,000.00
Oneota St.	0.53	0.53	50.00	70.00	20.00	146,000.00

<sup>a</sup>Distance computed for local streets from Interstate ramp egress point to center commercial district to Interstate ramp ingress point; for Interstate, distance computed along Interstate from a point on direct line with this egress point to a point on a direct line with ingress point.

<sup>b</sup>Computed at \$0.093 per Interstate mileage and \$0.137 per local street mileage.

### Land-Use Environment

The nature and characteristics of land surrounding an interchange require careful consideration when locating a service district. Such items as the following might be considered:

1. Land uses surrounding the interchange;
2. Amount of land devoted to these uses;
3. Disposition of these land uses;
4. Major land uses and their special needs, if any;
5. Their trip generation characteristics;
6. Potential future expansion rates;
7. Significant basic changes occurring in the land-use pattern;
8. Scale of the existing land uses;
9. Purpose served by existing land uses;
10. Dominating or restricting topographic features;
11. Potential physical capability of available unused land;
12. Types of uses potentially best suited for the area;
13. Availability of water, power and sewer facilities to the area;
14. Population of the existing area;
15. Potential population growth rate;
16. The specific social and economic characteristics affecting the disposition and use of land in the area;
17. Prospects of using urban renewal to create a better functioning land-use environment;
18. General attractiveness of area and the availability of related services;
19. Location of other service areas; and
20. Compatibility of the service district with other uses found in the area.

### SCALING AMOUNT OF LAND NECESSARY IN SERVICE DISTRICTS

After the location of a service district has been determined, the amount of land necessary for highway-oriented uses in such a district must be determined. Gross misjudgment here will severely limit the effectiveness of the service district. Over-optimism will leave permanent pockets of undeveloped and unimproved land, invite marginal construction and uses, and create a pattern of scattered, inefficient development. Underestimating needs, however, will produce crowded developments which encroach on each other, thus creating congestion, improper spacing of traffic generators, and generally abdicating the opportunity for effective internal circulation of traffic at individual establishments.

The proper amount of land to be provided within service districts can be determined if there is a relationship between the amount of land used for highway-oriented uses and the volume of traffic associated with arterials serving these uses. In another study, it was found that at intersection nodes, a lineal relationship existed between the percent of total acreage found in these uses and the percent of total traffic volume (2).

For purposes of future land-use planning at service districts, it is necessary to know the magnitude or approximate lineal frontage of land needed for highway-oriented use purposes. To project these needs, the following method was developed and used in the West Duluth study.

1. Strips of commercial development along major arterials within urban development were selected. Criteria were that all strips be of similar length (approximately eight blocks long), begin at first occurrence of commercial zoning along the arterials, have been continually zoned for commercial purposes since the first establishment of zoning (within Duluth, 1924), have vacant property available for development if desired by private property owners, and be located outside of any distinguishable retail shopping area.

2. Two classifications of land use were defined—highway-oriented (gas, restaurant, motel, fruit and produce stands, drive-in restaurants and confectioners, drive-in dispensing machines, drive-in receiving and pick-up stations, auto repair, bars, auto accessories, gift and novelty, nursery, commercial recreation, used car and trailer sales) and non-highway-oriented (all other uses). The highway-oriented uses are adapted from the highway-oriented-urban arterial uses used by Borchert (2).

3. The lineal frontage of land used in each class was recorded. In Duluth, 1948, 1956, 1960 were the years used since they were the only time periods for which reliable traffic volume information was available.

4. The ADT volumes are then recorded for each strip.

5. The association between lineal feet of highway-oriented uses and traffic volume was computed. An association between lineal feet of highway-oriented uses and traffic volumes yielded a correlation coefficient of 0.81 and a coefficient of determination of 0.66. Therefore, two-thirds of the variance was associated with changes in the independent and dependent variables. Because the general magnitude and not a precise measure of future highway-oriented use needs was desired, further efforts to identify the other one-third variance was not necessary.

6. The association of lineal frontage of highway-oriented uses with traffic volumes was then plotted as in Figure 1 where the lineal association is quite apparent.

7. It was assumed that the lineal pattern would continue outside of the observation area.

8. Therefore, with the determination of a projected ADT volume for a particular year, the approximate amount of lineal frontage needed for highway-oriented uses could be scaled off, as was done in Figure 1 for the West Duluth study.

#### EXAMPLES OF ACTUAL HIGHWAY SERVICE DISTRICTS

Figures 2, 3 and 4 demonstrate the actual use of principles developed in the West Duluth study and discussed in this paper. The examples shown on these figures are not hypothetical but are the actual application of highway-oriented land-use planning principles to specific interchange areas in Duluth. Each figure shows how land would fully develop under the land-use development plans which predated the Interstate and how land will fully develop under the proposed land-use development plans based on highway-oriented land-use planning principles. In addition, each figure represents an interchange having a different basic function, i.e., (express, arterial, service).

##### Express Interchange

The purpose of this interchange is primarily to exchange traffic between the Interstate system and a major trunk highway. Actually this interchange is required to provide very little local service to the residentially surrounding land uses. As seen in Figure 2a, the commercial uses would have been allowed to encroach to the very ramp termini of this interchange.



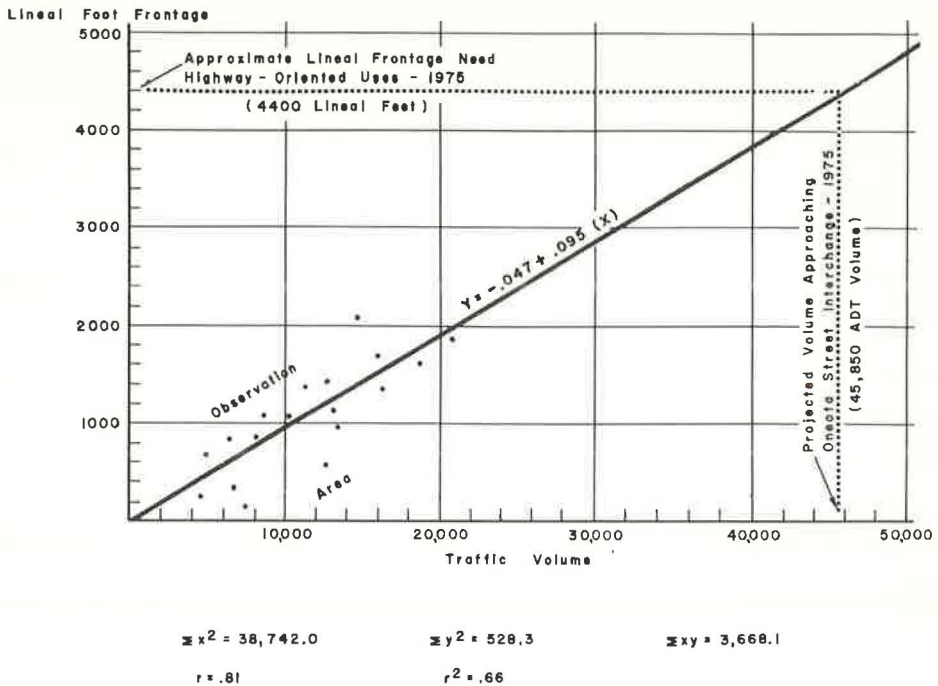


Figure 1. Relation of traffic volume to lineal frontage highway-oriented uses.

The characteristic trip passing through this interchange is of considerable length. Therefore, it is completely unnecessary that a service district be allowed to exist immediately on top of the interchange. In Figure 2b a service district has been created, commencing approximately 2,600 ft from the ramp termini. The changes in local street entrances into the major arterial street may be seen.

### Arterial Interchange

This interchange exchanges vehicles between the Interstate and a major trunk highway, and, possibly more important, it services the major land-use concentration of the existing West Duluth business district (commercial shopping area). Figure 3a shows how the commercial uses again encroach on the interchange, thus creating traffic congestion at this point.

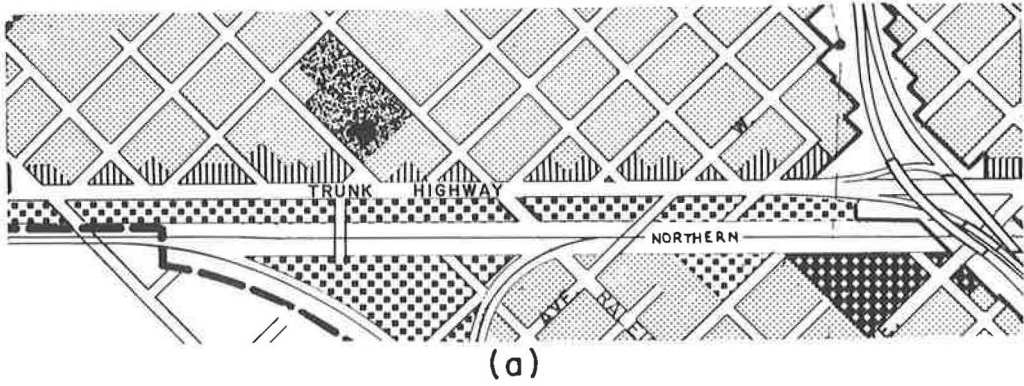
In Figure 3b, an urban renewal project has completely revamped the former business district. The service district has now been removed from the major arterial street and aligned to work with and complement the shopping area. Residential land uses have also been incorporated around this interchange.

### Service Interchange

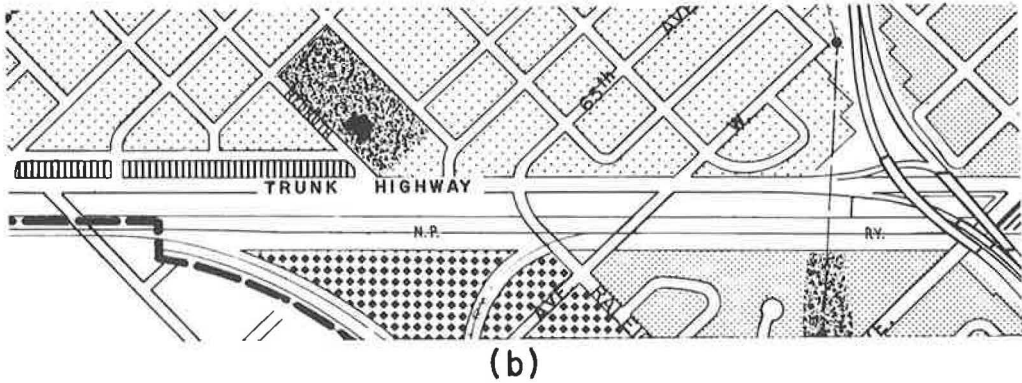
This interchange provides the opportunity of service to the road user who will travel a great distance on the Interstate, both before and after reaching this interchange. In Figure 4a, land-use development is completely inappropriate for this very strategic interchange.

Figure 4b shows how conveniently a road user can slip out of the Interstate, secure needed services, and return to the Interstate when highway-oriented land-use planning principles are used.









PRIOR EXISTING LAND USE PLAN



PROPOSED LAND USE DEVELOPMENT PLAN



GENERALIZED LAND USE

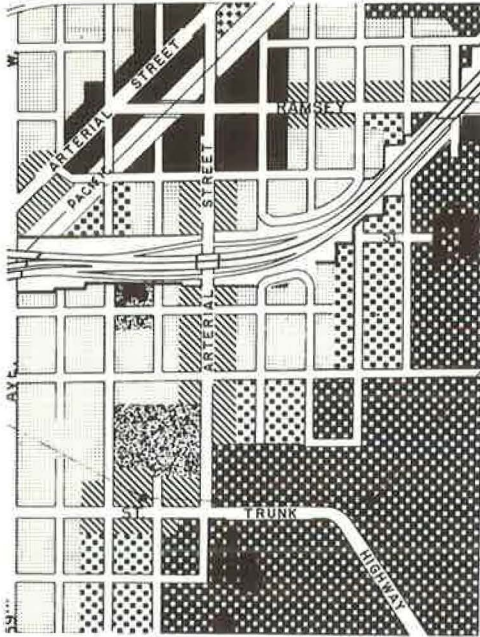
- |   |                                 |   |                             |
|---|---------------------------------|---|-----------------------------|
|  | RESIDENTIAL 0-15 D.U. per acre  |  | COMMUNITY SHOPPING AREA     |
|  | RESIDENTIAL 15-30 D.U. per acre |  | SERVICE COMMERCIAL DISTRICT |
|  | RESIDENTIAL 30-60 D.U. per acre |  | LIGHT INDUSTRY              |
|  | SCHOOLS - PARKS                 |  | HEAVY INDUSTRY              |

SCALE  0 1000 2000 FT

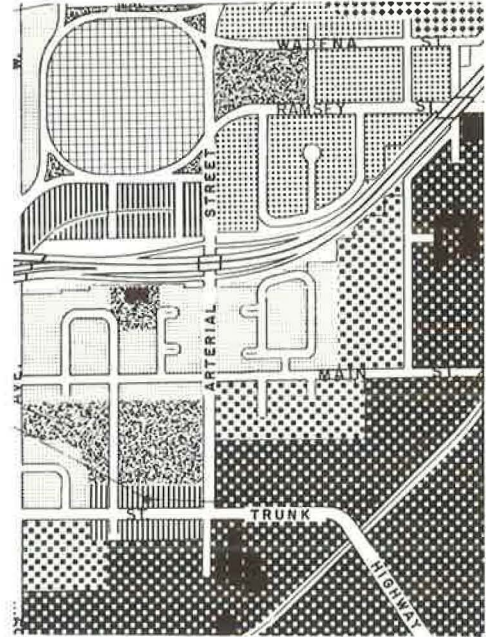
Figure 2. Land development at an express interchange.

PRIOR EXISTING LAND USE PLAN

PROPOSED LAND USE DEVELOPMENT PLAN







(a)



(b)

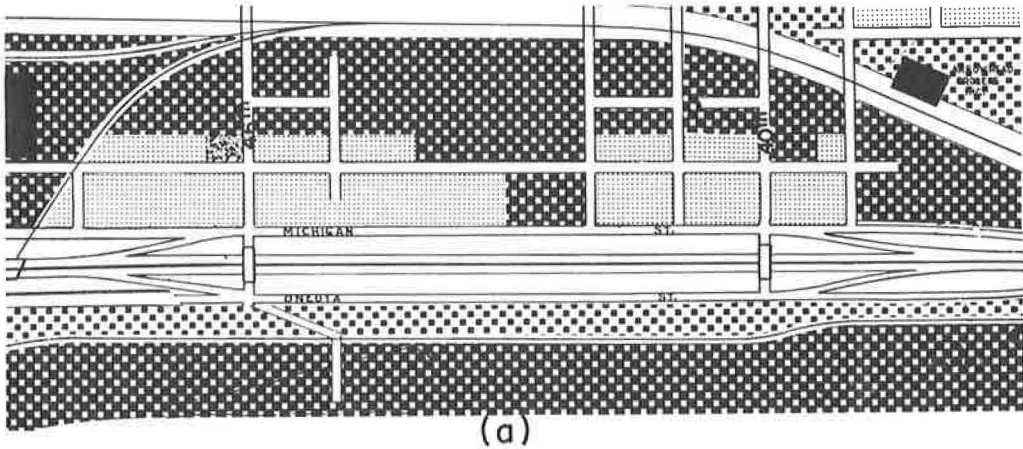
GENERALIZED LAND USE

- |   |                                 |   |                             |
|---|---------------------------------|---|-----------------------------|
|    | RESIDENTIAL 0-15 D.U. per acre  |    | COMMUNITY SHOPPING AREA     |
|    | RESIDENTIAL 15-30 D.U. per acre |    | SERVICE COMMERCIAL DISTRICT |
|  | RESIDENTIAL 30-60 D.U. per acre |  | LIGHT INDUSTRY              |
|  | SCHOOLS - PARKS                 |  | HEAVY INDUSTRY              |

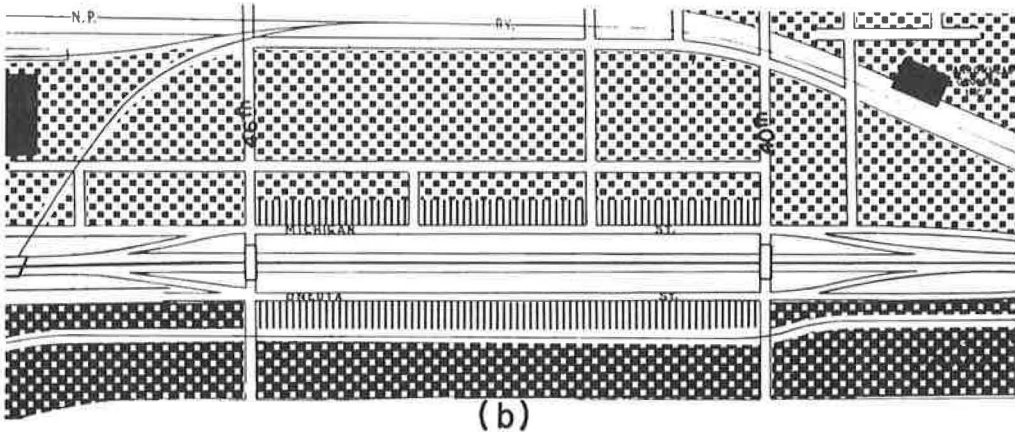
SCALE 0 1000 2000 FT

Figure 3. Land development at an arterial interchange.

## PRIOR EXISTING LAND USE PLAN



## PROPOSED LAND USE DEVELOPMENT PLAN



## GENERALIZED LAND USE

	RESIDENTIAL 0-15 D.U. per acre		COMMUNITY SHOPPING AREA
	RESIDENTIAL 15-30 D.U. per acre		SERVICE COMMERCIAL DISTRICT
	RESIDENTIAL 30-60 D.U. per acre		LIGHT INDUSTRY
	SCHOOLS - PARKS		HEAVY INDUSTRY

SCALE 0 1000 2000 FT

Figure 4. Land development at a service interchange.



## CONCLUSION

In this paper, the commercial highway service district has been discussed from the point of view of what it is, where it should be located and how much land area it should include. These are technical aspects which can be scaled and measured, and thus lead to definable solutions. The ultimate test of these solutions, however, is their actual application in the field, as seen in the immediately preceding section. This application will only occur when local officials recognize and accept the important role they must play in the development of the Interstate Highway System.

Although the specific application of various land-use controls is usually strictly a local responsibility, the whole question of promoting and effecting proper land-use controls at interchanges is not. In the immediate future, prudent control of land use at interchanges will only be accomplished through the cooperative efforts of state and local authorities. In many states, local communities possess adequate authority for assisting proper land-use development at interchanges, but many are reluctant to use this authority fully. These communities must be helped to understand the potential ramifications of the problem. In this area, the cooperative effort of a state agency in providing information would be very helpful.

On the other hand, many state legislatures have not granted adequate planning authority to local communities, such as authority to adopt an official map. The absence of such authority leaves a large gap in the planning process of the local communities. When such authority is lacking, state agencies should be willing to cooperate with local communities in presenting and securing the necessary enabling legislation.

The wisdom of deliberate cooperative efforts by state and local authorities is recognized in an instructional memorandum of the U. S. Bureau of Public Roads concerning urban transportation planning. This memorandum states that the Bureau will not approve any program for highway projects entailing expenditures of Federal funds in urbanized areas unless they find "that such projects are based on a continuing comprehensive transportation planning process carried on cooperatively by State and local communities...". This cooperation can only lead to beneficial results. The local planner will better grasp and understand the specific problems of the highway engineer. The highway engineers will develop a greater appreciation and understanding of the goals and aspirations of the local community. From practical experience in our relations with the Minnesota Department of Highways, we have found that such cooperation does not lead to compromise solutions, but to more intelligent and enlightened solutions.

## REFERENCES

1. Flaherty, Mark C., et al. Highways, Opportunities and Land Use Controls, A Case Study in Duluth. Duluth, Oct. 1964.
2. Borchert, John R. Beltline Commercial-Industrial Development. Univ. of Minnesota, Nov. 1960.



# Community Response to Highway Improvement\*

WALTER C. MCKAIN, University of Connecticut

Highway improvements may furnish the external stimulus essential for economic development in an area, but the immediacy of the response and the extent of economic growth also depend on the capacity for change existing within the community.

The Connecticut Turnpike had a favorable impact on the economic development of many towns in eastern Connecticut. Other communities in the same area were left relatively untouched. An attempt is made to illustrate the influence of human factors and social conditions on economic development with particular reference to the effect of a textile mill economy.

The textile mill has extended its influence into the latter half of the 20th century and left: (a) a labor force that does not readily improve its skills, (b) communities that tend to resist change and (c) a crisis approach to social action.

•HIGHWAYS AND highway improvements have always been instruments of social change. The social and economic consequences of earlier highways are well known. Patterns of land use were rewoven, the boundaries of trade centers were extended, villages appeared and disappeared, new resources were tapped and the value of existing resources was magnified. The parts of the nation were welded together and to some extent its destiny was shaped with each road-building program.

Until recently, highway planning has been concerned with existing or anticipated needs. Highways were considered the effects of social change, not its cause. If a new road happened to bring benefits to an area, this was considered an unexpected bonus. And if a highway improvement brought economic hardship, this was dismissed in the name of overall progress.

Not long ago scientists began to bring into focus the indirect benefits and disadvantages of highway improvements. The notion that highways can generate traffic as well as accommodate it and that they can be powerful forces for economic change logically followed. Congress and various state legislatures began to discuss highways in terms of this new dimension. The possibility of reversing economic trends in Appalachia by means of a highway system is a good illustration.

However, highways can furnish only the external stimulus for change. The response made to this stimulus depends on the capacity for change existing in the areas to be served. The presence of other resources, the availability of community leaders, and a plan for action are needed components for social action. Depending on the availability of these other elements, a new road can be either a minor irritant or a positive force for change. The ingredients for community development go far beyond adequate or even superior transportation.

---

\*This paper is based on Chapter VIII in a bulletin entitled "The Connecticut Turnpike—A Ribbon of Hope" to be published by the Storrs Agricultural Experiment Station at the University of Connecticut in cooperation with the Connecticut State Highway Department and the U. S. Bureau of Public Roads.

## THE CONNECTICUT TURNPIKE—A CASE IN POINT

The Connecticut Turnpike was extended into eastern Connecticut for the avowed purpose of stimulating the economy of that area. The issue was clearly drawn. Protagonists for the new road stated that it would bring economic prosperity to a depressed section of Connecticut. Those who opposed the road argued that highways should follow, not precede, economic development. The highway was authorized and later a research project was instituted by the University of Connecticut in cooperation with the Connecticut State Highway Department and the U. S. Bureau of Public Roads to measure the impact of the new facility on the economy of the region.

The Turnpike has already had a favorable impact on eastern Connecticut. Manufacturing employment and wage rates have risen. Real estate values have increased markedly, especially in the vicinity of the interchanges. The volume of retail sales, a barometer of economic advance, has climbed more rapidly there than in the state as a whole. The tourist business, including summer homes and overnight accommodations, has grown. There has been an in-migration of population. Local governments are providing more and better services.

Part of this improvement can be traced to the Connecticut Turnpike. Perhaps the most important contribution of the Turnpike has been to infuse eastern Connecticut with a spirit of optimism. After several decades of marking time, the region has begun to prosper.

The effect of the Turnpike on the individual communities in eastern Connecticut was not uniform. Some of the towns were quick to take advantage of the opportunities made available by the new highway. Others responded more slowly, and some did not respond at all. For example, retail sales as measured by tax receipts increased 54 percent between 1954 and 1962 in the area served by the Connecticut Turnpike. Four of the towns registered large gains (300 percent or more), but three had increases of less than 25 percent and two others actually had a decline in retail sales.

Although manufacturing employment rose 42 percent for the Turnpike area as a whole between 1954 and 1963, nine towns showed a decline in the number of manufacturing employees. Real estate values rose in all of the towns, but in some the rate of annual appreciation was much higher than that in others. A similar situation prevailed with respect to summer homes. Between 1957 and 1962 their number and assessed value in a few of the 24 towns near the Connecticut Turnpike rose sharply. In others, very little activity was reported. Population growth and local governmental services developed unevenly among the towns.

Why did some communities in eastern Connecticut respond to the opportunities offered by the Connecticut Turnpike and why did other towns appear to be unaffected? A number of reasons have been suggested.

Location in relation to the Connecticut Turnpike probably was not involved. All of the Turnpike towns by definition were within 5 miles of the Connecticut Turnpike, and the large number of exits and entrances to the highway has brought the Turnpike close to all of these towns. The supply of labor is not concentrated in any area. New manufacturing companies which came to eastern Connecticut have recruited labor in many different towns. Existing commuting patterns suggest a mobile labor force and shifting labor market areas. The presence of raw materials has not been an important ingredient in site location in Connecticut for 200 years. Almost all manufacturing in the state requires imports of raw materials. Available factory space may have had a discernible effect on the location of manufacturing firms in some towns and not in others, but most of the evidence suggests that vacant buildings have not been much of a magnet.

The extent of economic development in each of the Turnpike towns probably has been influenced by a variety of human factors and social conditions. These, in turn, can be understood only in their historical perspective. This history of eastern Connecticut is largely the history of the textile mills which, until the middle of the 20th century, dominated not only the economy, but also much of the fabric of social life. Most of the mills had departed by the time the Connecticut Turnpike was built, but their influence persisted, and it has adversely affected the capacity of the population to respond to change.

The physical and economic environment of eastern Connecticut was ideally suited to textile mills in the first years of the 19th century. An abundant water supply marked by sharp drops in levels provided the water power essential for the early mills. A labor force consisting of men, women, and children was available and growing. The rocky hillside farms could not compete with western agriculture, and many families turned to mill employment. At the same time investment capital, accumulated from nearby shipbuilding yards and centers of commerce, became available. Cheap cotton from the South and the nation's desire to be freed from the shackles of England completed the picture.

The Yankee entrepreneur provided the ingenuity and the managerial ability as well as the capital. He assumed a paternalistic attitude toward the laborers who worked in his factories. Within the mill the assigned role and status of the worker was one of subordination characterized by the acknowledgment that the Yankee manager knew what was best. The dependence and inertia of the workers extended outside the factory walls. Mill owners dictated the housing, the schools and other local services to be provided, the tax rate, and most other matters of community importance.

Immediately after the Civil War, a severe scarcity of labor prevailed in the textile industry. Mill owners began to look around to find a supply of labor to meet their needs. The immigrants from western Europe did not meet the requirements, but the French Canadian population to the north seemed to have the ideal characteristics (1): "They are considered very desirable 'help' by the employers, in as much as they are generally docile. . . do not object to long hours, nor disapprove of their children working in the mills."

From the start it was a happy decision. The attitude of the French Canadian immigrant meshed neatly with Yankee values. The Canadian farms on which they lived before coming to eastern Connecticut were family economic units. Everyone worked, and this work ethic remained intact when it was transferred to an industrial situation. Parents expected their children to enter the mills as part of the family effort. The wages, as low as they were, meant more money in the pocket than their farms in Canada had been able to provide.

The workers were industrious but lacked occupational versatility and the incentive for upward mobility. Strong family ties and devotion to their church gave them satisfactions which complemented the more materialistic goals of the Yankee ruling class.

Frugality, long a tradition of the native-born mill owners, was also inherent in the peasant farming operations of the French Canadians. Closely allied to personal frugality was distrust of public expenditures. The paternalistic mill owner provided public services on the level he wanted, and these seemed to meet the requirements of his labor force without necessitating any effort on their part.

Rivers initially determined the dispersion of the mills, but the expansion of the mills and later the railroads spawned the growth of many small densely populated mill villages which tended to become self-contained entities. Geographical isolation was accompanied by mental and social isolation favored by mill operators and immigrants alike. A form of self-imposed segregation developed and reinforced itself with each generation. Segregation of already cohesive groups into their own settlements was dysfunctional to the assimilation process.

The basic conservatism of the workers, reinforced by their peasant background, their strong family and religious ties and the attitudes of their employers, was given an additional impetus by the nature of the work itself. Textile operations are essentially machine-paced activities. A worker's speed is geared to the machines he tends. There is little or no incentive or even opportunity to learn new skills or to improve the skills already known. This tends to freeze the textile worker in his job and to complicate the retraining task. Components of the achievement ethic, such as ingenuity, the need for education, the desire to get ahead and community responsibility, were not encouraged by the everyday routine of mill workers.

When the Connecticut Turnpike was built, an opportunity was presented to replace the fading textile industry with a diversified manufacturing complex and to rebuild the system of community services to conform to modern standards. In part, this has been achieved. But change comes slowly in a situation where the human resources them-



selves must be rebuilt. The textile mill has extended its influence into the second half of the 20th century. Its presence is felt in three ways.

### A Labor Force Unwilling to Improve Its Limited Skills

Workers in eastern Connecticut are heavily concentrated in the blue collar classification, and a relatively large proportion of them are unskilled. Many others are equipped with skills that are largely obsolete. Textile mill owners tended to discourage both industrial and occupational diversification. A plentiful supply of cheap labor was their goal. The workers were content with this arrangement and placed a low value on acquiring either an education or a variety of skills. The transition from a kind of peasant agriculture to a machine-paced occupation was the extent of their willingness to change.

The closing of the textile mills left large segments of these workers without employment and without skills needed for reemployment. They were reluctant to learn new skills, and many lacked the education necessary for retraining. Former textile workers are less likely to migrate, and, in addition, tend to resist nontextile employment (2).

The educational attainment of workers in some of the Turnpike towns is relatively low. In Connecticut, 43.8 percent of the persons 25 and over have at least a high school education. In ten of the Turnpike towns less than 35 percent of the population have high school diplomas, and in seven of the towns less than 30 percent finished high school. In some of the towns from 8 to 10 percent of persons 25 and over have had less than 5 years of schooling.

Younger people in the community are securing more education than their parents, and since they have not been exposed firsthand to the textile mill psychology, many of them understand the importance of getting an education and acquiring diversified skills. The community at large has experienced difficulty in maintaining a higher quality educational program to meet these expectations. Low incomes suggest low taxes, and when this is coupled with an indifference to the need for education, support for the school system is lacking. Dependency ratios are high in the area which has more than its share of both children and older persons. The budgets for education in some of the Turnpike towns are exceedingly low. In Connecticut the net current expenses per pupil were \$422 in 1961-1962. Eight of the Turnpike towns had per pupil expenses of less than \$350. Teachers' salaries remain low and educational facilities are inadequate in these towns.

A few of the parents send their children to private schools. A system of parochial schools exists in several of the towns. Migration patterns show that many of the more ambitious and college-trained young people leave the area. The younger people who remain are often frustrated by the attitude of the older residents. The task of attracting new industries and upgrading community services becomes difficult in the face of such apathy.

### Communities Tending to Resist Change

Active civic concern for pressing community problems, such as the need for planning and zoning, the need for new roads and adequate road maintenance, industrial development, recreation, and the persistent need for an improved educational system, is held back because of a strong traditional orientation against change.

The departure of the textile mills after their domination of local affairs for so many years had placed a burden on the leadership structure. Paternalism did not encourage participation. When both the administration of local affairs and policy making were in the same hands, there was scant opportunity for new leadership.

The low educational level of a substantial part of the population has tended to retard the rise of local initiative. There is a lack of apprehension of vital community issues and a general reluctance to become acquainted with local problems or to realize that local action may be a solution. The inadequately informed public is sometimes further hampered by a lack of communication between local officials and the citizens.

The high degree of social cohesion existing within relatively small segregated settlements (villages) has inhibited action on the town level and has almost completely stymied regional activities. The population is family and village oriented; the town and the region are of secondary importance. Structural problems within local governments are another product of a village-oriented community. The overlapping of boroughs, towns, fire districts, school districts, and other governmental units presents knotty problems of taxation, administration, and authority. The machinery of government is not geared for prompt action or change.

Finally, outsiders who promote zoning, industrial development, and regional planning are often held in low esteem. Newcomers to the area are reluctant to take an active part in community affairs because of the resentment they might incur. Progress in community improvement under these conditions seems glacially slow.

#### A Crisis Approach to Social Action

The public's inattentiveness to local issues and its general reluctance to support any change in the status quo have stifled community action but have not obliterated it. Many town officials, as the mill owners before them, recognize the latent power of an aroused citizenry. They consider the voters apathetic but not anesthetized. Town meetings are usually poorly attended, but now and then the population is goaded into action by the magnitude of the problem.

This approach to action has led community leaders to use the deferment technique. New proposals are not presented on their merit for local action because they probably will be defeated, and prestige will be lost. Instead they are deferred until widespread support arises out of despair. In too many instances this has resulted in action that came too late to be of positive advantage. Complete collapse may be avoided in this way, but it does not promote steady progress.

The Connecticut Turnpike suggested the possibility of positive action, and some communities in eastern Connecticut were quick to take advantage of it. Others have preferred to wait to see what will happen. During the delay, problems in some towns may accumulate to such an extent that a crisis situation will exist. Only then will these towns begin to realize the full potential of the Turnpike.

It becomes apparent that the long domination of textile mills in eastern Connecticut has served as a barrier to community development. The paternalism of mill owners, the apathy of workers and the ecological distributions of mill villages have created a set of community values that in some instances have delayed community response to highway improvements.

Communities cannot expect to benefit from highway programs if they do not have or cannot acquire the other ingredients essential to economic growth. A new highway may be a necessary condition for economic development, but it is not a sufficient condition.

#### ACKNOWLEDGMENT

The author is indebted to Professor Franklin J. Watson of Central Connecticut State College who conducted much of the research and contributed many of the ideas contained in this paper.

#### REFERENCES

1. Copeland, Melvin T. The Cotton Manufacturing Industry in the United States. In Harvard Economic Studies VIII, p. 120. Harvard Univ. Press, Cambridge, Mass.
2. Miernyk, William. Interlabor Mobility: The Case of the Displaced Textile Worker. Bull. Bur. of Business and Econ. Res., Northeastern Univ., Boston, 1955.



# Highway Interchange Area Development

FLOYD I. THIEL, U. S. Bureau of Public Roads

Interchange research accomplished or sponsored by state highway and planning agencies has provided tentative findings on several aspects of the interchange problem. For example, some combination of land-use controls involving both the police power and eminent domain appears to be needed to guide interchange development in most areas. Local initiative should be relied on to the greatest extent possible, though state action will no doubt be needed in some instances. For rural interchange areas without land-use planning which are threatened with land uses generating more traffic than an interchange can handle, state action could be taken (e. g., by denying additional driveways onto state highways near the interchange). Guidance for development in interchange areas can also be encouraged by state highway agencies and others making available to local planning authorities those facts needed to act in local interchange planning situations (e. g., trip-generating characteristics of varying land uses, land uses compatible with the interchange and with one another, or interchanges experiencing fast growth). Several states are already providing much relevant information by means of brochures, movies, and speakers, but much additional research is needed on such matters as traffic characteristics of various land uses, traffic assignment, user service needs at interchanges, and ways of implementing known data.

•LAND-USE PROBLEMS are directly related to the amount and rate of land development. In this country the fast pace of land development is apparent, and land-use problems are becoming more numerous and serious. These problems result primarily from an increasing population, a rising standard of living, and an increasingly complex society (1, 11).

## AN OPPORTUNITY AND A PROBLEM

Land-use problems in areas near the interchanges of controlled-access highways are especially numerous and intense. Interchange areas are not ordinary places; because of their special advantages of accessibility, they tend to attract more economic activities than areas not served by an interchange. This constitutes both an opportunity and a potential problem. There is almost universal agreement that the opportunity for economic development offered by interchanges should be used. Interchanges can open up new areas for sound economic growth, revive the economic vigor of places needing economic revival, and perhaps even form the nucleus for a new kind of community. However, this development needs guidance if it is to continue to be economically sound over a period of time and the interchange is to operate as planned.

Changes in land use after a highway is built, such as in ribbon developments, may impair the usefulness of the highway. The goal for interchange area planning is to take advantage of the opportunity for economic development and at the same time guide or even restrain economic development that may be incompatible with the interchange or with other development in the interchange area.

## GUIDANCE FOR INTERCHANGE DEVELOPMENT

Considerable attention has been given to land-development problems and opportunities in interchange areas. For example, several planning groups and at least 17 state highway departments in cooperation with the U.S. Bureau of Public Roads have either conducted or sponsored research to find ways to maximize opportunities for economic development and to avoid land-use problems in interchange areas (see Appendix). Some of these studies involve analysis of all aspects of the interchange problem; others have been concerned only with certain aspects of this matter, such as the amount of space needed for highway-oriented businesses in interchange areas. This paper describes some of the more promising findings and recommendations from studies completed so far, offers a few suggestions for dealing with interchange matters, and calls attention to aspects of the interchange problem that appear to need additional research effort.

### Highlighting the Interchange Problem

The nature and seriousness of the interchange development problem have been highlighted effectively during the past 4 years or so by a number of individuals and organizations. One writer has described the freeway program as an "unqualified success with the exception of the interchange areas. . ." (2). Another has likened freeways to people, suggesting that they both pass through youth, maturity, and finally, old age. But interchanges reach the age of senility, he claims, more from the growth of traffic volumes than from the passage of time (3, pp. 22-23, 35).

The economic problem unsightly interchanges may pose for local areas, as well as the opportunity interchanges afford for economic betterment, has often been highlighted. A half dozen states have issued booklets calling attention to this valuable economic asset. To take proper advantage of an interchange, according to one account, planning must keep pace with economic development. If planning lags, the resulting development may be haphazard and poorly conceived. However, there is no need to "overplan for development, beyond any possible potential" (4). Interchanges are the "New Four Corners" (5) or "Your New Front Door" (6) and "you cannot afford anymore to show your cluttered backyards, your garbage patches to America" (7). So reads the literature intended to focus enough attention on the interchange development problem to cause something to be done about it.

One of the most successful efforts to highlight the interchange problem has been the 1961 Highway Research Board symposium "Land Use and Development at Highway Interchanges" (40). The papers presented at that session have not only caused a great deal of attention to be given to the highway interchange land-use problem, but also have provided an analysis of several aspects of the problem which still seems appropriate, for example, the description and evaluation of controls, the description of the land to be demanded and supplied at interchanges, and the need for user services.

### A Complex Problem

The complexity of the causes of the interchange problem is demonstrated by the fact that some interchanges with little economic development nearby are congested, whereas others handle traffic satisfactorily even though they are surrounded by development. One of the most baffling aspects of this problem appears to be the varying amounts of traffic generated some distance away but relying on the interchange for access. If it were not for the remotely generated traffic, the interchange problem could be solved by permitting only those land uses in the area served by the interchange which will not generate more traffic than the interchange can handle. Actually, this itself is a formidable problem, since it necessitates accurate traffic-generating characteristics and information about the portion of traffic generated near the interchange which does not use the interchange.

A fairly common hypothesis of most interchange studies appears to have been that interchange areas without some publicly enforced form of land-use planning are likely to develop in an undesirable way from the point of view of economics, aesthetics, and traffic generation. This hypothesis appears to be still generally valid, but the fact that it often does not apply indicates how complex this problem is. In a study in Texas,

for example, Adkins failed to find any serious interchange problem in areas without land-use controls, that is, at interchanges subject only to market restraints. The Texas experience has caused some speculation concerning the possibility that the free market may work satisfactorily, that land uses able to afford to be near interchanges will be suitable for those interchanges (8). In evaluating the Texas experience—that is, absence of congestion—the effect of frontage or service roads needs to be kept in mind. For example,

in Houston, where there is no zoning ordinance and the Gulf Freeway is solidly lined with commercial and industrial uses, congestion at intersections was noticeably absent, even under the most heavy conditions of use. This might be partially attributed to the fact that this freeway, like many of those in Texas, has continuous collector-distributor roadways on either side of it which take a portion of the total transportation corridor demand. (9, p. 44)

Interchange problems are also complicated by the need to balance needs of different highway users. For example, one of the most commonly suggested ways of easing traffic congestion problems at interchanges is to limit access for some distance along the feeder road. But for highway users desiring to leave the highway only far enough to obtain food and fuel, such access control simply lengthens the distance they must travel for this service (10).

To discern the true relationship between the elements of this complex interchange problem, several researchers have resorted to simulation models, for example, in research completed or under way at the University of Washington, Pennsylvania State University, University of West Virginia, and the University of Virginia. Variables analyzed in an attempt to predict development at interchange areas have included population of the nearest urban place, population of the interchange area, traffic on the feeder road, age of the interchange, freeway capacity, land area available, and a number of characteristics of the land. Some of the models have been concerned only with a limited part of the whole interchange situation, such as predicting need for service stations or motels. An adequate testing of these models as yet has not been possible because of the lack of information, especially traffic and land-use data in sufficient detail, and population data for the appropriate areas. Researchers at Pennsylvania State University appear to be making good progress toward obtaining suitable data for verifying their model of 23 variables.

#### Development Controls Available

That there may be problems in attempting to control economic development by public decree was obvious at least as early as 1763 when King George III attempted to arrest the westward movement in America by forbidding settlements beyond the sources of rivers flowing into the Atlantic (11, p. 16). But problems of difficult enforcement have not kept land-use controls from being used. In fact, the adoption of land-use planning measures has increased significantly in recent years. At the present time, over 90 percent of the 1,355 cities with more than 10,000 people have an official planning agency (12).

Controls available to guide land development in interchange areas have been surveyed on a number of occasions. A 1960 survey by the Pennsylvania Department of Highways revealed that in the 36 states from which responses were received, there was little land-use protection provided explicitly for interchanges beyond extending access control between 100 and 1,000 ft along the feeder road (13). In a 1961 survey of the protection provided at interchanges, only 17 states reported using some access control on feeder roads (14, pp. 21-58). Twenty-two states indicated that they had no interchange protection planned or in effect. In several cases, the nonurban nature of the state was cited as a reason for not providing measures to guide interchange development.



Variations in land-use controls available in urban and rural areas were also shown by responses to a recent survey of counties conducted by the American Association of State Highway Officials and the National Association of County Officials. Twenty-five pertinent questions were asked on such land-use control techniques as zoning, subdivision regulations, driveway controls, setbacks, access regulations near interchanges, building codes, and mapped highway ordinance, and information was provided on the number of counties responding affirmatively to the questions. For urban counties, affirmative responses were about 43 percent, compared with about 22 percent for the rural counties (15). As might be expected, the 1,200 counties through which the Interstate System passes have more of the selected land-use control measures available than the 1,800 non-Interstate counties. Favorable responses for Interstate counties were 27 percent, compared with 20 percent for non-Interstate counties. Variations between Interstate and non-Interstate counties and urban and rural counties are indicated in Table 1.

TABLE 1  
LAND-USE CONTROLS AVAILABLE

State	Counties Responding Affirmatively to 25 Selected Questions (%)			
	All Counties	Interstate Counties <sup>a</sup>		
		All	Urban <sup>b</sup>	Rural
Ala.	13	14	26	11
Ariz.	29	32	72	23
Calif.	58	64	81	58
Colo.	28	36	55	28
Fla.	35	38	52	28
Ga.	18	26	66	18
Idaho	14	22	41	16
Ill.	22	29	51	21
Ind.	25	35	45	32
Iowa	19	27	37	24
Kan.	16	30	55	23
Ky.	14	19	42	16
Md.	45	54	60	50
Mich.	25	28	30	25
Minn.	22	26	34	24
Miss.	11	16	32	14
Mo.	11	17	40	9
Neb.	5	18	44	8
Nev.	35	40	54	35
N. J.	31	31	31	29
N. Y.	19	24	28	21
N. C.	10	9	23	4
Ohio	31	40	59	34
Ore.	35	39	63	31
Pa.	18	19	31	15
S. C.	5	8	37	2
S. D.	10	9	19	6
Tenn.	13	20	61	15
Tex.	10	13	17	10
Utah	30	31	58	22
Va.	28	34	64	30
Wash.	48	51	64	45
Wis.	22	33	40	28
Wyo.	7	7	9	5
Avg.	22.4	27.6	44.7	22.3
Median	20	27	43	22

<sup>a</sup>Interstate counties are those crossed by or adjacent to an Interstate highway.

<sup>b</sup>Urban Counties are those which: (a) are part of a standard metropolitan statistical area, (b) had a 1960 population of 100,000 or more and showed an increase of 50 percent or more from 1950 to 1960, (c) had a population increase of 100 percent or more from 1950 to 1960, or (d) in 1960 were 70 percent or more urbanized (higher percent than typical for the United States).





TABLE 2  
LAND-USE CONTROLS AVAILABLE  
TO COUNTIES

State	Rank <sup>a</sup>			
	All Counties	Interstate Counties		
		All	Urban	Rural
Calif.	1	1	1	1
Wash.	2	3	4	3
Md.	3	2	8	2
Nev.	4	5	13	4
Ore.	5	6	6	7
Fla.	6	7	14	11
Ohio	7	4	9	5
N. J.	8	13	26	9
Utah	9	14	10	18
Ariz.	10	12	2	16
Colo.	11	8	11	10
Va.	12	10	5	8
Ind.	13	9	16	6
Mich.	14	18	28	13
Wis.	15	11	20	12
Ill.	16	17	15	19
Minn.	17	20	24	15
Iowa	18	16	22	14
N. Y.	19	21	29	20
Ga.	20	19	3	21
Pa.	21	25	27	25
Kan.	22	15	12	17
Idaho	23	22	19	23
Ky.	24	24	18	22
Tenn.	25	23	7	24
Ala.	26	29	30	27
Mo.	27	27	21	29
Miss.	28	28	25	26
Tex.	29	30	33	28
N. C.	30	31	31	33
S. D.	31	32	32	31
Wyo.	32	34	34	32
Neb.	33	26	17	30
S. C.	34	33	23	34

<sup>a</sup>The rankings indicate for each state the relative number of affirmative responses which counties made to 25 selected questions on the availability of land-use controls.

districts to guide development and highway strip zoning. In a few states, such measures have been enacted or are now receiving serious consideration.

A standard feature of any plan to provide land-use controls by means of interchange districts, strip zoning, or other state action is to use local initiative to the greatest extent possible. This can be done in several different ways: by excluding local areas or interchange districts from statewide zoning if local planning of development is deemed satisfactory; by changing local control only to the extent of referring rezoning questions to a state agency; by giving local governments a specified period of time to zone or provide other land-use control in interchange areas; or by leaving zoning matters generally to localities except where local practice and state interests are clearly incompatible.

To combine state leadership with local initiative, local interests need to be taken into consideration as soon as possible. Highway plans are much more likely to be respected locally if they have been made a part of the local land-use plans. This has been shown to be the case in a number of locations. In Duluth, Minn., for example, several interchanges of I-35 have been integrated with local planning, and local streets have become frontage roads along a portion of the system. Coordinated planning of this type, with city planners sharing in the decisions on location and alignment, seems likely to continue to receive local support for orderly development in the interchange area. Other areas where effective coordination of interchange and local planning have been reported

include Illinois and Tulsa, Okla. The coordination in Tulsa has resulted in a fairly general acceptance of driveway plans approved and administered jointly by the local planning commission and the State highway department (16). In Illinois, highway and local development plans have been proposed (by Barton-Aschman Associates) for selected interchange areas intended to maximize opportunities for local development and also to facilitate service for highway travelers.

One of the biggest problems with any land-use control plan involving states is that of forming a staff large enough and experienced enough to make it work. It may be advisable for states to assume responsibility for those aspects of interchange control with which they have had experience, such as the extension of access control along the feeder road, and to provide information and leadership to enable local land-use control authorities to do their job more effectively. Relevant information includes early word about route locations, traffic forecasts, design capacities, and trip-generating characteristics of different land uses. Elements of leadership that can be supplied include a clear understanding of the intended purpose of a highway in a particular area—for example, for tourist travel or commuting, or to bypass urban traffic congestion—and ways that localities can maximize the opportunities afforded by nearby highway facilities. In some instances (e.g., Alabama and Pennsylvania), this leadership has been



provided in part by state university spokesmen, especially from universities involved in analyzing the economic opportunities afforded by nearby highways.

Eminent Domain and Police Power.—As in the matter of which level of government should administer land-use controls, the type of controls that might be most appropriate for interchange areas has received a great deal of attention. Of all the legal techniques available, only the power of eminent domain and the police power have received much use along highways. Up to the present time the police power has, of course, been used more than the power of eminent domain to guide development in interchange areas.

The police power, involving a reasonable regulation of property with no payment to the owner, is exercised through such measures as zoning, subdivision regulations, mapped streets, setbacks, and driveway controls. Of these, zoning is the most common and best known.

The problems and shortcomings of zoning are fairly well known. In brief, zoning is generally not able to withstand economic pressure very long. Zoning has been likened (17, p. 25) to weeds in a garden requiring "constant attention which is difficult to sustain over a long period of time. . . . Zoning is vulnerable to review, change, and pressure from special interests."

These zoning problems have been well documented. For example, in the AASHO-NACO survey, Montgomery, Prince Georges, and Howard Counties, three fast-growing counties in Maryland which are crossed by an Interstate highway, appear to have nearly all of the land-use controls about which the questionnaire inquires. But the existence of these controls has not safeguarded areas in these counties from land-development problems. That these problems may be fairly common is suggested by a University of Washington study, as well as by other studies. Information concerning the disposition of rezoning applications from some 41 municipalities during the survey period shows that an applicant for a rezoning had a 61 to 80 percent chance of getting what he wants in the first application. The study found that "the situation is similar for rezoning activity adjacent to or near interchanges in six cities and counties studied in detail through field work." This problem of rezoning is, of course, only a part of the overall problem. Fully as important as this is the problem of inadequate enforcement of zoning and other land-use control measures. As the Washington University study (17, pp. 10-23) stated, typically, building departments and planning staffs do not make systematic checks of land use against the zoning map. Public prosecutors act only when requested to do so either by the administrative unit concerned or by a complaining citizen.

Experience in New Orleans and Philadelphia shows a similar pattern of zoning appeals and exceptions. Of 963 cases studied in a recent year in New Orleans, 90 percent were granted. Of 256 cases heard in Philadelphia, only 47 were refused. It is interesting to note that for the 30 persons appearing in person, the appeals each took an average 18 minutes compared with 3½ minutes for those absent (11).

The advantages of zoning are also fairly obvious. It can slow the pace of development until more intensive measures can be provided, and it can affect the density of development. Zoning can also be especially effective in helping to stabilize land use following redevelopment.

Subdivision regulations, another police power, are also being used to a considerable extent, though not as widely as zoning. The utility of subdivision regulations appears to stem largely from the fact that these regulations affect developers at a time when they are still able to make changes in the subdivision and then pass any increased cost along to the buyers.

The power of eminent domain, involving the payment of public money for certain property rights, can also be effective for controlling land use. For purposes of land-use control, the power of eminent domain involves such techniques as development rights, easements, purchase and leaseback, and excess condemnation. The primary advantage of these methods of controlling land use appears to be the simple enforcement. Since an agreement by which landowners transfer redevelopment or other rights has the power of a contract, violations of these rights are not likely to occur.

The main disadvantage of controlling land use by means of eminent domain is the high cost. For example, costs for redevelopment have been found to range from 13 to 84 percent of the market value in fee simple along portions of the Mississippi River

Parkway in Wisconsin and along some parts of the Natchez-Trace Parkway in the South (17, p. 37). And an easement forbidding high-rise apartments on a 47-acre site along the Potomac River adjacent to Washington, D. C., was valued at \$750,000 by a jury, even though the cost of the property in fee was only \$650,000 a short time before (18). There appears to be general agreement that when the cost of purchasing certain rights to control the use of the land approaches the cost of purchasing the property in fee, it is preferable for the public agency to purchase the property outright; later, if all or part of the property is sold, development can be controlled by some means such as restrictive covenants.

A package containing both police power and eminent domain techniques appears to be the best answer for guiding economic development near interchanges. For example, Horwood suggests a package with zoning, land redesign, and the acquisition of access rights. Acquisition of access rights is ordinarily less expensive than most other eminent domain techniques of land-use control, but can be effective if used carefully. For example, access rights can be purchased only for industrial or other uses considered potentially hazardous to interchange traffic capacity, and still leave the landowner free to develop the land with some other use. An example of an apparently successful combination of the police power and eminent domain has been reported in Tennessee where, if a building permit is requested that would interfere with future highway building, the land involved is acquired by the highway agency (19). Such a fusion of police power controls and eminent domain appears to offer optimum protection for both the public interest and the private property owners' rights.

Certain land-use controls which are being adapted from other situations may also offer some help for the interchange problem. For example, studies in Minnesota and Illinois have proposed that only those uses which require a highway location should be permitted to be in such locations. This concept has a precedent, among other places, in "Waterfront Districts" which recognizes a harbor or similar facility as a natural resource in which the community has a vested interest. In the same way, an Interstate highway could be recognized as a transportation resource in which the whole community has an interest (20). Another possible approach which is not new is to use development performance standards to limit the amount of traffic permitted by large traffic generators, for example, along the lines of the standards now employed to determine when establishments exceed permitted levels of smoke, sewage, odors, or noise.

### Priorities for Interchanges

The job of providing land-use planning for all interchange areas seems almost overwhelming. Like most formidable jobs, however, it becomes manageable when approached one part at a time. If the parts of the interchange problem are to be considered in logical order, suburban interchanges near the fringes of urban centers appear to deserve attention first. These interchanges are more likely to undergo uncoordinated development of land than interchanges in urban or rural areas. In rural areas, land development problems can be expected to be fairly mild. Urban interchanges, on the other hand, may feel some pressure for economic development; however, these urban interchange areas are more likely to have general land-use controls available and to have the use of more of the surrounding land already fixed.

A study in Georgia has demonstrated the usefulness of a system of priorities for focusing attention on the interchanges which need solutions first. This study analyzes interchanges according to their location (urban, rural, suburban) and the type of crossroad (primary, secondary, etc.), and develops a priority system to indicate just how critical the need is for county planning. Counties in Priority 1 are those which have portions of the Interstate completed or due for completion by 1965 and which have unincorporated areas not subject to planning commissions. Priority 2 generally includes those counties which will not have a portion of the Interstate System completed until after 1965. Priority 3 includes those counties which have programs deemed adequate for controlling land use. The need for fast action in the interchange problem is suggested by the fact that 50 percent of the 58 Georgia counties through which the Interstate Highway System passes have been placed in Priority 1, that is, with an Interstate



highway but without adequate land-use planning protection. Only 10 percent of the 58 counties were judged to have adequate land-use control programs (21, pp. 83-88). Figures 2 and 3 show the priorities assigned to Georgia counties crossed by the Interstate System and Georgia counties with planning commissions.

Priorities of a somewhat similar type have been developed in Pennsylvania, Michigan, Minnesota, and by the committee of AASHO-NACO referred to earlier. In Pennsylvania, interchanges have been listed according to whether they will occur in cities, boroughs, first class townships, or second class townships. In addition, highway locations and county planning commissions have been related to one another, e. g., by means of maps as in Figure 4. The interchange priorities system for Michigan involves redesign and reconstruction of interchanges rather than land planning in the surrounding area. It is interesting to note, though, that some of the conditions justifying redesign are matters that could have been alleviated earlier by land planning; for example, a change in nearby land use bringing a sudden jump in traffic volumes (3, p. 3).

In the Duluth, Minn., study, a priority system has also been established for land-use planning. This priority system consists of: (a) immediate actions prior to Interstate construction; (b) actions with Interstate construction; and (c) future actions (20, pp. 14, 66-69). The NACO-AASHO survey of interchanges has provided general information showing the availability of land-use planning techniques in fast growing and/or urban areas with Interstate routes, counties which might be regarded as high priority because interchange problems there are expected to be more critical than they are in rural areas.

### Space Needs at Interchanges

The amount of the land made available for development at interchanges which will be used and the type of use this land will be put to appears to be the crux of the interchange problem. Garrison has estimated that by 1980 intensive land development will occur near the interchanges of large metropolitan areas but that in small urban centers the supply of land near interchanges will exceed the demand (22). Space needed for residential development is expected to exceed greatly that for the other specified uses,

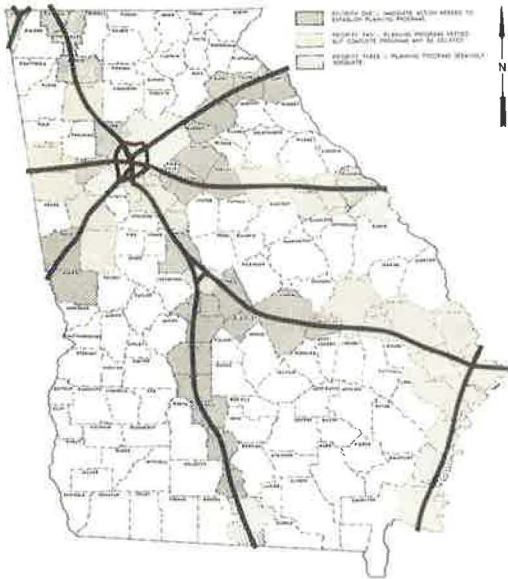


Figure 2. Priorities for county planning in Georgia for land-use planning controls along the Interstate Highway System (21).

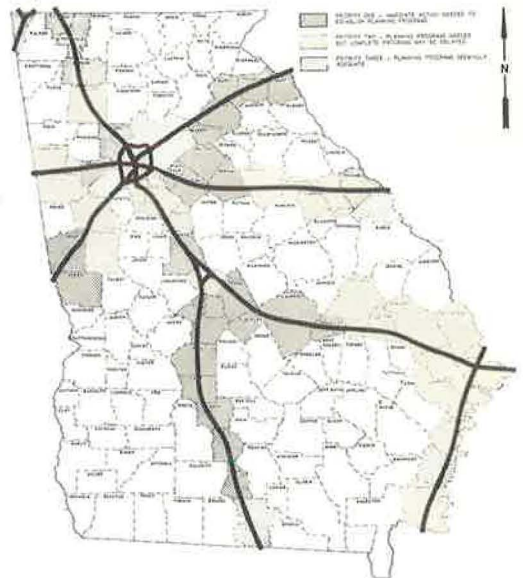


Figure 3. Counties of Georgia with official county or joint city-county planning commissions (21).

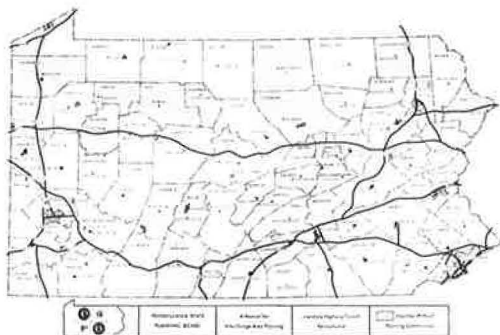


Figure 4. Interstate highways in Pennsylvania and counties without planning commissions.

industrial and shopping centers. Although the space needed for shopping centers is by far the smallest of the three uses, this use needs careful coordination with interchange plans because of the high traffic-generating characteristics of shopping centers.

Space needs for highway services in interchange areas have received special attention. For example, studies in Minnesota have related the amount of space used for highway services to the traffic volumes along the highway. Using this information and traffic projections for 1975, the study in Duluth has estimated the amount of space needed for highway service near certain interchanges. For example, an expected 45,850 average daily traffic in 1975 calls for about 4,400 lineal feet for highway service at one interchange in

Duluth (20, p. 30; 23). Pennsylvania researchers have gathered information from interchange sites concerning the relative frequency of service stations, restaurants, and motels. It was found to be 21:14:10, i. e., 21 service stations to 14 restaurants to 10 motels (24). And in a study in Wisconsin, auto service and food service were found to constitute 66 percent of all roadside establishments (14, p. 43). It is no doubt obvious that existing space allocations near interchanges can only be of limited usefulness in estimating space needs for highway services because of the apparent tendency of some oil companies to obtain more space for service stations than will be needed in the immediate future.

In addition to the amount of space devoted to highway services, it is important for interchange planning to know the preferred location of highway services relative to the interchange. Several studies have indicated that the most desired location for highway services is the first quadrant of an interchange on the right-hand side when leaving an urban area, apparently because service facilities can be reached without making left turns, even on a diamond interchange. The first quadrant on the right-hand side when approaching, rather than leaving, an urban center has also been found desirable (4, p. 13; 25).

The use of frontage roads has in some cases efficiently provided space for highway services, for example, in the Duluth area and in many areas in Texas. In some cases the frontage roads also serve as traffic reservoir areas and assist in alleviating traffic backup on exit ramps (26). A perennial problem with frontage roads is that they may magnify roadside control problems if they are used in nonurban areas where strict land-use controls are not available.

#### AN ANSWER FOR ALL INTERCHANGES

The bulk of the 14,000 Interstate interchanges will be in rural areas. In many of these rural interchange areas there is little land-use planning beyond crop rotation and, in fact, no agency or individual available to administer land-use planning legislation even if it were to be enacted.

Some thought has of course been given to what can be done to provide effective land-use control in the absence of land-use planning by local authorities. In some states (e. g., California and Florida), legislation has been provided for interchange districts on a limited basis. In a number of states, the state highway agency is relied on to help administer or police subdivision regulations, roadside zoning, driveway controls, or some similar land-use control measure. And more sweeping land-use control measures in rural interchange areas have been considered; for example, it has been proposed that existing land uses around interchanges be frozen by state action until an acceptable land-use plan is evolved, either by local or state action. The effect of such a freezing or fixing of existing land use would apparently be quite similar to the results of agricul-



tural zoning where this exists. Both approaches would probably dampen land development activity, as is intended.

An alternative plan would be to permit economic development in interchange areas until the time when traffic volumes on the feeder road and/or at the interchange approach design volumes. When this occurs, it seems reasonable to expect highway builders to take action to prevent further deterioration at the interchange. The problem is what action to take. In the past, the situation has sometimes been permitted to get out of hand to the point where the only solution has been to redesign the interchanges. A better approach would seem to be to limit development to what the highway facility can be expected to accommodate, perhaps by permitting no additional driveways onto feeder roads within a certain distance of the interchange.

This is obviously a modest approach. It would permit localities to misplan or ignore interchanges unless the land uses nearby threatened to overwhelm the interchange with traffic. The suggestion is not worthwhile as a substitute for more adequate plans already in existence or planned. It is intended only to replace the lack of any organized approach, a situation existing in many rural interchanges at the present time.

An advantage of acting to restrain development only at those rural interchanges where traffic congestion threatens is that it would concentrate land-planning effort to those interchanges where attention is needed. Many rural interchanges may never experience any appreciable development, and it seems unrealistic to expect that a land-use plan will be developed for each interchange. Although a land-use plan in sparsely populated rural areas might be quite simple, the effort that is available for guiding roadside development probably needs to be channeled to locations urgently needing guidance.

A serious disadvantage of such a hands-off type of approach at interchanges is that it may permit some rural interchanges to develop into honky-tonk, junkyard eyesores. Because of this, more effective land-use planning should be fostered wherever this is realistic. But if past experience is any guide, land-use planning can be expected to continue to lag behind highway construction.

For urban and suburban areas, nearly any combination of these land-use control devices can provide a satisfactory solution if they can be enforced. To guide interchange development in either urban, suburban, or rural areas, the big need appears to be for more specific information. Much of this information is of a type that local authorities have a right to expect from highway builders; for example, traffic-generating characteristics of certain land uses, design capacities of highway facilities, and compatible and incompatible land uses in interchange areas. Several states, through their interchange pamphlets or manuals, movies, speakers, and other media, have provided communities with at least some of the vital information regarding such factors as driveway spacing and service roads (Fig. 5). Undoubtedly, more specific information of this type would result in more effective local planning and land-use control.

Existing land-use controls can apparently also be made to function more efficiently if better cooperation could be achieved between interested agencies. For example, at a recent rezoning to permit construction of a 16-acre amusement park and swimming pool on a busy approach road to a major highway facility, only local residents and the amusement park builders appeared. Perhaps highway builders could assume more responsibility to see that heavy traffic-generating uses do not encroach on highway facilities. Another possibility for cooperative action exists with the Federal Housing Authority. At least in a few instances, the Federal Housing Authority can apparently help prevent development on future highway right-of-way by refusing to participate in the financing.

#### ADDITIONAL INFORMATION NEEDED

The interchange research completed so far has obviously not provided all the



Figure 5. Desirable type of setback (39).

answers needed to solve the interchange problem. In some cases, the approaches recommended in the various studies have differed. For example, the Georgia study favored land planning primarily at the local level contrasted with the approach recommended in most studies that important responsibility for land-use planning be lodged with a state agency. One conclusion on which there appears to be complete agreement is that more needs to be learned to solve the interchange problem. One of the more obvious overall gaps is the absence of criteria and guidelines needed to apply the various legal techniques available to reach the overall goal. At the present time, there appears to be general agreement concerning the ultimate goal—orderly, properly functioning interchanges. There is also a fairly satisfactory understanding of different land-use control measures available, e. g., zoning and redevelopment rights. But the principles of desirable land-use arrangements near interchanges are still not settled, at least not completely. It is almost as if the way to plan (the legal techniques) has been learned but what to plan (the desirable arrangement of land use) is still unknown. What appears to be urgently needed now is specific information about matters such as land uses suitable for interchange locations, which uses are good neighbors in an interchange setting, trip-generating characteristics of land uses near interchanges, space needs for highway services, and ways of putting into use what research has demonstrated to be good practice.

### Trip-Generation Characteristics

Most studies of interchange development involve some attempt to determine whether traffic using the interchange will be able to be accommodated. Such an analysis requires fairly specific information about trip-generating characteristics of land uses served by the interchange, what the area is that is served by the interchange, and traffic capacity of the interchange. In the past, there have been problems in getting specific information on any of these three items, including traffic assignment data (8, 9). Information now available is still far from satisfactory. For example, there is general agreement that the interchange area should be the area of origin and destination for trips using the interchange. Although this concept is pure, it is unwieldy, and some zone based on experience of typical interchanges will probably need to be used. Trip-generation characteristics of different land uses near interchanges are becoming available, at least on a fragmentary basis. Thus, although there is little specific information available concerning the trip-generating characteristics of such highway user services as service stations, motels, and eating places, experience has shown that these uses rarely have a traffic-generating pattern that conflicts with the urban work trip. In at least one study, fewer vehicles turning into service stations caused interference to traffic than was the case for restaurants, motels, residential, commercial, 15 percent interference turns for service stations vs 24 percent interference turns for other uses surveyed (27). Some of the reasons for this are no doubt obvious, e. g., open spaces around service stations, or numerous service stations so that left turns and waiting to enter can ordinarily be avoided.

Some trip-generation information pertinent to interchange planning is also available for shopping centers. For example, regional shopping centers staying open in the evenings apparently have their peak traffic around 8:00 PM (28, 29), neighborhood shopping centers appear to have their peak loads earlier in the evening (30); shopping centers need to be a substantial distance from ramp ends and they should be placed where left turns can be avoided on the trip home from work (21, pp. 39-40). Figure 6 shows a shopping center located too close to a ramp exit. Vehicles must make right turns into the parking lot in front of traffic coming from the freeway ramp. The hazards would have been substantially reduced if access had been prohibited for 500 feet beyond the end of the ramp, rather than only 240 as it was. This situation is, of course, more dangerous on exit ramps than on entrance ramps.

The urban transportation studies now under way are likely to be a useful source for traffic-generation characteristics. For interchanges at varying distances from large urban centers, it seems important to have trip-generation information by density as well as by land use. Such information from urban studies in Chicago, Pittsburgh,





Figure 6. Example of inadequate access control on a crossroad beyond end of ramp.

Detroit and the Twin Cities is summarized in Figures 7 to 11 (38). Density, or distance from downtown appears to have a fairly noticeable effect on most of the uses classified. In addition to valuable trip-generation data, the experience which urban transportation studies are developing with comprehensive planning should be useful in dealing with interchange development problems generally, including interchange areas outside urban areas. In addition, experience being gained through the Urban Renewal Administration's "Workable Programs for Community Improvement" may prove helpful in solving interchange development problems (31).

For analyzing and anticipating land-development problems at interchanges, traffic-generation characteristics for nearby land uses obviously need to be supplemented with information about the amount of traffic which actually uses the interchange and information about the percentage of crossroad traffic on the feeder road making use of

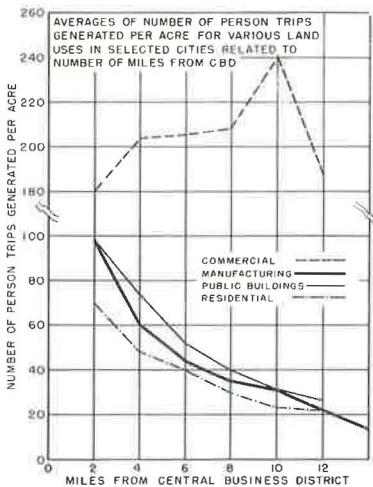


Figure 7. Averages of number of person trips generated per acre for various land uses in selected cities related to number of miles from CBD (38).

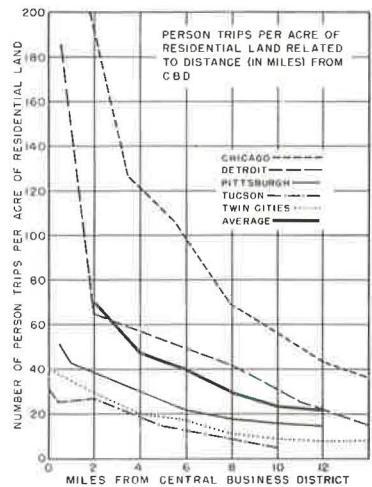


Figure 8. Person trips per acre of residential land related to distance (in miles) from CBD (38).

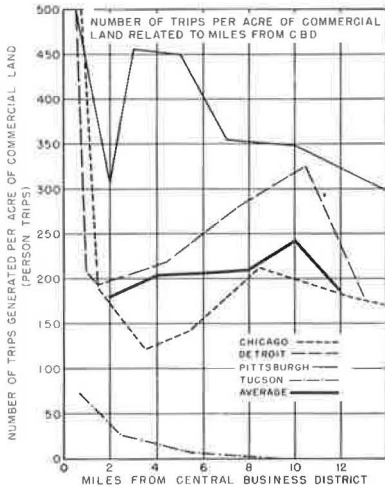


Figure 9. Number of trips per acre of commercial land related to miles from CBD (39).

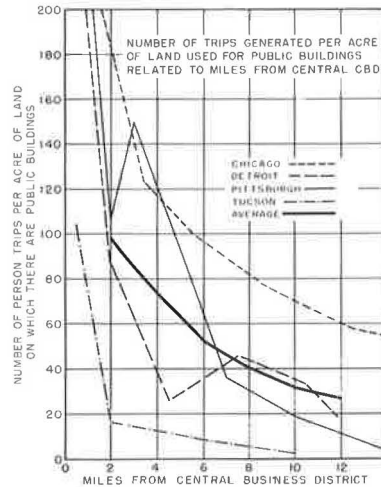


Figure 10. Average (excluding Tucson) person trips per acre of manufacturing related to miles CBD (38).

the interchange. This obviously can vary, for example, up to 100 percent if the feeder road deadends at the interchange (14, p. 47).

To spread the traffic burden at interchanges, a variety of land uses appears desirable. However, such a variety of land uses at interchange areas may create other problems, for example, the necessity for shoppers to travel some distance to reach similar type stores. This question resembles most of those referred to previously: it needs more research.

### Compatible and Incompatible Uses

There is hope that many of the land-use problems arising at interchanges can be solved by excluding incompatible uses from the interchange area. The general principle of compatible and incompatible uses has, of course, been used before the time of the interchange problem. The application of this principle in interchange areas presents some problems and emphasizes the need for more research. At the present time, information available on compatible uses appears to be contradictory in some respects, no doubt because it is still incomplete.

It has long been axiomatic in city planning theory that like things belong together. For example, food wholesalers located together permit careful buyers to visit several establishments with a minimum of travel. Such highway-oriented establishments as service stations, restaurants, and motels are ordinarily regarded as compatible because they have common customers. Having such compatible uses near one another, preferably in the same quadrant of the interchange to obviate the need for crossing the interstate or the

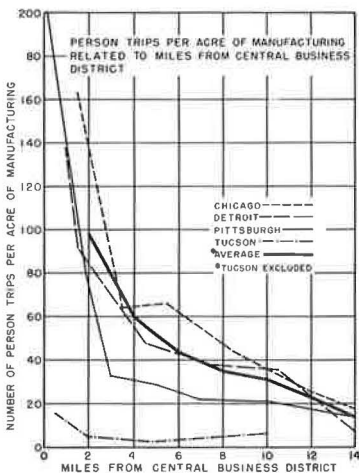


Figure 11. Number of trips generated per acre of land used for public buildings related to miles from Central CBD (39).

feeder road, seems reasonable as a goal and has been achieved in many locations.

The principle of grouping like or compatible uses together, however, may need to be applied to interchange areas with some restraint. For it is obvious that "a land use arrangement which has a variety of uses is superior to one which has segregation of uses; variety spreads the traffic burden while segregation concentrates it (32). For example, a factory and a machine shop may be compatible but their proximity to one another and to an interchange may aggravate traffic problems during the morning and evening peak traffic periods.

Research findings are already suggesting ways to reconcile these two principles, i. e., like uses are compatible but a variety of uses spreads the traffic burden. If different quadrants of an interchange are put to different uses, both principles can apparently be served. Thus, perhaps such low traffic generators as motels can be located in one quadrant and a factory, with heavy peak traffic loads, in another. Such an arrangement would not, however, accord with another concept receiving some attention at the present time, that some interchanges should specialize in highway services and others in community services.

A good deal of additional research is needed, however, to learn more about the conditions under which certain uses are compatible and incompatible. For example, the general belief that highway user service facilities are compatible may need to be revised. At one interchange, an overnight facility for horses traveling by trailer or truck has appeared. Although this is apparently a highway-oriented business, it is probably incompatible with such highway-oriented businesses as motels and restaurants. Also complicating the concept that highway-oriented businesses are compatible are the motels serving as community and convention centers as well as tourist stops. The traffic-generating characteristics of such motels no doubt differ from those of motels catering only to highway travelers.

The concept of compatibility can also be applied to compatibility between the interchange and certain types of use. Perhaps what needs to be kept in mind is that some establishments appearing at interchange locations do not need to be there and in fact may be harmful to the interchange or may be harmed by it. For example, auto junkyards, though low traffic generators, should probably be kept away from interchanges for obvious reasons. For different reasons, such uses as schools and churches may find interchange locations less desirable than others, for example, a location along a limited-access highway between interchanges with access away from the highway or by means of a frontage road. Such a location would permit the institution to realize the benefit of being on display along a modern highway, of having an easily remembered address (e. g., near a certain interchange or exit number), and of being easily accessible to neighborhood walkers. It seems fairly obvious that considerable additional experience and research are needed to learn just which uses are compatible with one another and with the highway.

### Space Needs Near Interchanges

Additional research is also needed to learn whether the need for user services or other vital needs are being satisfactorily anticipated. There is general agreement that space for user services should have priority and that other uses, such as residential, should not preempt space that may be needed for highway services. So far, because of the aggressiveness of oil companies in acquiring building sites, there appears to be little if any danger of a shortage of space for service stations.

But the need for space for other highway services is not receiving adequate attention. For example, off-street parking at strategic locations near interchanges for assembling in car pools is becoming fairly common in outer suburban areas of large cities and this need should be recognized and met. At present, haphazard parking along sides of feeder roads, for example, has several bad effects: snow removal and maintenance are impeded, landscaping may be damaged, capacity may be reduced on the crossroad, and drivers' sight distances may be reduced so that the accident potential is increased. Little specific information is available on this problem. One study indicates (a) that interchanges where such parking occurs need space for about



5 to 10 cars; (b) that such parkers typically travel 30 miles to work, one-fourth of it before reaching the interchange; and (c) that the average carpool assembling at such interchanges contains 3.5 members (33). The wisdom of alleviating downtown traffic problems by encouraging such carpooling seems obvious.

Additional research effort is needed to learn generally what the future space requirements will be for such highway user services as motels and service stations. The use of traffic forecasts to estimate space needs for these highway user services needs testing. Such relatively minor problems as parking to rendezvous in carpools need to be studied to learn how this need can be anticipated, for example, by considering population densities and social and economic characteristics. Information about workable solutions to the problem should also be gathered and analyzed. For example, a few shopping centers now apparently welcome all-day parkers. This solution, though not applicable for interchanges in outer suburban areas where no shopping center parking may be available, seems promising, since commuter parking normally ends between 5 or 6 PM, before peak shopping center parking around 6 to 8 PM.

### Techniques to Implement Interchange Planning

There appears to be some impatience with local government for failing to provide adequately for orderly development in interchange areas. But local officials cannot always be ready to supervise development suddenly brought into being by highway construction. Furthermore, the facts a local government needs to deal effectively with some of the land-use problems in interchange areas often can come only from a sophisticated regional planning operation, from urban transportation studies, or from a state highway agency.

There are, however, situations where enough is known to make it fairly clear that local land-use control would be desirable. A few of the incentives used to encourage local government to act have included: (a) state grants to localities to cover costs of administering land-use controls; (b) state highway improvements conditioned on the existence of an acceptable local land-use plan; and (c) tax relief for developers using good design, when good design can be agreed on (34).

As suggested earlier, one of the best ways to encourage local land-use planning is to provide the information and technical assistance necessary. It will no doubt also be worthwhile to illustrate and make explicit from time to time general truths about transportation and land-use relationships; for example, (a) highways sustain land values only so long as there is a reasonable balance between the capacity of the highway and the uses to which the land is being put (35) or (b) good aesthetics is good economics. Studies in Pennsylvania and Texas especially have emphasized the close relationship existing between good aesthetics and good economics, the fact that unsightly interchanges are likely to suffer in competing for the tourist trade with well-planned interchanges. In a study near Dallas, the close relationship between the high development standards and the sound economic development in one town (Richardson) was demonstrated convincingly, especially when the results were compared with other nearby towns with lower development standards (36).

### Need to Quantify Data

Some of the information which has emerged from interchange research has been presented in numerical form. Such quantification, though it may have limitations, permits comparison between study findings in different locations and ultimately should facilitate certain administrative decisions. The attempt, for example, that has been made to compare redevelopment costs with the cost of acquisition in fee could obviously be useful in making a decision as to which approach to use (17, p. 37). In another analysis, the cost of not having some such device as roadside zoning was reduced to a numerical value by taking the \$0.05 of each highway dollar spent to remove structures from highway right-of-way and applying this to the \$500,000 being spent to modernize the system over a 20-year period. The resulting \$25,000 could be regarded as the cost of not having some type of land-use control to prevent structures from being erected on land to be used for highway right-of-way. Other useful types



of quantification of aspects of the interchange problem include the data on rezonings presented by Horwood and his colleagues, data which Adkins and Pendleton and others have presented on annual percentage changes of land use in interchange areas (8, p. 4-17; 37), and information associating development trends for certain areas with the number of new driveways (2, p. 70).

### A Study Approach Needed

One of the useful findings from interchange studies completed so far is a fuller realization of just how complex the interchange problem is. In at least one study, the general hypothesis that there tend to be problems in interchange areas not subject to public control of land planning was not proved (8, p. 20). As noted, there are a number of instances where interchanges without land-use controls have developed with no significant traffic congestion and other interchanges with land-use controls available which have become land development and traffic problems. What is apparently needed is a case study approach, a study in depth. This will permit delineation of the area of origin and destination for the traffic using the interchange. It would help explain the extent to which land uses a considerable distance from the interchange may generate traffic which makes use of the interchange (e.g., hospitals).

Studies in the detail necessary to understand all aspects of the interchange area will apparently require considerable research effort. To assist in selecting interchange areas for studies in depth, use can be made of large-scale approaches, that is, those involving a large number of interchanges, such as aerial surveys, mailed questionnaire surveys, or land-use inventories made while driving through an interchange. Broad-scale studies of this type can also be useful in gathering information on secondary but important aspects of the interchange problem including (a) optimum distances for controlling access along the feeder road; (b) whether orderly development and a sound tax base tend to be associated with adequate land-use controls; (c) whether interchange areas tend to become specialized, for example, with tourist services, or community services; (d) how well such needs as commuter parking and highway services are being met; and (e) which interchanges are developing rapidly and are perhaps in special need of land-use planning.

### SUMMARY

Interchanges present the locality in which they are located with both an opportunity and a potential problem. The economic activity which may be attracted to the interchange area can be beneficial if it develops in an orderly way. But the development may be a source of problems if it is not planned.

The interchange studies completed so far have been useful in the following ways.

1. They have focused attention on land development matters in interchange areas.
2. They have provided a priority system so that planning effort can be directed first to interchanges of critical need.
3. They have shown how complex the interchange problem is, for example, because of traffic generated in areas remote from the interchange.
4. They have analyzed land-use controls pertinent to the problem and have even suggested such new methods as licenses on a need-to-be-there basis and criteria for maximum amounts of traffic that will be permitted from certain establishments.
5. They have evaluated the effectiveness of different land-use controls in interchange areas, suggesting that eminent domain techniques are more promising than the police power.
6. They have provided guidelines for determining space availability and space needs for highway services and other uses at interchanges.

One of the shortcomings of some interchange studies completed in the past is the failure to consider what can be done in the absence of land-use planning in the interchange area. For interchange areas unprotected by local land-use planning, it seems reasonable to freeze any future development near an interchange when traffic capacities of the interchange ramps threaten to be exceeded. Such a provision could be

enforced in a number of different ways, for example, by permitting no additional drive-ways onto the feeder road near the interchange when traffic volumes approach capacity.

Additional information urgently needed includes the following:

1. Amounts and types of traffic generated by different land uses near interchanges;
2. Amount of interchange space needed for service stations, motels, and other uses;
3. Which uses are compatible and which are incompatible;
4. Whether it is good practice, as is supposed, to have similar uses, such as highway service facilities, in one quadrant of an interchange and a different use, such as industrial, in another quadrant;
5. Whether well-planned, pleasant-appearing interchanges do in fact have a better economic future than poorly planned interchanges; and
6. Whether more attention should be given to such highway needs as rest areas and signs indicating highway services.

To obtain the necessary information for interchange areas, studies in depth and of broad coverage are needed. Surveys involving a fairly large number of interchanges should be helpful in selecting interchanges for a suitable analysis in depth and would also provide information about such aspects of the problem as driveway openings near interchange ramps, and highway service facilities. As far as possible, research findings should be quantified; for example, given in percentage changes of land development, lineal feet or square feet needed for highway services, cost of controls through eminent domain procedures, or percentage of zoning appeals granted.

#### REFERENCES

1. Ottoson, Howard W., ed. Are Land Use Conflicts Growing in Number and Intensity? *In* Land Use Policy and Problems in the United States, p. 293. Lincoln, Univ. of Nebraska, 1963.
2. Covey, Frank M., Jr. Roadside Protection Through Access Control. Chap. 7. Thesis, D. Jur. Sci., Univ. of Wisconsin Law School, March 1960.
3. Neve, James P., Jr. A Scorecard for Interchanges. *Traffic Eng.*, Vol. 32, No. 12, Sept. 1962.
4. Interchange Area Development. HOP Comm. of Ohio, representatives from Ohio Dept. of Highways, Oil Ind., and Ohio Planners Conf.
5. The New Four Corners. Michigan State Highway Dept., Off. of Planning.
6. A New Front Door For Your Community. Pennsylvania State Planning Board, Harrisburg.
7. Wild, Carl. Speech at groundbreaking of Keystone Shortway, Brookville, Pa., March 19, 1959.
8. Adkins, William G. Studies of Land Development at Interchanges. *Texas Transp. Inst.*, June 1962.
9. Horwood, Edgar M. Socially-Oriented Concern. *In* Land Development Policy at Highway Interchanges, Vol. 5. Univ. of Washington, Dec. 1961.
10. Highway Access Areas in Tennessee. Tennessee State Planning Commission, Nashville, 1962.
11. Delafons, John. Land Use Controls in the United States. Joint Center of Urban Studies, M. I. T. and Harvard Univ., 1962.
12. *Municipal Yearbook*, 1963. Int. City Managers' Assoc., Chicago, Ill.
13. Resumé of questionnaire submitted to all states. Pennsylvania Dept. of Highways, July 1960, unpubl.
14. Covey, Frank M., Jr. Freeway Interchanges: A Case Study and an Overview. *Marquette Law Review*, Vol. 45, No. 1, Summer 1961.
15. Subcommittee No. 2 of AASHO-NACO. Planning Control of Development Near Major Interchanges in Rural and Urban Outer-Fringe Interchanges. U.S. Bureau of Public Roads, Nov. 1964, unpubl.
16. Powers, Leroy. Regulation of Access vs Control of Access in Oklahoma. Highway Research Board Bull. 140, pp. 55-59, 1956.



17. Graves, Charles H., Horwood, Edgar M., and Rodgers, Clark. The Interchange Problem. In *An Evaluation of Land Use Controls at Freeway Approaches*, Vol. 3. Univ. of Washington, Transp. Res. Group, Dec. 1961.
18. Washington Post, Sept. 22 and 25, 1964.
19. Stanhagen, William H. Highway Interchanges and Land-Use Controls. Highway Research Board Bull. 288, pp. 32-60, 1961.
20. Flaherty, Mark C. Highways—Opportunities and Land-Use Controls. Minnesota Highway Res. Proj., 1964 (draft).
21. Atkinson, Harry W., and Menhinick, Howard K. Methods of Land-Use Planning and Regulation on the Interstate Highway System. In *Land-Use Planning and Control Along the Interstate Highway System in Georgia*. Georgia Inst. of Tech., Atlanta, July 1963.
22. Garrison, William. Supply and Demand for Land at Highway Interchanges. Highway Research Board Bull. 288, pp. 61-66, 1961.
23. Borchert, John R. Beltline—Commercial Industrial Development. Univ. of Minnesota, Nov. 1960.
24. Twark, R. D., and Sauerlander, O. H. A Predictive Model of Growth and Interchange Sites. Pennsylvania State Univ., Prog. Rept. p. 4, 1964, unpubl.
25. Davis, John T., and Ames, David L. Parkway Impact Study—An Investigation of the Effects of Parkways in the National Capital Region. Pp. 80-98, George Washington Univ., 1962.
26. Hess, Joseph W. Capacities and Characteristics of Ramp-Freeway Connections. Highway Research Record No. 27, pp. 69-115, 1963.
27. Wolfe, R. I. Effects of Ribbon Development on Traffic Flow. *Traffic Quarterly*, Vol. 18, No. 1, p. 44, Jan. 1964.
28. Hansen, Walter G., and Silver, Jacob. Characteristics of Travel to a Regional Shopping Center. *Public Roads*, Vol. 31, No. 5, pp. 101-108, Dec. 1960.
29. Cleveland, Donald E., and Mueller, Edward A. Traffic Characteristics and Regional Shopping Centers. Yale Univ., Bureau of Highway Traffic, 1961.
30. Burton, Robert C., Edens, David G., and Knapp, Frederick D., Jr. Socio-Economic Impact of the Capital Beltway in Virginia Before Study. Univ. of Virginia, Bur. of Population and Econ. Res., 1963.
31. Weaver, Robert C. Current Trends in Urban Renewal. *Land Economics*, Vol. 39, No. 4, Nov. 1963.
32. Mitchell, R. B., and Rapkin, C. A Function of Land Use. In *Urban Traffic*, pp. 175-177. New York, Columbia Univ. Press, 1954.
33. Gruenbaum, Michael T., and Hale, Peter P. Parking Conditions and Habits Near Expressway Interchanges. *Traffic Eng.*, Vol. 30, No. 9, p. 18, June 1960.
34. Meyerson, Martin. Face of the Metropolis. P. 236. New York, Random House, 1963.
35. Greeley, Roland B., Nash, William W., and Manheim, Marvin L. Interdependence of Transportation and Land-Use Planning. Chap. 6, p. 12. M. I. T., May 1961.
36. Adkins, William G., and Thompson, Russel H. Some Economic Effects of the Suburban Portion of North Central Expressway. *Texas Transp. Inst.*, Bull. 15, 1961.
37. Pendleton, William C., and Wagner, Robert R. Economic and Legal Aspects of Land-Use at Freeway Interchanges. P. 20. U.S. Dept. of Agriculture, Aug. 1960.
38. Bottiny, W., Eckartt, A., and Walsh, W. Summaries of Chicago, Detroit, Pittsburgh, Tucson and Twin Cities transportation studies.
39. A Manual for Interchange Area Planning. Pennsylvania State Planning Board.
40. Land Use and Development at Highway Interchanges: A Symposium. Highway Research Board Bull. 288, 1961. 82 pp.

## *Appendix*

### INTERCHANGE AND LAND-USE CONTROL STUDIES

Completed November 1964

Georgia.—The Georgia Institute of Technology, in cooperation with the Georgia State Highway Department and the U. S. Bureau of Public Roads, has completed a study entitled "Land Use Planning and Control on the Interstate System in Georgia." This study establishes a priority system for counties according to the need which counties have for land-use planning. Priority 1 consists of those counties without a planning commission but with an Interstate highway completed or due to be completed soon.

Illinois.—Barton-Aschman Associates, in cooperation with the Illinois Division of Highways, has prepared a study "Highways and Land Use Relationships in Interchange Areas," including supplementary reports. This study reviews pertinent interchange analysis and makes recommendations involving land-use control, design, and location matters. For land-use control, state action is recommended only when the community has "defaulted" in providing control of development in the interchange area. The study found that only 15 of 51 Interstate counties had zoning controls and that 25 percent of the 200 interchanges in Illinois have existing or potential traffic problems.

Kansas.—The League of Kansas Municipalities, in cooperation with the Kansas State Highway Commission and the U. S. Bureau of Public Roads, has completed a study of land-use and planning controls entitled "Planning Tools—Theory, Law, and Practice." This is a study of the theory and application of land-use and planning controls available to local governing units for developing safe and efficient streets and highways in Kansas.

Michigan.—The Michigan State Highway Department has prepared a report, "Interchange Development Along 180 Miles of I-94" which analyzes the development occurring near 66 interchanges within 3½ year after the freeway opened. In general, the report suggests that the experience of motels and service stations near interchanges justified the high prices paid for sites near interchanges.

Minnesota.—"Highways—Opportunities and Land Use Controls, A Case Study in Duluth" is a study prepared by the Duluth Department of Research and Planning in cooperation with the Minnesota Highway Department and U. S. Bureau of Public Roads. This study investigates the possibilities for coordinating highway planning and local land-use planning. The study recommends locations for interchanges, frontage roads and service facilities (e. g., service stations and motels). It also provides guidelines for determining space needed for highway services and describes types of land-use controls that might be appropriate in interchange areas.

Mississippi.—The University of Mississippi, in cooperation with the Mississippi State Highway Department and the U. S. Bureau of Public Roads, has completed a report entitled "A Planned Interchange in a Residential Area—Some Interim Influences." This report examines the influence which a planned (but uncompleted) freeway and a full cloverleaf interchange have on residential property values.

Pennsylvania.—Pennsylvania State University, in cooperation with the Pennsylvania State Department of Highways and the U. S. Bureau of Public Roads, has completed a study entitled "Planned versus Unregulated Development in a Suburban Community—A Case Study." This study reviews the problems that arise in the absence of effective planning in a community experiencing rapid growth and describes policies and programs that local government can utilize to solve growth problems related to highway development.

Tennessee.—The Tennessee State Planning Commission, in cooperation with the Housing and Home Finance Agency, has completed a report entitled "Highway Access Areas in Tennessee," a study of problems and suggestions to plan and guide land developments at interchanges by (a) new legislation to aid local governments within existing planning jurisdictions, and (b) a cooperative program for the State to initiate and local government to assume responsibility outside of existing planning jurisdictions.

Texas.—The Texas Transportation Institute, in cooperation with the U. S. Bureau of Public Roads, has completed a report entitled "Studies of Land Development at Interchanges." This report recommends that case studies in depth should be conducted using interchange areas where the land-use problem has definitely been demonstrated.



Virginia. —The Virginia Council of Highway Investigation and Research, in cooperation with the Virginia Highway Department and the U.S. Bureau of Public Roads, has completed Progress Report No. 4 of "A Study of the Economic Effects of the Emporia Interchange, Bypass and Business Loop." This study analyzes the economic effects on business, land value, and land use in the general area of the aforementioned facilities. A further report completed, "Economic Problems Emerging as a Result of Interchange Patterns on the Interstate Highway System of Virginia," describes the need for considering nonuser effects in justifying highway improvements, for example, at an interchange. This report also presents a model and a problem solution intended to show the relationship between interchange capacity, land-use development, land-use control devices, and construction and maintenance costs. For purposes of the problem solution, values are assigned rather than being based on experience.

Washington. —The University of Washington, Transportation Research Group of the Graduate School, in cooperation with the U.S. Bureau of Public Roads, has completed five volumes, Research Reports Nos. 21 through 25, in the general area of "A Study of Land Development Problems at Freeway Interchanges." The purpose of this study is to identify the land uses competing for sites in approach areas and areas adjacent to highway interchanges, the congestion and traffic-generating characteristics of such land use, the adequacy of present controls, and future needs at freeway approaches and highway interchange areas.

Wisconsin. —The University of Wisconsin, in cooperation with the Wisconsin State Highway Commission and the U.S. Bureau of Public Roads, has completed a report entitled "A Study and Evaluation of Local Highway Planning in Wisconsin." This study recommends changes in administrative practices and in the scope, detail, and technical content of both state and local long-range highway system plans. The key is provided in this report to integrating land-use and transportation planning in Wisconsin's rapidly expanding urban areas.

The Wisconsin Department of Resource Development has completed a study entitled "The Protection and Development of Interchanges on Wisconsin's State Highway System." The findings of this study indicate that the Interstate problem should be dealt with in the context of a comprehensive plan based on economic, population, land-use, and other data, the principal elements of which are land, transportation, and public facilities and services plans.

Nationwide. —A number of state highway departments and planning agencies have issued pamphlets or manuals intended to facilitate land-use planning at interchange areas. For example, Pennsylvania has issued "A Manual for Interchange Area Development Planning," and a pamphlet entitled "A New Front Door for Your Community." Michigan has issued a pamphlet, "The New Four Corners—Interchange Areas," and Ohio has issued a pamphlet, "Interchange Area Development." These deal with such matters as desirable driveway spacing, recommended setbacks, and the close relationship between good aesthetics and good economics. These, as well as a movie on land use at interchanges produced in Michigan, suggest to communities ways to use interchanges for economic betterment.

#### In Progress November 1964

Maryland. —Maryland is beginning a freeway interchange control study to determine and recommend an action program to be undertaken by the State Roads Commission in cooperation with local governments: (a) to preserve and improve the capacity and safety of the major highways interchanging with the Baltimore Beltway and other existing freeways, (b) to establish design and land-use standards and policies for development of adjoining access highways for other freeways in Maryland, and (c) to evaluate the combined needs for coordinated highway and land-development design standards, in the interest of highway safety and efficiency, as well as of optimum land development in the vicinity of major highway routes.

Mississippi. —Mississippi is conducting a study entitled "Control of Development of Interchanges." The study will investigate the best methods of controlling development at interchanges in Mississippi's urban and rural areas to plan those interchanges in a

way that will minimize the effect of business and residential interference with efficient traffic flow.

Nebraska. —The Nebraska Department of Roads is in the process of collecting data on land-use changes along I-80 between Lincoln and Omaha and preparing a study on land use near interchanges.

Oklahoma. —The University of Oklahoma Center of Urban and Regional Studies, in cooperation with the Oklahoma State Highway Department, is conducting a study of land-use patterns that now exist in the vicinity of highway and expressway interchanges at selected locations in urban and rural areas in Oklahoma. The purpose of Oklahoma's "Highway Interchange and Land Use Study" is to determine how interchange location affects land use and how different land-use patterns influence the capacity of the interchange.

Pennsylvania. —The Pennsylvania State University, in cooperation with the Pennsylvania State Department of Highways, is conducting a study entitled "The Impact of Highway Improvement on Land Use, Business Enterprise, and Community Development in Selected Areas of Pennsylvania." This study includes procedures for planning and predicting growth at interchange locations, for estimating quantitative measures of the extent to which growth can be explained, and for determining how social deterrents to planning and zoning activities can be overcome. A research model is now being assembled, processed, and analyzed for use in arriving at an optimum developmental plan. The study will also include an analysis of community receptivity to planning and zoning in 20 or 25 interchange communities along major expressways.

Utah. —Utah is conducting a highway interchange and land-use control study entitled "Land Use Adjacent to Interchanges."

Vermont. —Vermont is conducting a study entitled "Interchange and Land Use" which includes a study of interchanges on I-89 and I-91.

Washington. —The Washington Department of Highways is making an inventory of interchanges for certain highway-oriented business. It is expected that the study will cover businesses within 1 mile of interchanges.

West Virginia. —The University of West Virginia, in cooperation with the West Virginia State Road Commission, is conducting a study on "Land Use and Planning Controls in West Virginia" to improve and modernize standards, practices, and procedures for land-use and planning control.



# Interchange Development Along 180 Miles of I-94

ROGER H. ASHLEY and WILLIAM F. BERARD

Respectively, Economic Survey Officer and Assistant Economic Survey Officer,  
Michigan State Highway Department

All interchanges on 180 mi of freeway are analyzed and classified in relationship to the community. Guidelines are set up for predicting benefits. For each classification, the degree of development and the observed and expected land values are given. Business success of service stations and motels in relationship to an interchange classification is also analyzed.

•DOES EVERY interchange on a limited-access freeway develop benefits? The introduction of the freeways, and particularly the advent of the interstate program, have caused many appraisers, investors, and property owners to ponder this question. A number of studies conducted in Michigan and other states during the past several years demonstrated that benefits accrue at some interchanges. However, they did not provide a predictable pattern to use on other interchanges for anticipating changes in highest and best use or in estimating value increment. To help solve this problem, a 180-mi stretch of I-94 with 66 interchanges was selected because it extends as a freeway across the full width of Michigan and serves both rural communities and large cities (Fig. 1).

## STUDY BACKGROUND

The history of I-94 actually began in 1942 with the Detroit Industrial Expressway, constructed between Detroit and the west side of Ypsilanti,  $\frac{1}{2}$  mile east of US 23. The expressway had crossings at grade and points of direct access for the adjoining ownership. In 1956, the expressway was extended westward to the west side of Ann Arbor. This was constructed as a limited-access facility with interchanges and overpasses on the main roads. Several side roads entered at grade, but these were closed in 1963.

In 1953, another section was constructed which skirted the north side of Jackson. This was limited access with overpasses and several substandard off- and on-ramps. The substandard interchanges are being upgraded or eliminated. The three that are being eliminated have not been included in this study because the market reaction would reflect this factor.

With the advent of the Interstate Program in 1957, the remainder of I-94 was constructed to freeway standards. The entire freeway was opened to traffic on Dec. 19, 1960.

This study did not consider I-94 east of US 23 (Detroit Industrial Expressway) because of the various highway improvement programs instituted since 1952 by the Michigan State Highway Department. The changes included several new interchanges and the elimination of several at-grade intersections. This has undoubtedly influenced the market, and so might not give a true picture.

### Types of Interchanges

In the first step of this analysis, the 66 interchanges (see Land Economic Study No. 14 of the Michigan State Highway Department for individual interchange write-ups) were





Figure 1. Study site.

separated into four major categories: full, partial, closed, and terminal interchanges. Full interchanges are those which allow the motorist to leave the freeway when traveling in either direction, reach any quadrant, and then return to the freeway to continue in either direction. Partial interchanges are those which serve off-traffic in only one direction and allow on-traffic in only one direction. Closed interchanges occur at the intersection of two limited-access highways; adjoining land is accessible only by indirect or circuitous routes. Terminal interchanges are those in the area where the freeway is being terminated and channeled into noncontrolled-access highways. The percentage breakdown as to type of interchange is shown in Figure 2.

#### LAND-USE ANALYSIS OF FULL, PARTIAL, AND CLOSED INTERCHANGES

The variations of land uses among the full, partial, and closed interchanges were compared. Attempts were made to locate all sales by checking county records, by contacting real estate agencies, and by personal contact of the owners. The purposes of the sales were determined by buyer contact and all physical activity was checked. The land use was classified in each quadrant of the interchange as commercial, industrial, residential, vacant, or governmental.

Commercial use was rated the highest because it is most clearly associated with the freeway user, as well as being compatible with the freeway. If there was commercial activity in a quadrant, either by actual use or by sale for future commercial use, the quadrant was classified as commercial.

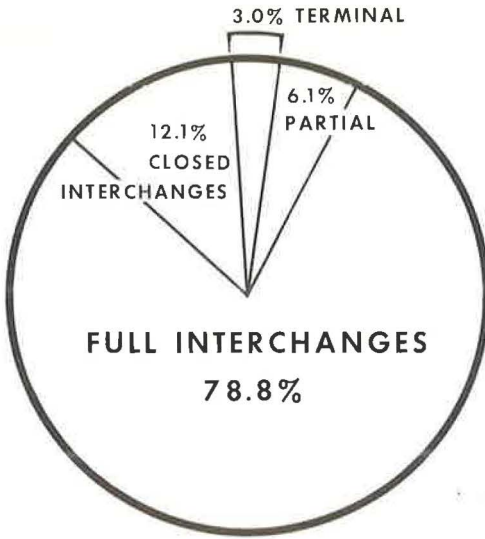


Figure 2. Percentage distribution by type of 66 interchanges on I 94 from Indiana state line to US 23 east of Ann Arbor.

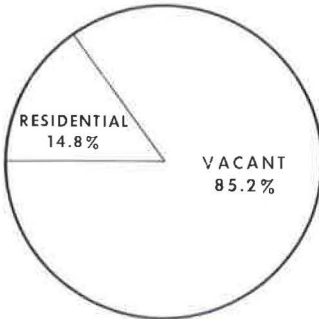
Industrial use was considered the next level of activity. This use has been found to be compatible with freeways, but dependency on proximity to the freeway is not as critical as commercial use. If a quadrant had both commercial and industrial use, the commercial use dominated the classification even though the industrial use might have occupied more area.

The residential rating was given to all quadrants with houses, including farm dwellings. If a sale had occurred for another use, i.e., commercial or industrial, the sale-use classification dominated, but when the property had not sold, it was classified as residential regardless of market potential or asking price.

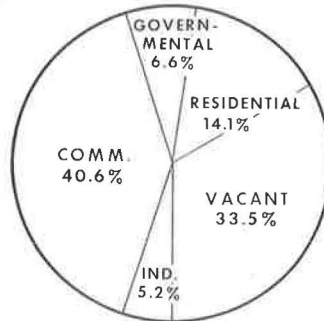
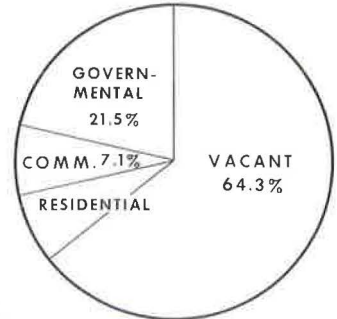
The vacant classification was given to land which had not been committed. This included farms or land being held without any activity. If it had been sold, its classification reflected the reason for the sale.

The governmental classification covered lands owned by governmental agencies or by institutions and so not available for development.

**CLOSED INTERCHANGES (8)  
QUADRANTS (27)**



**PARTIAL INTERCHANGES (4)  
QUADRANTS (14)**



**FULL INTERCHANGES (52)  
QUADRANTS (208)**

Figure 3. Land-use relationship.

The land-use relationship by type of interchange is shown in Figure 3. The terminal interchange was not considered representative and, therefore, was not analyzed.

It is immediately apparent that development at full interchanges has shown a marked response to the freeway, which is in sharp contrast to the closed or limited-access interchanges. The only partial interchange having major activity was closely associated with a nearby full interchange. From this we can conclude that access which permits movement in both directions on a freeway is practically an axiom for commercial development on freeways. Benefits would be unusual on partial interchanges and practically nonexistent on closed interchanges.

#### ANALYSIS OF FULL INTERCHANGE

At this point, the analysis is confined to the full interchange. Although each full interchange is an entity, certain broad categories tend to stand out. To try to bracket these categories, four major groupings of the full interchange have been established.

1. Major city interchanges. This designation was used for interchanges at cities with over 10,000 population and located on the most direct route into the city. If a state or US-designated trunkline made a reasonably direct penetration into the city, it was automatically included (Fig. 1).

2. Secondary city interchanges. This included all of the interchanges around the cities of over 10,000 population, but it excluded those routes classified as major city interchanges.

3. Small town interchanges. This was the main, and generally the only, interchange adjoining a city or town of under 10,000 persons. A further restriction was that the interchange would be within 1 mile of the city limits or within 2 miles of the center of the city.

4. Rural interchanges. This included all interchanges that were not associated with a city or town.

Each of these categories shade into the other because of the adjoining environment and opportunities for investment. Some of the secondary city interchanges around Kalamazoo are upgrading toward major city interchanges, whereas the secondary city interchanges near Battle Creek verge on a rural classification. The percentage breakdown of quadrant development is shown in Figure 4.

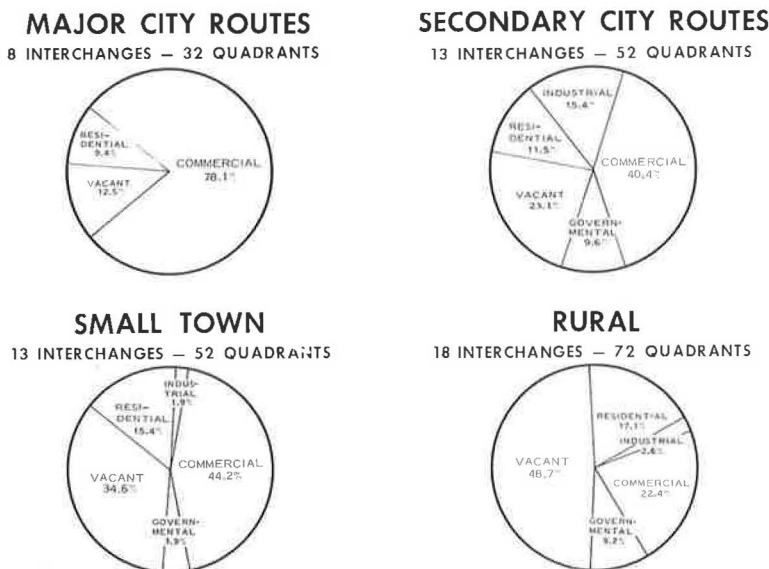


Figure 4. Full interchange, percentage breakdown of quadrant development.



The major city interchange stands out with its heavy emphasis on commercial activity (almost 80 percent of the quadrants). This activity covers not only service stations, but also 100-unit motels, restaurants, and shopping centers. Those lands at major city interchanges which have not been channeled into interchange uses are being held at prices considerably above the 1959-1960 price level.

Secondary city and small town interchanges have very similar patterns of commercial development. More industrial development was found at the secondary city interchanges than at the small town interchanges. The interchange near the city provides industry with quick, convenient access plus identity, and it is nearer the market or supplier.

The rural interchanges are conspicuous because of the small amount of commercial and industrial use that has developed. Only one out of four quadrants has reflected activity. Part of this can be explained by no supporting local market and lack of identity by association with cities or towns listed on maps.

The various types of commercial uses within 1,000 ft of the interchange were explored in relationship to the interchange classifications. A summary of the quantity of use per interchange is shown in Table 1.

The major city classification is outstanding in all phases of commercial development. Service station development varied from two to five per interchange. Six of the eight interchanges had at least three restaurants. Motels are chiefly associated with the major city interchange; they are at present a rarity on the other interchanges. In the rural areas, less than half the interchanges had service stations and approximately a quarter had restaurants.

#### DEVELOPMENT OF LAND VALUES ON FULL INTERCHANGE

After preliminary analysis of various sales, it became apparent that a well-informed market did not exist in 1960. The initial sales around the full interchange varied with the skill of the negotiator. Secondary sites often sold for greater amounts than did the prime locations. This can be partially explained by the fact that the freeway was a new concept in 1960. The investor had little or no experience on which to base his decisions, and, therefore, with this uncertainty, competition was slow in developing. Many times the seller did not recognize the market potential; when an apparent "bonanza" was offered, he was quick to accept without actual testing of the market. For these reasons, any averages on market value reaction give a very incomplete picture of today's market on I-94. Were I-94 constructed today with the background of experience available, the market reaction would be more pronounced, and truer relationships between price and interchange could be developed.

Recognizing these limitations, the sales of 1959 through 1963 are compared with the appraised value as estimated by the independent appraiser in 1958 and 1959. The results are presented in Table 2 and Figure 5.

Part of the increment can be explained by the general land market rise. In the control areas studied, values have increased 10 to 185 percent. An increment range of 15 to 35 percent, though, would probably bracket the average for general land increment.

TABLE 1  
QUANTITY OF COMMERCIAL DEVELOPMENT PER INTERCHANGE ON  
FULL INTERCHANGES

Interchange Classification	No.	Service Stations	Restaurants	Motels	Shopping Centers	Sales Uncommitted <sup>a</sup>
Major city	8	3.38	2.38	1.25	0.38	0.38
Secondary city	13	1.38	0.46	0.15	0.08	0.54
Small town	13	1.23	0.54	0.00	0.00	0.62
Rural	18	0.44	0.28	0.00	0.00	0.50
Average		1.33	0.71	0.31	0.08	0.52

<sup>a</sup>Known sales where no construction has started.

TABLE 2  
VALUE INCREMENT AS PERCENT OF  
BEFORE VALUE

Interchange Classification	Service Stations Only (%)	All Other Sales (%)
Major city	441	227
Secondary city	388	215
Small town	641	205
Rural	627	161
Average <sup>a</sup>	505	201

<sup>a</sup>Service station sales, 15; other sales, 52.

A study of the 1963-1964 market, indicating the probable range in values for service stations sites, is shown in Figure 6. The site size listed is that which tends to predominate. The range of value would bracket most sales. Occasionally, a superior site may sell for more or a poor site requiring considerable preparation or having poor view may sell for less.

Although experience in other land uses is more limited than that of service stations, we are able to draw some conclusions. At major city interchanges, motels and major restaurants are paying \$12,500/acre for 4 to 5 acre sites. In

one case, a major department store paid \$19,750/acre. Several of the tracts were purchased or developed in the early 1960's. Since they are not on the market today, the true market cannot be measured without consideration of the improvements.

### BUSINESS SUCCESS AND THE FULL INTERCHANGE

Has the full interchange location proven successful for business, and is the money being spent for sites justified? To answer these questions partially, the service stations have been explored in detail. The gross use tax returns of four major motels and four minor motels have also been examined.

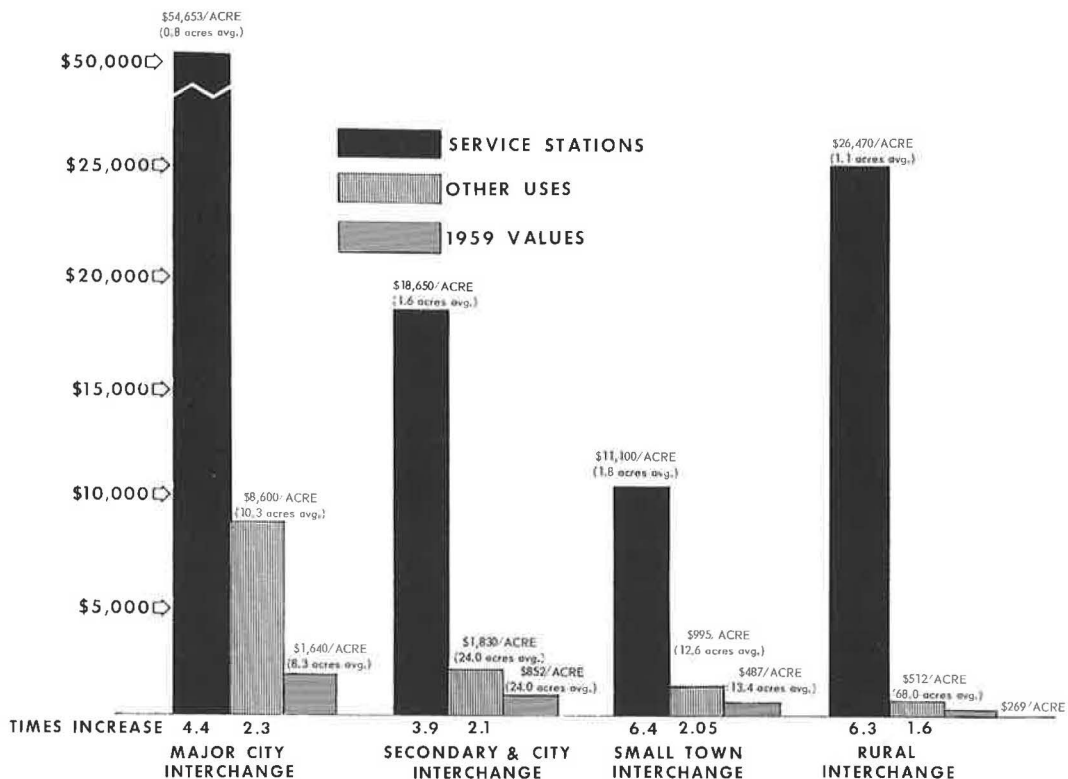


Figure 5. Full interchange land value changes, 1960-1964 sales averages compared to 1959 appraised values.

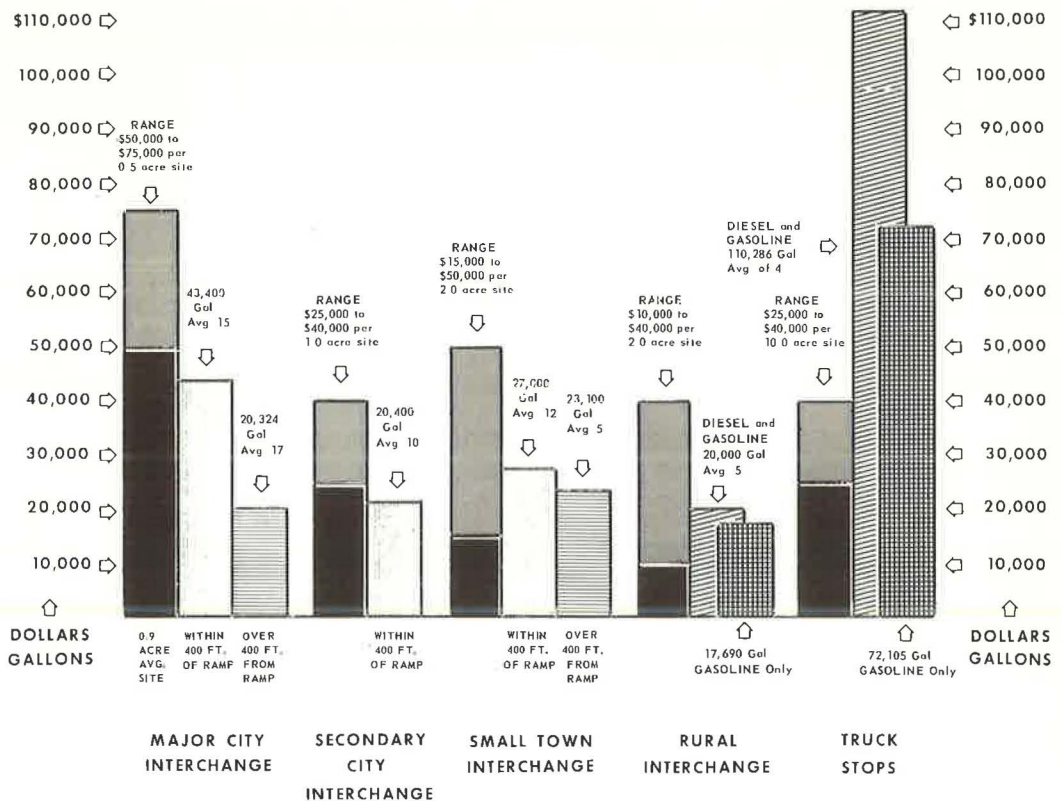


Figure 6. Full interchange service station activity showing 1963 price range for sites and 1963 gallonages.

### Service Stations

All of the petroleum companies cooperated in this study by furnishing a month-by-month pumpage for 1963. Inasmuch as each company is in a very competitive position, we have held the individual gallonages in confidence and have dealt with the stations by averaging the gallonage of the stations within each interchange classification. A statistical analysis was made to find the standard deviation of the mean and to test whether there was a significant difference of business success between the interchange classifications. The results are given in Table 3.

The major city interchange stands out from all other classes. The pumpage is almost double the average of the other three groups. It was 60 percent better than for small town interchanges and 117 percent better than for rural interchanges. Although

TABLE 3  
SERVICE STATION GALLONAGE COMPARISON, FULL INTERCHANGE

Interchange Classification	No. Stations	Avg. Gal/Mo (thousands)	Std. Dev. of Mean <sup>a</sup>	Std. Error of Dif. Between Means <sup>b</sup>			
				Major City	Secondary City	Small Town	Rural
Major city	15	43.4	21.70	-	6.6 S	6.6 S	7.2 S
Secondary city	10	20.4	9.35	6.3 S	-	4.6 NS	5.4 NS
Small town	12	27.0	11.11	6.6 S	4.6 NS	-	5.7 NS
Rural	5	20.0	10.09	7.2 S	5.4 NS	5.7 NS	-
Total	42	30.4					

<sup>a</sup>A standard deviation from the mean brackets approximately 66 percent of the stations.

<sup>b</sup>S = significant; NS = not significant.



there was considerable variation of pumpage within the major city class, the differences between the major city and the other classes were found to be statistically significant.

The small town interchanges averaged 30 to 35 percent above the secondary city and rural interchanges. This difference, though, was not found to be significant. The fact that the secondary city interchange is grouped with the small town and rural interchanges indicates that the aura of the large city contributes little to the service station business at the secondary city interchange. As the city builds out to the freeway, the secondary city interchange will probably move toward the major city interchange in development patterns and values. The four truck stops (three on secondary city interchanges and one at a small town interchange) were not considered in this analysis. A graphic presentation of the relationship between prices paid and gallonage pumped is shown in Figure 6.

#### Service Station Sites at Interchange vs Those Over 400 Feet Away

To test whether there is an advantage of being next to the freeway, a group of 17 stations on the major city routes over 400 ft away from but within 1 mi of the interchange were checked. They averaged 20,800 gal/mo (std. dev., 9.9), which compares with 43,400 gal/mo at the interchange. The difference is found to be statistically significant and sharply focuses on benefits derived from the interchange.

In the case of the small town locations, only five stations were studied, with all but one in the business district. They averaged 23,100 gal/mo, which compares with 27,000 gal/mo at the interchange. This indicates that the interchange sites were in a superior position to the small town station. The size of the sample, though, makes the results inconclusive, and the difference was not significant. In each case, the interchange station was outside or on the edge of the city limits. The reader might contemplate the business success of the station at the edge of a small town without the freeway.

#### Service Stations and Competition

As more and more service stations are added along I-94, the danger of excessive competition becomes a pertinent question. To test this point, seven service stations were selected from small town and major city interchanges which had operation records through 1963 and the first half of 1964. In 1963, these stations averaged 38,700 gal/mo. In the first half of 1963, the seven test stations filed tax returns amounting to \$17,293. During the same period in 1964, the return mounted to \$18,579, an increase of 7.5 percent (Fig. 7). Thus, the established stations more than held their own even though there was a 36 percent increase in the number of new stations. Fuel tax collections for Michigan registered a 7 percent increase in the first half of 1964 over the same period in 1963. The traffic on I-94 increased 9 percent during the same interval.

#### Motels and Freeways

At almost every major city interchange, a motel is in operation or under construction. From this alone, we can conclude that certain interchanges have special motel attraction. Because the motel has been a little slower than the service station to swing into activity along I-94, we do not have as much business experience to analyze. Many of the larger motels were opening for business during the winter of 1962-1963. Immediately after opening, motels go through a break-in period with their occupancy rate gradually building up to a normal level. This tends to limit the value of comparison at this time. Also, an actual return per room or motel was not available for detailed analysis.

To try to bridge this lack of information, the motel use tax returns were analyzed. Returns were obtained on four large and four small motels, averaging 97 and 19 rooms per motel, respectively. The general hotel-motel business trend, as indicated by use tax returns from the entire state, is used as a comparison to test the business climate for the freeway motels (Table 4).

1963 Average Monthly Pumpage — 38,700 Gallons per Station for 7 Test Stations

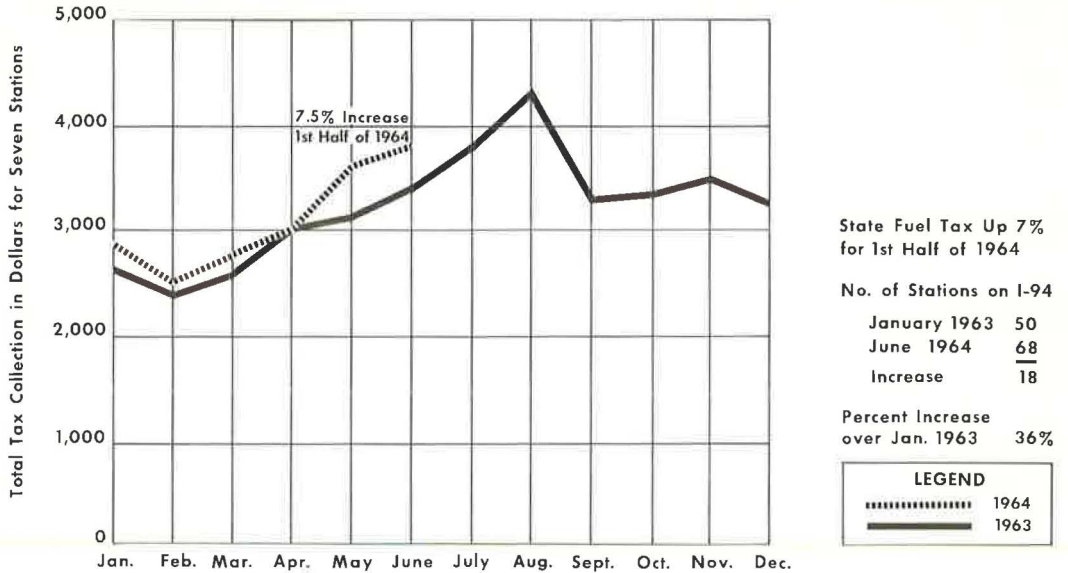


Figure 7. Service station and competition, 1963-64 sales tax comparison.

Because the data on large motels were incomplete before January 1963, the small motels are used as a yardstick. Their pattern of increase follows the general trend in returns for the state at large. The state-at-large returns would be expected to increase due to the general growth of hotel and motel accommodations; the fact that the small motel has increased proportionately as rapidly as the state at large indicates that the construction of new motels has not adversely affected the small motel business success (Fig. 8).

The large motels have registered a much better return in 1964 than in 1963 (Fig. 9). This can be partially explained by the fact that two of the four motels were going through a break-in period in the early part of 1963 (one opening in November 1962 and the other in January 1963). To obtain a better comparison, the second quarters of 1963 and 1964 are analyzed.

During this period, their returns increased 22 percent compared to the state-at-large increase of 9.2 percent. The increase can be attributed primarily to new business and was not at the expense of other motels on I-94 (Fig. 8).

Another indication of business success is the construction of new motels and the adding on to the present facilities. Three new motels, under construction, will add

Type Motel	Total No. Rooms	Returns (\$)		Increase (%)	Returns (\$)	
		2nd Half 1962	2nd Half 1963		1st Half 1963	1st Half 1964
		Large	387		N. A.	19,754
Small	74	2,521	2,829	12.2	2,253	2,460
State at large	-	-	-	5.5	-	-

<sup>a</sup> A 4 percent motel-hotel use tax collected on all room sales.

250 units. At Ann Arbor, the Holiday Inn Syndicate is preparing to add 56 units in November. The effect of the new units (a 30 percent increase) on present facilities is unknown. Undoubtedly, the traffic growth will tend to absorb the additional motel units (Table 5). It is estimated by the Traffic Division of the Michigan State Highway Department that the number of vehicles on I-94 will more than double in the next 10 years. This should easily absorb the motels that are now under construction.

This motel study indicates that the investment made in land and improvements has proven sound. We can conclude that the land use for motels is proper for the major city interchange. How successful motels will be at lesser interchanges remains to be tested.

### TRUCK STOPS

In analyzing various interchanges, certain ones were found to be focal points for truckers. Was the primary factor in the development of the successful truck stop chance, management, or location with respect to the highway system? Management combined with extensive parking areas, diesel fuel, 24-hr service, and reasonably priced food in liberal servings undoubtedly help. However, it takes more than this—it takes a special type of location. The most successful truck stops are oriented toward an intersection of a major trunkline or with the industrial complex of a major city. Four such locations which have developed are discussed in the following.

1. Napier Road. The Famous Truck Stop is located at this secondary city interchange. Napier Road is the first interchange west of the junction of I-196, which serves the Holland-Grand Haven-Muskegon area; as a result, the Famous Truck Stop is in the direct line of the Chicago-Western Michigan traffic and the I-94 traffic. The proprietor had previously owned and managed a truck stop on US 31 and US 33, northeast of Benton Harbor.

2. Sprinkle-Cork. The Half Way House and Marathon Service are located at this secondary city interchange, which adjoins the industrial area in southeast Kalamazoo and the city of Portage. It is also the first interchange east of the junction of US 131 freeway where land was available for development.

3. US 27. The Coffee Cup with Phillips 66 Service is located at this interchange of US 27 serving central Michigan and eastern Indiana. As a result, it is the branching-off point for a number of trucks traveling on I-94. This advantage may be lost, though, due to the proposed relocation of US 27 approximately 1½ mile west, which will be known as I-69. When this occurs, the most strategic location will be Eleven Mile Road, a secondary city interchange. Anticipating this advantage, the Te-Khi Grill with Texaco and the Country House with American Oil have already been constructed.

4. Sargent Road. H and M Grill with Phillips 66 Service is located at the secondary city interchange on the northeast side of Jackson. It is also the first interchange east of US 127 freeway, south. The trucker going from Detroit to the Jackson area must pass this interchange. Previous to construction of I-94, a restaurant-truck stop and a weigh station were located on old US 12, east of Sargent Road. One year after the freeway opened to traffic, the weigh station was relocated. During this interim period,

RETURNS<sup>a</sup>

Increase (%)	Returns (\$)		Increase (%)	Returns (\$)		Increase (%)
	1st Qu. 1963	1st Qu. 1964		2nd Qu. 1963	2nd Qu. 1964	
28.6	5,529	7,652	38.4	8,287	10,124	22.2
9.2	1,003	1,092	8.9	1,250	1,368	9.4
9.5	-	-	9.8	-	-	9.2



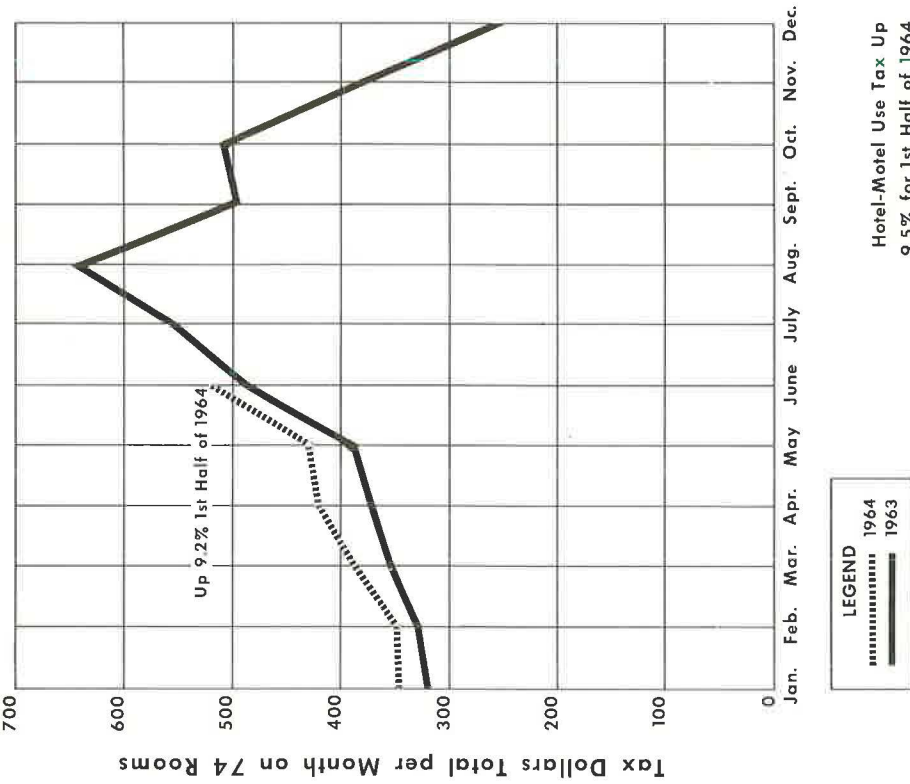


Figure 8. Use tax returns on four small motels.

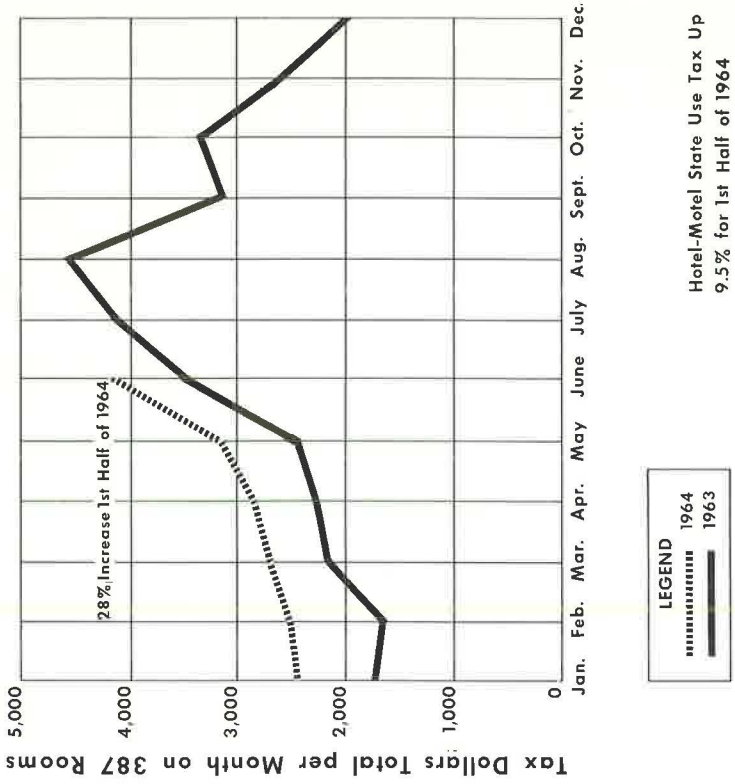


Figure 9. Use tax returns on four large motels.

TABLE 5  
AVERAGE DAILY TRAFFIC  
COUNT AT MARSHALL<sup>a</sup>

Period	ADT
1962	9,508
1963	10,597
1964	11,514
Increase 1963 over 1962 (%)	11.5
Increase 1964 over 1963 (%)	8.7

<sup>a</sup>From average for April, May and June.

the H and M Grill was opened and developed a truck business. The combination of freeways plus the weigh station helped to make this location a success.

These four truck stops, which are open 24 hr a day, averaged 110,000 gal/mo in 1963. Their pumpage varied little with the seasons, which is in sharp contrast to a typical highway service station.

A truck stop (20-yr operation history) on old US 12, just west of the I-94 and Mich. 60 interchange, was excluded from this study because of its location in a terminal area.

At the present time, I-94 ends 4 mi south of LaPorte Road, a feeder to the Indiana Toll Road. Eventually, when Indiana has completed its portion of the Interstate Program, I-94 will connect the Gary-South Chicago industrial complex with Michigan. In the interim, a large percentage of the trucks are using the old US 12 route. As a result, a true freeway pattern does not exist.

Several rural interchanges had restaurant-service stations which were trying to develop trucker business. Pumpage averaged only 15 to 30 percent of those stops considered to be strategically located.

Truck stops require 5- to 10-acre sites at grade with the crossroads. The fact that there were no truck stops at a major city interchange indicates that those locations commanded more expensive development.

It is realized that the volume of data is limited. Therefore, it has been the intent to point out what appeared to be a direct relation between the highway network and the truck stop as to location. Further research will help to clarify truck stops and land use at interchanges.

## SUMMARY

This study, made 3½ yr after the opening of the freeway, demonstrates the following.

1. All major city interchanges developed high commercial values, with service station sites selling for \$75,000/site or up to \$170,000/acre, and restaurant and motel sites selling for \$12,500/acre. Almost 80 percent of the major city interchange quadrants have some form of commercial development. Considering all of these major city interchanges, there was an average of 3.38 service stations, 2.38 restaurants, 1.25 motels, and 0.38 shopping center per interchange.

2. At the secondary city interchanges, some form of commercial development can be expected. This is indicated by the fact that 40 percent of the quadrants have been put to commercial use. The average per interchange was 1.38 service stations, 0.46 restaurant, and 0.15 motel. In addition, there was some industrial development. The lesser amount of commercial development and the lower gasoline pumpage indicate that the secondary city interchange should not be classified with the major city interchanges.

3. Almost every small town interchange is likely to have commercial development. There was an average of 1.23 service stations and 0.54 restaurant per interchange. Gasoline pumpage has averaged more at the small town interchange (27,000 gal/mo) than at the secondary city or rural interchange (20,000 gal/mo).

4. Rural interchanges have been slow to show development, with less than 50 percent having development or sales for commercial use. Only one quarter of the quadrants were commercially or industrially occupied. This would indicate that allowance for benefits must be treated with extreme caution. A rural interchange near an active recreation area or near an industrial complex may develop high land values.

5. No sales of land in an interchange area indicated a loss in value by reason of grade change, triangulation, or reduction of access. Potential service station sites

registered a five-fold increase, and the averages of all other sales indicated a doubling of values.

6. Partial or half interchanges showed little reaction to the freeway, except where the interchange was closely associated with a full interchange.

7. Closed interchanges (the intersection of two limited-access freeways) showed no signs of enhancement from the freeway.

8. At major city interchanges, service stations within 400 ft of the interchange averaged twice the gallonage of those 400 ft to 1 mi away from the interchange, indicating that the proximity to the interchange afforded a better business location and so would command a higher value.

9. The business success recorded by service stations and motels demonstrates that the investments in land and buildings at the interchanges have been justified.

10. The continued increase in volume of business at interchanges indicates that supply has not yet exceeded demand.

In the final analysis, this study demonstrates that the question is not whether there are benefits at an interchange, but how great are the benefits. The amount of benefits on a future interchange can best be estimated by comparing it with a similar class of interchange on an existing facility.

#### EPILOGUE—THE PRINCIPLE OF CHANGE

A basic principle of real estate activity is change, and probably the most dynamic example of this principle is found in the interchange area.

The limited-access freeway has broken the mold of the old highway commercial pattern. It concentrates development rather than diffuses it and, consequently, allows investment in more lavish improvements. It has given a permanency to investments that never existed before in the history of highways.

In the end, the ever-increasing traffic and the traveling habits of the public will determine the intensity of use. To anticipate these changes, our investigation must and will continue to give us better understanding.