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ANALYSIS OF URBAN RESIDENTIAL ENVIRONMENTS USING COLOR INFRARED AERIAL PHOTOGRAPHY: AN EXAMINATION OF SOCIOECONOMIC VARIABLES AND PHYSICAL CHARACTERISTICS OF SELECTED AREAS IN THE LOS ANGELES BASIN

by

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with Addendum

AN APPLICATION OF THE CONCEPTS OF THE LOS ANGELES RESIDENTIAL ENVIRONMENT STUDY TO THE ONTARIO-UPLAND REGION OF CALIFORNIA

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FOREWORD

Mr. Robert H. Mullens, Jr. has been involved in research on the potential of remote sensing in the urban environment for more than two years. He has participated in the activities of the "Remote Sensing of Southern California and Related Environments" contract and in the Association of American Geographers' "Land Use Mapping of Southwestern United States" project. Most of his work was directed by Professor Norman J. W. Thrower, University of California, Los Angeles and one outgrowth was a master's thesis from which this report was extracted and supplemented.

The majority of the images used as data were acquired at a scale of 1/6,000 during Mission 73, NASA 926, May 24, 1968. However, the higher altitude imagery (1/60,000) that resulted from Mission 42 and 56 were also used as back up information and has contributed to techniques and methods presented. In addition to the NASA imagery, many groups and individuals contributed to the report. The credit is described in the following acknowledgement extracted from Mr. Mullens thesis.

> The author expresses his thanks to the many people who offered their time and assistance in the preparation of this thesis. Numerous individuals in several public agencies throughout Los Angeles County provided help in obtaining statistics on the socio-economic variables examined in this study. Professor Leonard W. Bowden and the members of the West Valley

Planning Commission showed considerable interest in the application of the imagery used in this study in the urban environment and their encouragement was appreciated. In addition, the assistance provided by Professor Bowden and Professor Robert Pease, and their staff, at the University of California, Riverside, in the preparation of the photographic supplement was especially helpful.

...Professor Norman J. W. Thrower...presented extreme patience and careful guidance to all stages of the research and writing activities, without which the study could not have been completed...

To the National Aeronautics and Space Administration, which provided the research money making this study possible, through various agencies including the United States Geological Survey and the Association of American Geographers, and to the various employees of those organizations, I also extend my deepest appreciation. Their assistance, in cooperation with the University of California, Departments of Geography at Los Angeles and Riverside, was a key element in...this research.

To fellow graduate students John E. Estes, who first introduced me to the field of remote sensing, and Leslie W. Senger, who assisted me in most phases of the research, I owe a special debt of gratitude...

Mr. Leslie W. Senger was at the same time working on applying the concepts developed in cooperation with Mr. Mullens to the Ontario-Upland region. In order to eliminate redundancy in reporting, it was deemed appropriate to include a synopsis of his work as an addendum to this report. Both the research done by Mullens and by Senger contribute significantly to the methodology of resource analysis via remote sensing being undertaken in Southern California.

Leonard W. Bowden
Principal Investigator, Site 130

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SUPPLEMENT

ABSTRACT

Aerial photographs have been widely used by urban planners and researchers as a valuable source of information about the urban environment since the end of World War II. Recent research sponsored by the United States government as part of the Earth Resources Survey Program has resulted in the development of a variety of new photographic techniques. The use of color infrared film (Kodak Aero Ektachrome, type 8443) has been greatly expanded as a result of improved capabilities and has shown great potential in the analysis of urban environments.

The images produced on color infrared film, (CIR) present a very detailed and informative picture of the urban environment. In this study aerial photographs taken with CIR film have been used to differentiate various types of residential areas in the Los Angeles basin, using characteristics of the physical environment which vary from one type of residential area to another. Residential areas of varying quality have been classified based on these characteristics.

The socioeconomic characteristics of large urban populations are also associated with specific types of residential environments. It is thus possible to associate the characteristics of the physical environment with socioeconomic variables

within these residential environments. Features of the physical environment, identifiable on CIR aerial photography of Los Angeles are examined to determine which of these are the best indicators of "quality of residential areas" or "social areas" as determined by the socioeconomic characteristics of the inhabitants of the selected areas. Association between several physical features and the socioeconomic variables was found to exist with considerable regularity.

CHAPTER I

INTRODUCTION

Analysis of the urban environment is possibly the most difficult and challenging task in the entire field of remote sensing.[1] The great diversity of the urban environment, produced by the variety of people and activities found within it, and the complex nature of the spatial relationships present help to explain the relatively slow advance of the field of remote sensing in this area. Only recently have the first full-scale attempts been made to analyze the urban environment using various remote sensing techniques. Many other areas still receive more attention in the field.

Examination of the urban environment usually requires an analysis of much smaller features than is true of remote sensing research in such fields as agriculture, forestry,

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[1] Remote sensing is a rapidly expanding method of analysis in the field of geography. In its broadest application the term refers to any information gathering system which is not in direct contact with the phenomena being surveyed. Thus, for example, the eyes and ears of the trained geographer might be considered as "remote sensors." The term is, however, used here in its normal, more restricted sense which refers to the use of various instruments to produce and record data about the environment. This data is in the form of images which must be interpreted to produce useful information.

geology, and meterology where patterns are normally examined rather than individual objects. Furthermore, when dealing with urban areas it is often not the physical environment itself in which one is interested, but the many interrelationships between people and activities present in the area. Direct interpretation from the imagery is, therefore, impossible in many cases, and it becomes necessary to establish surrogates[2] which relate in some way to the feature which is under study.

While the city presents such problems in the application of remote sensing methods of analysis, it may eventually be found that these techniques have their greatest value in aiding in the solution of some of the problems inevitably produced within this diverse area. The field of remote sensing seems to have great potential in urban area analysis because of the great volume of information which will be produced about our cities when space vehicles provide continuous surveillance of these ever-changing environments. The basic advantages of information gathering

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[2]Surrogates are identifiable items on remote sensing imagery which are related in some definite way with a feature which is not directly visible on the imagery. For example, a complex curving street pattern in an urban residential area often indicates a hilly topography which often cannot be directly detected on the imagery; or as used in this study, certain features of the environment visible on the imagery indicate quality of the residential area in terms of both the physical environment and the socioeconomic characteristics of the inhabitants of that environment.

sensors mounted in space relate to the scope of the surveillance which is made possible. Very large areas can be examined simultaneously and the dynamic urban environments can receive constant examination.

Remote sensors will never become the sole source of data for urban areas, but they can replace other sources of information where remote sensors have advantages with respect to the flexibility, reliability, and the timeliness of the information which they collect. Promising areas for urban remote sensing include the delimitation of urbanism, the determination of urban land uses and internal structure, and the study of urban dynamics. This last topic consists of such simple tasks as transportation surveillance, disaster surveillance, monitoring air and water pollution, and monitoring harbor siltation. In addition, it includes the more complex problem of viewing the city in an ecological framework. This involves monitoring the inputs and outputs of energy and matter into the complex system which forms a city.[3]

In addition to the great potential offered by remote sensing from space, large amounts of information about our urban areas should be available within the near future

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[3]Robert H. Alexander, Leonard W. Bowden, Duane F. Marble, Eric G. Moore, "Remote Sensing of Urban Environments," Proceedings of the Fifth Symposium on Remote Sensing of Environment (Ann Arbor: The University of Michigan, 1968), pp. 890-895.

from a variety of new remote sensing devices now being tested on conventional aircraft. The specific applications of such exotic sensors as radar and thermal infrared scanners, for example, within the urban environment are still largely unknown. However, the application of new photographic systems to the analysis of the urban environment is receiving considerable attention. These sensors seem particularly appropriate for the acquisition of detailed information concerning such topics as the types and spatial structuring of urban land uses, the nature of the urban transportation pattern, and the varying quality of urban housing.

The information concerning the physical city which is present on aerial photographs taken from conventional aircraft is also of sociological significance because of the relationships between the physical and social structure of the city demonstrated in previous studies.[4] Thus, certain aspects of the social ecology of the city can be examined using these photographs as a tool. Limited aspects of this subject will be examined in this study of urban residential environments.

The importance of the urban environment can hardly be overemphasized in this modern age. During this century,

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[4]Norman E. Green, Aerial Photography in the Analysis of Urban Structures, Ecological and Social (Unpublished Ph.D. dissertation, University of North Carolina, Chapel Hill, 1955).

cities have become increasingly significant as the urban areas claim a greater and greater percentage of the world's population. The fantastic growth of most cities in the United States, both in population and in areal extent, has made possible a higher standard of living for a majority of the population, but has also given rise to a number of exceedingly complex problems.

This study is part of a growing body of research in the field of remote sensing, designed to determine the type and usefulness of information which can be obtained about the urban environment from various remote sensing instruments. Different instruments, such as radar equipment, ultraviolet scanners, thermal infrared scanners, and various photographic instruments and films, collect information from different portions of the electromagnetic spectrum. Used in combination, they often furnish information which could not be produced by any one of them alone. Various multispectral systems (more than one sensor) are now being developed in an attempt to produce a variety of remote sensing systems which can be suited to a large range of purposes.

Color infrared (CIR) aerial photography is the remote sensor used in this study to determine the quality of residential areas in the Los Angeles basin. Previous study has indicated that this imagery is especially suited for examination of residential areas in the urban environ-

ment.[5] The purpose of this study is to establish definite photographic surrogates which can be used to identify residential areas of various quality using CIR film in aerial photography. It also attempts to determine what can be inferred about the social environment from information on residential area quality obtained from surrogates on CIR aerial photography.

The physical appearance of the residential areas is used to determine basic residential quality, while various sociological and ecological concepts are used as a basis for the examination of the social phenomena which have previously been shown to be associated with various types of residential areas. Statistics are collected on a variety of socioeconomic phenomena which are correlated with surrogate information obtained directly from CIR aerial photography. This surrogate information is, in general, found to be highly correlated with information obtained from several public sources and was obtained with considerably less time and effort. Before examining in detail the nature of the variables to be considered as part of the study of quality of the residential environment, it is necessary to examine the previous uses of conventional aerial photography in urban area research.

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[5]Leonard W. Bowden, Multi-Sensor Signatures of Urban Morphology, Function, and Evolution. Technical Report 2. (Riverside, California: Department of Geography, University of California, March 1968).

Particular emphasis will be placed upon studies dealing with residential areas.

Literature

In his well-known study, Melville C. Branch, Jr. reviewed how aerial photography was used by urban planners from 1920 to 1948.[6] During this period aerial photography was used almost exclusively to derive data about the physical features of the city, including the land upon which the city rests, the water in and around the urban area, the transportation lines of the city, and the structures of the city itself. Air photos were primarily used to aid in the construction of land use maps or to supplement the information presented on such maps. They were also consulted and put to practical use when changes were to be made in the basic physical state of the urban environment.

However, Branch also considered the urban area in terms of people and wrote of ecological relationships between various physical residential types and the mode of life of the inhabitants of these residential types. He mentioned certain variables of sociological interest related to these residential types which might be examined by identification of various characteristics of the physical

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[6]Melville C. Branch, Jr., Aerial Photography in Urban Planning and Research (Cambridge: Harvard University Press, 1948).

city, but he did not attempt to determine any systematic relationships between physical features identifiable on the photography and any sociological variables. Thus, while his basic concern was with the physical city, he did make some comment about how the residential environment can be analyzed to produce certain information about the inhabitants of that environment. Basically, however, photo interpretation of this era was concerned with identification of the physical city and classification of the variety of urban features which were identified.

During the 1950's several articles by Matthew M. Witenstein appeared in Photogrammetric Engineering which expanded the usefulness of aerial photographic interpretation in urban analysis and planning.[7] He was concerned with an inventory of the physical land use of the city and with the application of various planning techniques based upon information produced by this inventory. While he advanced the use of aerial photographs in the planning

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[7]Matthew M. Witenstein, "Application of Photo Interpretation to Urban Area Analysis," Photogrammetric Engineering, XVIII, No. 3 (June 1952), 490-492. Matthew M. Witenstein, "Photo Sociometrics: The Application of Aerial Photography to Urban Administration and Planning Problems," Photogrammetric Engineering, XX, No. 3 (June 1954), 419-427. Matthew M. Witenstein, "Uses and Limitations of Aerial Photography in Urban Analysis and Planning," Photogrammetric Engineering, XXI, No. 4 (September 1955), 566-572. Matthew M. Witenstein, "Report on the Application of Aerial Photography to Urban Land Use Inventory, Analysis, and Planning," Photogrammetric Engineering, XXII, No. 4 (September 1956), 656-663.

field, he was still concerned essentially with information about the physical city. His work nevertheless represents a definite advance in the field. Prior to his writings on urban area analysis and the application of aerial photography in geographic research, major concern was given to even more basic problems of mapping and development of identification keys.[8] Witenstein was not, however, very concerned with the extraction of information dealing with urban social phenomena, but rather with the extraction of much more restricted kinds of information related to urban land use planning.

While the urban planners of the 1950's maintained an emphasis on analysis of the physical city, Norman E. Green attempted to analyze the socioeconomic structure of urban areas using black and white aerial photographs. Green, a sociologist, used aerial photography to relate the physical-spatial structure of the city to its social structure within the basic framework of urban ecology. Aerial photography was seen as a supplementary source of information to census materials for supplying data on small spatial areas

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[8] A photographic key helps the observer to organize the information present in aerial photographs, and guides him to a correct identification of unknown objects. Objects to be identified are often illustrated, and the distinctive characteristics of the objects are systematically listed and briefly described. Photographic keys serve to facilitate analysis by helping to identify individual objects and by focusing attention on features which form a pattern.

in an ecological analysis. The work of Green and Robert B. Monier represents the first systematic attempt to adapt photo interpretation as a research tool in the social sciences.[9] They went far beyond urban area analysis of the physical city. They found the photographic method to be a useful tool in the analysis of population size and density in the urban environment, and, more important for this study, their analysis produced a great amount of information concerning the patterning of intra-urban socio-economic areas.

Green and Monier developed a method of analysis of the social structure of an urban area based upon four items which could be obtained from photographic interpretation of black and white aerial photography. These were: 1) location of the area with respect to three concentric circular zones centered in the central business district (CBD); 2) residential desirability as determined by land use characteristics; 3) prevalence of single family homes; and 4) density of housing in average number of dwelling units per block.[10] Information on these four items was

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[9]Norman E. Green and Robert B. Monier, "Aerial Photographic Interpretation and the Human Ecology of the City," Photogrammetic Engineering, XXV, No. 5 (December 1959), 770.

[10]Norman E. Green and Robert B. Monier, "Aerial Photographic Interpretation and Human Geography of the City," The Professional Geographer, IX, No. 5 (September 1957), 4.

collected by census tracts for a number of cities in the United States and subsequent statistical analysis revealed a number of highly consistent relationships between groupings derived from this information and a variety of social structural categories. This pioneering study opened the door to the use of aerial photographs as a tool in urban social area analysis. This was accomplished by showing the accuracy of photo interpretation data, regarding certain physical-spatial categories in the urban environment, and by developing methods which illustrated that certain systematic relationships exist between these physical-spatial categories and some demographic and social-structural characteristics of the city.

A more recent study utilizing aerial photography for urban area research was conducted by Samuel M. Hadfield for the Chicago Area Transportation Study (CATS) in 1963.[11] This study shows how surrogate information from remote sensors may be used to derive various kinds of information which are either difficult to observe directly or which would be hard to obtain by more direct methods. The objective of this study was to develop and test a synthetic approach toward obtaining traffic origin-destination (O-D) data. This information had previously been obtained through

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[11]Samuel M. Hadfield, An Evaluation of Land Use and Dwelling Unit Data Derived from Aerial Photography, Report UR-1 (Chicago: Chicago Area Transportation Study, 1963).

very time consuming and expensive home interview surveys. Aerial photography was seen as a possible alternative approach for obtaining this information with much less effort and expense using surrogates.

Similar considerations have led in the last few years to an ever increasing utilization of more complex photographic systems such as multi-band photography,[12] black and white infrared photography, a variety of color enhancement systems, and the color infrared (CIR) photography used in this study. Research into the utilization of even more exotic systems operating completely outside the visible spectrum (such as thermal infrared and radar) also continues. The employment of all these systems in the solution of everyday problems will undoubtedly increase as their capabilities and money-saving potential become better known.

The CATS project used previous research relationships (the number of dwelling units, land area, and nonresidential building floor area classified by land use type were found to be related to the number of vehicle trips generated) to obtain estimates of trip ends for a number of small areas

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[12]Multi-band photography utilizes a number of lenses (often nine) simultaneously in a single camera system to produce images of exactly the same area. The lenses are filtered to produce sensitivity to different portions of the electromagnetic spectrum from violet through the visible range to the near infrared. More information can usually be extracted from the several images produced than is possible from a single photographic image.

using information obtained from vertical, stereoscopic, and low oblique photography. Correction factors similar to those developed by Green in his dissertation[13] were constructed to compensate for errors made in the estimation of dwelling units from aerial photographs. Ground checks showed that measurements from the photographs compared well with the true situation. Errors present tended to be systematic, with consistent underestimation of nonresidential floor area and of the number of dwelling units. More accurate estimates were easily produced with the application of the correction factors. The accuracy of the information was measured in terms of the use to which it was to be put. The information was required to provide useful trip estimates for a number of small areas, and it was found to fulfill adequately this purpose.[14]

Questions about data need, data availability, and data accuracy have become of key importance to the remote sensing analysis of urban areas. The development of an urban information system is a focal point in current remote sensing literature on the urban environment. Conventional aerial photography has been used as a source of information

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[13]Green, Aerial Photography . . .

[14]Duane F. Marble and Edwin N. Thomas, "Some Observations on the Utility of Multispectral Photography for Urban Research," Proceedings of the Fourth Symposium on Remote Sensing of Environment (Ann Arbor, Michigan: Willow Run Laboratories, June 1966), p. 138.

about the environment for many years and various other sensors are now being used to produce even more data. The use of several sensors in combination and the new platforms which are becoming available will further enhance the data gathering potential of remote sensing systems. However, the simple collection of greater and greater amounts of data in itself is no solution to the problem of obtaining timely and reliable flows of information concerning urban areas. The development of urban information systems is a necessary part of the application of data received from remote sensing systems.

In 1966 Duane F. Marble and Edwin N. Thomas headed a research group at Northwestern University which addressed itself to the problem of how efficiently to incorporate data obtained from remote sensors into operational urban information systems. Three steps of general importance to the establishment of viable urban information systems have been described by these authors.[15] In the first place, they suggest the need for a systematic and comprehensive determination of the kinds of information required for effective and efficient planning of the urban environment. Secondly, determination of alternative ways of filling perceived needs is necessary. This includes specifying alternative information sources, information handling

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[15] Ibid., pp. 135-144.

capabilities, and information flow structures. Restriction to present capabilities must not occur, and the utility of the entire field of multispectral sensors mounted on a variety of platforms must be examined. Also other information system components besides data collection, such as devices for automated pattern recognition and the development of appropriate two dimensional statistical models and basic two dimensional computer language, must be given some attention. Thirdly, the system which most efficiently meets the needs at the least cost, considering all the alternatives for filling data needs, should be selected. Flexibility to reduce costs, considering the changing needs environment and the improving technical capabilities, should be an important factor in system selection.

Another recent study designed to examine the potential of remote sensing imagery to fulfill urban data needs is Barry Wellar's Generation of Housing Quality Data from Multiband Aerial Photographs.[16] The purpose of this study was to attempt to discover significant correlates of poor housing quality using data obtained from low altitude multiband aerial photography. Wellar examines a variety of time-consuming, expensive, and often inadequate and

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[16]Barry Wellar, Generation of Housing Quality Data From Multiband Aerial Photographs (Evanston, Ill.: Department of Geography, Northwestern University, April 1967).

contradictory methods currently used for the evaluation of housing quality. He attempts to develop a procedure producing a rapid, reliable, and objective source of housing data from multiband aerial photographs. He finds the most consistent indicators of low housing quality to be: 1) the presence of litter, garbage, and other rubbish on occupied as well as vacant lots; 2) the lack of landscaping in yards and parkways and the presence of weeds on vacant lots; 3) the number of vacant lots; 4) nonresidential hazards and nuisances including industrial plants and warehouses; and 5) the degree of lot crowding. These "real" features which produce "true" images on photographs are interpreted to represent housing quality; that is, they are photographic surrogates of housing quality. Further limited attempts to develop a weighting scale measuring the relative importance of these surrogates are made in this study, but the author himself admits the weights assigned have not been statistically validated.

This study by Wellar attempts to apply the information obtained from a single remote sensor to a narrowly defined task, i.e., to evaluate housing quality on a house to house basis using surrogates identified on the imagery. Wellar has a short section of criticism of Green's analysis of social structure of urban areas using conventional photography. He states, "It is felt there are too many exceptions to each of Green's four items, and that the items

are too broad. As a consequence, results (levels of desirability) generated by Green are felt to be unreliable."[17]

While Green was concerned with information at the block level and had as his objects of study selected areas representing entire cities, Wellar's study is concerned with considerably smaller areas in his attempt to develop a house by house technique for evaluating housing quality. Green's purpose was not nearly so narrowly defined as Wellar's and this is reflected in the units for which information was collected. While Green's study is clearly not completely suitable to Wellar's purpose, this in itself does not mean that Green's findings are any less significant. Green's sociological approach differs markedly from Wellar's problem oriented approach, and Wellar's basic criticism of Green seems more related to this difference in purpose than to a difference in findings.

Wellar's comments concerning the many exceptions to each of Green's four items and the broadness of each of these items cannot be completely dismissed, however. Many contradictions do indeed exist, but the scale of analysis used by Green usually obscured these irregularities. Wellar, on the other hand, could not possibly ignore these many irregularities because of his more

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[17] Ibid., p. 15.

intensive study of urban residential areas. While the present study has a scale of analysis closer to that used by Green than that used by Wellar, several of the limitations of Green's study, as pointed out by Wellar, must be dealt with here.

The studies of both Wellar and Green have direct bearing on the present study. This study is concerned with the utilization of still another type of photography in the analysis of urban residential areas. Whereas Green used conventional black and white aerial photography and Wellar used multiband photography, this study is essentially based upon low altitude (3,000 ft.) and large scale (1:6,000) color infrared aerial photography taken over the metropolitan Los Angeles area on May 24, 1968, at about 1:00 P.M.[18]

While Green and Wellar were essentially dealing with older cities in the Eastern United States, this study deals with the atypical Southern California environment.

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[18]The National Aeronautics and Space Administration (NASA) is currently sponsoring research at a wide variety of test sites throughout the United States to investigate potential applications of remote sensing techniques. From May 20-May 24, 1968, NASA sponsored a number of aircraft flights over various areas as part of the Southern California Test Site program. Most of the resulting imagery covered portions of the Coachella and Imperial Valleys, but a wide range of sensors were also used on the May 24th flight over the Los Angeles area. Some of the imagery was made available to the UCLA Geography Department as part of a NASA joint contract with the Los Angeles and Riverside campuses of the University of California.

The superior resolution of CIR film, which results from its haze-penetrating quality, and the vegetation enhancement, which is produced because of the high degree of infrared reflectance present from healthy plants, make this film a valuable sensor of the urban environment.[19] Both of these factors are of great value in differentiating various types of residential areas. As a result, CIR film is far superior to normal color photography for this purpose.

The present study does not attempt to provide a house by house analysis for various areas in the Los Angeles vicinity. This type of analysis is presently underway at Northwestern University. Field work had been carried out during the week preceding the May 24th flight by a group of students from Northwestern University and UCLA. These students used housing and environmental appraisal forms prepared by Barry Wellar to accomplish a house by house survey of selected blocks lying within the area to be covered by the May 24th flight. The photography itself was of large enough scale that a house by house survey could also be accomplished from it. Correlation and analysis of the field information and the data obtained from the aerial photography is a primary concern of this Northwestern research group. The present study, on the

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[19]Bowden, op. cit.

other hand, is designed to analyze larger areas, specifically census tracts or combinations of census tracts. Certain sociological and ecological concepts are applied to these areas in a manner similar to Green's study.

Theoretical Background

The photographic surrogates used in this study are correlated with census information on income, home value, occupation, and education and with local public agency statistics on mental health, public health, crime, and delinquency. These variables, which are correlated with information produced by the photographic surrogates, are believed to be related to quality of residential areas, based upon concepts introduced by urban ecologists about half a century ago. While the human ecologists led by Robert Ezra Park, Robert D. McKenzie, and Ernest W. Burgess have had a declining position in the field of American sociology since the 1920's, when they were the theoretical leaders of this field, their basic conceptions concerning the spatial relationships which are produced in a large urban environment within the United States have remained generally intact. The natural areas concept as developed by these urban ecologists may have some theoretical shortcomings, but it does at least partially explain the residential patterns which seem to develop in our large metropolitan areas. Residential differentiation, which

the natural areas concept attempted to explain, is still quite evident based upon ethnic group and social rank.

Such urban ecologists as Frederick M. Thrasher, Clifford Shaw, W. C. Reckless, H. W. Zorbaugh, R. E. L. Faris, M. W. Dunham, H. D. McKay, Nels Anderson, and E. R. Mowrer produced a large volume of work relating the spatial distribution of such social phenomena as juvenile gangs and delinquency areas, mental disorders, commercialized vice, criminal activity, family disorganization, activities of high society, and activities of hobos or homeless men to various types of residential areas within the city.[20] While the theoretical formulations of the urban ecologists have been seriously questioned and often discarded, these empirical studies remain as a lasting contribution to

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[20]Frederick M. Thrasher, The Gang: A Study of 1313 Gangs in Chicago (Chicago: University of Chicago Press, 1927). Clifford R. Shaw and Henry D. McKay, Juvenile Delinquency and Urban Areas (Chicago: The University of Chicago Press, 1942). Clifford Shaw, et al., Delinquency Areas: A Study of the Geographic Distribution of School Truants, Juvenile Delinquents, and Adult Offenders in Chicago (Chicago: The University of Chicago Press, 1929). W. C. Reckless, "The Distribution of Commercialized Vice in the City: A Sociological Analysis," Publications of the American Sociological Society, XX (July 1926), 166-167. H. W. Zorbaugh, The Gold Coast and the Slum (Chicago: The University of Chicago Press, 1929). R. E. L. Faris and H. W. Dunham, Mental Disorders in Urban Areas: An Ecological Study of Schizophrenia and Other Psychoses (Chicago: The University of Chicago Press, 1939). Nels Anderson, The Hobo: The Sociology of the Homeless Man (Chicago: The University of Chicago Press, 1923). E. R. Mowrer, Family Disorganization (Chicago: The University of Chicago Press, 1927).

sociological research. In this way urban ecologists have shown that certain social phenomena are intimately associated with various types of residential areas within the city. Numerous other sociologists with different theoretical orientations have also pointed to the importance of residential location as an indicator of the characteristics of the urban population. For example, Svend Riemer has commented on the relationship between residential locus and status position,

> The city dweller's address tells not only where he lives, but where he belongs on the social scale. From street to street and from block to block there is a consciousness of social status as conveyed by residence in that very location.[21]

Norman E. Green justified his heavy dependence on housing categories based on these considerations. He stated,

> The rationale for the primary interest in housing categories was based on the underlying hypothesis that information describing "residential subareas" in terms of housing types and densities is significantly related to population sizes and densities and has predictive value regarding the socioeconomic status structure of these subareas. . . . [The] usefulness of the photographic method in urban sociology would be largely determined by systematic tests of accuracy of the photographically obtained data on residential structures.[22]

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[21]Svend Riemer, The Modern City (New York: Prentice-Hall, Inc., 1952).

[22]Norman E. Green, "Aerial Photographic Analysis of Residential Neighborhoods: An Evaluation of Data Accuracy," Social Forces, XXXV (December 1956), 142.

M. M. Witenstein noted similar relationships,

> Many other values. . . . can be attached to the recognizable housing types because the characteristics of income, social habits, commodity preferences, remain remarkably consistent throughout each dwelling type and between similar dwelling types in various cities.[23]

Green's interest in the percentage of dwelling units classified as single units, detached, and the average number of dwelling units per block is based upon ecological studies which have shown that these two housing items are intercorrelated with several demographic and sociological variables. The prevalence of single family homes was shown to be positively related to home ownership, income, and occupational status, while high dwelling unit density was associated with lower income groups, high population density, and higher rates of personal and social disorganization. Green found that photographic data yielded "accurate subarea rankings and category classifications" regarding these two housing items, and noted that "such rankings and classifications have been found to be empirically related to the ecological patterning of the urban stratification system."[24] He concluded from this that "the aerial photographic method may be adapted as a useful

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[23]Witenstein, "Photo Sociometrics: The Application of Aerial Photography to Urban Administration and Planning Problems," p. 422.

[24]Green, "Aerial Photographic Analysis . . . ," p. 147.

research tool in urban sociology."[25]

As early as 1948, Branch realized in a general way the possible values of aerial photography in studying more abstract social phenomena in urban areas. He commented,

> Although photographic representation is of the physical corpus and does not reveal economic, sociological, or governmental material directly, a surprising amount of indirect information pertaining to these fields is reflected in the three-dimensional characteristics of the community . . . Neighborhood situation and character as seen from above are sociologically revealing.[26]

In another statement he elaborated somewhat upon this idea as follows,

> . . . it is also apparent that certain information of a general nature is reflected in various characteristics of the physical city . . . the proportions of different residential types disclose one aspect of the mode of life of the inhabitants; or the density, arrangement, and spacing of houses- as well as their situation and character- are ecologically meaningful.[27]

Green expanded upon these ideas in two ways. First, he established the accuracy of the data which could be collected on physical, structural, and spatial items such as house types, numbers and densities, spatial location and distribution, and land use characteristics using conventional aerial photographs. Secondly, he attempted to determine how these physical-structural data are system-

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[25] Ibid.

[26] Branch, op. cit., p. 8.

[27] Ibid., p. 17.

atically related to elements of the social structure of the city. He concluded that photographic interpretation may be profitably utilized in supplementing and substituting for other social data sources, particularly in studies concerning ecological bases of the urban social stratification system. This is true because patterns and variations in residential distributions parallel variations in socio-economic status distinctions. Green's rationale for concentration on residences as one of the more important items of urban physical structure was based upon the commonly accepted social values and sentiments which are associated with housing types and various kinds of residential neighborhoods. Thus, residential location has meaning in terms of occupation, educational level, income class, nationality group, cultural attributes, and even religious preference.

When using aerial photographs to attempt to learn something about the social environment of any area, the use of surrogates identified from the physical environment becomes a necessity. Green's work fundamentally consisted of establishing the nature of the sociophysical relationships as related to the physical factors which he identified from black and white aerial photography. Furthermore, he established the theoretical structure upon which studies of this type are based,

> The fundamental hypothesis recognizes that urban social systems exist in physical settings and are housed in, and characterized by, material-cultural features. Such physical units are sociologically significant in that they limit, facilitate, or condition social interaction. Accordingly, certain aerial photographic information about the city should be meaningful for social science research because of the multiple interdependencies among physical and social elements.[28]

Robert E. Park made further comment upon the nature of the relationship between these elements of the urban environment,

> It is because social relations are so frequently and so inevitably correlated with spatial relations, because physical distances are, or seem to be, the indices of social distances, that statistics have any significance whatsoever for sociology. And this is true, finally because it is only as social and physical facts can be reduced to, or correlated with, spatial facts that they can be measured at all.[29]

Within this general framework the present study attempts to examine the degree of association between a wide variety of physical factors identifiable on low altitude color infrared imagery and various social facts related to the quality of the residential environment. Not as much stress upon the type and density of housing units is present in this study because a number of other

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[28]Norman E. Green, "Aerial Photographic Interpretation and the Social Structure of the City," Photogrammetric Engineering, XXIII, No. 1 (March 1957), 90.

[29]Robert E. Park, "The Urban Community as a Spatial Pattern and a Moral Order," in E. W. Burgess (Ed.), The Urban Community (Chicago: The University of Chicago Press, 1926), p. 18.

physical features can be identified on the CIR photography which seem to be better indicators of socioeconomic features in the Los Angeles area. Also, while Green had as a focal point of analysis the delimitation of the social stratification system within a city as it was areally expressed, this study must be more limited because of the small amount of imagery available for use. Thus, this study deals with a variety of socioeconomic characteristics which are related to the urban social structure, but the nature of the urban social structure itself is not considered.

Through scalogram analysis, Green attempted to describe the multiple interrelationships which exist between physical structures (the four items he examined on the photography) and the social structures (socioeconomic status areas as determined by a variety of socioeconomic characteristics). While the features which he considered within the framework of social structure closely relate to the variables which are examined in this study, the methods and purposes of analysis differ considerably.

The scalogram analysis technique was used by Green to develop scale types which he felt essentially defined the pattern of social ecology of the city. He was thus attempting to develop a model by which the entire urban environment could be sociologically analyzed using black and white aerial photographs. In contrast, this study has considerably less complex goals. It employs some of

Green's conclusions concerning the relationship between certain physical features and the socioeconomic environment and attempts to discover other physical features which can be identified on the CIR photography which also are surrogates of a variety of socioeconomic conditions. Results of the study may lead to further studies which attempt to develop a comprehensive method of analysis of the urban social structure using CIR aerial photography.

While Green developed a scale of residential desirability using four variables, this study ranks the quality of residential areas based on an investigation of over fifteen characteristics of residential areas, which can be identified on CIR aerial photography. Once the study areas have been ranked according to these characteristics, these rankings are correlated with the rankings of these areas in relation to various socioeconomic factors. If there is variation in the socioeconomic characteristics relating to quality of the residential areas and if the photographic surrogates are good indicators of residential area quality, then these correlations should be quite high.

Analysis of the relationship which exists between photographic and ground data forms the heart of the study. Thus, the study does not attempt to develop a technique for defining the urban social ecology, but only attempts to establish the definite relationship between a variety

of photographic surrogates on the CIR film and a number of socioeconomic factors in the Los Angeles area. Relationships noted in this study can be very useful in the analysis of the physical form of the urban environment, and in the association of this form with various socioeconomic characteristics of the population inhabiting this environment.

CHAPTER II

PRELIMINARY STEPS TO CORRELATION ANALYSIS

Selection of the Study Areas

After considerable preliminary inspection of all the CIR photography of the May 24th flight over Los Angeles to determine the diversity of residential areas covered by the flight line, twenty-four areas were selected for analysis (see Appendix). The selection of these study areas was based upon the following six criteria: 1) inclusion of as many types of residential areas as possible; 2) inclusion of areas from all parts of the flight line to obtain as much diversity of location and residential environment as possible; 3) inclusion of areas which conform to census tract boundaries- either one or more census tracts depending upon the size and location of the tracts (when more than one census tract formed a single study area, all census tracts involved had a very similar appearance on the photography), 4) at least 90 percent of the census tract (or tracts) forming a study area was covered by the photography; 5) no adjacent census tracts were chosen as separate study areas unless there appeared to be a marked difference in the residential environment (a fairly even spacing of study areas was desired);

6) inclusion of neither too many nor too few study areas-too many would produce too little differentiation in characteristics of the study areas while too few would be likely to produce an unrepresentative sample of the types of residential areas which exist in the area.

In addition to the large scale CIR aerial photography which forms the basis for this study, a limited amount of high altitude (30,000 ft.), small scale (1:60,000), CIR aerial photography was used to make a quick, general investigation of the vicinity of each of the study areas. This was necessary because the study areas usually filled up almost the entire frame of the large scale imagery and it was believed that the localities of the study areas themselves would exert an influence on the nature of the residential area. This additional imagery was also needed to put the study area in perspective in relation to the Los Angeles area as a whole.

In an earlier study I attempted to differentiate various qualities of residential areas over a much larger cross section of the Los Angeles basin using 1:60,000 scale CIR photography.[1] While that study included almost the entire range of residential environments in the Los Angeles area, the current study is more limited as to the

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[1]Bowden, op. cit., pp. 20-28.

types of residential areas which could be included. The May flight was primarily designed to cover several county areas in South and East Los Angeles and also a few city areas near downtown Los Angeles. These are all poorer quality residential areas which were being covered to determine the usefulness of low altitude CIR photography in detecting dilapidated or deteriorating housing in the Los Angeles area. City and county public health surveys of housing condition of these areas had been obtained prior to the flight to serve as a ground check of information derived from the aerial photographs. This was in addition to the previously mentioned fieldwork undertaken by university students.

Although several middle class housing areas were also included along the flight line, none of the very high status residential environments were covered. Not even a better upper middle class residential area was photographed. The areas covered were basically rather homogeneous residential areas where average family income levels were almost all between $3,000 and $7,500 per annum. Understandably, a very substantial percentage of census tracts in the Los Angeles area have average incomes well above this level with several tracts having average annual family income levels above $25,000.

This lack of coverage of the more exclusive residential areas presents a certain limitation to the study in that it

restricts the range of data collected. However, it was found in the earlier study of the Los Angeles area, using the 1:60,000 scale photography, that differentiation within better quality residential areas was much easier than differentiation within the poorer quality residential areas. This was generally true because of the larger size of each residential lot, the unusually luxuriant and varied nature of the often well-landscaped vegetation, and the great variation of landscapes typical of better residential districts. The location of most of the better residential neighborhoods in the Los Angeles vicinity, within hilly areas or in foothill locations on the slopes of the surrounding mountains creates a wide variety of landscapes which are easily identifiable as better quality residential areas. Of course, differentiation between areas of high residential quality and areas of low residential quality was easier than differentiation within each of these types of areas.

The concentration of this study on poorer quality residential areas probably has great potential advantages. The information present on the May 24th photography is of much more use to a variety of public agencies than similar photography of better quality residential areas would be. Identification of blighted areas, poverty areas, or areas of substandard housing is probably more important than any other type of study of the residential environment of the

city. Increasing awareness of the role played by the residential environment in producing many of today's most pressing social problems has created an intense interest in identifying areas of poor housing and social disorganization, so that programs designed to alleviate these problems can be adequately located and administered.

While the information produced by this study is more likely to be of practical utility than if other areas were covered, the production of information itself is made more difficult by the homogeneous nature of the residential areas and lack of very large socioeconomic differentiations. The use of aerial photos to produce data about these problem areas has certain advantages over other kinds of information which might be collected, namely speed and comprehensiveness of coverage. Data for very extensive areas can be collected and analyzed very rapidly. Moreover, the aerial view enables one to investigate areas not easily seen from the ground such as back yards, interior courtyards, roofs of buildings, areas surrounded by heavy vegetation, hilly areas, and other outlying or isolated areas. Thus, while certain limitations are produced by the types of areas covered, it is also true that the photographic investigation of just such areas has very great potential for direct application of the research findings.

Selection of Surrogates to be Examined on the CIR Photography

Selection of surrogates for residential area quality was primarily based upon a search of the past literature on the subject. This was designed to determine what photographic data had been used to identify residential quality in past research using all types of aerial photography. Previous research by this author suggested other features as did discussions with city planners and other researchers in the field of remote sensing. A list of eighteen features was finally produced as representing those items which could be identified on the photography which might be significantly related to quality of residential areas (Table 1).

During the course of investigation of these features on the photography, the information on these items was condensed into nine categories to simplify data collection and analysis for a large number of areas. The following categories were developed: 1) Dwelling Type, 2) Vegetation, 3) Litter, 4) Vacant Land, 5) Land Use, 6) Location, 7) Pools and Patios, 8) Lot and Home Size, and 9) Streets. Dwelling type was used because of Green's emphasis on this feature. The predominance of single family dwellings and the trend towards more and more new multi-unit dwellings in the Los Angeles area made this category of special interest.

TABLE 1

PHOTOGRAPHIC SURROGATES

1. Dwelling Type	Single family vs. multi-unit structures
2. Vegetation Appearance	Landscaping, trees, lawns
3. Litter and Rubbish	In yards, alleys, vacant lots
4. Vacant Land	Number of lots and area covered
5. Land Use	Within the study area itself
6. Location	Takes into account surrounding land use
7. Lot Size	Including dwelling units per block
8. Home Size	Refers only to single family dwellings
9. Home Shape and Roof type	Indicator of age of housing structure
10. Pools, Patios, Umbrellas	Number and distribution
11. Street Condition	Road surface and road paint condition
12. Street Width	Including parking availability
13. Street Pattern	Terrain and age of housing indicator
14. Street Lighting	Based on number and type of street lights
15. Street Traffic	Cars and/or trucks
16. Sidewalks and Curbs	Presence and condition
17. Railroads	Presence and number
18. Schools, Parks, Golf Courses, etc.	Presence, condition, and number

Vegetation was used by Wellar in his analysis of housing quality using multiband imagery. The vegetation enhancement produced by the CIR film is probably the greatest advantage this film has over other types of film for analysis of residential areas. Better residential areas typically have healthier vegetation in the form of green lawns, landscaped shrubs and flower gardens, and a variety of tree types. Poorer quality areas are usually characterized by unhealthy lawns or dirt yards, less vegetation, little or no landscaping or upkeep, and a smaller variety of trees and shrubs.

Litter and vacant land were also used by Wellar. The large scale and high resolution levels of the CIR photography made these features, which are characteristic of poorer quality residential areas, very easy to identify. The condition of the vacant lots seems to be an important characteristic. Lots in better quality residential areas, even if unutilized are still usually well maintained. In less desirable residential areas they are often not well cared for and become very overgrown and cluttered with refuse. Better quality residential areas characteristically have less litter because of more thorough maintenance, and also have very few vacant lots. Land values and taxes are high in better residential districts, so it is very uneconomical to have vacant land in these areas.

Land use and location were used by Green, but are slightly modified as used in this study. Green used the land use category in a very loose and quite subjective manner in his desirable-undesirable residential differentiation. He includes in this category any features he noted in photo interpretation which he felt affected the "residential desirability" of an area. Only residential and various types of industrial land use are considered in this study. Some consideration of the special land uses listed as item 18 in Table 1 was made early in the study, but these land uses were found to be generally insignificant or to have a very complex relationship with the quality of residential area and were therefore given no further attention. Industry, on the other hand, especially heavy industry and the associated railroad tracks and railroad yards, was quite clearly seen to be detrimental to the residential environment and, therefore, was associated with poor quality residential areas.

Green's location category has also been modified because Los Angeles is unlike the middle-sized cities which Green examined. Simple concentric rings surrounding the CBD do not realistically relate to locational influences in the Los Angeles area. In the present study this category refers to the quality of the surrounding residential environment and to the presence or absence of industrial activity nearby. This was determined by reference

to the high altitude CIR photography which proved to be quite adequate to perform this task, when used in conjunction with the low altitude CIR photography.

Pools and Patios refers to the number and, to some extent, the spacing of these features which are easily identified on CIR photography and which are found quite extensively in the Los Angeles area. Previous research with CIR photography dealing with this area indicated that these features could be identified quite closely with better residential areas. Lot and Home Size is another category developed from prior investigations for Green used lot crowding and number of dwelling units per block as features associated with residential desirability. Consideration of home shape and roof type was easily included within this category because it is another aspect of housing itself.

All of the features concerning streets and the one relating to condition of sidewalks and curbs were combined into the "Streets" category. It was believed that each individual feature would be a weak indicator, but that the combined set of criteria might form an important indicator of quality of residential areas. It was also very convenient to consider these items together since they are closely associated features. Better quality areas tended to have well-paved, well-lit, well-marked, fairly wide streets with adequate parking, while poorer quality areas

had less well-paved, often narrow, sparingly marked, and less well-lit streets. The sidewalks and curbs of these poorer areas were often interrupted and generally in fairly evident disrepair, especially in many areas adjacent to railroad facilities.

A numerical scale was developed for each of these nine surrogate categories. Each study area was assigned a number from this scale ranging from one to five for each variable after all the areas had been closely examined in relation to all these variables. Notes were taken during the course of investigation which were later used to assign values to each variable. This interpretation was a key step in the analysis, but was accomplished in a very short period of time. Less than an hour was needed to interpret the photography of each of these study areas. Three days proved to be a quite adequate period of time to examine all the areas quite intensively from the CIR photography. For every variable the lower numbers on the scale represented desirable conditions, which previous research had indicated would be associated with better quality residential areas, and higher numbers represented the undesirable conditions usually associated with poorer quality residential areas. The numerical values are shown in Table 2.

The categories are admittedly quite subjective, but this was due to a desire to use only information which

TABLE 2

NUMERICAL VALUES FOR THE NINE SURROGATE CATEGORIES

Dwelling Type

1. 81-100% Single family res.
2. 61- 80% " " "
3. 41- 60% " " "
4. 21- 40% " " "
5. 0- 20% " " "

Litter

1. None
2. Light accumulations
3. Many light accumulations
4. Heavy accumulations
5. Many heavy accumulations

Land Use

1. Residential
2. Some light industry
3. Much light industry
4. Some heavy industry
5. Much heavy industry

Pools & Patios

1. Very widespread
2. Many--Above average
3. Several
4. Few--Scattered
5. None

Streets

1. Excellent condition
2. Good condition
3. Adequate condition
4. Minor repairs needed
5. Major repairs needed

Vegetation

1. Luxuriant
2. Landscaped
3. Neat, well kept
4. Unkempt
5. Bare/Overgrown

Vacant Land

1. None
2. Few lots
3. Several lots
4. Many lots
5. Very many lots

Location

1. Amid better housing
2. Amid average housing
3. Amid poorer housing
4. Light industry present
5. Heavy industry present

Lot & Home Size

1. Very large
2. Large
3. Medium
4. Small
5. Very small

could be rapidly interpreted by a human observer using only a light table and small (8X) tube magnifier to interpret the CIR film. It was desired to use as little equipment as possible because of the preliminary nature of the investigation of this topic and because this would insure that the work could be easily duplicated in practical application by such people as urban planners. Further advances in the field of data analysis, using more sophisticated instruments by which information can be more directly extracted from the imagery, will alter the role of the human interpreter. The categories and numerical scales used in this study proved adequate to place a large amount of information interpreted from the photography into a more workable form.

Assignment of numerical values for each variable for each study area was the basic interpretive task which was performed from the photography (Table 3). The most difficult interpretation and least reliable information applied to the dwelling types category. Whereas Green's study developed out of a very intensive, systematic investigation of the reliability of aerial photography to determine numbers and types of dwelling units using a large team of interpreters and field assistants, this study lacks this rigorous approach in regard to this feature. Much less emphasis was placed upon this category, however. Assigning scale values for all other

TABLE 3

SURROGATE SCALE VALUES FOR EACH STUDY AREA

Study Area	Dwelling Type	Vegetation	Litter	Vacant Land	Land Use	Location	Pools & Patios	Lot & Home Size	Streets
1	5	3	2	3	2	2	4	4	1
2	1	3	2	2	1	1	3	3	1
3	2	3	2	2	3	4	4	4	2
4A	1	3	3	3	3	4	4	4	4
4B	2	2	1	1	3	4	2	2	1
5	1	3	2	1	2	]	4	3	2
6A	1	4	4	3	1	3	5	2	2
6B	2	5	4	5	1	4	4	3	3
7	1	5	5	5	5	4	5	2	3
8	1	4	5	4	1	3	5	4	3
9	1	3	3	3	2	2	3	3	2
10	1	2	2	2	2	1	2	2	2
11	2	4	3	2	1	2	4	2	4
12	3	5	5	5	2	3	5	4	4
13	5		Not Applicable						
14	1	4	4	3	5	5	5	4	4
15A	1	5	5	5	1	5	5	5	5
15B	5		Not Applicable						
16	1	5	5	5	4	5	5	3	3
17	1	3	5	4	5	4	4	4	5
18A	1	3	3	1	1	2	3	4	1
18B	2	3	4	2	1	2	3	3	2
18C			Not Applicable						
19	2	3	3	2	1	5	3	4	2

categories except lot and home size and pools and patios was also subjectively done, but with a much greater degree of accuracy expected. Assigning values was usually a fairly easy task as values were assigned on a comparative basis. In the other two categories values were assigned on a more objective basis; average numbers of pools and patios were established, and lot and home sizes were actually measured using a scaled magnifier.

CHAPTER III

CORRELATION OF PHOTOGRAPHIC SURROGATES WITH CENSUS VARIABLES

Once the interpretation of the photography was completed and the scale values assigned, information was collected from the 1960 U. S. Census of Population and Housing for all the census tracts within the study areas on income, occupation, education, and home values. The study areas were first ranked with respect to each category of information collected (Table 4). Next, the scale values for each of the nine photographic surrogates derived for each study area (Table 3) were used to rank the study areas for each surrogate. Correlations between income ranking and the rankings obtained for the nine photographic surrogates were then determined using the Kendall Rank Correlation technique[1] which formed the basis of all subsequent correlation analysis (Table 5).

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[1]The Kendall rank-order correlation is similar to the Spearman rank order correlation. Both measures can be used to correlate ordinal scaling of two variables. As long as both variables can be ranked, either of these measures can be used to give correlations. The numerical value of the Kendall measure is usually less than that of the Spearman which gives relatively more weight to extreme differences in rank. Neither measure can be interpreted in terms of the percentage of variation explained since

TABLE 4

RANKINGS OF ALL STUDY AREAS FOR ALL SOCIOECONOMIC VARIABLES

Study Areas	Income	Occupation	Education	Home Value	Mental Health	Public Health	Adult Probation	Juvenile Probation	Crime Rate
1	10	3	2.5	1	3	4	7	7	-
2	4	6	5	3	4	1	2	4	1
3	8	6	10	4	14	3	6	5	5
4A	13	15.5	6	13	19	13	18	19	3
4B	1	1	1	2	6	6	4	1	6
5	11	8.5	4	6	8	10	13	17	8
6A	17	15.5	14	10	16	19	22	13	16
6B	21	4	7	8	21	15	19	11	18
7	22	23	23	17	23	18	17	14	17
8	14	19.5	24	14.5	10	7.5	9	12	4
9	5	10.5	16	9	5	5	12	6	7
10	2	2	2.5	5	2	2	3	2	2
11	9	6	9	11	11	7.5	5	8	11
12	18	15.5	17	7	18	11	14	16	15
13	24	12.5	13	24	24	20	16	-	19
14	15	22	22	21	15	9	20	18	10
15A	20	19.5	21	19	22	17	24	23	13
15B	23	24	18	23	17	14	15	21	9
16	19	19.5	20	22	20	16	23	22	12
17	12	19.5	19	20	12	12	21	20	14
18A	3	12.5	8	12	7	-	1	10	-
18B	6	15.5	12	14.5	13	-	11	9	-
18C	16	10.5	11	18	1	-	8	3	-
19	7	8.5	15	16	9	-	10	15	-

TABLE 5

CORRELATIONS OF INCOME AND HOME VALUE WITH THE PHOTOGRAPHIC SURROGATES FOR AREAS OF DIFFERENT DWELLING TYPES

Dwelling Type Areas	Vegetation	Litter	Vacant Land	Land Use	Location	Streets	Pools & Patios	Lot & Home Size
Income								
Single Family Areas	.780	.659	.780	.312	.555	.489	.656	.000
Nonsingle Family Areas	.620	.540	.650	-.170	.050	.160	.460	.060
All Areas	.572	.425	.547	.166	.338	.183	.566	.059
Home Value								
Single Family Areas	.470	.563	.416	.087	.782	.695	.525	.278
Nonsingle Family Areas	-.138	.077	-.185	.015	.185	.054	.000	.207
All Areas	.217	.428	.225	.053	.466	.392	.329	.246

This table shows the preliminary correlations which were obtained between the income and home value socioeconomic variables and the various photographic surrogates in relation to different dwelling type areas. Note that the correlations between the socioeconomic variables and the photographic surrogates were larger in all but one case for single family areas than for nonsingle family areas. None of the correlations between home value and these surrogates were statistically significant at the .05 level when nonsingle family areas were considered alone. The three highest correlations between income and these surrogates for nonsingle family areas were significant at the .05 level while another was significant at the .10 level. This table is representative of the early results which led to the special consideration of dwelling types given in the main body of the text. The dwelling type surrogate as first established had very low statistical correlations with the socioeconomic variables and was subsequently altered to make this surrogate more useful in the study.

Although the dwelling type surrogate was not closely correlated with income ranking, this factor influenced the correlations of all the other surrogates with the income variable. Similar results were present when home value ranking was correlated with the surrogate rankings (Table 5). In contrast to Green's study areas, it was found that single family dwelling areas were not necessarily of high quality in Los Angeles, at least for the areas examined in this study. Quite the opposite was often true. This probably results from the greater percentage of single family unit housing in Los Angeles as compared with cities in the eastern United States. Los Angeles has a large area of single family unit slums (low quality residential areas) in contrast to these eastern cities where slums are more

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the notion of variation is meaningless with ordinal scales. The correlation can only be interpreted as a measure of the degree to which ranks in the proper order exceed in number those in the reverse order.

Adopting a significance level of .01 and assuming that the rankings of 20 areas are being correlated, a correlation of .42 or above is necessary to be significant. Reference is made to the case where 20 areas are involved because in this study 20 study areas are most often subjected to correlation analysis. Correlations of .42 or above mean that there is only a 1% probability that there is actually no relationship between the two rankings. When only 10 areas were subjected to correlation analysis (10 single family dwelling type or 10 mixed dwelling type areas) correlations had to be .645 or above to achieve this same effect. For application of this technique or determination of other significance levels refer to Hubert M. Blalock, Social Statistics (New York: McGraw-Hill Book Company, 1960), pp. 319-324.

vertical in nature; that is, they are composed of multi-story structures (including two and three story row houses), which house a number of families. The large number of low quality, single family dwelling areas in this study also resulted from the nature of the flight line which was established to cover the poorer quality residential districts of the city.

When single family residential areas were combined with areas with much greater multi-unit residence, it was difficult to obtain meaningful correlations between many of the photographic surrogates and the socioeconomic variables. Information on dwelling types became much more useful by dividing all census tracts into single family census tracts (90% or more single family units by area), mixed tracts (less than 90% but more than 50% single family units by areas), and multi-unit tracts (more than 50% multi-unit dwellings by area). Only five tracts fell into this last category and they were eliminated from further correlation calculations because of their special nature. That is, for these areas the photographic surrogates which were applied to the other study areas were not good indicators of the socioeconomic levels present. Other factors became more important, as discussed in a later chapter. These tracts were either public housing developments, public housing developments and private development combinations, or areas in or near the CBD's of Los Angeles or Santa Monica.

The necessity of dividing the study areas into categories based upon dwelling types, in order to accurately reflect relationships between the photographic surrogates and socioeconomic variables, indicates the complexity of the residential areas of Los Angeles as compared with cities examined by Green. Many older parts of the city in South and East Los Angeles are low quality residential areas which are almost entirely composed of single family structures, a structure characteristic of higher quality residential areas in most cities in the eastern United States. In contrast to South and East Los Angeles many of the areas of more recent development on the west side of the city are being slowly converted into multi-unit residential districts, but remain high quality residential areas.

Income Correlations

With the elimination of the five census tracts (four study areas) from correlation analysis, the vegetation, litter, vacant land, and pools and patios surrogates had the highest correlations with income (.42-.57; Table 5). Significantly higher correlations were found to exist (.65-.78) when only single family tracts (ten study areas) were considered. Mixed tracts (ten study areas) when examined separately had lower correlations with the eight photographic surrogates being considered, but the same

four surrogates had the highest correlations. Thus, only these four surrogates were consistent indicators of income levels. The other surrogates were poor indicators mainly because of the very low correlations in areas of mixed dwelling types. In these areas there was almost no correlation at all between income levels and the land use, location, streets, and lot and home size surrogates. Also, while pools and patios were a good indicator of income levels in single family areas, they were a much weaker indicator in mixed dwelling unit areas.

It is worthy of note that not one of the surrogates used by Green is a useful indicator of income levels among these study areas. The dwelling type category has already been drastically modified to suit the study areas used in this research. His density of homes (lot & home size category) is also unsuited to these study areas because of the large number of single family residences in uncrowded, poor quality, residential areas. The land use and location categories are also poor indicators of income levels for these study areas because of the widespread occurrence of industrial areas, especially large light industrial areas, throughout the study region. Some of the higher quality study areas happen to be located near isolated industrial areas on the west side of town.

Because of occasional unrepresentative features such as this, which resulted from the specific flight line which

was used, the areas examined in this analysis cannot be considered completely representative of the entire Los Angeles area. Therefore, just because Green's surrogates do not seem to apply to the specific areas in this study, does not mean that they are completely unsuited to analysis of the Los Angeles area. A broader sample of residential areas in the Los Angeles basin would undoubtedly result in better correlations between his photographic surrogates and socioeconomic variables. However, the fact that other surrogates on the CIR film have good correlations with the socioeconomic variables, even when Green's surrogates seem to fail, may indicate a greater predictive power for the CIR surrogates.

The four best photographic surrogates were combined to try to produce higher correlations with income ranking. Vegetation, litter, and vacant land when combined produced a correlation of over .77 and, when the surrogate pools and patios was added, this was raised to over .79. The correlations were higher for single family areas considered separately (.86 & .795) and lower for the mixed areas using these surrogate combinations. These correlations indicate that a very accurate differentiation of residential areas according to income is possible using the CIR photography.

Home Value Correlations

A different set of photographic surrogates became important when home value was examined (Table 5). Location,

streets, and litter had the highest correlations (.39-.46) with pools and patios slightly less important (.33). With single family tracts correlations were again higher (.56-.78). These large differences emphasize the effect which the presence of multi-unit residential structures has upon home values of an area. No photographic surrogate had a significant correlation with home values in nonsingle family areas. This explains why there were rather low correlations when all the areas were considered together. For single family areas location, especially, but also streets had much higher correlations than any of the other photographic surrogates (.78 & .69). Using the three best indicators of home value, correlations around .78 were obtained in single family areas, but the best which could be done for all areas was just over .55.

The importance of general location within the entire metropolitan area influences home values more strongly than such factors as general appearance or nearby land uses and it is, therefore, difficult to assess home values from aerial photographs alone. Someone unfamiliar with the city, possessing only large scale aerial photos of one of the study areas, could do little more than give a general idea of the home values. The ranking of home values shows all the areas in West Los Angeles near the top, other areas west of the downtown area next, and most of the other areas are found below these west side areas

regardless of their rankings for other socioeconomic indicators. Aerial photos of large scale are of much less value in picking up such gross patterns than many other sources of information present on the ground. These gross patterns are, however, generally recognizable on CIR aerial photographs at a scale greater than 1:50,000.

Also important in influencing home values are the number of multi-unit dwellings present in an area. Those areas with heavy concentrations of multi-unit structures generally have higher home values. This influence can be detected from aerial photographs, but it is of lesser importance than the gross patterning of home values present within large urban areas. Higher status locations (every city has its area of exclusive addresses) produce higher home values and these are also difficult to interpret from aerial photos. Large areas similar to the concentric rings used by Green need to be introduced to make any sense out of the variation in home values which is present by location within the city. As a result of these factors CIR aerial photography would seem to be of only limited utility in indicating home values. This is especially true of large scale photography used without reference to other sources of information.

Occupation Correlations

The census lists nine occupational categories of which eight are of importance for this study. One census category,

private household workers, was not a dominant occupation of males for any of the study areas and was, therefore, not considered. The three categories having the highest number of male employees in each census tract were considered to typify each area. A numerical value was assigned to each category as follows: 1) Professional, 2) Managerial, 3) Clerical, 4) Sales, 5) Craftsmen, 6) Operatives, 7) Service Workers, 8) Laborers. This scale does not necessarily represent a gradation of incomes, but probably comes as close as possible to grading life styles and associated social rank.[2] The study areas were ranked based upon numerical scores derived from this scale (Table 6).

The occupational ranking derived in this manner correlated very highly (.74) with an income ranking of single family dwelling areas, but only a .575 correlation existed for all study areas. Occupation and income are usually closely associated, but factors such as family size variation (number of people working in each family), locational wage differentiation, and the existence of high status-low paying jobs and vice versa decrease the degree of the relationship. This is especially true when a small number of quite different appearing residential areas are considered, as was the case here.

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[2]Alvin Boskoff, The Sociology of Urban Regions (New York: Appleton-Century-Crofts, 1962), pp. 199-200; and James M. Beshers, Urban Social Structure (New York: The Free Press of Glencoe, Inc., 1962), pp. 96-97.

TABLE 6

OCCUPATIONAL RANKING OF TWENTY STUDY AREAS

Study Area	Values for Three Top Occupations	Total Points	Rank	Ranked List of Study Areas
2	5 + 1 + 6	12	5	4B
3	1 + 5 + 6	12	5	10
4A	6 + 5 + 7	18	12.5	6B
4B	1 + 2 + 4	7	1	2
5	6 + 2 + $\frac{3+7}{2}$	13	7.5	Tie 3
6A	6 + 7 + 5	18	12.5	11
6B	6 + 3 + 1	10	3	5
7	6 + 8 + 7	21	20	Tie 19
8	6 + 5 + 8	19	16.5	9
9	5 + 6 + 3	14	9	18A
10	5 + 1 + 2	8	2	4A
11	5 + 1 + 6	12	5	6A
12	6 + 5 + 7	18	12.5	Tie 12
14	6 + 5 + $\frac{8+7}{2}$	18.5	19	18B
15A	6 + 8 + 5	19	16.5	8
16	6 + 8 + 5	19	16.5	15A
17	6 + 5 + 8	19	16.5	Tie 16
18A	5 + 6 + $\frac{5+6}{2}$	16.5	10	17
18B	6 + 5 + 7	18	12.5	14
19	6 + 5 + 2	13	7.5	7

The ranking derived from a combination of vegetation, litter, and vacant land surrogate values had a high (.61) correlation with the occupational ranking. Single family residential areas alone had slightly higher correlations--over .65. The six photographic surrogates appropriate for analysis of the particular study areas in this research (eliminating dwelling type, land use, and lot and home size), each produced significant middle range correlations (.42-.70) with the occupation ranking. A ranking produced by combining the values of all six of the photographic surrogates had a reliable .60 correlation with the occupational ranking.

The similar range of correlations of income and occupation with the six photographic surrogates prompted a closer look at the relationship between these variables. It was found that four groups of study areas were formed by the relationships between income and occupation. One group consisted of the highest quality west side study areas and one other suburban area, the second group was composed of the remaining west side and suburban areas, the third group had areas surrounding downtown Los Angeles and one in South Los Angeles, and the last group was formed by the poorest areas of South Los Angeles (Table 7). Because of this close spatial relationship which exists between income and occupational characteristics, the same photographic surrogates can be used to differentiate between areas of

TABLE 7

GROUPS FORMED BY INCOME AND OCCUPATION RANKINGS

Study Areas	Income Rank	Occupation Rank	Total Points	
2	4	5	9	
3	8	5	13	Group 1 0-10
4A	12	12.5	24.5	Areas 2,4B,10
4B	1	1	2	
5	10	7.5	17.5	Group 2 11-20
6A	15	12.5	27.5	Areas 3,5,9,11, 18A,18B,19
6B	19	3	22	
7	20	20	40	Group 3 21-30
8	13	16.5	29.5	Areas 4A,6A,6B, 8,12,17
9	5	9	14	
10	2	2	4	Group 4 31-40
11	9	5	14	Areas 7,14,15A,16
12	16	12.5	28.5	
14	14	19	33	
15A	18	16.5	34.5	
16	17	16.5	33.5	
17	11	16.5	27.5	
18A	3	10	13	
18B	6	12.5	18.5	
19	7	7.5	14.5	

various income levels as well as between areas of differing occupational characteristics.

Education Correlations

Information on education was also gathered from the 1960 census. Study areas were ranked according to median school years completed by persons twenty-five years old and over. This ranking had a surprisingly low correlation with the income ranking of these areas (.46). On the other hand, the correlation between the educational ranking and the occupational ranking was considerably higher (over .70). Locational variations were responsible for this difference. Areas south and east of downtown Los Angeles usually had higher income levels than occupational levels (probably due to larger families and more workers per household) while minority areas on the west side tended to have lower income levels than educational levels (perhaps due to the typically lower income levels of educated Negroes as compared with educated whites).

The ranking of study areas produced from a combination of the vegetation, litter, and vacant land surrogates had a .655 correlation with the educational ranking. This correlation was very similar to the correlation produced by income and occupation with these photographic surrogates. Thus, rather than obtain correlations between education and each individual photographic surrogate, it was decided to examine education in combination with income and occupation.

These variables are clearly highly interrelated socio-economic factors. It is widely recognized that occupational level increases with educational level and that income level usually increases accordingly. Eshref Shevky and Marilyn Williams combine these three variables together as forming an indication of social rank in their classic study defining the social areas of Los Angeles.[3]

Examination of the rankings produced by the study areas for these three variables showed that considerable variation existed (Table 8). For example, one study area had a variation in these rankings from 3rd to 19th out of twenty study areas because of its unique location adjacent to the USC campus in a Negro section of town. However, whereas several areas showed fairly large variability in these three rankings, when all rankings were considered together, four distinct groups of areas were shown to exist (Table 8). The top group consisted of three study areas, two in West Los Angeles and one in the suburb of El Monte; the second group contained outlying areas south and east of downtown Los Angeles and other areas on the west side; the third group contained two areas near downtown Los Angeles on the west side and one predominately white area in South Los Angeles; the fourth group contained

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[3]Eshref Shevky and Marilyn Williams, The Social Areas of Los Angeles (Berkeley: University of California Press, 1949).

TABLE 8

GROUPS FORMED BY SOCIAL RANK VARIABLES

Study Areas	Income	Occupation	Education	Total	
2	4	5	4	13	
3	8	5	9	22	Group 1 0-15
4A	12	12.5	5	29.5	Areas 2,4B,10
4B	1	1	1	3	
5	10	7.5	3	20.5	Group 2 20-30
6A	15	12.5	11	38.5	Areas 3,4A,5,6B,9
6B	19	3	6	28	11,18A,18B,19
7	20	20	19	59	
8	13	16.5	20	49.5	Group 3 35-45
9	5	9	13	27	Areas 6A,12,17
10	2	2	2	6	
11	9	5	8	22	Group 4 46-60
12	16	12.5	14	42.5	Areas 7,8,14,15A,16
14	14	19	18	51	
15A	18	16.5	17	51.5	
16	17	16.5	16	49.5	
17	11	16.5	15	42.5	
18A	3	10	7	20	
18B	6	12.5	10	28.5	
19	7	7.5	12	26.5	

three heavily Negro areas in South Los Angeles and two predominately Mexican-American areas in East and South Los Angeles.

These groupings are important because similar groupings can be formed by combining the information from a number of photographic surrogates. Slightly different groupings can be formed depending upon the number of photographic surrogates considered, but the number of groups (4) remains constant. The consensus of the various groupings produced by the photographic surrogates places three areas in group one, seven areas in group two, six areas in group three, and four areas in group four. The grouping formed by the social rank variables is compared with the grouping formed by the photographic surrogates in Table 9.

A fairly close correlation existed between these groupings. However, five out of the twenty study areas were placed in separate groups by social rank variables and photographic surrogates. One is the area near the USC campus, another an urban renewal area adjacent to downtown Los Angeles, the third a mixed Negro-white area on the west side of town, and the other two are the predominately Mexican-American areas east and south of downtown Los Angeles.

Because of the great variation these areas exhibit in relation to education, income, and occupation, it was

TABLE 9

COMPARISON OF SURROGATE AND SOCIAL RANK GROUPS

Photographic Surrogate Groups		Social Rank Groups	
Group 1	Areas 2,4B,10	Group 1	Areas 2,4B,10
Group 2	Areas 3,5,9,11 18A,18B,19	Group 2	Areas 3,4A,5,6B,9 11,18A,18B,19
Group 3	Areas 4A,6A,6B,8,14,17	Group 3	Areas 6A,12,17
Group 4	Areas 7,12,15A,16	Group 4	Areas 7,8,14,15A,16

Study Areas Placed in the Same Groups

2,3,4B,5,6A,7,9,10,11,15A,16,17,18A,18B,19

Study Areas Placed in Different Groups

4A,6B,8,12,14

impossible for the photographic surrogates to correlate highly with all three variables. The photographic surrogates did have consistent medium correlations with all of these variables and, when these variables were considered together, the photographic surrogates came fairly close to reproducing the social rank categories produced by the census information. No area was placed more than one category away from the categories produced by the census information. Moreover, all five areas where differences did occur were rather exceptional areas as described above.

The middle range correlations between the surrogate ranking of the study areas and the ranking of these areas in relation to census variables are very consistent except for home value. As a result, none of the surrogates seem to be good indicators of one variable and poor indicators of another variable. This refers basically to the social rank variables. Home value is a special variable which has somewhat different surrogates which correlate highly with it. In general, however, it was found that surrogates which were good indicators for one socioeconomic variable were also good indicators for most of the other socioeconomic variables examined in this study.

CHAPTER IV

CORRELATION OF PHOTOGRAPHIC SURROGATES WITH NONCENSUS VARIABLES

In addition to the socioeconomic information obtained easily and directly from the 1960 census report, other statistics concerning mental health, public health, crime, and delinquency were obtained from local public agencies in the Los Angeles area. These statistics concern in-patient and out-patient admissions to count mental health facilities; morbidity counts compiled by the Department of Public Health; crime and arrest reports of the Los Angeles Police Department and county crime reports of the seven major criminal offenses; and Probation Department reports of new juvenile referrals and new adult applications for probation.

Mental health statistics refer to in-patient and out-patient admissions to all county mental health facilities for a number of six month periods from 1964 to 1966 (Table 10).[1] Prior to 1964 statistics were not collected

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[1]Los Angeles County Department of Mental Health, Computer Print-Out of Census Tract and Health Area Distributions of County Mental Health Services, Evaluation and Research Division.

TABLE 10

RESIDENTIAL LOCATIONS OF PATIENTS ADMITTED TO MENTAL HEALTH CLINICS IN LOS ANGELES COUNTY FOR SELECTED PERIODS 1964-1966

Study Areas	Out-Patient Admissions Jan-June 1966	In-Patient Admissions Jan-June 1966	Out-Patient Admissions July-Dec. 1965	In-Patient Admissions July-Dec. 1964	Out-Patient Admissions July-Dec. 1964
1	11	8	10	3	5
2	5	3	1	1	3
3	9	2	7	3	1
4A	24	13	31	1	16
4B	15	9	10	0	9
5	5	3	5	2	5
6A	27	6	19	8	9
6B	30	15	22	14	20
7	58	14	52	7	52
8	13	1	12	8	18
9	13	2	6	4	4
10	7	2	4	1	3
11	13	8	18	5	17
12	24	6	27	15	16
13	37	12	31	21	24
14	20	7	30	8	22
15A	25	5	20	5	15
15B	11	3	16	4	7
16	18	2	17	1	9
17	14	7	17	6	8
18A	1	0	4	0	1
18B	10	2	16	3	16
18C	1	0	4	0	1
19	4	3	5	1	5

on a census tract basis, but were collected separately by each mental health facility. Information was available from the 1964 to 1966 period which combined the statistics of all the separate facilities and gave the total number of patients treated from each census tract in the city (that is, information on the residential location of all patients was collected). Complete information was not available for this period because only sample reports have been made. Statistics were gathered on both a census tract and a health district basis for this report. The statistics collected for health districts contained rankings of these districts based upon the number of admissions per 1,000 people using population estimates made by the Department of Mental Health (Table 11).[2] This information was more difficult to interpret than census tract information which coincided with the study areas and was used only as a general check on the information collected by census tracts.

Whereas mental health statistics were available for all study areas, public health statistics on morbidity were available for only twenty of the twenty-four study areas. These statistics consist of morbidity counts for all census tracts except those in the Long Beach Health District for the years 1966 and 1967. The compilation of information on a census tract basis is quite a recent

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[2] Ibid.

TABLE 11

MENTAL HEALTH STATISTICS BY HEALTH DISTRICTS

Health District	Out-Patient Admissions Jan-June 1966	Rate Per 100,000 People	Rank	In-Patient Admissions Jan-June 1966	Rate Per 100,000 People	Rank
Santa Monica-West	807	315.9	4	257	101.4	4
Southwest	969	611.4	7	303	191.8	8
Southeast	590	1000.0	10	172	291.5	9
East Los Angeles	320	397.5	5	73	90.7	2
El Monte	383	292.4	3	118	90.4	1
Central	806	826.7	9	325	335.1	10
San Antonio	412	289.1	2	150	105.3	5
South	599	815.0	8	129	175.5	7
Compton	525	426.8	6	134	109.8	6
Long Beach	508	270.2	1	176	93.9	3

Health District	Out-Patient Admissions July-Dec. 1965	Rate Per 100,000 People	Rank	In-Patient Admissions July-Dec. 1965	Rate Per 100,000 People	Rank
Santa Monica-West	612	246.7	1	253	102.0	1
Southwest	910	578.9	7	319	202.9	8
Southeast	514	870.4	10	151	255.7	9
East Los Angeles	299	368.5	4	108	133.1	6
El Monte	394	303.9	3	143	110.3	4
Central	726	748.1	8	322	331.8	10
San Antonio	416	293.5	2	166	117.1	5
South	565	771.3	9	131	178.8	7
Compton	501	414.6	5	125	103.4	2
Long Beach	820	439.1	6	204	109.2	3

innovation for the Department of Public Health in Los Angeles County; no information of this kind is available for years preceding 1966. Because information was unavailable for the four study areas in Long Beach, these areas had to be eliminated from analysis when this variable was considered.

Probation Department statistics by census tracts were only available for 1967, but they covered all the study areas. The Los Angeles Police Department, on the other hand, had a variety of statistics on the number of crimes and arrests for all recent past years, but these statistics were only available for thirteen of the twenty-four study areas located within the city limits. Statistics for these areas were gathered for the years 1966 and 1967: this involved reworking eight quarterly reports produced by the Police Department.

The Los Angeles County Sheriff's Department supplied statistics on crimes for five of the study areas. Their reporting areas do not coincide with the census tract boundaries of the study areas in two cases, but the information was still usable. Four study areas in Long Beach and one in Santa Monica have statistics on crimes collected by local police stations which would not release this information.

Public Health Correlations

Morbidity counts for the following diseases were collected for 1966:[3]

Amebiasis
Brucellosis
Chancroid
Coccidioid
Encephalitis Chickenpox
Encephalitis Measles
Encephalitis Undetermined
Epilepsy
German Measles
Gonococcus Infections
Gonorrhea, Epidemiologic
Hepatitis, Infections
Hepatitis, Serum
Lymphogranuloma Venereum
Measles
Meningitis, Mumps
Meningitis, Undetermined
Meningococcal Infections
Mumps
Pertussis
Salmonella Infections
Scarlet Fever
Shigella Infections
Syphilis Primary
Syphilis Secondary
Syphilis Early Latent
Syphilis Late Latent
Syphilis Congenital
Syphilis Epidemiologic
Tuberculosis, Pulmonary Minimal
Tuberculosis Moderately Advanced
Tuberculosis Far Advanced
Tuberculosis Primary
Tuberculosis Non-Pulmonary

The 1967 counts excluded brucellosis and the three encephalitis diseases. Total morbidity counts were then determined for each study area for this two year period. Rates of occurrence of these diseases were computed for the study areas based upon population figures of the 1960 census, and then the study areas were ranked according to these rates (Table 12).

This public health ranking and rankings produced by the photographic surrogates do not have very strong correlations. Vegetation, litter, and vacant land

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[3]Los Angeles County Health Department, Division of Vital Records, "Summary of Cases of Reportable Diseases in the Health Department: Census Tract Areas."

TABLE 12

PUBLIC HEALTH STATISTICS AND RANKINGS

Study Areas	Total Morbidity 1966 & 1967	Rate Per 1,000 People	Rank	Ranked List of Study Areas
1	69	9.88	4	2
2	17	5.07	1	10
3	18	8.85	3	3
4A	314	44.1	13	1
4B	35	12.5	6	9
5	114	33.7	10	4B
6A	523	82.0	19	Tie 8
6B	392	59.6	15	Tie 11
7	718	81.8	18	14
8	148	18.0	7.5	5
9	86	12.15	5	12
10	43	6.75	2	17
11	129	18.0	7.5	4A
12	278	35.9	11	15B
13	354	97.5	20	6B
14	221	30.5	9	16
15A	299	68.2	17	15A
15B	216	58.0	14	7
16	215	61.0	16	6A
17	230	41.3	12	13

combined and the six photographic surrogates combined produce correlations between .55 and .60 with the public health rankings. Two factors reduce the expected close association between higher quality residential areas and high public health rankings. First, the nonsingle family dwelling areas when examined by themselves show little correlation between health ranking and ranking of residential quality using the photographic surrogates. On the other hand, single family areas have health rates which follow very closely the ranking of residential areas using these surrogates. In most cases the increase in multi-unit dwelling in an area seems to be related to higher disease rates. The other factor which seems to be influencing the correlations relates to location. A large area southwest and south of downtown Los Angeles containing five study areas seems to have higher disease rates than the quality of the residential areas would indicate. Other widely scattered areas have much lower disease rates than expected.

The correlations between health rankings and social rank indicators are also lower than expected (less than .35 with education, around .44 with occupation, and about .71 with income). In these particular areas, either public health conditions do not relate to social rank as closely as they should, according to concepts of urban ecology, or the information from the Public Health Department does not

accurately reflect the health conditions within these areas. If the public health statistics accurately reflect the health conditions of the study areas, then census information and CIR aerial photographs would both seem to be somewhat useful, but generally poor, indicators of health conditions in these areas. In this case, socioeconomic information obtained from the census and CIR aerial photography would have similar potential to identify areas of various public health conditions. However, aerial photography always has the advantage of time and flexibility when compared with data such as census information. If, on the other hand, the public health statistics do not accurately reflect public health conditions in these areas, it may be that the CIR aerial photography can locate areas of poor public health conditions better than it can be done from these statistical surveys.

The statistics on morbidity, which were used to indicate the state of public health conditions within the study areas, may be questioned because this type of information has only been collected for the past two years on the census tract level. Nevertheless, these reports seem to represent the most accurate information currently available on this subject. CIR aerial photography has clearly shown its utility in separating areas of low disease rates from areas of generally high disease rates. It is probable that certain influences are present which produce

variations in health conditions and which are undetectable from this type of photography. This would explain the inability of CIR photography to make fine distinctions between areas regarding the health conditions which are present. On the other hand, improved data collection procedures may enable CIR photography to identify features of the residential environment which contribute to the poor health conditions of many areas.

Information collected on a health district basis for the years 1960-1966 seemed to conform quite closely to statistics collected by census tracts for the years 1966 and 1967. The Central, Southwest, Southeast, and South health districts in Central Los Angeles continually had the highest disease rates of the ten health districts which contain study areas. Similarly, the Santa Monica-West, San Antonio, El Monte, and Long Beach districts continually had lower disease rates in areas removed from the Central Los Angeles area. The East Los Angeles and Compton districts, occupied mainly by minorities (Mexican-American and Negroes respectively), were found between these two groups both in location and in disease rates. This strong locational influence may explain the weak correlations between public health rankings and socioeconomic factors as well as between these rankings and rankings produced by photographic surrogates.

Mental Health Correlations

Statistics collected from the Department of Mental Health followed very similar patterns to those collected on public health. Areas where public health conditions were poor also typically had poor mental health conditions and vice versa. There was an especially close correlation where disease rates were high. Two districts, Santa Monica-West and San Antonio, had striking changes from very low physical disease rates to much higher mental disease rates. Still the strong relationship between these two types of health was shown by the high correlation (about .73) between the public health ranking and the mental health ranking of the study areas. The relationship was even stronger when single family dwelling areas were considered separately--over .90.

For study areas the correlations between the mental health ranking and the social rank variables were similar to the correlations between the public health ranking and these social rank variables. However, the correlation between the mental health ranking and the photographic surrogates increased in general between .10 and .20 above public health correlations. This seems to indicate that the location factor which greatly influenced statistics on public health conditions has less influence on mental health conditions. Whether this is due to a spatial

variation in the services provided, to different methods of collecting statistics, or to true differences in environmental influences on public and mental health conditions is difficult to say. Hopefully the statistics reflect an actual difference in the spatial distribution of public health and mental health problems, but at any rate these statistics are the best information available.

The study areas, which changed position in the rankings of mental health and public health rates, acquired a position in the mental health ranking in almost every case which created a closer correspondence between this ranking and the ranking of residential areas using photographic surrogates. The correlations between individual photographic surrogates and the mental health rate ranking ranged from .50 to .70. Vegetation had the highest correlation--approximately .70. Combinations of surrogates produced better correlations than most surrogates considered alone--approximately .65 for vegetation, litter, and vacant land combined and .70 for the six photo surrogates combined.

Again no single photographic surrogate was very highly correlated with the rankings derived from public agency statistics. Assuming that these statistics accurately reflect the mental health conditions of the area, it is obvious that examination of the physical environment alone will not enable the interpreter to deduce with complete accuracy the state of mental health of all areas. However,

these statistics do accurately reflect usage of the public mental health facilities and the correlations present are strong enough to permit fairly good estimation of those areas which will place the heaviest demands upon these facilities assuming all other things remain equal (location of facilities, availability of transportation, etc.).

Both the public and the mental health statistics used in this study are likely to be somewhat inaccurate measures of public and mental health conditions in the study areas because of the numerous factors which influence the nature of these statistics. The statistics reflect such factors as the attitude of the people toward mental illness and social diseases, the ability of these people to pay for private treatment, the location of the treatment facilities and the availability of transportation which provides access to these facilities, and the feelings of the people toward medical attention in general. Information on these subjects is difficult to obtain and beyond the scope of this study. However, these factors place limitations upon the adequacy of these statistics as indicators of public and mental health conditions which must be realized. Even with these limitations, however, the data source is the most comprehensive set of statistics on the subject which has ever been gathered for such a large portion of the County of Los Angeles.

Probation Correlations

The probation statistics collected for the year 1967 were used to produce rates for each study area based upon population figures of the 1960 census. The rates were ranked (Table 13) and correlated with rankings produced by the photographic surrogates. These correlations were constant around the .50-.60 level with little deviation from this range. Again the correlations were not strikingly high. It is possible to pick out where probation rates are generally high and areas where they are generally low, but a very accurate ranking of probation applications and referrals was impossible from aerial photographs alone as might be expected.

The adult probation and juvenile referral rankings were correlated with income rankings to determine how social rank characteristics correlated with these variables. Again the correlations were in the .50-.60 range. One spatial factor which helps to create these low correlations in relation to adult probation is the low rate of new referrals for all the study areas close to the downtown area. According to social rank indicators and to the surrogate values these areas are basically lower quality residential areas and would normally have a larger number of new probation applications. This locational factor prevents photographic surrogates from attaining very accurate predictive

TABLE 13

PROBATION STATISTICS, RATES, RANKINGS--1967

Study Areas	New Juvenile Referrals	New Adult Probation Applications	Juvenile Referral Rate Per 1,000 People	Adult Probation Application Rate Per 1,000 People	Juvenile Referral Rank	Adult Probation Rank
1	17	16	2.44	2.29	7	7
2	6	4	1.79	1.19	4	2
3	4	4	1.97	1.97	5	6
4A	57	54	8.00	7.60	19	18
4B	1	5	.35	1.75	1	4
5	21	17	6.20	5.02	17	13
6A	28	55	4.39	8.61	13	22
6B	26	52	3.96	7.90	11	19
7	40	65	4.55	7.40	14	17
8	34	21	4.14	2.55	12	9
9	17	32	2.40	4.52	6	12
10	6	10	.94	1.57	2	3
11	19	14	2.65	1.95	8	5
12	42	40	5.42	5.16	16	14
13	--	26	----	7.16	--	16
14	45	59	6.21	8.14	18	20
15A	55	50	12.50	11.40	23	24
15B	40	25	10.70	6.72	21	15
16	43	35	12.25	9.96	22	23
17	46	47	8.25	8.44	20	21
18A	4	1	3.56	.88	10	1
18B	16	14	3.21	3.12	9	11
18C	4	7	1.33	2.31	3	8
19	14	8	4.81	2.75	15	10

capabilities for this feature.

Crime Correlations

Collection of statistics relating to criminal activity within each study area proved to be the most difficult data gathering task which was encountered. The division of information concerning the urban environment throughout a number of separate administrative agencies became most apparent when attempting to gather this information. Five separate police and sheriff's departments were consulted--the Los Angeles Police Department, the Los Angeles County Sheriff's Department, the Santa Monica Police Department, the Long Beach Police Department, and the Compton Police Department--in an attempt to obtain comparable information on the number of crimes and arrests in each study area.

Because of the variation in the source of the statistics, numerous problems were encountered. The Santa Monica and Long Beach Police Departments were unable to provide the information requested primarily because of personnel shortages and data collection problems. In addition, there was some question as to the usefulness of the information which these agencies collected because their reporting districts did not coincide with the census tracts which formed study areas in this thesis. This was also a problem in working with the information obtained from the County Sheriff.

Another problem which was encountered was the lack of complete comparability of information collected by each department. While the Los Angeles City Police Department produced detailed quarterly reports on the number and types of crimes and arrests in each of their reporting districts, the Los Angeles County Sheriff's Department only released yearly reports on the seven major criminal offenses (willful homicide, forcible rape, robbery, aggravated assault, burglary, grand theft, and grand auto theft). The offenses in the Los Angeles Police arrest statistics include drunk, robbery, theft, burglary, felony assault, forgery, narcotics, vice, traffic, and other offenses. Their more comparable crime statistics include burglary, robbery, murder, rape, aggravated assault, theft (from person), theft (from auto), auto theft, bicycle theft, and other theft. The Compton Police Department had only very rough information on criminal activity in that city. For the one study area located in Compton the only information which was available consisted of a map where the location of all arrests made by the Compton Police Department in 1967 had been marked. Because of these various problems the information on criminal activity is considered the least reliable data which were collected for this study.

In spite of these problems, a ranking of seventeen of the twenty study areas examined by correlation analysis was produced. Los Angeles City and County information on

the number of crimes in each study area for the years 1966 and 1967 were considered comparable although the number of thefts were reported differently. This probably resulted in a somewhat higher ranking for some county areas than should actually be present, but the differences were not noticeable. The Compton area was included in the ranking based on the arrest information obtained for the year 1967. Table 14 shows the most accurate ranking which could be produced using these data.

Correlations between this ranking and the ranking produced by all six photo surrogates and that produced by vegetation, litter, and vacant land surrogates combined are significant statistically, but are not very high--.48 and .51 respectively. When only those areas within the City of Los Angeles were examined (statistics for these eleven areas all came from the Los Angeles Police Department) these correlations became .46 and .51 respectively. This suggests that the statistics, although gathered from various sources, are comparable. These correlations also indicate that for these study areas, the photographic surrogates can only broadly separate areas of high crime from areas of lower crime rates.

Correlations between rankings produced by statistics on the number of arrests for twelve study areas (Table 15) and rankings produced by these same photographic surrogates were slightly higher, .57 and .53 respectively, but

TABLE 14

CRIME STATISTICS AND RANKING

Study Areas	1967 Crimes	1966 Crimes	Total Crimes	Rank	Ranked List of Study Areas
2	44	73	117	1	2
3	160	120	280	5	10
4A	138	115	253	3	4A
4B	284	177	461	6	8
5	268	327	595	8	3
6A	558	595	1153	15	4B
6B	898	789	1687	17	9
7	755	604	1359	16	5
8	133	145	278	4	14
9	254	243	497	7	11
10	87	100	187	2	16
11	390	340	730	10	15A
12	630	517	1147	14	17
14	372	349	721	9	12
15A	532	428	960	12	6A
16	529	345	874	11	7
17	546	---	1092 (546 X 2)	13	6B

TABLE 15

CRIME AND ARREST STATISTICS FOR AREAS IN THE CITY OF LOS ANGELES

Study Areas	Total Crimes 1966 & 1967	Rank	Arrests 1966	Arrests 1967	Total Arrests 1966 & 1967	Rank
2	117	1	23	22	45	1
3	280	3	82	56	138	2
4A	253	2	193	196	389	4
4B	461	4	72	103	175	3
5	595	5	236	190	426	5
6A	1153	9	1080	1135	2215	10
6B	1687	11	649	833	1482	9
7	1359	10	1278	1399	2677	11
11	730	6	280	273	553	6
12	1147	8	478	593	1071	7
15A	960	7	469	624	1093	8

basically reinforce the conclusion that only broad patterns of criminal activity can be associated with the appearance of an area on the CIR photography. The correlations were, however, statistically significant and indicate that the relationship between quality of residential area and degree of criminal activity can be observed using this photography. The correlation between the arrest ranking and the crime ranking for the eleven study areas in the City of Los Angeles was .82--an expectedly high correlation. Even these two very closely related variables did not come very close to a perfect correlation, however, which means that correlations with photographic surrogates in the vicinity of .50 cannot be dismissed too lightly.

One factor which seems to influence the correlations between statistics on criminal activity and values of the photographic surrogates was the tendency for areas west of downtown Los Angeles to have greater amounts of criminal activity and areas south of the downtown area to have less criminal activity than would be suspected on the basis of analysis of the quality of the residential areas using the photography and application of concepts of urban ecology. Although CIR aerial photography permits a greater accuracy of analysis of socioeconomic factors such as criminal activity (in terms of locating spatial variation of these features) than is possible using any other remote sensor, the level of accuracy which is possible with respect to

each individual socioeconomic variable is still somewhat limited. The real value of the CIR aerial photography, as discussed in the next section, is its ability to identify different levels of residential quality. Each level of residential quality has associated with it a different range of socioeconomic characteristics.

CHAPTER V

ANALYSIS OF CORRELATION OF SOCIOECONOMIC VARIABLES AND PHOTOGRAPHIC SURROGATES

The great amount of variation which occurred in the rankings of the socioeconomic factors made it impossible for photographic surrogates to correlate highly with all or even most of these variables. Because these study areas were so relatively homogeneous and presented socioeconomic characteristics which were often similar to one another, the photographic surrogates alone were usually inadequate, by themselves, to rank the study areas with a great degree of accuracy in relation to any of these variables taken one at a time. However, certain basic relationships held true in most cases among the study areas. They can be divided into four basic types of categories into which most of the information collected and derived for these areas fits quite well.

Table 16 indicates the formation of four categories of study areas based upon the total of all the rankings of the various socioeconomic variables which were examined. These rank totals form four easily identifiable clusters with definite gaps between these clusters. Division of the study areas into four groups based upon the whole range of

TABLE 16

RANKINGS OF STUDY AREAS BY CATEGORIES
FOR ALL SOCIOECONOMIC VARIABLES

	Study Areas	Income	Occupation	Education	Home Value	Mental Health	Public Health	Adult Probation	Juvenile Probation	Crime Rate	Total of All Ranks	Rank Based on All Variables
Category	2	4	5	4	2	2	1	2	3	1	24	2.5
I	4B	1	1	1	1	4	5	4	1	6	24	2.5
Areas	10	2	2	2	4	1	2	3	2	2	20	1
	3	8	5	9	3	12	3	6	4	5	55	4
	5	10	7.5	3	5	6	9	11	15	8	74.5	8
Category	9	5	9	13	8	3	4	10	5	7	64	6
II	11	9	5	8	10	9	6.5	5	6	10	68.5	7
Areas	18A	3	10	7	11	5	--	1	8	--	45++	5
	18B	6	12.5	10	13.5	11	--	9	7	--	69++	9
	19	7	7.5	12	15	7	--	8	13	--	69.5++	10
	4A	12	12.5	5	12	16	12	14	17	3	103.5	12
	6A	15	12.5	11	9	14	17	18	11	15	122.5	15
Category	6B	19	3	6	7	18	13	15	9	17	107	13
III	8	13	16.5	20	13.5	8	6.5	7	10	4	98.5	11
Areas	12	16	12.5	14	6	15	10	12	14	14	113.5	14
	14	14	19	18	19	13	8	16	16	9	132	17
	17	11	16.5	15	18	10	11	17	18	13	129.5	16
Category	7	20	20	19	16	20	16	13	12	16	152	19
IV	15A	18	16.5	17	17	19	15	20	20	12	154	20
Areas	16	17	16.5	16	20	17	14	19	19	11	149	18

socioeconomic information which was collected was thus quite easy despite the marked variation in the socioeconomic characteristics for many areas. A categorization of study areas of this type seemed necessary to cope with this rather high variability of the rankings of the study areas with respect to the socioeconomic variables examined. The consistent middle range correlations also suggested that some grouping of the study areas might result in greater correlation between the photographic surrogate values and the socioeconomic rankings.

Table 17 shows the values of the photographic surrogates for the study areas in each of the categories developed above. The spread of the total surrogate values is less than for the total rank values of the socioeconomic variables and as a result the boundaries between the categories are less clear. However, all but one of the study areas have total surrogate values which place these areas in the correct order with respect to the categories formed by the socioeconomic characteristics. A .83 correlation exists between the ranking produced by the total of all socioeconomic ranks and the ranking produced by the total of all surrogate ranks. This is an indication of the close association between residential area quality as identified by CIR aerial photographs and the socioeconomic characteristics identified in this study.

TABLE 17

SURROGATE VALUES BY CATEGORIES OF STUDY AREAS

	Study Areas	Vegetation	Litter	Vacant Land	Location	Streets	Pools & Patios	Total	Rank Based on All Surrogates
Category	2	3	2	2	1	1	3	12	3
I	4B	2	1	1	4	1	2	11	1.5
Areas	10	2	2	2	1	2	2	11	1.5
	3	3	2	2	4	2	4	17	8
	5	3	2	1	2	2	4	14	5
Category	9	3	3	3	2	2	3	16	6.5
II	11	4	3	2	2	4	4	19	10
Areas	18A	3	3	1	2	1	3	13	4
	18B	3	4	2	2	2	3	16	6.5
	19	3	3	2	5	2	3	18	9
	4A	3	3	3	4	4	4	21	11.5
	6A	4	4	3	3	2	5	21	11.5
Category	6B	5	4	5	4	3	4	25	15
III	8	4	5	4	3	3	5	24	13
Areas	14	4	4	3	5	4	5	25	15
	17	3	5	4	4	5	4	25	15
	12	5	5	5	3	4	5	27	17.5
Category	7	5	5	5	4	3	5	27	17.5
IV	15A	5	5	5	5	5	5	30	20
Areas	16	5	5	5	5	3	5	28	19

The following is a short description of the areas in each category formed by totaling the ranks of the socio-economic variables as previously described. Further justification for these groupings is given in the detailed examination of these categories which follows this descriptive introduction.

Category I--This category contains three areas which had consistently high rankings for all the socioeconomic variables examined. These three areas are all distant from the downtown Los Angeles area; two are located in West Los Angeles and the other in the outlying El Monte area in the San Gabriel Valley.

Category II--This category contains three areas in the extreme southern portion of the flight line which are basically suburbs of the Long Beach area, one outlying area on the east side of town, and three other better quality residential areas on the west side of town.

Category III--This category contains seven lesser quality residential areas all with a large proportion of minority groups such as Mexican-Americans, Negroes, and Chinese. These areas are relatively widespread and are found on all sides of the downtown area. They are generally located close to the central city or in South Los Angeles.

Category IV--This category contains three areas, all in South Los Angeles and all with a very high concentration of Negroes within the area.

Category I contains the best middle class residential areas examined in this study. The suburban area in El Monte had very high rankings for all the variables except for home value. For this variable it was ranked 4th behind some West Los Angeles areas as a consequence of its outlying location. The one heavily single family dwelling area in West Los Angeles also had consistently very high rankings except for the social rank variables where rankings were 4th and 5th. The other west side area in this group showed some inconsistency in socioeconomic rankings with many number one rankings, but also several four to six rankings for noncensus variables.

On the CIR photography these three areas were identified as the highest ranking of the study areas using the six surrogates developed in this study. On the five point scale used in this study for these surrogates, only one four value was used to describe these three areas (one area was located adjacent to some light industry), only two three values were used, and all other values were one or two (Table 17). It is obvious that it was not at all difficult to pick out the higher quality residential areas using the photographic surrogates. These areas also exhibited less variation in socioeconomic characteristics than the lesser quality residential areas. This combination of characteristics made these areas the easiest group to identify.

Category II contains the next seven areas in ranking based on the photographic surrogates. Rankings for the socioeconomic variables were generally between five and ten with a few more exceptions than were present for Category I (Table 16). Location, socioeconomic characteristics, and appearance on the CIR photography were all very similar for these study areas. The correspondence of these factors clearly indicates that these areas are more related to one another than to any of the other areas. This was also revealed by the pattern of socioeconomic variable rankings. While each of these areas has a majority of its rankings between five and ten, the areas in the adjacent categories all had a minority of their rankings within this range.

Similarly, these areas form a group between the top three and the lesser quality areas based upon the ranking from the six photographic surrogates. The similarity of these areas was especially evident in relation to the vegetation, litter, and vacant land surrogates. Only two of these areas have a four value for any of these surrogates and there was only a single one value among them. All of the other surrogate values for these areas were twos and threes. This is very reminiscent of the typically neat, but not very extravagant appearance of most middle and lower middle class neighborhoods. In contrast to this group of areas, the better quality areas have more one and two surrogate scale values while the lesser quality areas

have, with one exception, many more four and five values for these surrogates (Table 17).

Category III contains areas which are located in the poorer residential sections of the city except for one mixed Negro and white area on the west side of town. This is the area mentioned above which has no four and five values for the three surrogates which seem best to identify Category II areas. The socioeconomic characteristics of this area clearly identify it as a Category III area, however. Thus, on the CIR photography this area most closely resembles the Category II areas of all the areas in Category III. When all the surrogate values are examined, however, this area became more clearly grouped with the other areas in Category III.

The seven areas in Category III generally have rankings of socioeconomic variables between 11 and 16 (Table 16). There is considerable variation within these limits for each study area, similar to the variation of Category II areas within its limits, but deviation from these limits is infrequent and seldom far from the limiting ranks. The photographic surrogates, on the other hand, rank these areas in a group below the ten areas in Categories I and II (Table 17).

In addition to the one west side area which approaches the photographic characteristics of a Category II area, one other area in this category located just northwest of

downtown Los Angeles appears related to another category of areas, Category IV, based upon its photographic characteristics. This area clearly belongs in Category III based upon its location and the rankings of the socioeconomic variables, but the photographic surrogates indicate that the area is more associated with the other category of areas. The area is located in a hilly area in an older section of town and is undergoing urban renewal. These factors, which are partly responsible for the changing character of residential units and people in the area, make it a unique area which is difficult to classify based solely on photographic surrogates. The surrogate values of the other areas in this category separate them as a group from the other study areas.

Category IV contains a small group of areas which are clearly distinguished from the other areas (with one exception) because of their particular photographic characteristics. In contrast to Category I areas, where all the characteristics were of a high standard, this category of areas is distinguishable because of the consistently poor quality of most of the photo characteristics of these areas. The surrogates identify the three areas of this category as the lowest ranking of all study areas. Vegetation, litter, and vacant land surrogates all have values of five for all these areas, and only one area has a three value for any of the surrogates.

In rankings for the socioeconomic variables the Category IV areas are consistently between 17 and 20, which places these areas at or near the bottom for most characteristics. All the areas are in South Los Angeles, and the only area to show any variation in the socioeconomic variables is the area closest to downtown Los Angeles. Home values and probation variables have slightly higher ranks than the other areas in this category. Otherwise, the information collected for these areas confirms their low standing based on values of the photographic surrogates. The ease with which these areas were identified on the CIR photography shows that identification of the best and worst quality residential areas can be accomplished quite easily. Grouping of the intermediate areas was also possible with somewhat less accuracy.

If a broader range of residential areas could have been examined, there seems little doubt that a nearly perfect ranking of these areas could have been accomplished using the CIR photography. This ranking would be based upon characteristics of the physical environment, but would also relate to a great variety of socioeconomic characteristics similar to those examined in this study. When the characteristics of the areas are as similar as they were for the areas examined in this study, it is difficult to differentiate them using any set of variables, photographic or otherwise. The areas allow differentiation into only a

certain number of categories and no further differentiation is meaningful.

Shevky and Williams, for example, divided the Los Angeles area into nine major social areas using 1940 census information.[1] The fourteen areas placed in Categories II and III in this study were spread throughout only three social areas in the Shevky and Williams study. In their study all the areas in Category II were placed in a single social area. The areas in Category III were spread throughout three closely related social areas defined by their study. None of the study areas examined in this thesis were placed in any of the three types of social areas with high social rank as identified by Shevky and Williams.

This helps to confirm the lower and middle class status of all the residential areas in this study and strengthens the idea that the correlations achieved in this study would have been considerably higher if a broader range of residential types could have been examined. In that case, differentiation of the varying quality of the residential areas would have been easier, and more definite statements could be made about the socioeconomic characteristics typical of each type of residential area. More generalization would be possible because of the broader range of characteristics present.

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[1]Shevky and Williams, op. cit.

The close correlation between categories of study areas formed by socioeconomic variables and by surrogates from CIR aerial photography (19 of 20 areas) indicates the value of this photography in the analysis of the residential areas in the Los Angeles basin. While this study includes areas with a fairly narrow range of socioeconomic characteristics, these areas present a wide variety of physical appearances on the CIR photography. Included within these study areas are many districts with rather atypical characteristics such as urban renewal activity, location adjacent to a major university campus, integrated Negro-white and Negro-Mexican American populations, and Negro populations with middle class characteristics. In addition, the most heterogeneous area, in terms of ethnic groups present, within the City of Long Beach and the area of lowest socioeconomic status within the City of Compton are included in the study.

In spite of this wide range of unusual features, the CIR aerial photography was able to differentiate these areas into groups based upon certain characteristics of the physical environment almost as well as was possible using a wide range of socioeconomic statistics collected from a variety of public sources. This indicates a very good potential for this photography to provide information about socioeconomic variables like those examined in this study for all kinds of residential environments. Identification and categorization of all types of residential areas accord-

ing to the socioeconomic conditions present seems possible within the Los Angeles area because of the unique properties of the CIR film and equally important because of the residential differentiation produced by the social structure within urban areas in the United States today. While application of this technique for the examination of residential areas in Southern California seems to have great potential, its application in other cities in other portions of the United States may call for several adjustments because of the different environmental setting.

CHAPTER VI

ANALYSIS OF ATYPICAL RESIDENTIAL SITUATIONS

Residential Areas Eliminated from Correlation Analysis

The four study areas which were eliminated from correlation analysis early in the study because of their special nature demand a separate analysis. Different photographic surrogates must be used to indicate residential quality in these areas if, indeed, any surrogates can be found for these special residential environments. It is more likely that these areas will simply be identified as "downtown" areas of rooming houses and hotels or as "public housing" areas, and then the socioeconomic characteristics of these areas can be determined from these designations alone.

The study area in downtown Los Angeles exhibits few characteristics which are typical of other residential areas in the city. The type of residential dwellings which exist in this area can be readily recognized from the CIR aerial photography, and the area can be characterized quite easily by anyone who is aware of the typical characteristics of downtown residential districts in large metropolitan areas of the United States. Under the current value system of our society, these areas are undesirable as places of

residence, and, with the exception of some new high rise apartment buildings in the downtown areas of some cities, are very low quality residential areas. The socioeconomic characteristics of this district confirms its low status. Low income levels, low rent, and high disease and crime rates are found here.

The two study areas which have public housing structures and only a few private residential buildings must also be given special attention. The six photographic surrogates developed and used extensively in this study simply do not apply to these areas. Public housing is typically located in lower quality residential areas, and is generally an undesirable place of residence to most people. The two areas of this type present in this study have quite different socioeconomic characteristics because of the considerably different types of areas in which they are located, the different amounts of private housing present, and the different population characteristics (age, sex, race) within the two areas.

While one area is in the heart of the Negro ghetto in South Los Angeles (Watts), the other is in the suburbs of Long Beach. This latter area also has a very different type of population than the Watts area. However, these areas appear very similar on the CIR photography, and no differentiation can really be made between them. Here then is a situation where the photographic surrogates alone

cannot adequately categorize these areas except to identify them as public housing areas. This, in itself, reveals the lower socioeconomic status typical of these areas, but, as these two areas show, considerable variation is possible within very similar appearing areas of this type.

The fourth study area excluded from correlation analysis, which is located near downtown Santa Monica, is the most exceptional area of all. While well over 50 percent of this area was covered by multi-unit residential structures, the photographic surrogates were still valuable in identifying some of the socioeconomic characteristics of the area. While the three above study areas had almost no single-family dwellings present, this area still had a fair number (around 20% of the area). In addition, almost all the apartment buildings were of fairly recent construction and were rather small buildings. The photographic surrogates, as a result, fairly accurately identified most of the socioeconomic characteristics of this area, but because the area does not fit into any of the four categories formed by the other study areas it is examined separately.

This area combines many of the characteristics of Categories I and II without fitting well into either one. The large percentage of multi-unit dwellings clearly sets the area apart from the other study areas. The effects of this factor must be analyzed separately just as earlier it was often necessary to separate single family unit areas

from mixed dwelling areas. The very high home values present within this area occur partly because of location, but also in large part because of the large number of new multi-unit structures within the area. Construction of new apartment buildings itself raises property values and stimulates a faster conversion from single family to multi-unit residential structures.

The large number of apartment buildings is associated with the lower income level present in the area because apartment districts attract a different population than single family residential areas. The higher crime and probation referral rates in this area are also characteristics which seem to be typical of areas with a higher percentage of multi-unit dwellings. The rather large number of older retired people and young adults present in the area helps to account for some of the special socio-economic characteristics which exist here.

The percentage of multi-unit dwellings in an area becomes especially important when it is very high. The presence of a large number of multi-unit dwellings can be used as a photographic surrogate for a number of demographic and socioeconomic characteristics. Examination of the Los Angeles environment has shown that areas of this type are associated with such features as lower incomes, higher property and home values, older populations, lower school enrollments, higher population densities, fewer married

people, and smaller populations per household than are associated with similar areas of single family dwellings (this relationship does not hold for multi-unit public housing areas).

For the Los Angeles area, however, the relationship between increasing numbers of multi-unit residential structures and decreasing socioeconomic standards is not as simple as in the cities in the eastern United States examined by Green. In Los Angeles, where a large percentage of multi-unit structures usually indicates most of the features listed above, these factors alone do not mean that the quality of the residential area is lower than many single family dwelling areas in the city. To a much greater extent than most other cities, the lowest quality residential areas in Los Angeles are found in areas of single family dwellings.

All of the study areas demanding special analysis were areas where over half of the residential portion of the area was covered by multi-unit dwellings. These areas are rather infrequent in the Los Angeles basin. Knowledge of the special characteristics of these few areas allows the interpreter of the CIR photography to judge the quality of these localities and to make a fair estimation of the socioeconomic characteristics associated with them. Thus, although the photographic surrogates which were used in this study have little application to these areas, it is

still possible to draw conclusions about these types of areas by recognizing their special character and applying knowledge of these special types of areas to a particular locality. In this way, the CIR aerial photography may be applied to the analysis of the socioeconomic characteristics of all portions of the urban environment.

Comparison of Adjacent Study Areas

When the study areas were selected, emphasis was placed upon choosing residential neighborhoods which were separated from one another except in four cases where adjacent study areas were selected for purposes of comparison. Three pairs of study areas and one group of three study areas were selected for analysis. These areas were all located west and south of downtown Los Angeles. The two, or in one case three, study areas in each of these four groups exhibited on the CIR aerial photography what appeared to be obvious differences in either age or type of housing units present. It was desired to determine if these obvious physical differences could be related to the socioeconomic characteristics of the population of these areas with approximately equal locations within the city. Thus, the location factor was kept constant in these examples in an attempt to relate any socioeconomic differences present to the different physical form of the city.

One pair of study areas on the west side of the city

was selected because a railroad track neatly separated what appeared to be an older residential area from a much newer one. In addition to this age difference in the housing, as indicated on the photography by such features as street patterning, lot size and spacing of houses, and shape of the houses and associated roof type, other differences in appearance of the photographic surrogates were obvious. The newer tract had lower values for all of the photographic surrogates and also had higher rankings for all the socioeconomic variables except those relating to criminal activity (this is probably caused by the presence of a large department store in the area). This close association between values for the surrogates and types of socioeconomic characteristics for these areas with adjacent locations, indicates that these surrogates are valuable indicators of a series of socioeconomic characteristics present in each area.

The second pair of study areas is located just southwest of downtown Los Angeles. These two areas were chosen to contrast the characteristics of a neighborhood or large old homes populated mostly by Negroes with the characteristics of an area of similar homes interspersed with a fairly large number of newer apartment buildings. This second area is also adjacent to the USC campus, houses a considerable number of students, and is being influenced by an urban renewal project to expand the USC campus into

part of this area.

The socioeconomic characteristics of these two areas turned out to be very similar except in relation to education and occupation. These differences were a result of the presence of the USC campus nearby. The values for the photographic surrogates for the two areas also were very similar (except for the obvious difference in dwelling types). Both of these areas were placed in the same categories based upon socioeconomic variables and values of the surrogates. Therefore, it must be concluded that outside of the variation in social rank variables between the two areas caused by the location adjacent to a university campus, these areas are actually very similar and the presence of the many new apartment buildings has little influence. Apparently a greater percentage of the area must be covered by multi-unit residential structures before they have a significant influence on the area.

The third pair of areas is located in Watts within South Los Angeles. One area is a very poor quality single family residential area and the other a small public housing unit. The type of housing in these two areas is vastly different, one almost entirely single family residences and the other totally multi-unit residences, and the appearance of the two areas on the aerial photography was markedly different. The area of public housing appears to be of higher quality than the other area which has a very poor

appearance. It was, however, impossible to apply the photographic surrogates to the public housing area, as discussed earlier.

The socioeconomic characteristics of the two areas were very similar despite the very different physical form of the areas. The only significant difference appeared in the number of new adult probations and this was caused by the smaller number of males over 21 years of age in the public housing area. The demographic characteristics of the two areas were different, however, and accounted for the differences in socioeconomic conditions which did exist. The public housing area had a higher percentage of Negroes, more children, more female-headed households, much higher population densities, and a very much younger population than the adjacent area.

The fourth combination of neighborhoods contains three study areas of diverse character in Long Beach. One study area is composed of one small housing tract completely lacking any multi-unit residential dwellings. It is a small area of single family homes of apparently slightly more recent construction than the adjacent area. This adjacent area is also basically composed of single family residences, but also has a significant number of multi-unit dwellings. The third area in this group is composed of public housing, private multi-unit structures, and a few single family residences. It was compared with the

the public housing in Watts earlier in this study.

The socioeconomic characteristics of the first two areas were basically similar, but considerable variation with regard to noncensus variables was present. Whether this variation is related to different living conditions within these neighborhoods or to the changing population composition of these areas (Negroes have been moving into the area from the east part of Long Beach since the 1960 census) is hard to say. According to the census information the populations of these two areas were very similar in 1960. Unless the population characteristics have greatly changed since this census, the variation with respect to these socioeconomic variables is difficult to understand on the basis of information obtainable from the photographs.

The slight difference in dwelling types may offer a partial explanation with the more desirable characteristics being associated with the single family dwelling area and the less desirable with the area with more multi-unit dwellings. The other photographic surrogates for these two areas had very similar values; the single family area appeared to be only a slightly better residential area. The two areas were placed in the same categories according to surrogate values and also according to the socioeconomic variables. Socioeconomic variable rankings followed surrogate values very closely; the single family unit area

had slightly better surrogate values and slightly higher rankings for the socioeconomic variables.

The third area in this group had highly varied socioeconomic characteristics, as varied as any of the study areas. These characteristics resembled those of the adjacent areas to some extent, but there are enough differences so that they could not really be grouped together. Here the difference in residential forms is reflected in differences in socioeconomic characteristics. The younger and more heavily Negro population of the drab public housing portion of this study area probably is responsible for the variation of the socioeconomic characteristics of this area from the two adjacent areas. The lower income of the inhabitants of this area is the most obvious socioeconomic difference between this area and the adjacent areas.

Comparison of these adjacent study areas pointed out three things. First, and most important, it showed that when surrogate values are greatly different for adjacent areas, it can also be expected that socioeconomic characteristics of the areas will be very different. Thus, variations in surrogate values are closely followed by variations in socioeconomic characteristics of the areas. Secondly, it showed that public housing areas can be distinguished on the photography even if the surrogates do not apply well to them. Furthermore, it showed that the demographic and socioeconomic characteristics of these areas are quite

variable and related to the quality of surrounding residential areas. Thirdly, it showed that slight differences in the number of multi-unit dwellings in a neighborhood has only limited if any effect on the socioeconomic characteristics of an area. This factor becomes of much greater importance when large percentages of a residential district are covered by multi-unit structures.

CHAPTER VII

CONCLUSIONS

With the six photographic surrogates used in this study it was possible to differentiate various types of residential areas which were associated with a number of socioeconomic characteristics in the Los Angeles area. While these surrogates did not produce a ranking of study areas which had exceedingly high correlations with the rankings of the study areas for a number of socioeconomic variables, they did provide information which permitted division of the residential areas of the city into various groups. Each of these groups contained areas with similar socioeconomic standards and corresponding social rank.

It is concluded that photographic surrogates can be used to identify various types of residential areas in the Los Angeles basin from CIR aerial photography faster than by any other means, while still retaining a high degree of accuracy. While definite conclusions can only be made concerning the utility of this photography in the examination of the Los Angeles residential environment, certain extrapolations can be made concerning its use in other large metropolitan areas. Norman E. Green, in his study of numerous cities mostly in the eastern United States, used

surrogates very similar to the dwelling type, land use, location, and lot and home size surrogates used in this study. He found that these surrogates worked adequately to produce significant correlations with the socioeconomic characteristics which he considered. Thus, the use of these surrogates would seem to produce fair results in almost all cities in the United States. The great advantage of using these particular surrogates is that they are not affected by seasonal changes and thus they can be applied at any time during the year.

The application of the other surrogates such as vegetation, litter, vacant land, and streets, which are particularly appropriate surrogates when CIR film is used, is made more difficult because seasonal variations of these features are present. There is, however, at least some evidence that these variables which are subject to seasonal variation can be used to differentiate residential environments in other parts of the country. Barry Wellar found these surrogates to be useful indicators of housing quality in the Chicago area.[1] The use of these surrogates in winter months in areas outside Southern California remains highly questionable, however, because of the great seasonal variations in most other parts of the country.

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[1]Wellar, op. cit.

Certain surrogates which were used such as pools and patios and possibly streets (as defined for this study), have less application in urban areas in other parts of the country. Los Angeles is unquestionably a unique major city in the United States especially in relation to the physical features of the residential part of the city. Different features of the physical environment may be found to be useful indicators of the social environment of the other major American cities.

The superior resolution of the CIR photography as compared with any other photography which relies entirely upon wavelengths within the visible spectrum, is present no matter what surrogates are used. Thus, as long as any photographic surrogates are present which are good indicators of varying residential area or housing quality, CIR photography will be a valuable sensor in the analysis of the urban residential environment. The vegetation enhancement property of the film, on the other hand, while extremely important in an examination of the Los Angeles area, may have less usefulness in other sections of the country.

Using physical characteristics of the environment identifiable on CIR aerial photography, the socioeconomic differentiation of the residential areas of large metropolitan areas can probably be identified to a very substantial degree. The physical structures of the city, visible on CIR aerial photography, lend themselves very

well to an ecological analysis of the urban environment. Once various types of residential environments have been identified, a number of inferences can be made about such things as public and mental health conditions, crime and delinquency rates, housing quality, social rank of the inhabitants of the area, and demographic characteristics because of the ecological structuring of the large metropolitan areas of the United States.

The residential areas of a large city create a definite patterning of socioeconomic characteristics of the population of that city. CIR aerial photography provides a practical method for identifying the various residential areas which are associated with various socioeconomic status areas of the city. Through use of this photography, the physical form of the environment can be associated with the social characteristics and structuring of the city.

The great advantage of using CIR aerial photography to perform an analysis of urban residential areas concerns the ease with which information can be obtained for a very large urban area in a very short period of time. The time needed to fly over the area concerned, develop the film, and interpret the resulting images is considerably less than the time it would take to consult census materials and public agencies to obtain similar information. In many cases it may be found that the public agencies simply do not collect the kind of information desired for the specific

spatial units in which one is interested.

The advantages of flight flexibility, rapid coverage of even large areas, near real time information, and the possibilities of obtaining large amounts of additional information must be taken into account when considering the use of CIR aerial photography, or any other remote sensing system. One of the main problems in acquiring information about the urban environment is the fragmentation of information throughout a variety of city and county agencies. Using CIR photography it is possible to arrange the information for any desired spatial unit. Retention of the photography also makes it possible to recheck the area at any time or to adjust the information if different areas become our interest. This great flexibility which is provided by the use of aerial photography is a great advantage over static information sources present on the ground. The advantages of remote sensing systems makes them especially useful in areas of rapid urban growth or rapid change of any kind. In these areas, the information obtained from such remote sensing systems as CIR aerial photography may often be superior to prior census information or other earth-bound information sources.

The rapid and accurate collection of information about large areas of the city is becoming essential with the ever increasing concern with the problems found within the urban environment. Only by accurately knowing the present condi-

tion of the urban areas can city planners and other public officials make adequate plans for the future. The desire for information is especially great for substandard or blighted sectors of the city. With the help of the photographic surrogates used in this study, it is possible to differentiate easily those areas where socioeconomic, housing, and other conditions of the residential area are poorest. Substandard conditions of the physical environment were again shown to be associated with substandard health conditions and higher crime rates in this study.

Quantification of the surrogates used in this study is a problem which must be solved before this film can be easily applied to a wide range of cities across the United States. Features such as land use, vacant land, lot and home size, and possibly the area covered by various dwelling types can be measured directly from the photography. Vegetation appearance, the amount of litter present, the location of the area, and the condition of the streets all seem to call for a subjective judgment from the interpreter. It may be possible to measure the intensity of the infrared return from vegetation mechanically, but these other variables may prove to be very difficult to quantify. Quantification of surrogates which provide information about the urban environment seems to be a worthwhile goal, nevertheless, because of the vast amount of information which this procedure would make readily available. A

search for surrogates more susceptible to quantification may be necessary, however, before this procedure can be widely adopted.

The use of CIR aerial photography should prove to be of great aid to planning agencies in most parts of the country. The clarity of the CIR aerial photography and the amount of information contained on this imagery about the urban environment is unparalleled by any other type of photography or any other remote sensor. This photography should provide public officials with a clearer view of the city and its various residential areas than they have ever had before. Aerial photography has been useful to both researchers and planners in their examination of the urban environment, but the use of CIR film in this work should greatly increase the types of useful information which can be obtained.

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APPENDIX

STUDY AREAS

Study Area 1: Census tract 7015. Located in Santa Monica. About 80% multi-unit dwellings, 20% single family dwellings by area. No industrial districts nearby, but the area has many heavily commercial streets. Many community facilities such as hospitals, parks, schools are present. Surrounded by good residential areas with many new multi-unit dwellings.

Study Area 2: Census Tract 2713. Located in West Los Angeles. Single family residential area with no industry and little commercial activity present. Homogeneous middle-class residential area surrounded by similar housing.

Study Area 3: Census Tract 2701. Located adjacent to Culver City on the north side. Mixed single family and multi-unit residential area with newer multi-unit buildings and older single family homes. Area contains part of and is adjacent to the main light industrial and commercial areas of Culver City.

Study Area 4A: Census Tracts 2198 & 2199. Located adjacent to Culver City on the east side. Another mixed single family and multi-unit residential area, but with much older housing than area 3. This area also includes and borders a large light industrial area in Culver City. Little commercial activity is present except for one large department store. A mixed Negro-white population inhabits this area with the Negroes predominating.

Study Area 4B: Census Tract 2201. Located adjacent to Culver City on the east side and adjacent to area 4A on its south side. Separated from area 4A by a railroad track. Definite middle class area considered a mixed single family and multi-unit residential area because of a large multi-unit development completely separate from the single family dwellings. Fairly new homes and a completely white population. Completely residential area except for an extension to the west into the light industrial area bordering Culver City.

Study Area 5: Census Tract 2193. Located in the Crenshaw District. Mixed single family and multi-unit residential area much like area 4A except for better maintenance. Middle class area of older homes. Borders a railroad and some light industry as well as residential areas of similar quality. Predominately populated by Negroes.

Study Area 6A: Census Tracts 2221 & 2222. Located in the Exposition Park area southwest of downtown Los Angeles. Mixed single family and multi-unit residential area. Large old homes with a few new multi-unit structures. Strictly residential area surrounded on all sides by more residential areas. Negroes predominate in the area.

Study Area 6B: Census Tracts 2218 & 2219. Located in the Exposition Park area adjacent to area 6A on the east side. Also a mixed single family and multi-unit residential area, but contains many more large, new multi-unit apartment buildings than area 6A. Adjacent to the USC campus and to a light industrial area. Area is changing from a completely residential area because of urban renewal activity to expand the USC campus into this area. Predominately a Negro population with a large number of young students.

Study Area 7: Census Tracts 2264 & 2265. Located just south of downtown Los Angeles. Single family dwelling area with very few apartments. Industry mixed in the area and located near the area on three sides. Little commercial activity is present. A heavily Negro population inhabits the area.

Study Area 8: Census Tract 5312. Located in East Los Angeles not too distant from downtown Los Angeles. Old single family dwelling area with a high concentration of buildings per lot. Strictly a residential area surrounded by similar residential areas except on the east side where it borders a very large cemetary. Fairly close to a large railroad yard. Older, basically lower class residential area inhabited primarily by Mexican-Americans.

Study Area 9: Census Tract 5303. Located in East Los Angeles well removed from the downtown area. Single family dwelling area with numerous Spanish style homes. Two large commercial streets pass through the area. No industry is in the vicinity of this basically middle class area; a golf course is located nearby. A large Mexican-American population is present although they are not a majority of the inhabitants.

Study Area 10: Census Tract 4315. Located in the San Gabriel Valley near El Monte. Almost entirely single family residences with some very new housing tracts. Definite middle class residential area surrounded by the same except for a large flood control basin on the eastern boundary of the area. Many very large residential lots are present in this suburban location.

Study Area 11: Census Tracts 1955 & 1956. Located in the Silver Lake District just south and east of the lake. Heterogeneous, hilly area with mixed single family and multi-unit structures. Older portion of the city. Basically a middle class area with some lower class elements in the southern portion of the area closer to downtown Los Angeles. Surrounded by the same type of heterogeneous residential districts with no industry nearby.

Study Area 12: Census Tracts 2082 & 2083. Located in the Temple Urban Renewal Area just northwest of downtown Los Angeles. Another very heterogeneous area of older single family dwellings, older multi-unit dwellings, and very many new multi-unit dwellings. Nonindustrial, lower class residential area with a large Mexican-American and Chinese population. Much land is vacant probably in preparation for urban renewal activities.

Study Area 13: Census Tracts 2077 & 2078. Located within the downtown Los Angeles area. Basically a nonresidential area with commercial activities dominant. Almost all residences are multi-unit structures inhabited by a lower class, white population.

Study Area 14: Census Tracts 5327 & 5330. Located in the Florence area south of downtown Los Angeles. Single family dwelling area in an industrial part of the city. Some heavy industry is located within the area and also borders the area on the north and east sides. A lower class area with a mixed Negro, Mexican-American, and white population.

Study Area 15A: Census Tract 2422. Located in Watts. Single family dwelling area with little commercial or industrial activity within the area. Numerous railroad tracks and heavy industries are located nearby in this industrial section of the city. The population is mostly Negro with some Mexican-Americans and very few nonminority group whites.

Study Area 15B: Census Tract 2421. Located in Watts adjacent to area 15A. Composed entirely of multi-unit public housing. Directly borders a large heavy industrial area. The population is almost entirely Negro.

Study Area 16: Census Tract 5406. Located in the Willowbrook area. Single family residential area composed mostly of older housing and located adjacent to heavy industrial areas. Little commercial or industrial activity is present in the area itself. Surrounded by heavy industry, public housing, and similar residential areas of poor housing. Mostly Negro population with some Mexican-Americans.

Study Area 17: Census Tract 5426. Located in Compton. Single family residential area adjacent to the heavy industrial and commercial center of Compton. Some better residences are located close to the civic center of Compton. Much vacant land is present away from this center in the more typically lower class areas. This area is near the undeveloped Dominguez Hills area in South Los Angeles, but otherwise is surrounded mostly by similar lower class residential areas. The population is a mixed Negro, white, Mexican-American group.

Study Area 18A: Census Tract 5724. Located in northwest Long Beach. This is a small single family dwelling area composed entirely of one fairly new subdivision. Strictly residential area with no industry nearby. Definite middle class area surrounded by open land and other single family residential areas. The population is changing from an entirely white population in 1960 to an integrated Negro-white population.

Study Area 18B: Census Tract 5723. Located in northwest Long Beach adjacent to area 18A. Mixed area of single family and multi-unit residential dwellings. Residences are of fairly recent construction as compared with other areas south of downtown Los Angeles. No industry is located near this middle class neighborhood and little commercial activity is present. The population is changing from an entirely white population in 1960 to an integrated Negro-white population.

Study Area 18C: Census Tract 5725. Located in northwest Long Beach adjacent to area 18B. Basically a multi-family dwelling area, but it contains a few single family residences. The multi-unit dwellings are a combination of public housing and new and old private developments. The population is predominately white, but also has a variety of other racial and ethnic groups present.

Study Area 19: Census Tract 5729. Located in west Long Beach. Mixed single family and multi-unit area. Half of the area contains few if any multi-unit dwellings while the other half contains a high percentage of multi-unit dwellings. This latter area is adjacent to a large light industrial area. Similar residential areas surround this district on other sides, but it is also near a considerable amount of undeveloped land to the west. The population is basically white, but it also contains a variety of other racial and ethnic groups.

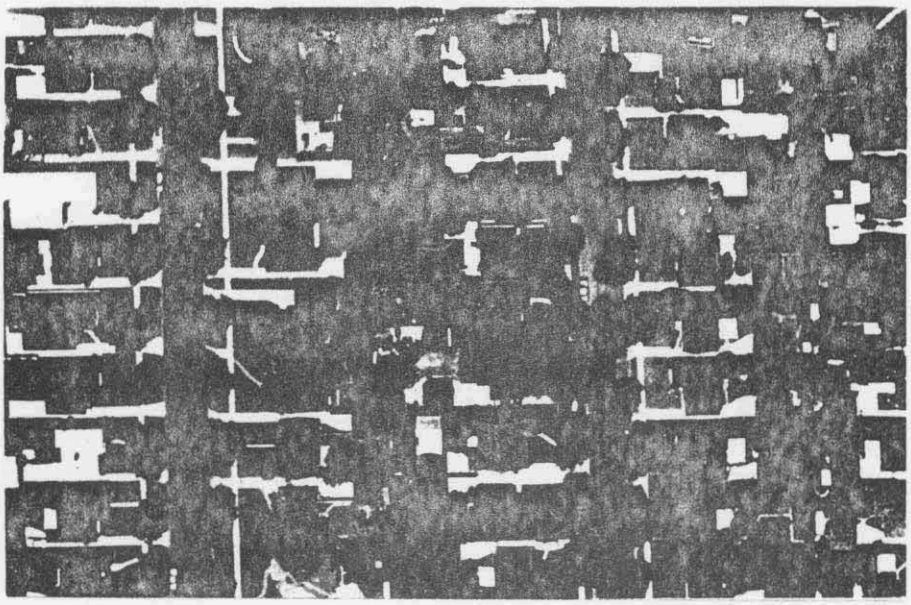
SUPPLEMENT

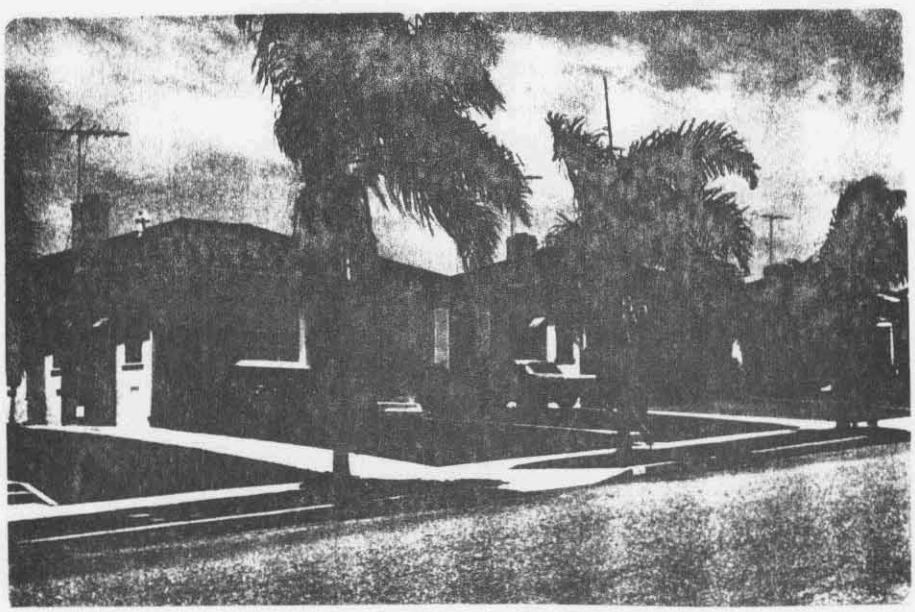
PHOTOGRAPH 1

Color infrared aerial photograph--Area 4B. Note the numerous healthy trees lining the streets, the well planned spacing of homes, the numerous patios in back yards, and the intensity of infrared reflectance from all vegetation (bright reds).

PHOTOGRAPH 2

Ground ektachrome photograph of Area 4B. Note the newer style housing, the well-kept vegetation, good condition of curbs, streets, and sidewalks, and the trees lining the streets.



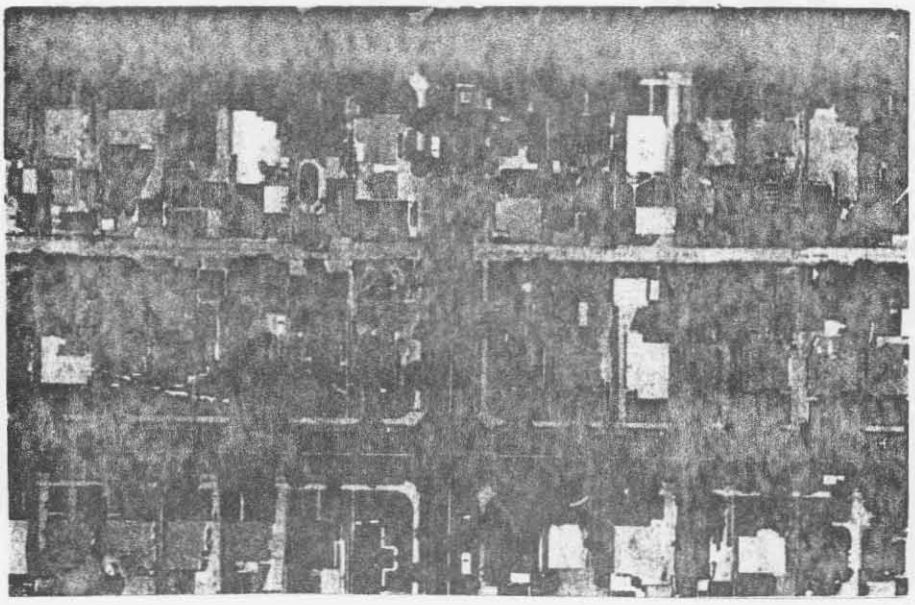


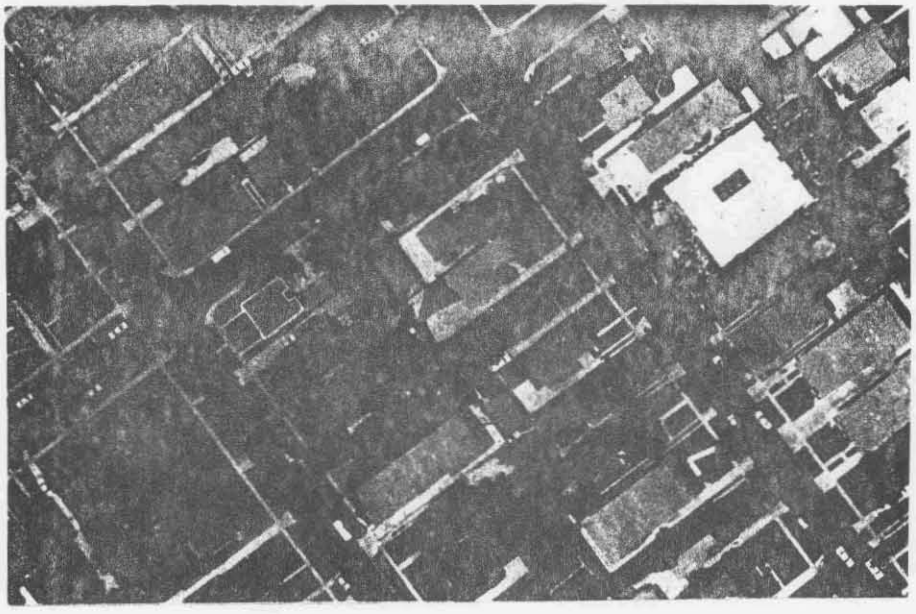
PHOTOGRAPH 3

Color infrared aerial photograph--Area 18B. Note the tree-lined, well painted streets, the pools in the upper left corner, the more degraded vegetation as compared with Area 4B, and the more frequent litter accumulations.

PHOTOGRAPH 4

Color infrared aerial photograph--Area 3. Note the generally healthy condition of the vegetation with several palm trees present (middle right), and the large number of apartment buildings present including the large white building under construction.



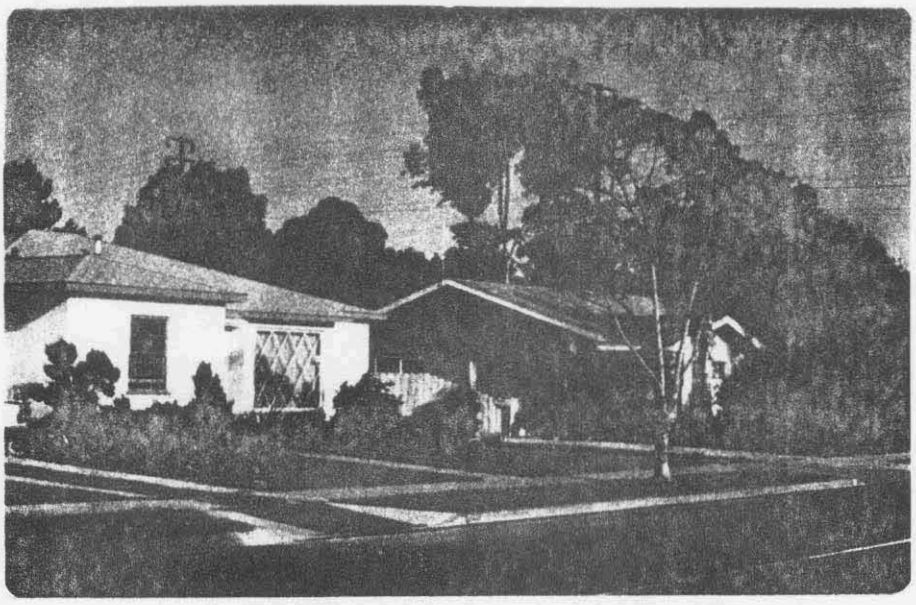


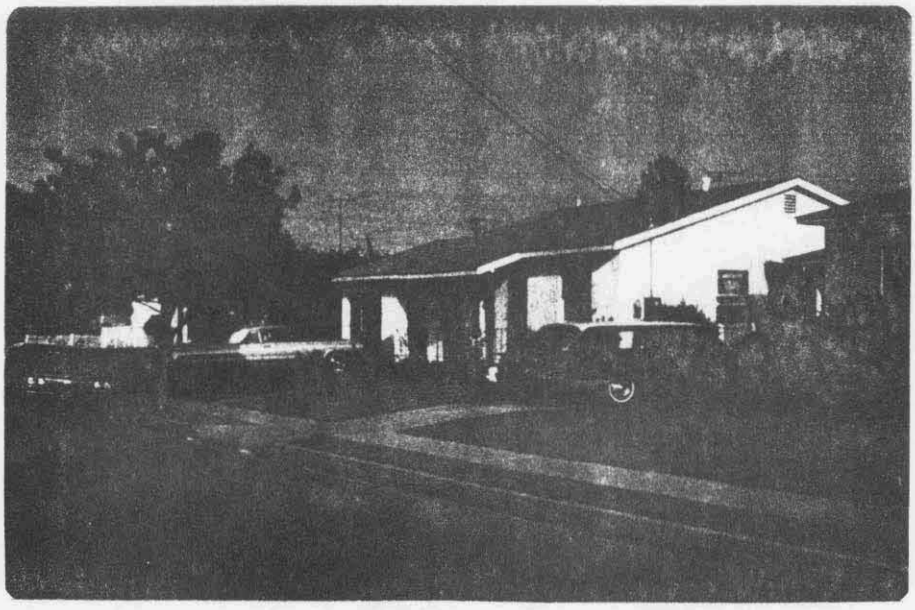
PHOTOGRAPH 5

Ground ektachrome photograph of Area 18B. Note the healthy but not luxuriant vegetation and the good condition of the street, curb, and sidewalk. Compare with aerial view--Photograph 3.

PHOTOGRAPH 6

Ground ektachrome photograph of Area 18B. Note the similarity to the above picture--similar well-kept but not extravagant housing and yards. Note the numerous utility lines present in both photographs.



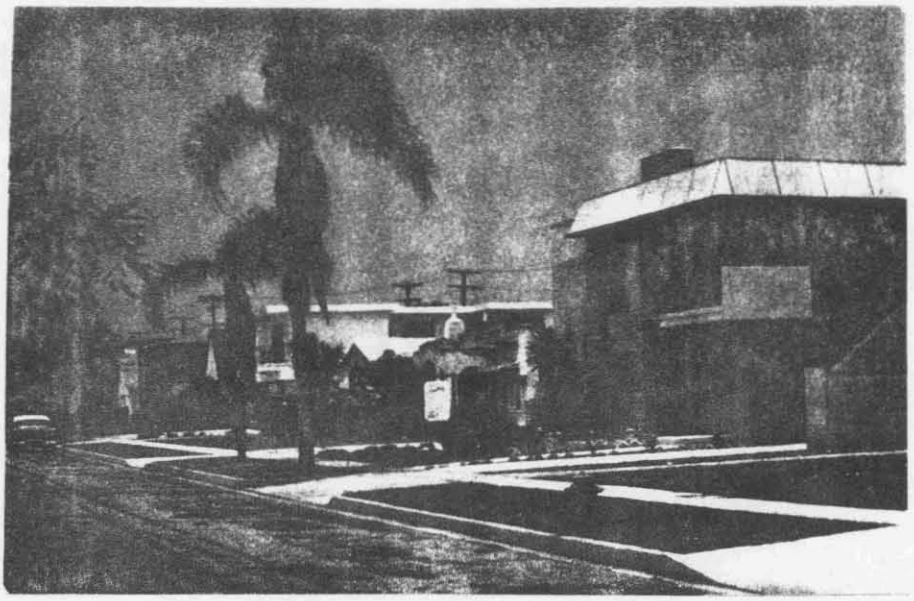


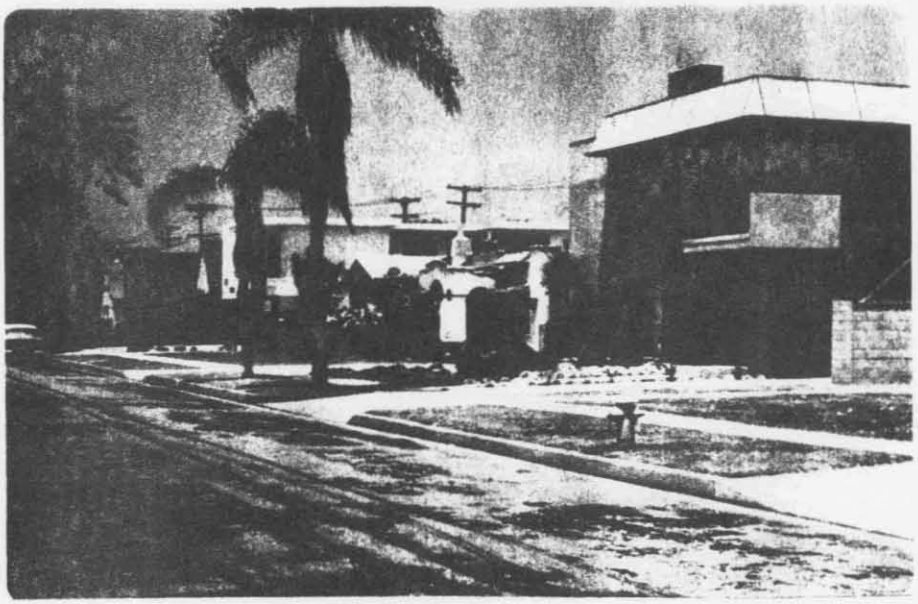
PHOTOGRAPH 7

Ground ektachrome photograph of Area 3. Note the palm trees and new apartment buildings mixed in with older Spanish style housing. Compare the vegetation (well kept) and streets (slightly mottled) with their appearance on Photograph 4.

PHOTOGRAPH 8

Ground color infrared photograph of Area 3. Note the intensity of infrared reflectance from the healthy vegetation and the accentuation of oil slicks in the street. Note also the color shift from red to yellow in this infrared photograph.



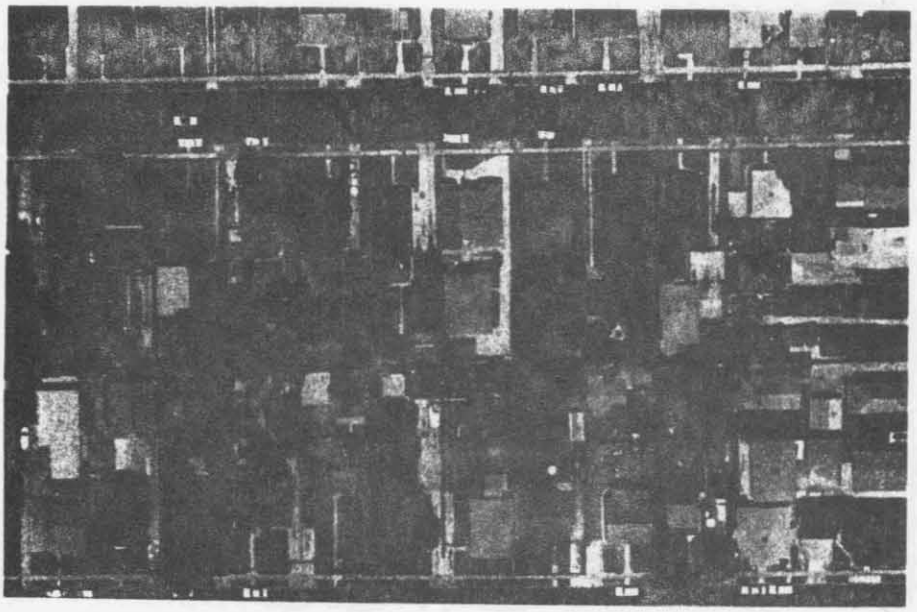


PHOTOGRAPH 9

Color infrared aerial photograph--Area 1. This shows the return from heavily commercial streets as well as from some of the adjacent residential areas of a highly varied nature. Palm trees, small older homes, and large apartment buildings were common in this area.

PHOTOGRAPH 10

Color infrared aerial photograph--Area 8. Note the large number of buildings crowded together, the large size of the homes, and the unplanned appearance with numerous separate residences in the back yards which indicate an older residential area.



PHOTOGRAPH 11

Ground ektachrome photograph of Area 8. Note the larger old homes and the unkempt vegetation engulfing these homes. Note the encroachment of vegetation around the sidewalk and curbing.

PHOTOGRAPH 12

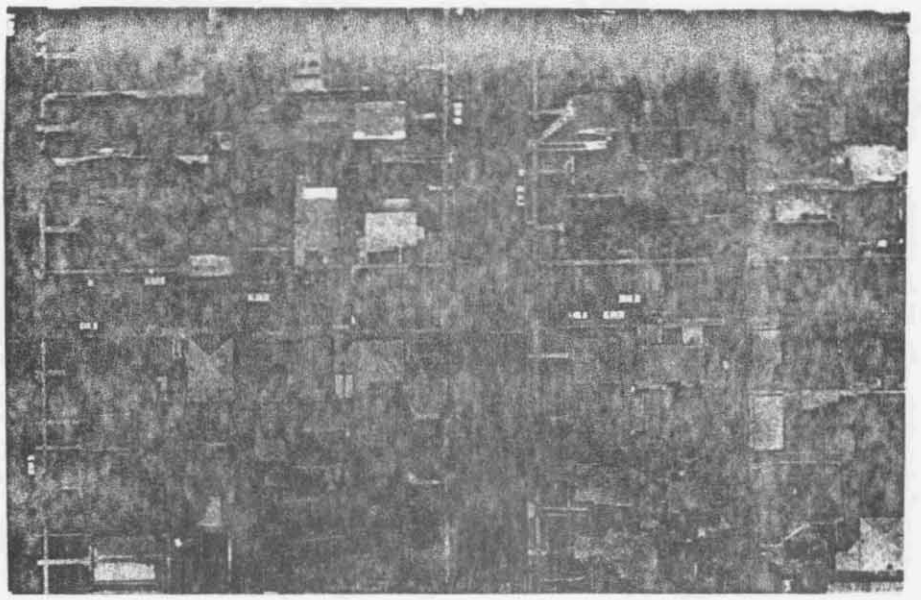
Ground ektachrome photograph of Area 8. Note the numerous homes and dense vegetation within this hilly environment. Green lawns and well-kept vegetation are lacking. These factors identify the area as an older and poorer residential district.

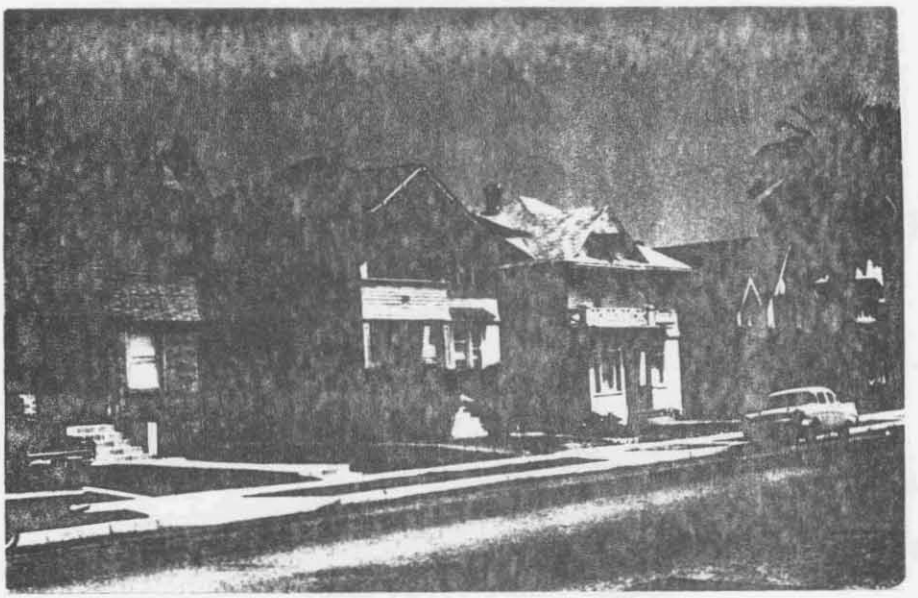
PHOTOGRAPH 13

Color infrared aerial photograph--Area 6A. Note the larger homes, mottled appearance of the vegetation with few trees except in clusters, and the striped appearance of the streets. Note also the garages lining the alleys--typical of older residential areas in this city.

PHOTOGRAPH 14

Ground ektachrome photograph of Area 6A. Note the large old homes with no driveways in front, fairly well kept vegetation, large palms, and streets striped by oil drippings from automobiles. Compare with aerial view above.



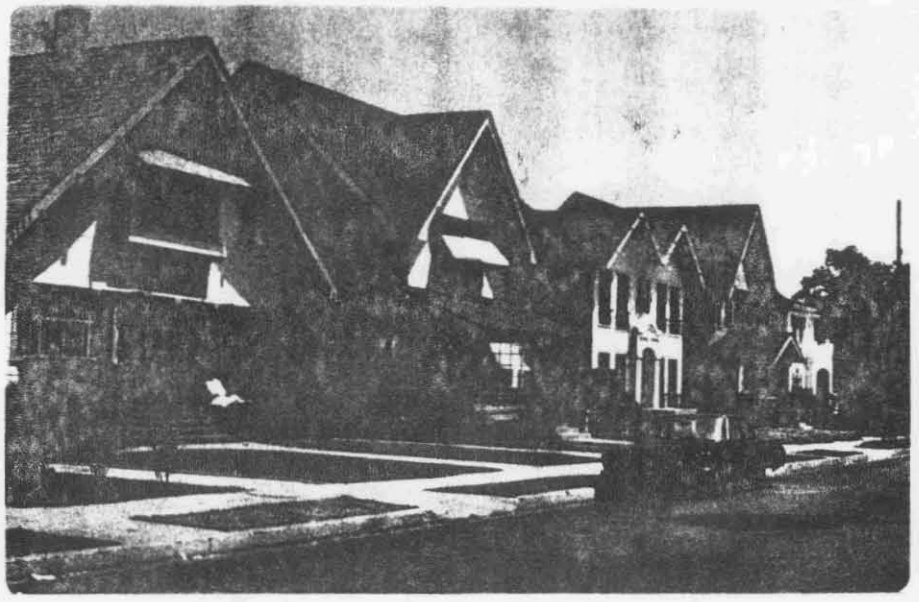


PHOTOGRAPH 15

Ground ektachrome photograph of Area 6A. More large old homes with occasional driveways leading to the backyards. Note the rather small yards with some repair and cleaning necessary along the curbing.

PHOTOGRAPH 16

Ground color infrared photograph of Area 6A. Note the variation in infrared reflectance of the yard on the left--compare with above photograph. Except for the color shift, note the similar appearance of both photographs. Little haze penetration is necessary at ground level.

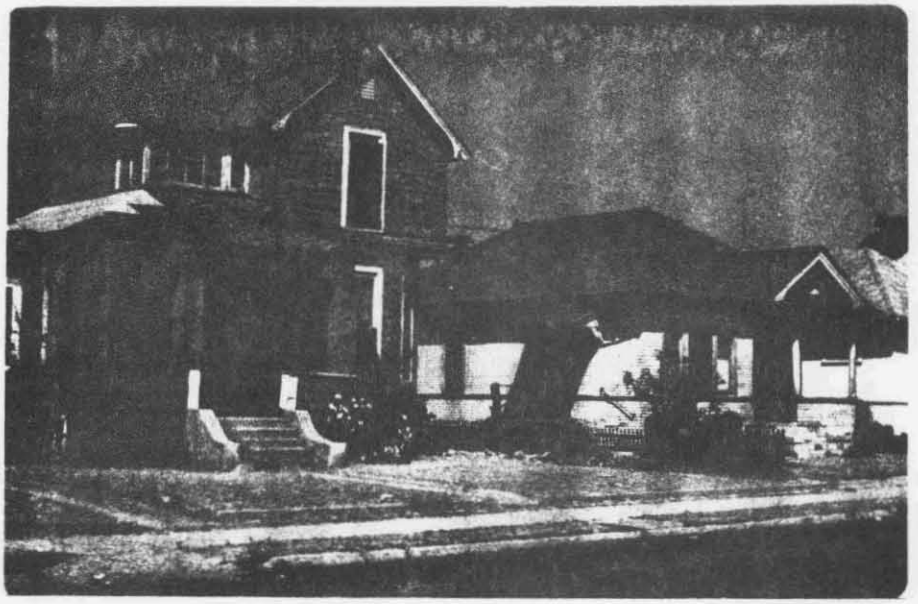


PHOTOGRAPH 17

Ground ektachrome photograph of Area 7. Note the older homes, the yellow in most of the yards, and the disrepair of the fence (middle left). Compare with photograph below taken in same area.

PHOTOGRAPH 18

Ground ektachrome photograph of Area 7. The poor condition of the yard and other vegetation and the litter present were two of the best indicators of lower quality residential areas. Variations between sections of these poorer areas were often considerable as shown by these two photographs.

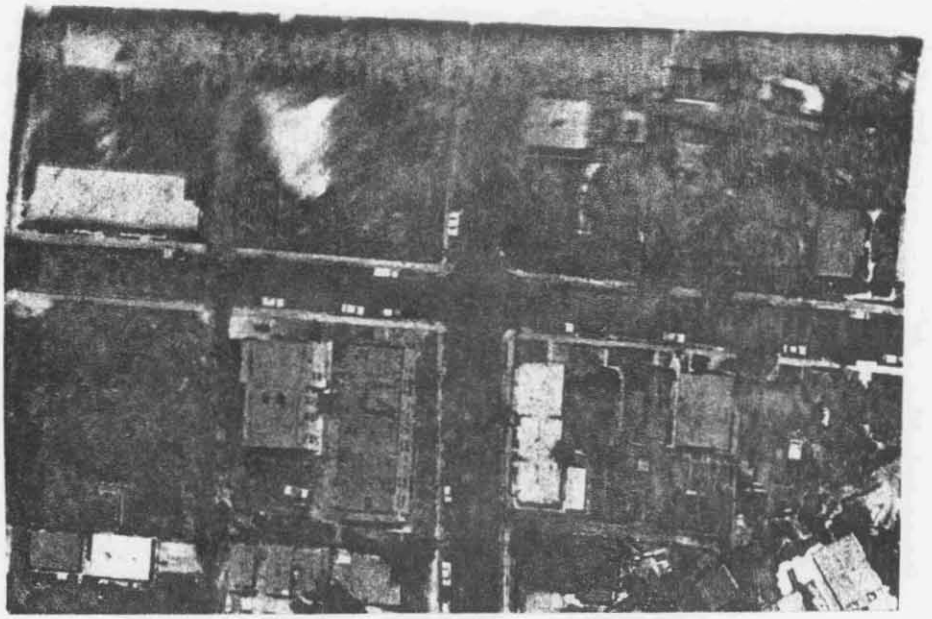


PHOTOGRAPH 19

Color infrared aerial photograph--Area 12. The extensive areas of vacant land, the extremely poor condition of the vegetation, the litter present, and the poor condition of roads, sidewalks, and curbs identified this heterogeneous, hilly area as a poor residential district.

PHOTOGRAPH 20

Color infrared aerial photograph--Area 16. Large amounts of vacant land, very heavy litter accumulations, and generally poor vegetation identified this area as an extremely poor single family dwelling unit residential district.

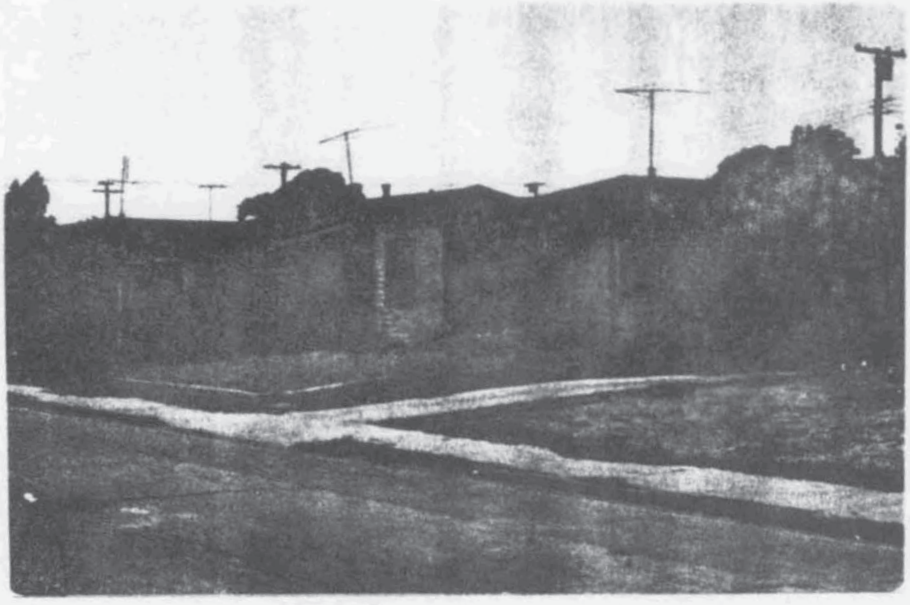


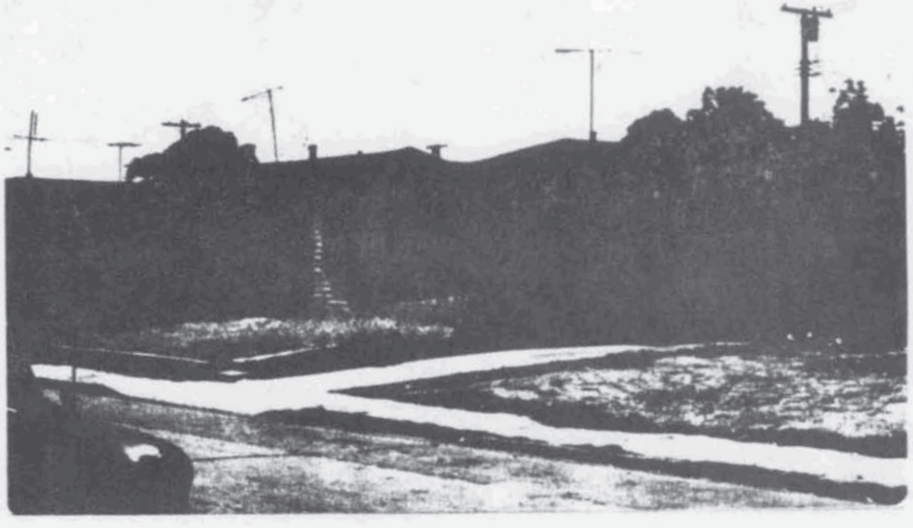
PHOTOGRAPH 21

Ground ektachrome photograph of South Los Angeles. Barren vacant lots, unkempt yards, and dilapidated housing of this type characterizes parts of Areas 14, 15A, 16, and 17, in this part of the city. Note also the poor condition of the streets, sidewalks, and curbs.

PHOTOGRAPH 22

Ground color infrared photograph of above area. Note the red appearance of vigorous vegetation and the yellowish appearance of the weeds in the yard in front of the house in the foreground. Note also how litter is evident in the vacant lot.



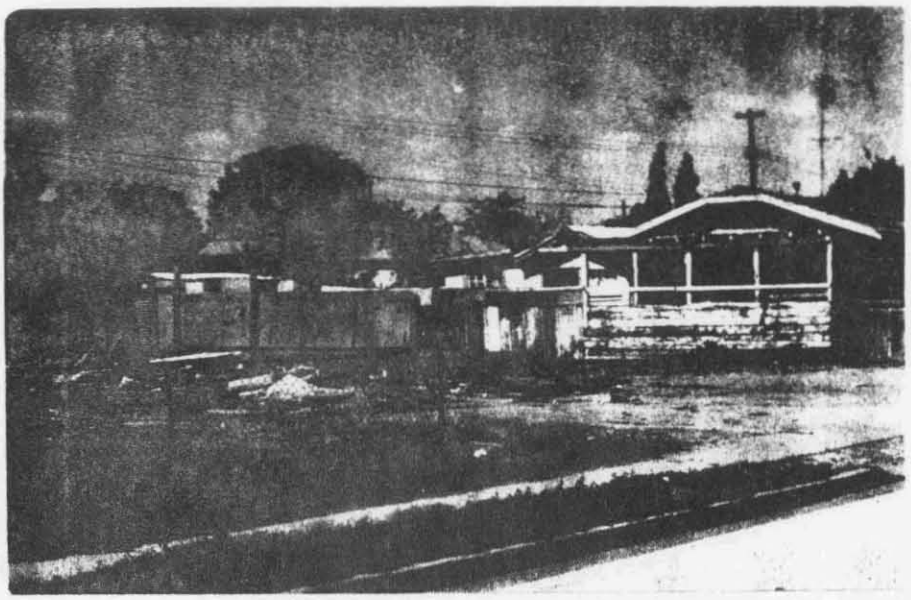


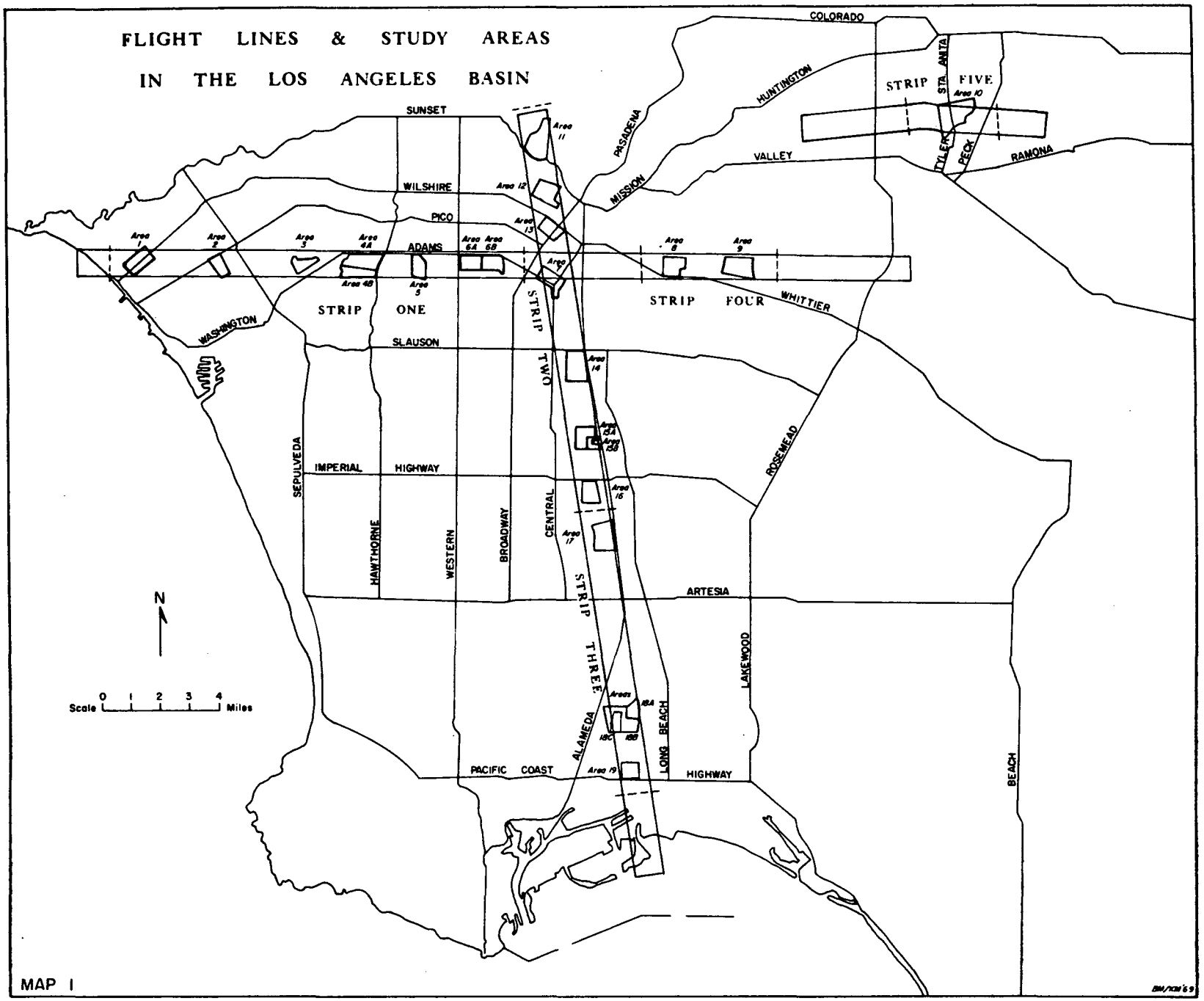
PHOTOGRAPH 23

Ground ektachrome photograph of South Los Angeles. Large vacant lots with heavy accumulations of litter and rubbish are found throughout many of the poor residential areas in Los Angeles. Note the single family housing in the background.

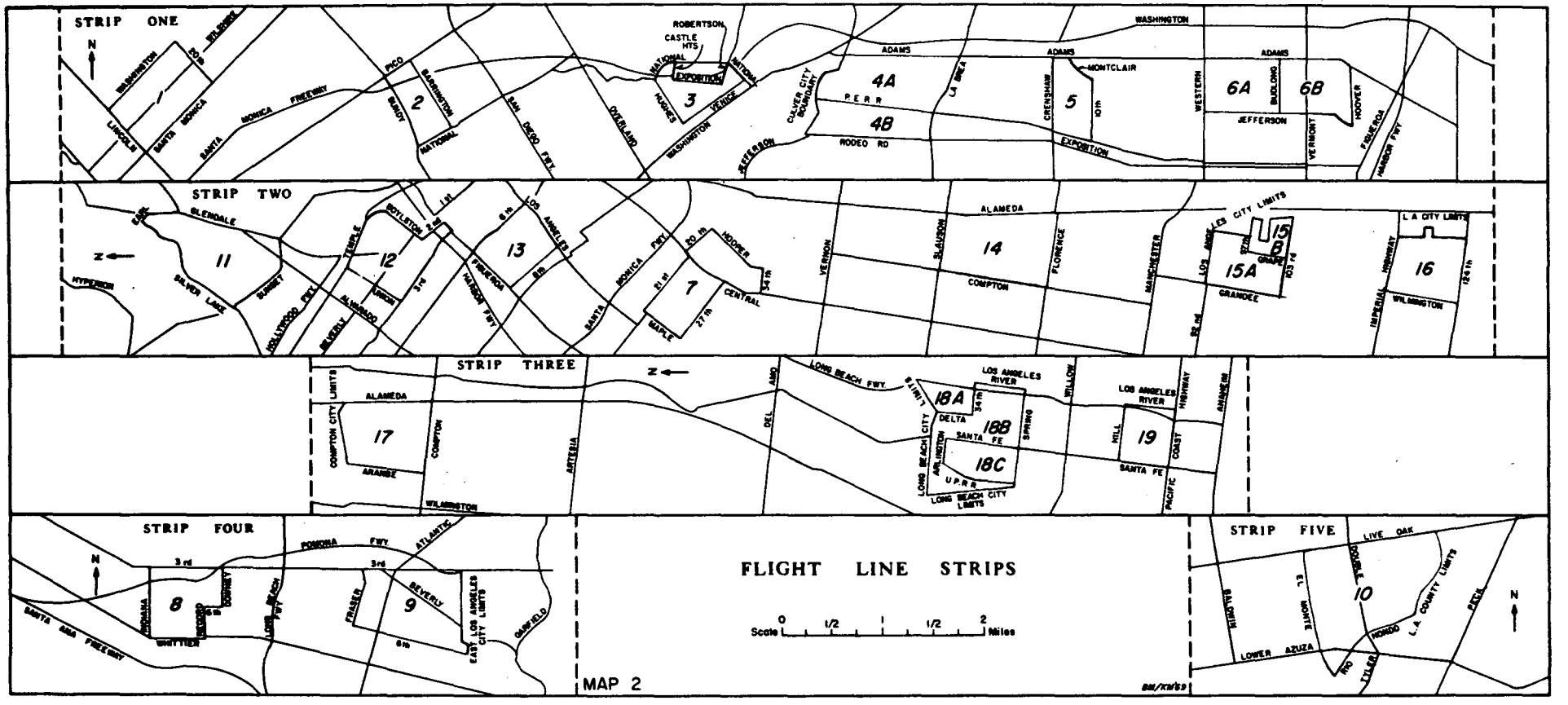
PHOTOGRAPH 24

Ground color infrared photograph of above area. Note the intense infrared reflectance from the sparse, but vigorous and overgrown vegetation and the contrasting white or gray appearance of the barren and littered areas. Such contrasts are easily identifiable from aerial photographs using color infrared film.




FLIGHT LINES & STUDY AREAS
IN THE LOS ANGELES BASIN
COLORADO
SUNSET
WILSHIRE
PICO
ADAMS
VALLEY
HUNTINGTON
PASADENA
MISSION
STA ANITA
TYLER
PECK
RAMONA
WASHINGTON
SLAUSON
IMPERIAL HIGHWAY
WHITTIER
ROSEMEAD
SEPULVEDA
HAWTHORNE
WESTERN
BROADWAY
CENTRAL
ARTESIA
LAKEWOOD
LONG BEACH
ALAMEDA
PACIFIC COAST HIGHWAY
BEACH
STRIP ONE
STRIP TWO
STRIP THREE
STRIP FOUR
STRIP FIVE
Area 1
Area 2
Area 3
Area 4A
Area 4B
Area 5
Area 6A
Area 6B
Area 6
Area 7
Area 8
Area 9
Area 10
Area 11
Area 12
Area 13
Area 14
Area 15A
Area 15B
Area 15
Area 17
Area 18
Area 18A
Area 18B
Area 18C
Area 19
N
Scale 0 1 2 3 4 Miles

MAP 1


STRIP ONE
STRIP TWO
STRIP THREE
STRIP FOUR
STRIP FIVE
FLIGHT LINE STRIPS
Scale 0 1/2 1 1/2 2 Miles
MAP 2
WASHINGTON
SANTA MONICA FREEWAY
PICO
NATIONAL
SAN DIEGO FWY.
OVERLAND
WASHINGTON
JEFFERSON
ADAMS
CULVER CITY BOUNDARY
LA BREA
CRENSHAW
WESTERN
MONTCLAIR
EXPOSITION
JEFFERSON
RODEO RD
VERMONT
HOOVER
FIGUEROA
HARBOR FWY
ALAMEDA
LOS ANGELES CITY LIMITS
VERNON
SLAUSON
FLORENCE
MANCHESTER
COMPTON
GRANDEE
IMPERIAL HIGHWAY
WILMINGTON
LA CITY LIMITS
HYPERION
SILVER LAKE
SUNSET
HOLLYWOOD FWY.
BEVERLY
ALVARADO
TEMPLE
BOYLSTON
LOS ANGELES
HARBOR FWY
SANTA MONICA FWY.
MAPLE
CENTRAL
HOOVER
COMPTON CITY LIMITS
ARTERIA
ARLINGTON
LONG BEACH FWY.
DEL AMO
LONG BEACH CITY LIMITS
LOS ANGELES RIVER
DELTA
SANTA FE
SPRING
WILLOW
HILL
PACIFIC COAST HIGHWAY
ANAHEIM
UPRR
SANTA ANA FREEWAY
VENTURA FWY
ATLANTIC
POMONA FWY
LONG BEACH FWY
FRASER
BEVERLY
EAST LOS ANGELES CITY LIMITS
GARFIELD
LIVE OAK
DURFEE
TEMPLE CITY
HONDO
L.A. COUNTY LIMITS
BALDWIN HILLS
LOWER AZUSA RD
AZUSA
1
2
3
4A
4B
5
6A
6B
7
8
9
10
11
12
13
14
15
15A
15B
16
17
18A
18B
18C
19

ADDENDUM

AN APPLICATION OF THE CONCEPTS OF THE LOS ANGELES RESIDENTIAL ENVIRONMENT STUDY TO THE ONTARIO-UPLAND REGION OF CALIFORNIA

By

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Department of Geography
University of California, Los Angeles

A study was designed to test the validity of the relationships, between socio-economic characteristics of the urban population and photographic surrogates from color infrared (CIR) imagery, which were investigated in a Los Angeles study of residential environment. The Los Angeles study was performed by Robert H. Mullens, Jr. for the "Remote Sensing of Southern California and related environments project." The present investigation is an application of criteria developed in the Los Angeles study to CIR imagery of the Ontario-Upland area, to determine if relatively homogeneous socio-economic areas can be delimited and assigned a rank on a hierarchal scale. These areas are ranked from those having the best photographically determined surrogate conditions down to those having the worst). Rank, therefore, is on a relative basis; each area is compared with the other areas to establish a rank relative to that of every other area. Socio-economic data such as home value, income, and education are then collected for census tracts of that region, and the tracts are ranked from highest to lowest on the basis of this information. Rankings of socio-economic variables (by census tracts) are then compared to the ranking of census tracts by imagery to determine if relationships exist. Ontario-Upland was selected as

a test region because its rural-urban nature contrasts strongly with the highly urbanized Los Angeles environment and would, therefore, either increase the significance of the Los Angeles study or point out its limitations.[1]

The Los Angeles study was an attempt to demonstrate that photographic surrogates could be developed from CIR imagery to delimit socio-economic areas within the urban environment. Concepts of urban ecology developed by sociologists were utilized for background material, as well as studies of a similar nature using photographic imagery. The basic idea is that there is a spatial patterning of social and economic characteristics of the population, and the material conditions in the environment may be one reflection of such patterning.

Detailed information was extracted from the imagery, based on ideas suggested by sociologists, city planners, housing quality investigations in the remote sensing field, and a prior investigation of residential area quality. The data was then condensed into categories and a numerical scale devised from 1 to 5, to rank the conditions found within each category. Lower numbers represent conditions associated with higher

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[1]Ontario-Upland is located approximate 40 miles east of Central Los Angeles.

quality residential areas, while higher numbers indicate the opposite or less desirable areas. Words such as better, higher, and middle are frequently used in this study to describe areas, because the methodology associated with this approach is subjective. Thus the terms are descriptive rather than quantitative and are used to express the nature of comparisons made between units within the given study region. The numerical scales used for each variable are listed in Table 2, page 41.

An area will have one numerical score for each category listed in Table 2, and a composite score can be computed for each one by adding these numbers together. Once scores have been computed for all the areas that have been delineated, they can be ranked in relation to each other and statements about comparative socio-economic conditions within them can be made.

In some categories the scaling system is subject to valid criticism. Vacant land may often be found in the very best residential areas, where it is being held at high cost for future development. Such lots are usually very well kept, in contrast to lots in slum environments. However, the number of such lots can be a detracting feature of such an area, and in both the suties of Los Angeles and of Ontario-

Upland study attempts to demonstrate that these categories and the remaining ones can be successfully applied to another urban area to produce similar results.

In the Los Angeles study, the areas delimited by means of the nine categories were associated with census tracts that were completely (or very nearly) contained within them. Census information from 1960 was then utilized for all the tracts within these study areas on such things as income, home value, and occupation. The tracts were then ranked, both on the basis of their various socio-economic characteristics and the composite score obtained from the categories using the CIR imagery. A Kendall Rank Correlation Coefficient test was then run to compare the various socio-economic rankings to that obtained from the imagery. The correlations were not especially high (50-60%), but they were significant enough to indicate the existence of a relationship.

An investigation into the reason for these correlations disclosed that study areas could be sorted into groups and that, while there was still considerable variation within these groups, the groups themselves presented a good picture of the socio-economic environment. The real utility of this approach would then seem to lie in a grouping of those photographically determined areas, rather than on a strictly

individual basis. The Ontario-Upland study is thus presented as a test case for the validity of, and the ability to reproduce, the findings of the original study by Mullens.

The investigation utilized CIR imagery of Ontario and Upland, California taken in July, 1968 by Western Aerial Survey, Inc. with an approximate scale of 1:8000. (The imagery was flown as a cooperative project between the Departments of Geography, University of California, Los Angeles and Riverside and the San Bernardino County Planning Commission. The region selected for final study is bounded by 16th Street to the north, Mission Blvd. to the south, Benson Avenue to the west, and Baker Avenue to the east. This region was chosen because, in opposition to the Los Angeles study, it possessed a large range of social and economic conditions. The assumption was made that social and economic phenomena are closely related to the class structure of a region. Therefore, studies investigating such characteristics should deal with a wide range of social classes for the most significant results. The availability of imagery limited Mullens to concentration on lower-middle and lower classes, while the imagery for Ontario-Upland covered an area possessing a range of classes ranking from lower to upper, though excluding the very highest socio-economic groups. A good test situation was thus presented for the concepts

developed in the prior study.

Since the technique is oriented to spatially distributed phenomena, the first step in the investigation was a general survey of the imagery to delimit approximate boundaries of socio-economic areas - using the previously developed categories, but not assigning definite scores to the areas. The areas were then examined in detail using the eight categories of vegetation, litter, vacant land, location, streets, pools and patios, land use, and lot and home size. A dwelling type category was not needed because of the high percentage of single family residences and the few apartments in Ontario and Upland. The boundaries of the areas were determined and a number code was assigned to each area based on the numerical scale developed for the photographic categories. The order of the number code corresponds to the following order of the categories: vegetation, litter, vacant land, location, streets, pools and patios, land use, lot and home size. The areas that were finalized are shown by map on page 170 and are described as follows:

Area 00 (31143413, rank 9): A small area of middle quality homes near San Antonio Community Hospital in Upland. Although the conditions of the material environment were about average for the area itself, location in a larger area of very poor housing and the proximity of railroad tracks tended to lower

its eventual ranking.

Area 1 (21313211, rank 4): Very large homes was the outstanding characteristic of this area near the Red Hill Country Club. Generally one of the best areas, several vacant lots and a lack of very well developed streets (and related features, as street lighting) lowered the ranking somewhat.

Area 2 (21112111, rank 1): Houses here are part of a very new tract in the northern part of Upland, dominated by large lot size, abundance of pools, and generally the best material environmental conditions of the entire Ontario-Upland region. Detailed examination substantiates the immediate visual impact of excellent environmental quality.

Area 3 (54454443, rank 13): A location in the southeast portion of Upland that is of very poor quality. The vicinity of railroad tracks and heavy industry, large amounts of vacant land, and heavy accumulations of litter in the residential sections made it easy to classify this area.

Area 4 (31353443, rank 11): This area is situated on the west side of downtown Upland and located near industry. Few pools, mixed land use, and only average residential qualities brought its rank down.

Area 5 (31143321, rank 7): A new housing tract in the northeast part of Ontario, it appears to be a good area although

average ranking on vegetation and location of industry nearby prevented the rank from being higher.

Area 6 (31142412, rank 8): Located near John Galvin Park in eastern Ontario, it is a generally good area with large homes and no vacant land, but again average vegetation and industrial location caused a middle ranking.

Area 7 (21142313, rank 6): Again a fairly good area, located east of Campus Avenue in Ontario. Vegetation is very good, the homes are medium-sized, and other conditions pertaining strictly to the area are good. The location of industry nearby, however, brings the ranking down, although it still remains the best of the middle-ranked areas.

Area 8 (21112312, rank 3): Located west of Campus Avenue near Chaffey High School, the small numbers in the area's code indicate good quality, with large homes, landscaped vegetation, no litter or vacant land, etc.

Area 9 (21222112, rank 2): Scoring well in all categories, overall balance and the widespread occurrence of pools caused this area to be ranked higher than Area 8 (although both had the same total score).

Area 10 (31343423, rank 10): The area is just south of Chaffey High School, almost centered on Euclid Ave. It is another average type area where location near light industry and the presence of few pools lower its rank.

Area 11, (21242112, rank 5): Housing tracts that are somewhat older than those of Area 2 in Upland exist here on the west side of Ontario. While a very good area, the location of heavy industry to the south, along Holt Ave., caused it to be ranked the lowest of the better areas.

Area 12 (55554544, rank 14): Visually, this is by far the worst of all the study areas. Heavy industry, numerous vacant lots, many large accumulations of litter, poor vegetation, and no pools clearly indicate the poor material environment of this area. It is basically to the southeast of downtown Ontario and near Ontario International Airport.

Area 13 (42343543, rank 12): Vegetation is poor, litter exists, and there are several vacant lots. In addition, there is considerable heavy industry nearby. These factors contributed to the low ranking for the area.

After these areas were analyzed, the scores from the various categories were added together and numerical totals derived for each area. They were then ranked by their total scores. In the case of ties, the areas were re-examined to detect any minor differences, such as slightly better vegetation or more pools, and these differences were used for final ranking.

The greatest difficulty in the study then occurred. All the census tracts for the Ontario-Upland region, except 10 and 16, contained at least three study areas.

PHOTOGRAPHICALLY DETERMINED STUDY AREAS FOR THE ONTARIO-UPLAND REGION

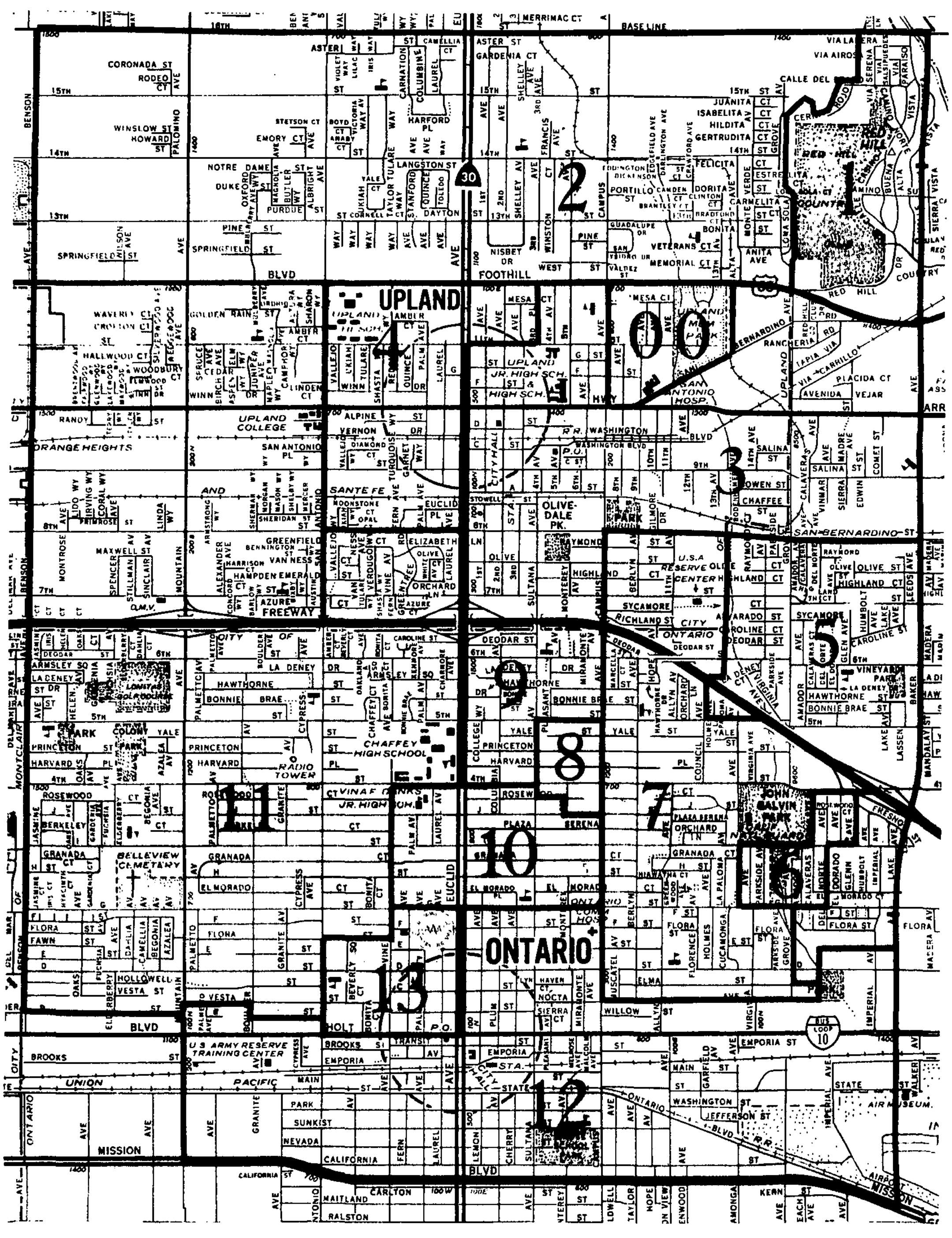

Table 18 Composition of Census Tracts by Study Area

Census Tract	Study Areas
8	1,2,4,11
9	00,3,4,7
10	11
11	10,11,13
12	8,9,10
13	5,6,7
14	10,12,13
15	5,7,12
16	12

A subjective judgement had to be made as to the impact of the various study areas on the census tracts. The final decision was in terms of the amount of the tract covered by the study area and the numerical score that was used to rank the area. Then the 1960 Census was used to acquire data on income, home value, occupation, and education for the tracts. The tracts were then ranked, highest at the top and lowest at the bottom, by this information and by study areas, with the following results:

Table 19 Census Tract Rankings

Rank	Census Tracts Ranked by Photographic Surrogates	Census Tracts Ranked by Income	Census Tracts Ranked by Home Value	Census Tracts Ranked by Occupation	Census Tracts Ranked by Education
1	8	12	8	11	12
2	12	10	11	12	8
3	10	8	10	8	11
4	11	11	12	10	10
5	13	13	14	13	13
6	15	9	13	14	14
7	14	15	9	15	9
8	9	14	15	9	15
9	16	16	16	16	16

A Kendall Rank Correlation Coefficient test was then run to compare the ranking by study areas with the rankings by the four census variables. Correlations ranging from 72% to 78% were found, which were more significant than those found in the Los Angeles study. There was still considerable variation, however, in the ranking of the tracts. To explain the variation, the study areas were examined for possible larger groupings. Five such groups were found: Group 1 (2), Group 2 (1,8,9,11), Group 3 (5,6,7), Group 4 (00,4,10,13), and Group 5 (3,12). The census tracts were then examined in light of these groupings, and they were found to fall into four groupings:

Group 1(8,10,11,12), Group 2 (13), Group 3 (9,14,15), and Group 4 (16). As in the Los Angeles study, the final grouping proved to be highly significant. While individual census tracts varied considerably in ranking, the variation was confined to the groups determined by study area aggregations. Statements can, therefore, be made about socio-economic characteristics of the population in terms of study area groupings, with a high degree of reliability to be expected. The group is the consistent indicator of this information, whereas each study area experiences some degree of variability as a data source.

Conclusion

A limitation imposed on the Los Angeles study, by the nature of the available imagery, was that it had to concern itself with a rather homogeneous spectrum of environments. Only middle class and lower class areas could be studied. There were, therefore, some doubts as to the applicability of the methodology developed in the study to another local framework where a larger spectrum of environments could be investigated. The results of the Ontario-Upland study definitely indicates that the methodology is applicable.

Socio-economic areas within a local framework can be

determined with a moderate degree of precision. They can then be ranked on a hierarchal basis, from best to worst (using photographic surrogates), and socio-economic statements made about them on a relative basis. That is, these areas can be compared to each other within their local framework using comparative adjectives--as, the inhabitants of one area have a higher income than those of another (although one cannot say just how much that income is).

When these areas are formed into groups, such statements can be made even more authoritatively because the two studies have demonstrated that, while there is intragroup variation in ranking, there appears to be definite intergroup segregation; that is, the socio-economic areas may vary within their grouping in terms of ranking, but they generally do not cross over into other groups (again in terms of rank). As a theoretical model, assume three groups exist with three socio-economic areas in each: 1 (A,B,C), 11 (D,E,F), and 111 (G,H,I). Within a group, say group 1, B may be ranked above A or A above B. Assume then that group 11 (D,E,F) is a lower rank than group 1. Almost never, then, will D,E, or F be ranked above A,B, or C. There is definite indication, therefore, that significant generalizations can be made about the socio-economic environment using groupings of photographically determinable socio-economic

areas.

A case in point is census tract 11, which photographic surrogates placed in Group 1 with census tracts 8,10, and 12. An examination of Table II will show that census tract 11 varies in ranking from 1 to 4 in regard to the four socio-economic characteristics derived from the census reports, and the ranking given by the photographic surrogates. However, while there is considerable variation in its ranking relative to the other elements of Group 1, census tract 11 is always ranked above the elements of the remaining three groups.

The Los Angeles and Ontario-Upland studies point out the validity of the methodology developed. The technique employed applies to large and small scale areas. However, the criteria utilized for these studies may only be applicable within a local framework; further investigation is necessary to test the criteria at different scales of area. New criteria are needed for foreign areas where different cultural patterns exist. At this stage of inquiry, the two studies indicate the method and criteria are valid for use within local frameworks in Southern California.