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AN INTEGRATED METHODOLOGY FOR ESTIMATING DEMAND FOR ESSENTIAL SERVICES WITH AN APPLICATION TO HOSPITAL CARE

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RESEARCH REPORT 1

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COUNCIL FOR ADVANCED TRANSPORTATION STUDIES
The University of Texas at Austin

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16. Abstract
A methodology to estimate the demand for essential services by enumeration district is developed. The framework of the methodology considers total demand for essential services and associated transportation to be the sum of latent and satisfied demand. The origins of latent demand are indicated by examining the barriers which must be overcome by an individual to satisfy an existing need. The method for estimating satisfied demand begins with census data by enumeration district. Actual usage rates of a service, cross-classified by factors influencing actual usage such as age, sex, race, and income are obtained from national surveys and then applied to the local census data to obtain an estimate of satisfied demand for the service by enumeration district. The methodology was used to estimate the satisfied demand for hospital care and was found to be accurate to within 7/10 of one percent for the study region. Total demand for a service may be estimated in a similar fashion by substituting barrier-free usage rates in the above methodology. Latent demand by enumeration district then became the difference between total and satisfied demand.

The total transportation associated with a service system is obtained by assigning the demand by enumeration district to the closest facility up to its capacity with spillovers to the next closest facility. Total travel is then calculated using these origin-destination links and the frequency of trips.

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EXECUTIVE SUMMARY

INTRODUCTION

A methodology to estimate demand for essential services is designed to meet two major criteria:

(1) It should be of use to government agencies at the county, COG or state level. To this end the methodology should be capable of indicating the amount of latent demand for essential services, because knowledge of its magnitude and location would be critical for planning additional services. It should be capable of providing the necessary inputs for planning new delivery systems, particularly with respect to transportation implications which are often ignored. To identify the transportation implications for a rural/urban region the methodology must be able to estimate demand for essential services at the level of small rural communities. Currently, Council of Government planning is accomplished at the county level which is much too large a division to identify transportation implications of existing or planned supply systems. To be of lasting usefulness the methodology must be capable of indicating the impact of changing environmental parameters, such as demographic characteristics of the population, on the demand for essential services. Thus, the methodology must have the potential to predict the future demand for essential services for all locations in a region based on projected changes in the region's demographic character.

(2) The methodology should be capable of implementation by local, regional and state government agencies. Such a criterion suggests that the methodology should use as input, readily available data. Local agencies frequently do not have the funds for undertaking major surveys and generally need to work with data they already have or can obtain from other sources without high out-of-pocket expenditures. The methodology should be relatively simple so that its

process could be readily understood by users who did not possess extensive training in model building. Such an approach would improve the likelihood of acceptance and utilization of the methodology by local government agencies. Also, the users would be more aware of the limitations in the methodology and thus reduce the possibility of misinterpretation of the results. The methodology should also be capable of ready updating to provide timely reports on the effect of changes in the environmental parameters on the demand for essential services.

PROBLEM STUDIED

The methodology developed to estimate the demand for essential services combines usage rates cross-classified by such factors as age, sex, race and income obtained from national surveys and applies these to local census data at the enumeration district level. Latent demand is considered the difference between total demand and satisfied demand. The usage rates from national surveys are used to generate satisfied demand with total demand generated in a similar fashion by substituting barrier-free usage rates.

RESULTS ACHIEVED

To demonstrate the feasibility of the methodology, the essential service of hospital care is selected because actual data are available on the number of persons admitted to hospitals by county of residence in the study area (Capital Area Planning Council). Furthermore, estimating the demand for hospital care is of particular interest to local planning agencies because of their responsibility under the Hill Burton Act to determine the need for new hospital construction or additions to bed capacity in their area.

The process of determining demand for hospitalization will provide a severe test of the methodology because of the inherent problem of migration. In particular, in Texas a one day patient-origin survey is conducted once every two years by the State Department of Health. The results of this survey will be used to account for patiend migration (i.e. infer the county of

origin of patients admitted to each hospital in the region).

Information on the usage rate of hospitals per person is obtained from a national survey conducted by the National Center for Health Statistics. A computer program is written to read the computer tapes containing the census data on age and sex for each enumeration district in the region. The satisfied demand for hospitalization obtained from above is then compared with the actual data collected for the region's hospitals. Accounting for migration it is found that the predicted hospitalizations for the region is within 7/10 of one percent of the actual figure for hospital admissions.

UTILIZATION OF RESULTS

As noted above, the reported application to estimating hospitalizations is of direct interest to regional health planners. The methodology for estimating the demand for essential services also provides input to the procedure for estimating a service system's derived transportation demand. Finally, the methodology will provide input to the network planning model to be developed in subsequent years research.

CONCLUSION

A methodology for estimating the demand for essential services meeting the design criteria of being useful to regional planners and being easily implemented has been developed. Its application to estimating the demand for the essential service of hospital care proved successful.

PREFACE

This document brings together several activities that were accomplished in the first year of a research project entitled "Access to Essential Services." This project is Topic I in a research program entitled "Transportation to Fulfill Human Needs in a Rural/Urban Environment" which is being conducted by the Council for Advanced Transportation Studies of The University of Texas at Austin under the sponsorship of the U.S. Department of Transportation. The methodology described in this report to estimate the demand for essential services by enumeration district is one of several planning aids to be developed in this research effort. The demand estimates generated by this methodology will be input to the network planning model now under development. In addition to this completed effort the report includes a literature overview and a detailed description of our study region.

The authors gratefully acknowledge the work of other persons on this project including: Ms Charlotte Clarke, The University of Texas Graduate School of Social Work; Dr. Carol Deetz, The University of Texas School of Nursing; Dr. Stan Burnham, The University of Texas, Department of Health, Physical Education and Recreation; Captain James L. Mayer, USN (Ret.); and students, Mr. David L. Brown, Mr. William Perrin, Mr. Kevin Bowman, Ms. Nowl Engoeman, and our secretary Ms. Janette Scott.

The contents of this draft report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the U.S. Department of Transportion. This report does not constitute a standard specification, or regulation.

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I. INTRODUCTION

THE RESEARCH

This report brings together several first year accomplishments of a research project entitled "Access to Essential Services," which is one of the five topics under a broad research program entitled "Transportation to Fulfill Human Needs in the Rural/Urban Environment" being conducted by the Division of Research in Transportation of the Council for Advanced Transportation Studies of The University of Texas at Austin, with support from the U. S. Department of Transportation. Research in Topic I "Access to Essential Services," relates to the role of transportation in making essential services available to a rural/urban population. This task was divided into three sequential sections occupying a three-year span.[1] The first year's work has concentrated upon the demand for essential services and associated transportation. Work in the second year will emphasize the specification of alternative supply systems to meet that demand. Evaluation of these alternative systems with recommendations for priorities will be the subject of the third year's efforts.

This report includes in addition to a description of the methodology for estimating demand for essential services[2] a literature overview and a description of the study area. A brief summary of each section of the report follows.

LITERATURE OVERVIEW

The second section of this report provides a broad ranging literature overview. It does not attempt to be a comprehensive, but rather to provide

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[1] More detail concerning the work plans is available in R. Briggs, et al, "Access to Essential Services," Austin, Texas: The University of Texas, Council for Advanced Transportation Studies, Research Memorandum No. 2, April 1973.

[2] The interested reader is directed to the following document for a scheme to classify and define essential services: R. Briggs and J. Fitzsimmons, "The Definition of Essential Services and the Identification of Key Problem Areas," Austin, Texas, The University of Texas, Council for Advanced Transportation.

a broad introduction to the many facets of essential services as they relate to transportation.

Transportation cannot be considered independently of other aspects of the essential service system. The demand for transportation is a derived demand, generated as a consequence of the spatial location of the demand for essential services relative to the spatial location of the facilities supplying these services. Thus, the first part of the literature review concentrates upon assessment of the demand for essential services. Specific considerations here include satisfied, latent, induced and future demand for the services and associated transportation. The second part discusses the supply of essential services, focusing upon the spatial distribution of facilities providing them.

The third part concentrates upon transportation, per se. The importance of spatial separation between the location of the demand and the sources of supply as a barrier to obtaining services is established. Transportation systems presently utilized to overcome this barrier are then discussed, followed by an outline and evaluation of proposed systems for the future. These systems involve transportation of people to the supply facilities, utilization of mobile units to bring facilities to people, and the use of communication systems as a substitute for the movement of people to facilities.

In making essential services available to a rural population, transportation is certainly not the only problem. In order to assess its importance relative to other problems and assure the assignment of fiscal and temporal resources in an optimal manner, the fourth part concentrates upon other factors relevant to the provision of essential services in rural areas. These factors are discussed under the broad categories entitled social-psychological, economic, and administrative.

The final part contains a summary and the conclusions of the research. The major sources of literature are identified and discussed. Those aspects of the accessibility problem which have received the focus of attention in the literature thus far are pointed out. Finally, several aspects of the accessibility problem which are in need of further research are identified.

THE STUDY REGION

The third section of the report describes the existing essential service system in the study area--The Capital Area Planning Council Region. This Council of Government (COG) for south central Texas covers a ten county region around Austin, Texas, with a population of approximately 500,000, 52% of which resides in the City of Austin. The rural area, upon which the research is concentrating, is fairly typical of two types of environments found in the central United States. A fault-line dissects the region, and the western portion is characterized by steep hills, ravines and rough surface terrain, whereas a relatively level plain is found in the east. The topographic characteristics of the west, combined with the relatively few crossings of the Colorado river system, can make access to some of the more remote areas quite difficult. In contrast, the eastern region has good highway access to most areas.

Ranching is the major economic activity, with open grazing in the west, and some fodder crop production in the east. Excluding Travis County which is the Austin S.M.S.A., population densities are generally low, particularly in the west as against the east, ranging from less than 11 people per square mile to up to 40 people per square mile. The three central counties (Williamson, Travis, and Hays) have slightly higher densities because of development associated with Interstate 35 which runs through the region linking Dallas, 200 miles to the north, with San Antonio, 75 miles south.

Transportation within the region is almost entirely dependent upon the private automobile. Although most communities have some service, routes and scheduling are oriented more to linking the major cities of Texas (Austin, San Antonio, Houston, and Dallas) than serving the intra-regional needs of the population. The nature of the network is such that the western part of the region is linked more to San Antonio than Austin. Five of the counties have no cab service in any of their communities. Although Community Action Agencies, together with volunteers, provide some transportation for the disadvantaged, two of the counties are without any formal system.

Communications are considered to be an important present and future facet of the essential service system. Only two major region-wide systems exist at present. A common-user leased telephone system, TEX-AN, links all

state offices within the study region, as well as all other regions in the state. A second, region-wide system is the Texas Statewide Law Enforcement Voice Radio Communication System. Although this constitutes an excellent system for law enforcement purposes, it is not likely to provide communication capabilities for other services. Other than radio links between privately owned ambulances and their company dispatches, there is no emergency medical communication system in the study region.

Facilities providing essential services are strongly concentrated in the Austin urban area. There are distinct problems with physician availability in the rural counties, and, although most have at least one hospital, utilization rates are low, partly because of the problems with respect to physician availability. Few of the counties have health departments and mental health facilities are strongly concentrated in Austin. Although all counties are covered by outreach workers from the state school and hospital, several counties do not have a resident worker, thus travel occupies a considerable proportion of the worker's time.

ESTIMATING DEMAND FOR ESSENTIAL SERVICES

In the final section of the report an integrated methodology is described. This methodology was designed to meet three specifications: first, that it be of use to government agencies at the county, COG, or state level; secondly, that it be capable of implementation by agencies at these levels; thirdly, that it provide the inputs necessary for subsequent years research.

The integrated framework considers total demand for essential services and associated transportation to be the sum of latent and satisfied demand. The origins of latent as against satisfied demand are then indicated by examining the barriers which must be overcome by an individual to satisfy an existing need. Nine such barriers are identified: (1) recognition of symptoms, (2) recognition of need to interact with a service facility, (3) knowledge of service availability, (4) ability to pay, (5) availability of transportation, (6) service open at time needed or accessible, (7) eligibility to use service, (8) facility capacity, and (9) discrimination. Only when all these barriers can be overcome will the service actually be used; otherwise, latent demand is generated.

The methodology for estimating satisfied demand begins with census data by enumeration district. Actual usage rates of a service, cross-classified by factors influencing actual usage such as age, sex, race and income are obtained from national surveys and then applied to the local census data to obtain an estimate of satisfied demand for the service by enumeration district. These estimates are then assigned to existing facilities and compared with the actual usage with the actual usage of these facilities.

The latent demand procedure has a structure similar to that of the satisfied demand procedure in that usage rates per household are applied to census data by enumeration districts. It differs in that the usage rates used are those likely to pertain in barrier-free situations. The model applies these to the census data to give an estimate of total demand per enumeration district. By inputing satisfied demand per enumeration district, an estimate of the latent demand per enumeration district is then obtained by subtraction.

Transportation demand is derived from the demand for the essential service, together with the location of the service facilities relative to the location of the clients. The demand for essential services by enumeration district is obtained from either of the previous models. This demand is then assigned, using, at present, a shortest path algorithm, to existing or planned facilities up to the known usage rate or capacity, and spillovers are assigned elsewhere. From this a matrix of the number of trips between all enumeration districts is obtained, travel volumes on road network links are calculated, and total travel in the system is estimated.

DATA DISPLAY SYSTEMS

For use in this project several computer mapping systems were developed or made operational on The University of Texas at Austin C.D.C. 6400/6600 computer system by project personnel. It is felt that the visual display of information is an excellent aid in regional planning. Specifically, three software packages have been utilized. MAPOUT was developed by a project member (Mr. David Brown) for plotting line and symbol data related to rural counties, and utilizes the CALCOMP plotter. MAPPER, initially developed by Mr. David Karney of The University of Texas, Bureau of Business Research, provides choropleth maps of county data for the State of Texas. SYMAP, a

general mapping package developed by Harvard University, Graduate School of Design, generates choropleth, proximal and contour maps on the standard line printer.

ADDITIONAL RESEARCH AND PUBLICATIONS

This report describes the main accomplishments of the first year of the project. It is the base for future year's work concerned with the development of models for the design and evaluation of essential service systems and associated transportation. Other publications from the first year's work are:

Briggs, Ronald, et. al. "Access to Essential Services," Austin, Texas: The University of Texas at Austin, Council for Advanced Transportation Studies, Research Memo No. 2, April 1973.

> This memorandum comprises the proposal upon which the present research is based.

Briggs, Ronald and J. Fitzsimmons. "The Definition of Essential Services and the Identification of Key Problem Areas," Austin, Texas: The University of Texas at Austin, Council for Advanced Transportation Studies, Research Memo No. 9, January 1974.

> An expanded version of Section II of the present report. A framework is developed and used to define essential services and identify key problem areas in their availability. Emphasis is placed upon differences between the functional and dysfunctional population, between goods and services, and between supply systems and consumer behavior in high versus low density environments.

Enders, Wayne T., R. Briggs, and Patricia Poston. "Access to Essential Services: Literature Overview and Bibliography," Austin, Texas: The University of Texas at Austin, Council for Advanced Transportation Studies, Research Memo No. 12, April 1974.

> In addition to the literature overview reproduced as Section III of the year-end report, the memo contains an extensive bibliography. The bibliography will also be published as:

Enders, Wayne T., Patricia Poston, and Ronald Briggs. "Access to Essential Services," Monticello, Illinois: Council of Planning Librarians Exchange Bibliography Series (forthcoming, 1974).

II. LITERATURE OVERVIEW

INTRODUCTION

The focus of this literature overview is toward synthesizing and evaluating previously published research relevant to improving the accessibility of essential services. The discussion of essential services in the previous section isolated those services in which particularly acute accessibility problems exist. It was suggested that they comprise services for the dysfunctional population in rural regions. Thus, emphasis in this review is placed upon personal services related to physical, social, and psychological health in rural regions rather than upon the supply of goods.

Transportation cannot be considered independently of other aspects of the essential service system. The demand for transportation is a derived demand, generated as a consequence of the spatial location of the demand for essential services relative to the spatial location of the facilities supplying these services. Thus, the first section of the literature review concentrates upon assessment of the demand for essential services. Specific considerations here include satisfied, latent, induced, and future demand for the services and associated transportation. The second section discusses the supply of essential services, focusing upon the spatial distribution of facilities providing them.

The third section concentrates upon transportation, per se. The importance of spatial separation between the location of the demand and the sources of supply as a barrier to obtaining services is established. Transportation systems presently utilized to overcome this barrier are then discussed, followed by an outline and evaluation of proposed systems for the future. These systems involve transportation of people to the supply facilities, utilization of mobile units to bring facilities to people, and the use of communication systems as a substitute for the movement of people or facilities.

In making essential services available to a rural population, lack of transportation cannot be considered the only problem. In order to assess its importance relative to other problems and assure the assignment of

fiscal and temporal resources in a satisfactory manner, the fourth section concentrates upon other factors relevant to the provision of essential services in rural areas. These factors are discussed under the broad categories entitled social-psychological, economic, and administrative.

The final section contains a summary and conclusion. The major sources of literature are identified and discussed. Those aspects of the accessibility problem which have received the focus of attention in the literature thus far are pointed out. Finally, several aspects of the accessibility problem which are in need of further research are identified.

This overview is not intended to be comprehensive. The fields covered are so broad that to be all-inclusive would be a major effort in its own right. The intention is to place transportation into the broad context of providing a population with essential services. The major problems are highlighted and references, together with an extensive bibliography, are provided to direct interested persons to bodies of literature on specific topics.

DEMAND

Of major importance in the formulation of plans designed to improve the accessibility of services is the identification of the quantity or level of services required. From the traditional economic point of view the amount of services (supply) required would be equal to the demand for the service at a given price. In planning the provision of essential services, however, this concept is not wholly appropriate by itself and must be considered along with, and distinguished from, the concept of need.

DEFINITION OF DEMAND NEED

The differentiating characteristics of the concepts of need and demand, as they apply to medical services, have been discussed in the literature

(Boulding,[1] Feldstein,[2] Jeffers, Bognanno, and Bartlett;[3] Wirick and Barlow,[4] Fash, et al.,[5]). The distinctions can be appropriately extended to include other essential services such as mental health care and rehabilitation. Viewed from traditional economics, the demand for goods or services arises out of consumers attempting to satisfy their psychologically formulated wants. Because most consumers have limited financial resources, however, they cannot buy all the goods and services in the quantities desired. Thus, it is assumed that consumers are rational and allocate available financial resources among alternative goods and services, purchasing that combination of them which yields the maximum satisfaction attainable, given their limited financial resources and the prices of goods and services in the market place. Utilizing traditional economic theory but considering some non-traditional issues, Fuchs[6] provides an important analysis of health care as an element of the U. S. economic system. A less traditional approach which views "health"

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[1]Boulding, Kenneth E. "The Concept of Need for Health Services," Milbank Memorial Fund Quarterly, 44, (1966), 202-223.

[2]Feldstein, Paul. "Research on the Demand for Health Services," Milbank Memorial Fund Quarterly, 44, (1966), 128-163.

[3]Jeffers, J.R., M.F. Bognanno, and J.C. Bartlett. "On the Demand Versus Need for Medical Services and the Concept of 'Shortage'," American Journal of Public Health, 61, (1971), 46-63.

[4]Wirick, Grover C. and Robin Barlow. "The Economic and Social Determinants of the Demand for Health Services," The Economics of Medical Care. Ann Arbor, Michigan: The University of Michigan Press, (1964).

[5]Fahs, Ivan J., Thomas Choi, Katheryn Barchas, and Paula Zakariasen. "Indicators of Need for Health Care Personnel: The Concept of Need, Alternative Measures Employed to Determine Need, and Suggested Model," Medical Care, 9, (1971), 144-151.

[6]Fuchs, Victor R. "Health Care and the U.S. Economic System," in Technology and Health Care Systems in the 1980's. DHEW Publication No. (HSM) 73-3016. Washington, D.C.: U.S. Government Printing Office, (1973).

as a commodity produced by the household through the purchase of goods and services together with inputs of their own time is developed by Grossman.[7]

One of the assumptions of traditional demand theory is that the consumer has perfect knowledge of the goods and services he purchases from which he is able to determine the combination yielding maximum satisfaction. However, in the case of health services, for example, most consumers are ignorant of professional standards of what constitutes good health and are not fully aware of the extent and limitations of the preventive, therapeutic and rehabilitative capabilities of modern medicine (Jeffers, Bognanno, Bartlett).[8] As a result some individuals may demand and utilize more care than is required, while others, being unaware of its value, may underutilize the services. Thus, while demand can be equated with the actual use of services, in only rare cases will it correspond to the true need for services.

The need for services, on the other hand, can be interpreted as the quantity of services that expert opinion regards as necessary for a population's members to meet contemporary standards. Unlike demand, need is established independent of economic considerations such as the price of the services and the financial resources of the consumer. Figure 1 graphically displays the relationship of the price of services to the differing concepts of demand and need for them. In planning for improvements in the accessibility of essential services consideration must be given to the needs of the population as well as that portion of demand above the need.

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[7]Grossman, M., The Demand for Health: A Theoretical and Empirical Investigation (New York: National Bureau of Economic Research, 1972), Occasional Paper No. 119.

[8](See Footnote 3, p. 9).

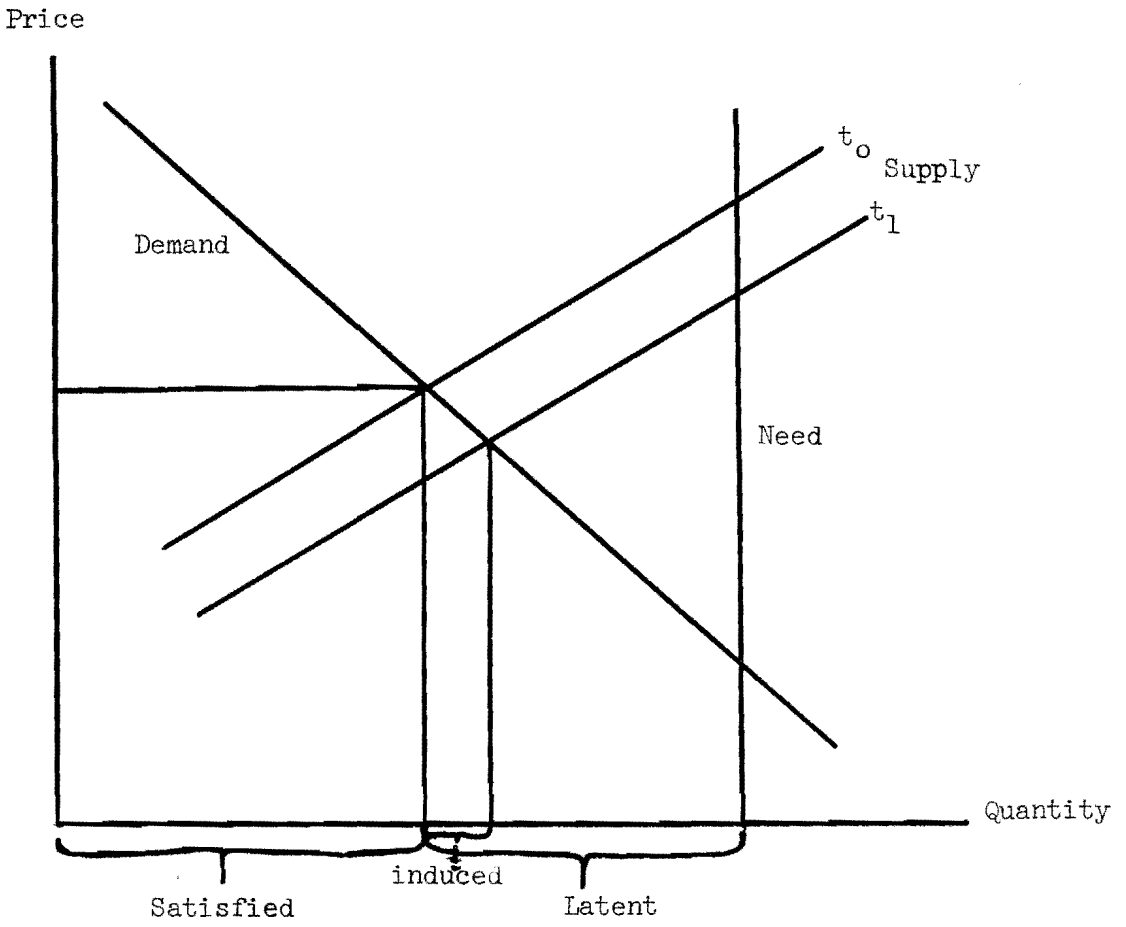

Figure 1. Demand and need curves for essential services

With specific respect to transportation the concept of need has been discussed by Truett and Balek,[9] Ornati,[10] Wickstrom[11] and most recently and comprehensively by Burkhardt and Eby[12] who also suggest a schema for its quantitative determination. Although excellent with respect to transportation, their criticisms of the concept for health care fail to recognize the greater relative importance of knowledge in this field than in transportation.

Having established the concept of need, it can now be used to qualify the definition of demand. For planning purposes demand can be considered under four classifications -- satisfied, latent, induced, and future. Consider demand in a system over a finite period of time assuming given incomes, prices and system configurations. Satisfied demand can be defined as the level of usage of existing services. This level may be higher, lower or the same as existing need. If only economic factors are considered then the magnitude of satisfied demand is given by the intersection of the price line with the demand curve, as in Figure 1.[13] Latent demand is defined as existing needs which are unsatisfied as a consequence of inadequacies in the present supply system

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[9] Truett, J. B. and A. J. Balek, "On the Need for a Definition of a Demand for Transportation," High Speed Ground Transportation Journal, 2 (1968), 576-592.

[10] Ornati, Oscar A., Transportation Needs of the Poor: A Case Study of New York City, New York: Praeger Publishers (1969).

[11] Wickstrom, G. V., "Defining Balanced Transportation--A Question of Opportunity," Traffic Quarterly (1971), 337-349.

[12] Burkhardt, Jon E. and Charles L. Eby, "Need as a Criterion for Trans-Planning," Highway Research Record, 435 (1973), 32-41.

[13] A more detailed consideration will be given in Section 4. Particular stress will be placed on non-economic factors.

(for further discussion see: Hoel, et al.,[14] Kinley[15]). Induced demand is a component of latent demand generated as a consequence of a given improvement in the supply system. Future demand implies an assessment of the above types of demand as they will occur in the future.

ESTIMATING DEMAND

Satisfied Demand

A major barrier to improving the availability of essential services is the simple absence of information on even the most simple demand type, namely satisfied demand, defined as the usage of existing facilities. Potentially, such information can be obtained in one of two ways, either through questionnaires to the population at large as to their usage of services, or through survey of facilities as to the amount of service provided. Although some data of the second type is collected by the U. S. Bureau of the Census with respect to retailing and some selected services (Census of Retailing) it does not encompass any types of health services. Furthermore, the questionnaires submitted to the population at large in the Census of Population and Housing contain no questions on essential service usage. At the national level the primary source of information on health is provided by the National Center for Health Statistics. Its information is of four types: (1) vital statistics on births, deaths, fetal deaths, marriages and divorces; (2) households interviews of 42,000 households providing information on uses of medical services by demographic characteristics, (3) health examinations of a sample population by teams of professional health practitioners, and (4) surveys of service supply facilities providing information on their

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[14]Hoel, L. A., E. D. Perle, K. J. Kansky, A. A. Kuen, E. S. Rosner, and H. T. Nesbitt, The Latent Demand for Transportation, Pittsburgh: Carnegie-Mellon University (1968), Report No. 2, Transportation Research Institute.

[15]Kinley, Holly J., "Latent Travel Demands of the Aging and Handicapped and Barriers to Travel," in Cantilli, E. and J. Shmelzer (eds.), Transportation and Aging: Selected Issues, Washington, D.C.: U.S. Government Printing Office (1971).

characteristics and usage (National Center for Health Statistics[16,17]). Unfortunately, this information is not locationally specific beyond broad divisions of the U. S. thus it does not provide direct information on local usage for use in regional planning.

Information which is locationally specific must be obtained from some specialized source and there are several discussions and suggestions in the literature as to the most appropriate of these (Department of Health, Education and Welfare,[18] U. S. Bureau of the Census[19,20]). Those which have been suggested or utilized include state Hill-Burton agencies for basic data on hospital utilization, Blue Cross/Blue Shield records, and data analysis and billing agencies employed by doctors and hospitals (Wennberg and Gittelsohn[21]).

Although for planning purposes it is frequently necessary to predict satisfied demand and assess its magnitude in the future, models for this purpose have not been extensively developed. The problem is particularly complex, as illustrated by the case of health care service, which has received more attention on this subject than other services. Feldstein provides a conceptual model for assessing existing and future demand for medical care based on several economic and cultural-demographic factors, prevailing medical

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[16]National Center for Health Statistics, Catalogue of Publications, 1962-1971, DHEW Publication No. (HSM) 73-1300, Washington, D.C.: U.S. Government Printing Office (1972).

[17]----------, Current Listing and Topical Index to the Vital and Health Statistics Series, 1962-1972, DHEW Publication No. (HSM) 73-1301 (Revised), Washington: U.S. Government Printing Office (1972)

[18]U.S. Department of Health Education, and Welfare, Areawide Planning for Hospitals and Related Health Facilities, PHS Publication No. 855 Washington, D.C.: U.S. Government Printing Office (1961).

[19]U.S. Bureau of the Census, Census Use Study: Health Information System, Report No. 7, Washington, D.C. (1969).

[20]U.S. Bureau of the Census, Census Use Study: Data Uses in Health Planning, Report No. 8, Washington, D.C. (1970).

[21]Wennberg, John and Alan Gittelsohn, "Small Area Variations in Health Care Delivery," Science, 182 (1973), 1102-1108.

practice, and the incidence of illness (Feldstein[22]). He stresses the importance of a multi-variate approach, but admits that studies of that kind have been few and varied widely in the variable employed (Cook,[23] Das Rheas,[24] Deshais,[25] Fahs, et. al,[26] Feldstein,[27] Rosenthal,[28] Feldstein and Carr,[29] Fowler,[30] Weisbrod,[31] Wirick,[32] Wirick and Barlow[33]). Specifically for planning

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[22](See Footnote 2, p. 9).

[23]Cook, Robert C., "Demographic Factors in Community Health Planning," Population Bulletin, 17 (1961), 1-11.

[24]Das Rheas, S., "Estimates of Hospital Demand Based on Age-Specific Measures of Utilization," Medical News, 4 (1968).

[25]Deshaies, John C., "Census Data for Health Planning," Unpublished Report of the New Haven Census Use Study. Presented before the Urban and Regional Information Systems Association, Clayton, Missouri (1968).

[26](See Footnote 5, p. 9).

[27]Feldstein, Paul, "The Demand for Medical Care," in Report of the Commission on Cost of Medical Care, Chicago: The American Medical Association (1964), 1.

[28]Rosenthal, Gerald D., The Demand for General Hospital Facilities, Chicago: The American Hospital Association (1964).

[29]Feldstein, Paul J. and John W. Carr, "The Effect of Income on Medical Care Spending," Proceedings of the Social Statistics Section, American Statistical Association, (1964), 93-105.

[30]Fowler, Irving, The Northern New York Rural Rehabilitation Survey Report, U.S. Office of Vocational Rehabilitation, Washington, D.C.: U.S. Government Printing Office (1957).

[31]Weisbrod, Burton, Economics of Public Health, Philadelphia: University of Pennsylvania Press (1961).

[32]Wirick, Grover C., "Multiple Equation Model of the Demand for Health Care," Health Services Research, 1 (1966), 133-143.

[33](See Footnote 4, p. 9).

purposes, a less complex approach has been suggested which essentially involves an extrapolation of existing usage rates based upon the projected demographic characteristics of the future population of a region (Department of Health, Education and Welfare[34]).

Research publications directed toward assessing and predicting demand for other essential services, particularly in rural areas, are much less numerious than in the field of health care. Nonetheless, some relevant work has been done in rehabilitation (Berkowitz,[35] Crystal,[36] Ridge,[37] Simons and Hutchinson[38]) and mental health (Busse,[39] Kott,[40] Ozarin and Feldman,[41]

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[34]U.S. Department of Health, Education and Welfare, Procedures for Areawide Health Facility Planning, PHS Publication No. 930-B-3, Washington, D.C.: U. S. Government Printing Office (1963).

[35]Berkowitz, Monroe, "The General Problems of Forecasting in Vocational Rehabilitation," in Berkowitz, M. (ed.), Estimating Rehabilitation Needs: A Conference on Planning for Vocational Rehabilitation, New Brunswick, New Jersey: Rutgers, The State University Press (1971).

[36]Crystal, Royal A., "Vocational Rehabilitation: Highlights and Demand for Services," in Berkowitz, M. (ed.), Estimating Rehabilitation Needs: A Conference on Planning for Vocational Rehabilitation, New Brunswick, New Jersey: Rutgers, The State University (1971).

[37]Ridge, Susan S., "The Allocation of Rehabilitation Funds Among States and Districts: An Evaluation," WP-183/RS010, Berkeley, California: Institute of Urban and Regional Development (1972).

[38]Simons, R. H. and John D. Hutchinson, Vocational Rehabilitation of the Disabled Disadvantaged in a Rural Setting. Washington, D.C.: U.S. Department of Health, Education and Welfare Services (1970).

[39]Busse, E. W., "The Origins of Priorities and the Effect of Pressure on Mental Health Services," Hospital Community Psychiatry, 22 (1971), 357-361.

[40]Kott, Maurice G., "Estimating the Number of the Retarded in New Jersey," in Berkowitz, M. (ed.), Estimating Rehabilitation Needs: A Conference on Planning for Vocational Rehabilitation, Bureau of Economic Research, New Brunswick, New Jersey: Rutgers, The State University Press (1971).

[41]Ozarin, L. D. and S. Feldman, "Implications for Health Service Delivery: The Community Mental Health Centers Amendments of 1970," American Journal of Public Health, 61 (1971), 1780-1784.

Saltzman (a)[42], Ridge (b)[43] Andrew[44]).

A critical element affecting the demand for essential services is a population's attitude toward the value of the service. Thus, the determination of existing demand also requires an interpretation of the public's changing concept of need at both the national and local levels (Reader,[45] Horvath,[46] Donabedian,[47] and Kott[48]). This requires a consideration of the second major type of demand, namely, latent demand.

Latent Demand

Determination of the latent demand for essential services requires an identification of the need for essential services. The accepted definition of need as indicated in the literature - the quantity expert opinion believes is necessary - allows for considerable variation from place to place and from

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[42]Saltzman, Ben (a), "Mental Health and the Rural Aging," The Journal of the Arkansas Medical Society, 68 (1971).

[43]Ridge, Susan S. (b), "Estimating Need for Rehabilitation Services," WP-182/RS009, Institute of Urban and Regional Development, Berkeley: University of California (1972).

[44]Andrew, Gwen, "Uses of Data in Planning Community Psychiatric Services," American Journal of Public Health, 55 (1965), 1925-1935.

[45]Reader, George G., "Community and Governmental Responsibility in Delivery of Medical Care to the Individual," Kilbourne, E. D. and Wilson G. S. Miller (eds.), Human Ecology and Public Health, London: The MacMillan Company (1969).

[46]Horvath, William J. (a), "Need for Estimating the Influence of Technological and Social Changes on Future Health Facility Requirements," Health Services Research, 3 (1968), 3-9.

[47]Donabedian, A., "Social Responsibility for Personal Health Services: An Examination of Basic Values," Inquiry, 8 (1971), 3-20.

[48](See Footnote 40, p. 16).

expert to expert. Also, it must be acknowledged that even among experts and groups of experts perfect knowledge as to the state of any population's health and the potential of modern medicine does not exist (Jeffers, Bognanno and Bartlett[49]).

A well developed field of knowledge for determining need does not yet exist. Some attempts have been made, however, to assist the "experts" in assessing the medical needs of a given population. A three factor model consisting of distance to services, income of the population, and ratio of medical personnel to population, for pointing out geographic areas of need has been suggested by Fahs (Fahs, et al.[50]). Perhaps the most sophisticated effort to quantify need was undertaken by Lee and Jones; but their early effort has not been duplicated or expanded on a large scale (Lee and Jones[51]). Boulding and others have emphasized a need for more sociological research into the analysis of perception of need as a means to more accurately determine the actual need (Boulding,[52] Devise,[53] Hawkins,[54] U.S. Department of Health, Education and Welfare[55]).

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[49](See Footnote 3, p. 9).

[50](See Footnote 5, p. 9).

[51]Lee, Roger I. and Lewis W. Jones, The Fundamentals of Good Medical Care, Chicago: University of Chicago Press (1933).

[52](See Footnote 1, p. 9).

[53]DeVise, Pierre, "Methods and Concepts of an Interdisciplinary Regional Hospital Study," Health Services Research, 3 (1966), 166-174.

[54]Hawkins, Norman G., Medical Sociology: Theory, Scope, and Method, Springfield, Illinois: Charles C. Thomas (1958).

[55]U.S. Department of Health, Education and Welfare, Conceptual Problems in Developing an Index of Health, U.S. Public Health Service Publication No. 1000, Series 2, No. 7. Washington, D.C.: U.S. Government Printing Office (1966).

For those services in which the client must satisfy the criteria of specific legal requirements, such as age, disability, or unemployment, a legal basis is provided for ascertaining need. Analysis of relevant data and records, and indicators of national and regional trends, facilitates prediction of the need population. However, even here, data may not be available as to the number of persons eligible without extensive surveying of the population.

Induced Demand

One aspect of demand that is especially difficult to assess is the quantity of demand, beyond existing or future demand, that will be induced to use essential services after improvements in the supply system. This specific topic has received very little attention in the literature on essential services. The primary approach has been to monitor the effects of an actual improvement in the supply system.

Unfortunately, the ability to generalize these results to other areas is often limited, and seldom has it been tested. These statements are equally true with respect to improvements in the transportation system in rural areas. Although the impact upon the number of trips to essential services in rural areas has been noted (for example, Burkhardt, et al.[56]), models of induced travel demand incorporating its impact upon the demand for essential services have not been developed. However, in the transportation literature there exist many studies directed toward determining and predicting travel demands that have potential value in establishing the role of transportation in providing accessibility to essential services. Some studies focus specifically upon problems of rural areas (Kaesehagen[57]), and others on urban areas

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[56]Burkhardt, Jon E., Charles S. Eby, James G. Abert, Armando Lago, James S. Hedrick, and Louis A. Spittle, The Transporation Needs of the Rural Poor, RMC Report UR-072, Bethesda, Maryland: RMC Corporation (1969).

[57]Kaeshagen, R.L., "A Rural Road Needs Model," Proceedings of the Australian Road Research Board, Paper No. 660, Part 1 (1971), 161-184.

(Brand and Manheim[58]), but many contain travel demand models in general, parts of which may be applicable to rural areas (Quandt and Young,[59] Quandt,[60] McDaniel,[61] Mouchachoir,[62] Hoel, et al.[63]). However, the link between these models and the demand for essential services remains to be forged.

Summary

A review of the existing literature has revealed many of the problems in assessing the demand for essential services. There are conceptual difficulties with the terms demand, and need, which fluctuate with attitudes of the public and the professionals. There are problems of variable selection, data gathering and analytical techniques. Most of the existing literature on demand for essential services is in the field of health care, but relatively few empirical studies are available.

Research on demand for other essential services, particularly in rural areas, is much less abundant. No publications which may have considered combining the demand for several services, for the purpose of determining the economic feasibility of various delivery systems, were located. For all essential services, little work has been done on identifying induced demand after accessibility improvements are completed.

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[58] Brand, D., and Manheim, M. L., (eds.) Urban Travel Demand Forecasting, HRB Special Report 143, (1973).

[59] Quandt, Richard E. and Kan Hua Young. "Cross-Sectional Travel Demand Models: Estimates and Tests," Journal of Regional Sciences, (1969), 201-214.

[60] Quandt, Richard E. (ed.) The Demand For Travel: Theory and Measurement. Lexington, Massachusetts: Heath Lexington Books, (1970).

[61] McDaniel, Dale E. "Transportation Forecasting: A Review," Technological Forecasting and Social Change, 3 (1972), 367-389.

[62] Mouchahoir, George E. "The Use of Multivariate Statistics in Transportation Planning," Traffic Engineering, (1971), 44-48.

[63] (See Footnote 14, p. 13).

Research on demand for other essential services, particularly in rural areas, is much less abundant. No publications which may have considered combining the demand for several services, for the purpose of determining the economic feasibility of various delivery systems, were located. For all essential services, little work has been done on identifying induced demand after accessibility improvements are completed.

On the other hand, the growing body of literature on concepts and methods to determine demand for health services forms a good basis upon which to develop models of demand for other essential services. Also, many of the existing models await the opportunity to be empirically applied. In addition, existing and forthcoming literature in such fields as transportation analysis and operations research constitutes a potential contribution to the analysis of the demand for essential services.

SUPPLY SYSTEMS

Because of the varied nature of need for essential services, it can readily be seen that no single, simple system can adequately provide the necessary accessibility to services (Phillips[64]). In this section the literature has been reviewed for the purpose of identifying the rural access systems currently in use and for discovering clues for needed research that may lead to improvements in the systems.

THE PROBLEMS

A special effort was expended to locate literature on existing systems which were consciously designed, through intra-agency coordination, to accommodate the combined or aggregate demand of more than one type of essential service. It was discovered that very little literature exists concerning cooperation among agencies with reference to such matters as sharing delivery vehicles, facility space, or trained personnel. This tends to imply, in turn, that little coordination among essential service agencies exists. Thus, as

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[64]Phillips, Donald F., "Reaching Out to Rural Communities," Hospitals, 46, (1972), 53-57.

the literature indicates, research on rural accessibility systems has focused primarily on the needs for specific individual services.

The location of essential service facilities depends, in great part, upon the type of service and the person or agency responsible for administering the service. In the normal competitive market situation services which have a relatively high demand per unit population usually will be dispersed through an area to the local level (Berry,[65] Losch[66]). More specialized services, for which the demand per unit population is smaller, will occur at less frequent intervals in the landscape, generally in the more important regional centers. The result is a hierarchical structuring of services centers or urban settlements with each center serving its surrounding region. The size of each respective region increases up through the hierarchy as more specialized services are provided.

In reality, a given service does not necessarily occupy a fixed unique level in this hierarchy. An option often exists between a centralized system, having a smaller number of larger service facilities each serving a more extensive region, and a dispersed system, having a larger number of smaller facilities each serving a less extensive region. These systems represent trade-offs between the agglomeration or scale economies achieved by the larger facilities of the centralized system as against the reductions in transportation costs, and consequently often an increase in the number of persons served in the total system, obtained by the dispersed configuration. However, it should not be forgotten that even with a dispersed system, problems of population accessibility to service units may still exist, although they may be somewhat smaller in magnitude than those prevailing in a centralized system.

Not only does the demand per unit population influence location patterns, the agency or person responsible for administering the service also has an important impact. This is particularly true with essential services, which

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[65] Berry, Brian J. L. Geography of Market Centers and Retail Distribution. Englewood Cliffs: Prentice Hall, Inc., (1967).

[66] Losch, August. The Economics of Location. New Haven: Yale University Press, (1954).

characteristically do not operate in the open market place. The location pattern of services offered by government agencies is partly influenced by the level of government responsible for their provision. Services offered by state agencies tend to have a more centralized pattern than those offered by county governments. Location decisions may be made on the basis of higher priority governmental goals unrelated to the needs or goals of the particular service being located. Where individual government units have limited resources they may be unable to afford a particular service yet may be unwilling to cooperate with surrounding units in a similar situation because of fears of sovereignty loss. Few of these factors have received attention in the literature, yet they have a marked impact upon the location pattern of services and contribute to the marked spatial inequality in their availability.

Again, this field of health care has received more attention on this topic than have other services. Here, attention has been directed, in part, toward the locational decisions of physicians since where they choose to reside influences to a great extent the locational availability of health care facilities at the primary level. For rural areas the trend is clear. There is no doubt that one of the major problems in rural health care is the astonishing decline in the number of rural physicians in recent years (Fein,[67] Fahs and Peterson[68]). Most of these physicians were general practitioners, many were elderly and as they were removed from the scene by retirement young doctors did not replace them in sufficient numbers to provide the needed health care (Castleton[69]). For a variety of reasons

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[67]Fein, Rashi. The Doctor Shortage: An Economic Diagnosis. Washington, D. C.: Brookings Institution, (1967).

[68]Fahs, Ivan J. and Osler L. Peterson. "Towns Without Physicians and Towns with Only One--A Study of Four States in the Upper Midwest, 1965," American Journal of Public Health, 58, (1968), 1200-1211.

[69]Castleton, M. C. "The Present Dilemma of Rural Health Services," Rocky Mountain Medical Journal, 67, (1970), 29-34.

young doctors are choosing to live in urban centers (Champion and Olsen;[70] Parker, Rix, and Tuxill;[71] Durbin;[72] and Packard[73]) and it does not appear likely that a reversal of the trend will occur in the foreseeable future. The result is that services of physician and other health personnel are becoming increasingly centralized in urban areas (Sanchez and Bynum[74]).

This manpower crisis is not limited to the health services. Professionals providing vocational rehabilitation, counselling services, and mental health services in rural areas are also choosing higher paying employment and the amenities of urban areas (Rusalem and Baxt,[75] Simons and Hutchinson[76]).

The effect of the centralization of physician and other professional services is to deprive residents in many rural areas from access to essential services. As will be discussed in greater detail in the transportation section, the primary means of accessibility in rural areas are the automobile and farm vehicles. When the separation of a rural resident from a health facility constitutes a considerable physical distance, calls on physicians are

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[70] Champion, Dean and Donald B. Olsen, "Physician Behavior in Southern Appalachia: Some Recruitment Factors," Journal of Health and Social Behavior, 12 (1971), 245-252.

[71] Parker, Ralph C., Richard A. Rix and Thomas G. Tuxill, "Social, Economic, and Demographic Factors Affecting Physician Population in Upstate New York," New York State Journal of Medicine, 69 (1969), 706-712.

[72] Durbin, Richard L., "Do New Hospitals Attract New Doctors?" The Modern Hospital, 100 (1963), 98-102.

[73] Packard, John M., "What is the Alabama Regional Medical Program and Its Practical Application to Rural Health?" The Journal of the Medical Association of the State of Alabama, 42 (1972), 429-435.

[74] Sanchez, Ray and Gaither Bynum, "Rural Health Care in New Mexico," Rocky Mountain Medical Journal, 68 (1971), 53-58.

[75] Rusalem, Herbert and Roland Baxt, "Delivering Rehabilitation Services," National Citizens Conference, U.S. Department of Health, Education and Welfare, Washington, D.C. (1970).

[76] Simons, R.H. and John D. Hutchinson, Vocational Rehabilitation of the Disabled Disadvantaged in a Rural Setting, Washington, D.C.: U.S. Department of Health, Education and Welfare, Social and Rehabilitation Service 1970).

often limited to emergency cases. Also, in rural areas, where poverty rates are above the national average, many people who do not have access to a motor vehicle are deprived of any access to health and other services (Saltzman (b)[77]). At the present, many rural areas can fairly be classified as "medically deprived" or as experiencing a "crisis in health care" (Castleton,[78] Council of Health Manpower and Council on Rural Health[79]).

The present situation in rural health care is not entirely as bleak as it appears from the preceeding paragraphs. Considerable research has been undertaken and some progress is being achieved in alleviating the problems created by the decline in physicians numbers. Furthermore, the research undertaken for rural health care can very often be expanded to include solutions to problems facing other essential services. For discussion purposes, strategies for improvement in the accessibility of essential services in rural areas can be discussed under four major categories: (1) incentive programs to encourage professionals to locate or remain in rural areas; (2) improved transportation systems for moving people to facilities; (3) mobile units moving facilities to the population; and (4) the substitution of communication for physical movement. In practice, any comprehensive system would necessarily consider all of the above strategies operating in various potential combinations. Literature on the first strategy indicates that it has not been overly successful. The other three which have greater transportation implications, are discussed in the section on transportation.

INCENTIVE PROGRAMS

The causes and magnitude of the lack of professionals, particularly medical personnel, in rural areas have been thoroughly discussed in the

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[77] Saltzman, Ben (b). "Health Care for the Disadvantaged in the Rural Area," The Journal of the Arkansas Medical Society, 67, (1971), 319-321.

[78] (See Footnote 69, p. 23).

[79] Council on Health Manpower and Council on Rural Health. "Priorities for Increasing Availability of Health Services in Rural Areas," Journal of the American Medical Association, 222, (1972), 1284-1285.

literature (Castleton,[80] Champion and Olsen,[81] Sanchez and Bynum,[82] Parker, Rix and Tuxill,[83] Fahs and Peterson[84]). In view of the increasing manpower shortage the question may be asked, "How can professional personnel be retained or attracted to rural areas?" There is little evidence that a favorable answer to this question exists. Many rural communities have derived incentive programs designed to recruit medical personnel and to encourage their staying in rural family practice; but most of these programs have met with failure (Perry,[85] Phillips[86]). The various methods proposed or employed to place more physicians or other health workers in rural areas include cancellation of student loans, payment of tuition, practice grants, tax exemptions or other financial inducements for service or periods of service (Durbin,[87] Perry[88]), provisions of medical facilities, greater use of rural preceptorships

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80(See Footnote 69, p. 23).

81(See Footnote 70, p. 24).

82(See Footnote 74, p. 24).

83(See Footnote 71, p. 24).

84(See Footnote 68, p. 23).

85Perry, Bradford G. "Transportation as a Component in the Delivery of Health Care to Rural Areas," Paper presented at the Rural Health Services Research Symposium, (1973).

86(See Footnote 69, p. 23).

87(See Footnote 72, p. 24).

88(See Footnote 85, p. 26).

during undergraduate and graduate medical school (Harrell[89]) and increased use of community hospitals for intern and resident training. Although many of these approaches have merit, it has become clear that, for some rural areas, solutions completely different from the traditional "physician in residence" must be sought (Council on Health Manpower and Council on Rural Health,[90] Castleton[91]).

Some success with incentive programs has been achieved, for example, in Vermont, Illinois and Wisconsin (Phillips[92]), but the evidence obtained from the limited literature on the topics suggests this strategy can be no more than a partial solution to the problem of rural needs. However, the potential of inducement programs has not been thoroughly explored in the literature and remains a valid field of inquiry.

TRANSPORTATION

THE DISTANCE FACTOR

Two basic interrelated problems in providing accessibility to essential services in rural areas can be readily recognized and understood: (a) the dispersed nature of rural population results in a comparatively low tax base per unit area placing limitations on the number and location of essential service facilities; and (b) in any economically feasible system of providing essential services to a rural area, many residents will live at great distances from permanently located service facilities. As a consequence, residents must travel substantial distances in order to obtain a needed service.

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[89] Harrell, George T. "Rural and Small Town Practice," Journal of the American Medical Association, 209, (1969), 399-402.

[90] (See Footnote 79, p. 25).

[91] (See Footnote 69, p. 23).

[92] (See Footnote 64, p. 21).

Evidence exists for several services that distance has a negative impact on the utilization of services (Swedner,[93] Girt,[94] Shannon and Dever[95]).

Hodges and Dorken[96] demonstrated that distance was a significant factor in the utilization of psychiatric services. Their rural Minnesota study established that a one-hour drive of approximately 40 to 60 miles was the 1 limit rural residents were willing or able to travel to a service. A study by the Utah Regional Rehabilitation Research Institute discovered that the relationship between rehabilitation counselor and client was adversely affected by geographic distance (Bitter[97]). Distance was also seen to be the reason that rural applicants for state rehabilitation programs would wait approximately twice as long as urban applicants before being accepted (Bitter[98]).

In the case of primary health care, distance from individuals to the source of health care has also been established as a barrier to utilization. Among farm people it was determined that the distance farmers reside from certain health personnel and facilities is related inversely to the use they

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[93]Swedner, Harold. "Prediction of Differences in Habits and Attitudes Toward Service Establishment in Rural and Urban Settings," Rural Sociology, 27, (1970), 396-417.

[94]Girt, John L. "Distance to General Medical Practice and its Effect on Revealed Ill-Health in a Rural Environment," Canadian Geographer, 17, (1973), 154-166.

[95]Shannon, Gary W., and G. E. Alan Dever. Health Care Delivery: Spatial Perspectives. New York: McGraw-Hill Company, (1974).

[96]Hodges, Allen and Herbert Dorken. "Location and Out-Patient Psychiatric Care," Public Health Reports, 76,(1961), 239-242.

[97]Bitter, James A. "Some Viable Service Delivery Approaches in Rural Rehabilitation," Rehabilitation Literature, 33, (1972), 354-358.

[98](See Footnote 97, p. 28).

make of such personnel and facilities (Jehlik and McNamara,[99] Altman,[1] and Ciocco and Altman[2]). In an attempt to more clearly identify the impact of distance, later models supplemented the distance parameter with transportation costs and modal choice as additional determinants of service usage (Garrison, et al.,[3] DeVise,[4] Long and Feldstein[5]).

More recent studies have been directed toward understanding the complex interaction of distance and additional socio-economic variables as they affect the utilization of health facilities (Abernathy and Schrems,[6] Abernathy and

[99]Jehlik, Paul J. and Robert L. McNamara. "The Relation of Distance to Differential Use of Certain Health Personnel and Facilities and to the Extent of Bed Illness," Rural Sociology, 17, (1952), 261-265.

[1]Altman, Isidore. Distances Travelled for Physician Care in Western Pennsylvania. U. S. Public Health Service Publication No. 19, Part II. Bethesda, Maryland: National Institute of Health, (1954).

[2]Ciocco, Antonio and Isidore Altman. Medical Service Areas and Distances Travelled for Physician Care in Western Pennsylvania. U. S. Public Health Service Publication No. 19, Part I. Bethesda, Maryland: National Institute of Health, (1954).

[3]Garrison, W. L., D. F. Marble, J. D. Nystuen and R. J. Morrill. Studies in Highway Development and Geographical Change. Seattle: University of Washington Press, (1959).

[4]DeVise, Pierre. "Hospital Study of Districts for Metropolitan Chicago," Technical Report No. 2, Hospital Planning Council for Metropolitan Chicago, (1966).

[5]Long, M. F. and P. V. Feldstein. "Economics of Hospital Systems: Peak Loads and Regional Coordination," American Economic Review, 57, (1967), 119-129.

[6]Abernathy, William J. and Edward L. Schrems. "Distance and Health Services: Issues of Utilization and Facility Choise for Demographic Strata," Research Paper No. 19, Stanford University, Graduate School of Business, (1971).

and Hershey,[7] Kane,[8] Weiss[9]). It appears that socio-economic and locational characteristics of the population must be considered together in order to provide a degree of understanding necessary for an "optimal" distribution of medical care services (Shannon, Bashur, and Metzner[10]). Some optimal location studies based upon distance or time away from facilities have been completed, thus providing a framework for expanded generalized model (Godlund,[11] Marrinson,[12] California, State of,[13] Drosness and Lubin,[14] Abernathy and Hershey,[15])

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[7]Abernathy, William J. and John C. Hershey. "A Spatial Allocation Model for Regional Health Services Planning," Research Paper No. 19, Stanford University, Graduate School of Business, (1971).

[8]Kane, R. L. "Determination of Health Care Priorities and Expectations Among Rural Consumers," Health Services Research, 7, (1969), 142-151.

[9]Weiss, J. W. and M. R. Greenlick. "Determinants of Medical Care Utilization: The Effects of Social Class and Distance on Contacts with the Medical Care System," Medical Care, 8, (1970), 456-462.

[10]Shannon, Gary W., Rashid L. Bashur, and Charles A. Metzner. "The Concept of Distance as a Factor in Accessibility and Utilization of Health Care," Medical Care Review, 26, (1969), 143-161.

[11]Godlund, Sven. "Population, Regional Hospitals, Transport Facilities and Regions: Planning for the Location of Regional Hospitals in Sweden," Royal University of Lund, Sweden, Department of Geography, Lund Studies in Geography, Series B, Human Geography, 21, (1961).

[12]Marrison, Ralph. "Hospital Service Areas: Time Replaces Space," Hospitals, 38, (1954), 52-54.

[13]California State Department of Public Health. Hospitals for California, Berkeley, (1964).

[14]Drosness, Daniel L. and Jerome W. Lubin. "Planning Can Be Based on Patient Travel," Modern Hospital, 196, (1966), 92-98.

[15](See Footnote 7, p. 30).

In view of the established impact of socio-economic variables on health service utilization it is apparent that the concept of distance and space in medical care research must be extended. Such an extension could be valuable in at least two ways; (a) immediately, in providing a more sound basis for planning the location of medical facilities; and (b) in the long run, for developing a general theory concerning medical care activities (Shannon, Bashur, and Metzner[16]).

In spite of the complexity of the problems associated with excessive distance, there is little evidence of cooperation and coordination among the relevant agencies to create an integrated transportation system for improving the overall accessibility of their services to rural residents. Such coordination among agencies may have the effect of creating a combined demand or other economies of scale sufficient to meet the economic costs of delivery in a dispersed population. The relatively new problem-solving techniques associated with systems analysis and operations research may provide some answers. These techniques have been applied only recently to essential service problems with most work having been completed in health care. A bibliography by James R. Newheiser[17] and another by Dunaye, Foote and Dunaye,[18] illustrate, however, that emphasis has been placed on improving management organization and efficiency rather than on the problems associated with excessive distances.

Although very little literature has addressed itself to multi-agency delivery systems designed to meet the integrated essential needs of rural residents, work in other areas may be directly relevant. Examples of existing models, which imply potential integrated multi-agency solutions have been concerned with: (a) the analysis of a multiple delivery network (Audland[19]),

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[16](See Footnote 7, p. 30).

[17]Newheiser, James R. Management of the Delivery of Health Care: An Annotated Bibliography. Austin: The University of Texas at Austin, Graduate School of Business, Working Paper No. 70-62, (1970).

[18]Dunaye, Thomas M., Bobbio L. Foote and Sue L. Dunaye. Health Planning Applications of Operations Research and Systems Analysis: A Selected Bibliography. Monticello, Illinois: Council of Planning Librarians Exchange Bibliography No. 233, (1971).

[19]Audland, M. "Single Analysis of a Multiple Delivery Network," Freight Management, (1969), 61-65.

(b) network analysis and the computer (Williams[20]), and (c) computer scheduling of vehicles from or more depots to a number of delivery points (Wren and Holliday[21]). In spite of the existing lack of coordination among agencies, the potential of this approach suggests that a much greater emphasis on this type of research is justified.

EXISTING TRANSPORTATION USAGE

The location of essential service facilities is characteristically in urban centers where the majority of the population can be most easily served. Some services are being provided through the use of mobile units, primarily on a temporary or experimental basis, but the great majority of essential services require the client to secure transportation to the permanent location of the facility. In most urban areas the personal, private model of transportation (automobile) is adequately supplemented by public transportation such as taxi-cabs, buses, and perhaps special purpose shuttle services.

Rural transportation is strongly characterized by a reliance on personal, private transportation such as the automobile or truck. Bus systems and the very limited rail passenger services are primarily oriented toward linking major cities. Services linking smaller rural communities are ancillary to this primary function, and as a consequence do not always meet the needs of rural residents. Other transportation elements serving unique functions in the existing rural system are general purpose networks oriented toward specific population sub-groups (aged, poor, etc.), "special purpose" networks such as school buses, ambulances, and volunteer transportation services such as "meals on wheels." Thus the rural resident's mode of transportation is restricted.

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[20]Williams, W. K. "Network Analysis and the Computer," Journal of the Institute of Highway Engineering, (1972), 333-344.

[21]Wren, Anthony and Allan Holliday. "Computer Scheduling of Vehicles from One or More Depots to a Number of Delivery Points," Operations Research Quarterly, (1973), 133-143.

Automobiles

The detrimental effects of a system that forces heavy reliance on the automobile are easily identified (Altschuler,[22] Highway Research Board[23]). Substantial proportions of the population are unable to drive for physical reasons (the blind, disabled, handicapped, and elderly), for educational reasons (illiterate and severely retarded), for financial reasons (the poor), for safety reasons (habitual traffic offenders), and for being below the minimum driving age. Some of these problems are more pronounced in rural areas than in urban regions particularly with respect to poverty and age.

Rural areas are typically characterized by below average incomes creating a greater incidence of poverty than in urban areas (Texas Office of Economic Opportunity[24]). Even where families do own an automobile, there may be considerable problems in its utilization (Burkhardt and Eby[25]). For poor families, the car may be in such a poor state of maintenance that only the shortest trips are possible. High and rising costs of gasoline and repairs are also a problem. In one-vehicle families, often the only vehicle must be used during the day by the working person, leaving it available for other purposes only in the evening when most services are not being offered (Saltzman (b)[26]). This is a critical problem when the health care of children is concerned, or when emergencies arise.

Because of out-migration by the young and some in-migration by retired persons, the age structure of the rural population is considerably older than that of the urban population, and severe transportation difficulties exist

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[22]Altschuler, Alan A. "Transit Subsidies: By Whom, For Whom?" Journal of the American Institute of Planners, (1969), 84-88.

[23]Highway Research Board. "Transit for the Poor, the Aged, and the Disadvantaged," Highway Research Record, (1972), 403.

[24]Texas Office of Economic Opportunity. Poverty in Texas. Austin, Texas: Department of Community Affairs, Texas Office of Economic Opportunity, (1972).

[25](See Footnote 12, p. 12).

[26](See Footnote 77, p. 25).

for older persons (Cantilli and Smelzer[27]). They are often not physically able to drive, especially long distances. They may be unwilling or unable to drive in urban areas, particularly heavily travelled and congested central city areas where most health care facilities above the primary level are located. In addition, a substantial proportion of the over-65 age group lives on low and fixed incomes which, when compared to the rising cost of automobile transportation, places them in situations similar to the rural poor.

Bus Systems

Alternatives to the automobile are sorely lacking in rural areas - bus and rail routes are primarily oriented toward linking major cities and do not necessarily link desired origins and destinations within rural areas, scheduling is infrequent and, equally important, time schedules are oriented toward generating traffic between major cities rather than meeting the time framework requirements of rural residents. This last point is particularly critical when service facilities are open only for relatively limited, specific time periods. In addition, a dispersed rural population must have some means of reaching bus and train stops. Thus, some type of personal, private transportation appears necessary even for utilization of the public system. Taxi service, which performs this function in urban areas, is either not available in rural areas or prohibitively expensive because of the relatively long distances involved.

Special Purpose Systems

Presently, special purpose transportation systems in rural communities are generally limited to ambulance services and school buses (Wilson[28]). Ambulance services are often supported by fire departments, police departments,

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[27]Cantilli, E. J. and J. L. Smelzner (eds.), Transportation and Aging: Selected Issues. Washington, D. C.: DHEW Publication No. (SRS) 72-20232, U. S. Government Printing Office, (1972).

[28]Wilson, Vernon E. "Rural Health Care Systems," Journal of the American Medical Association, 216, (1971), 1623-1626.

or funeral directors of which few have any medical training beyond routine first aid (McClendon and Fikes[29]).

Volunteer transportation systems meet inportant needs in many areas. Such systems include ambulances (Stonehill[30]), "meals on wheels," general social transportation for the elderly (Bell[31]), transportation to rehabilitation facilities for the disabled or mentally retarded, and others. However, it is exceedingly difficult to estimate the relative importance of these services. They do not receive a great deal of attention and rigorousevaluation in the literature even though their potential may be significant.

Summary

At present no nationwide comprehensive system exists which can satisfy the transportation demand generated by the needs of rural residents to have access to essential services. Several experimental systems are at various stages of planning or implementation, some of which exhibit considerable potential. These are discussed below in the section on potential systems.

POTENTIAL TRANSPORTATION SYSTEMS

Research and experimentation on potential transportation systems is now underway for several essential services. Barring a major breakthrough in technology, transportation systems of tomorrow will evolve from the research and experiments being conducted today. Potential transportation systems are of three types: (a) those involving the movement of people to facilities; (b) mobile units which move the facility to the people; and (c) communication systems involving a partial substitution of electronic communication for physical movement of people or facilities.

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[29]McClendon, Edward L. and Jerald M. Fikes. "Rural Ambulance Service," Journal of the American Hospital Association, 45, (1971), 69-71.

[30]Stonehill, R. B. "The Development of a Voluntary Rural Emergency Ambulance Service," Journal of the Indiana State Medical Association, 64, (1971), 1021-1022.

[31]Bell, John N. "Senior Citizen Mobile Service," in Cantilli, E. and J. Shmelzer, (eds.), Transportation and Aging: Selected Issues, Washington: U. S. Government Printing Office, (1971).

Moving People to Facilities

Transportation systems moving people to facilities are likely to remain heavily dependent upon the private automobile in the future. Given the dispersed nature of the rural population it is difficult to envision any other system type which will meet the needs of rural residents and be economically viable. Alternatives to the automobile which have been discussed in the literature include a general bus system oriented toward the whole population, privately owned or operated with subsidy, a general bus system oriented toward the non-automobile owning population, and specialized types of systems for particular services or groups of services.

Private Bus Systems

This alternative closely resembles the bus transportation system in operation today. In the previous section this system was seen to have four main problems involving routing, infrequent scheduling, inappropriate timing and the need for other transportation modes for reaching bus stops. The economics of bus operation would seem to preclude solutions to most of these problems within the framework of the presently operating bus system. Changes in routing and scheduling may have some impact in rural areas. However, there is a marked lack of research on the utilization of buses in such regions. Little is known about who rides buses, when they ride, and for what purposes.[32] Given the structural and functional differences between rural and urban areas it is dangerous to assume that the multitude of studies in urban areas are applicable to rural regions.[33] Thus, it is difficult to assess the potential impact of changes in routing and scheduling--but there is little evidence to suggest that the change would be significant. Since economic feasibility dictates the use of a very minimal number of buses to serve many small communities, this severely inhibits the achievement of a routing and time schedule appropriate for each community.

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[32] Virtually every major metropolitan area has conducted studies of transit ridership, yet there are few equivalent studies in rural areas.

[33] Some information is available for the disadvantaged (Burkhardt, et al., 1969, 1972).

Subsidized General Bus System

Subsidization of a general bus system either through the operators or riders (Altshuler[34]), is another alternative for providing improved transportation in rural regions. However, a cost-benefit analysis of operating such a system in a low density area, with relatively small numbers of total population, would not appear favorable from either an economic or political point of view. Secondly, many of the external factors which can partially justify subsidization in urban regions are not present in rural areas. These externalities in urban areas have the potential to include reduced air pollution, reduced need for larger highways, less traffic congestion, utilization of valuable land for purposes more efficient and productive than parking, reduced accident rates, reduced fuel consumption and others. With the exception of the last two, all these are associated with concentration and congestion and thus are inapplicable in rural regions. Furthermore, many of the factors behind these externalities provide inducements in urban areas for the automobile owning population to utilize public transportation. Their absence in rural areas further reduces the demand for public transportation and inhibits the operation of a system at a viable level.

A demand-actuated system (DART)[35] such as those utilized in the Dial-a-Ride concept (Highway Research Board,[36] Metropolitan Transit Commission[37]), as opposed to the more traditional fixed route and scheduling system employed by most present bus systems, appears to offer the greatest potential in terms of a general bus system for rural areas. Potentially, it overcomes some of the problems as regards scheduling which are associated with fixed route systems. Furthermore, since vehicles only operate when demand exists, rather than continuously, some savings in operating costs may be obtained. A door-to-door

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[34](See Footnote 22, p. 33).

[35]Demand-Actuated-Road-Transit

[36]Highway Research Board. "Demand-Responsive Transportation Systems," Proceedings of a Conference held June 12-14, 1972, Ann Arbor, Michigan. Highway Research Board Special Report, No. 136, (1973).

[37]Metropolitan Transit Commission. Report on Dial-A-Ride Technology. St. Paul, Minnesota, (1972).

service can also be provided which is likely to greatly increase the utility of the system, especially for those persons with mobility problems such as the aged and handicapped. However, even here low utilization may prevent the development of a system serving the whole population at reasonable levels of subsidy. Furthermore, a DART system can seriously impact local taxi-cabs. Indeed, the cab is an extreme form of the DART system and subsidization of cabs rather than the creation of a separate system has been recommended for some areas (Burkhardt, et al.[38])

Population Sub-Group Systems

Several experimental projects have been specifically oriented toward providing general transportation for those persons unable to use automobiles. Areas include, Cape May, New Jersey (Zahora[39]), Raleigh County, West Virginia (Burkhardt, et al.[40]), and Troy, New York (RCC Corporation[41]). With the exception of the last named, these demonstration projects were discontinued when financial support was exhausted. In addition, many small local systems are operated by Community Action Agencies and other interested groups using funds provided by local, state, or federal government agencies, particularly the Office of Economic Opportunity. In the formal literature there is little discussion of these systems thus general information on their nature and importance in the general transportation picture is difficult to assess.[42] Generally, they operate on a much simplified DART model. The systems in the region examined in this study are discussed in Section IV of the year-end report.

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[38](See Footnote 12, p. 12).

[39]Zahora, Ann. "Cape May's Transportation Demonstration Project," in Cantilli, E. and J. Shmelzer (eds.), Transportation and Aging: Selected Issues. Washington: U. S. Government Printing Office, (1971).

[40](See Footnote 12, p. 12).

[41]RCC Corporation. An Integrated Transportation System to Serve Health and Social Service Needs. Troy, New York: RRC Corporation, (1972).

[42]A brief description of some of these programs, with particular emphasis on the aged and handicapped, is in Vickory (1973).

Specific Service Systems

Ambulances are the major example of transportation systems oriented specific services. Indeed, more than any other service, the literature has focused upon means to improve the efficiency of emergency medical services in rural areas (Baxter,[43] Wilson[44]). Research and experiments to evaluate the operational and economic feasibility of employing helicopters as emergency units indicate its potential prominent role in the future (Bierman and Powers,[45] Bartlett,[46] Jacobs and McLaughlin,[47] Turner,[48] Schamadan and Sears,[49] London[50]

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[43]Baxter, W. E. "An Economical Ambulance Service Plan for the Small Community," Hospitals, 43, (1969), 72-74.

[44]Wilson, Robert J. "Ambulance Service and Emergency Rooms: Single Unit Needed for Today's Care," Hospital Tribune, 4, (1970).

[45]Bierman, Leland and Mark Powers. "Ambulance Services in Northwest South Dakota," Bulletin 569, South Dakota University Press, (1970).

[46]Bartlett, Nole C. "Helicopter Ambulances: An Evaluation of Their Operational and Economic Feasibility," Traffic Digest and Review, 19, 20, (1971), 1-7.

[47]Jacobs, Arthur R. and Curtis P. McLaughlin. "Analyzing the Role of the Helicopter in Emergency Medical Care for a Community," Medical Care, 5, (1967), 343-350.

[48]Turner, H. S. and H. V. Ellingson. "Use of the Helicopter as an Emergency Vehicle in the Civilian Environment: Results of a Survey Questionnaire," Aerospace Medicine, 41, (1970), 135-138.

[49]Schamadan, J. L. and R. L. Sears. "An Air Medical Evacuation System for Highway Accident Victims," Arizona Medicine, 26, (1969), 131-135.

[50]London, P. S. "Helicopters in Civilian Medical Services," Journal of Trauma, 10, (1970), 906.

Simmerman,[51] Roberts, Bailey, and Vandermade,[52] Redick,[53] Lomonaco,[54] Foster,[55] Jenkins[56]). An experimental van-type ambulance with a life-support system and specially trained emergency crew has been operating at, as yet, a modest dificit in the rural community of Tulare, California (McClendon and Fikes[57]). Experiments with fixed-wing aircraft have thus far had limited success and incur excessive expenses (Vickens[58]). "Presently, air transportation of rural patients is still in the embryonic stage and factors such as lack of trained manpower, money and societal interest are serving to retard its growth" (Perry[59]).

Current interest in improving ambulance service has focused quite naturally on aiding emergency medical need victims. There is little evidence to suggest that the results of the research and experimentation in this area are being transferred to other essential service areas. Furthermore, the potential use

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[51]Simmerman, David. "If You Are Going to Get Hurt, Do It In Illinois," Today's Health, 50, (1971), 27-29.

[52]Roberts, S., C. Bailey, and J. R. Vandermade. "Medicopter: An Airborne Intensive Care Unit," Annual Surgery, (1970), 325-333.

[53]Redick, L. F. "Helicopter Transportation of the Ill and Injured," Journal of the Kentucky Medical Association, 69, (1971), 789-791.

[54]Lomonaco, T. "The Organization of Air Transport Services for Sick and Injured Persons, Particularly Road Accident Victims," Panminerva Medicine, 11, (1969), 343-346.

[55]Foster, J. T. "Helicopters Make Sense in Medical Care," Modern Hospital, 112, (1969), 78-82.

[56]Jenkins, E. R. "Helicopter Evacuation of Highway Injuries," General Practice, 38, (1968), 151-152.

[57](See Footnote 29, p. 35)

[58]Vickens, Allan. "The Royal Flying Doctor Service of Australia," World Medical Journal, (1963), 171-172.

[59](See Footnote 85, p. 26)

of modified ambulances to serve the transportation needs of other essential service requirements has not been examined and may represent a significant contribution toward fulfilling the transport needs of rural residents.

Summary

A major characteristic of existing research and experimentation has been its atomistic approach to problem solution. Systems have been developed for specific population subgroups (the poor, or the elderly, or the handicapped or the retarded), or for particular service types (health care, or emergency medical or education). Little evidence appears of interagency cooperation in the solution of transportation problems, but this remains a potentially beneficial approach for the future.

In terms of future system configurations for moving persons to facilities in rural areas, reliance is likely to remain on the automobile. A local public transit system serving the whole population is highly unlikely in the presence of low demand per unit area. Most likely is a local system (probably employing Dial-A-Ride concepts) which is oriented only toward those segments of the population unable to use the automobile. This can be used to transport people to their final destination or to an intercity bus or rail system which may form a second level in a transportation hierarchy. However, emphasis must remain on flexibility in choosing systems to meet the variety of local circumstances, a conclusion which clearly follows from Burkhardt's [60] work.

Mobile Units

Another approach to the provision of services which gives evidence of being an important element of the future rural delivery system, is through the use of mobile units. The concept of using motorized vehicles to deliver for instance, medical care to isolated and semi-isolated rural areas was put into operation in the United States some 50 years ago (Bodenheimer[61]). Mobile units have already been serving rural residents in Africa

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[60] Burkhardt , Jon E., Charles C. Eby, Donald Flynn, Armande M. Lago, Theodore K. Martin, A Study of the Transportation Problems of the Rural Poor, Vol. 1: Summary and Recommendations, RMC Report UR-171, Bethesda: RMC Research Corp., (1972).

[61] Bodenheimer, Thomas N. "Mobile Units: A Solution to the Rural Health Care Problem?" Medical Care, 7, (1965), 144-154.

(Bodenheimer[62]) and in recent years have been introduced to India (Duraiswami[63]) and England (Canvin[64]).

Mobile medical units in the United States generally have been designed for the provision of primary preventive care such as immunization and x-rays (Editorial (a),[65] Editorial (b),[66]). In recent years, however, units have become increasingly more specialized. Currently, units with highly sophisticated medical equipment and trained personnel are under demonstration in several rural areas (Perry[67]). The design and operation of mobile units such as mobile coronary units, mobile surgical units, mobile intensive care units, and others may have a significant impact upon the deliveries of health care to rural areas in the future (Struxness,[68] Adgey and Zaidi,[69]

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[62](See Footnote 61, p. 41).

[63]Duraiswami, P. K. "Multipurpose Role of Mobile Hospitals in Rural India," Journal of the Royal College of Surgeons of Edinburgh, 16, (1971), 185-187.

[64]Canvin, R. W. "Improving General Practice Facilities for Rural Patients--An Experimental Mobile Surgery," Royal Society of Health Journal, 92, (1972), 141-145.

[65]Editorial, (a) "A Mobile Health Clinic in Rural Oklahoma," Health Service and Mental Health Administration, 86, (1971), 1064.

[66]Editorial, (b) "Rural Health Care on Wheels," Southern Hospitals, (1971),p.22.

[67](See Footnote 85, p. 26).

[68]Struxness, E. B. "Mobile Emergency Care: Present Usage and Future Potential," Paper prepared for a Seminar in Tele-Medicine-Promise for 1980, Massachusetts Medical Society, Boston, Massachusetts.

[69]Adgey, A. A. and S. A. Zaidi. "Mobile Coronary Care Teams," British Medical Journal, 4, (1969), 427-428.

Barber,[70] Canvin,[71] Cooper,[72] Morrin,[73] Nagel,[74] Rosati, Granatelli, and Lustig[75]).

Mobile units have not been restricted to medical care, but are demonstrating their utility in improving the access to other essential services. Units equipped with a variety of diagnostic and evaluative services have been designed to deliver allied health care such as rehabilitation, mental health, and family planning services. Their practicality and usefulness have been demonstrated in both the urban and rural areas (Peterson,[76] Winborn and Martinson,[77] Cummings and Kutner,[78] Oklahoma Rehabilitation Service,[79]

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[70]Barber, J. M., et al. "Mobile Coronary Care," Lancet, 2, (1970), 133-134.

[71](See Footnote 64, p. 42)

[72]Cooper, J. K., K. Steel, and J. P. Christodoulou. "Mobile Coronary Care--A Controversial Innovation," New England Journal of Medicine, 281, (1969), 906-907.

[73]Morrin, H. C. "St. Mary's 'Clinic on Wheels' Rolls to Disadvantaged Areas," Hospital Topics, 46, 37-38.

[74]Nagel, E. L., J. C. Hirschman, S. R. Nussenfeld, et al., "Telemetry-Medical Command in Coronary and Other Mobile Emergency Care Systems," Journal of the American Medical Association, 214, (1970), 332-338.

[75]Rosati, M. C., A. Granatelli, G. J. Lustig, et al., "Community Hospital Mobile Coronary Care Unit," New York Journal of Medicine, 70, (1970), 2462-2465.

[76]Peterson, L. J. Migrant Labor Health Report: Final Report. Idaho and Oregon: Lower Snake Valley, RD 0033.

[77]Winborn, Bob B., et al., "Innovation in Guidance: A Mobile Counseling Center," The Personal and Guidance Journal, 45, (1967).

[78]Cummings, Victor and Bernard Kutner. "The Rehabmobile: A Mobile Rehabilitation Clinic in an Urban Ghetto Area," Archives of Physical Medicine and Rehabilitation, 54, (1973), 19-24.

[79]Oklahoma Rehabilitation Service. A Mobile Rehabilitation Evaluation Team in the State Rehabilitation Agency. SRS Project No. RO-775. Oklahoma City, Oklahoma: Oklahoma Rehabilitation Agency.

Held and Prystowsky,[80] Knauff,[81] Munson,[82]).

A third element of the total essential services delivery system which is certain to occupy an increasingly important role in the future is the utilization of communication facilities. The obvious saving is in the elimination of distance as travel becomes increasingly expensive, particularly for professional personnel and, at times, life savingly critical for the patient.

The use of the telephone for medical diagnosis and advice is already widely practiced, although the number of facilities that provide such a service in a systematic organized manner is relatively small (Strain and Miller,[83] Pope[84]). In southeastern Oklahoma, a teleconference network, linking nine rural hospitals, has proved to be an effective and relatively inexpensive system of physician consultation, patient referral, education updating, and other information gathering (Anonymous[85]). Somewhat similar systems are in operation in other parts of the country (Reese and Thornton[86]).

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[80]Held, B. and H. Prystowsky. "Research in the Delivery of Health Care: Changing Reproductive Trends," American Journal of Obstetrics and Gynecology, 109, (1971), 32-35.

[81]Knauff, Lynn K. "Family Planning in 19 Rural Counties," Family Planning Perspectives, 4, (1972), 13-21.

[82]Munson, Robert B. "New Mexico's Proposed Physician-Monitored Remote Areas Health Program," Proceedings of the Institute of Electrical and Electronics Engineering, 57, (1969), 1887-1893.

[83]Strain, J. W. and J. D. Miller. "The Preparation, Utilization, and Evaluation of a Registered Nurse Trained to Give Telephone Advice in a Private Pediatric Office," Pediatrics, 47, (1971), 1051-1055.

[84]Pope, C. R., et al. "Determinants of Medical Care Utilization: The Use of Telephone for Reporting Symptoms," Journal of Health and Social Behavior, 12, (1971), 155-162.

[85]Anonymous. "Communication Lines Tie Nine Rural Hospitals into Network," Modern Hospital, 118, (1972), 93-95.

[86]Reese, James and Zane Thornton. "A Description of the Vermont-New Hampshire Medical Interactive Network," Paper presented at the National Telemetry Conference, Washington, D. C., (1971).

More sophisticated communication systems are currently in use which employ both audio and visual transmission between physician-patient (Reese and Thornton,[87] physician-mobile unit and satellite (Council on Rural Health,[88] Bain and Goldthorpe,[89] McClendon and Fikes,[90] Phillips,[91] Struxness,[92] Florida Regional Medical Program,[93] and physicians-physicians (Groom,[94] Packard,[95] Anonymous[96]). The employment of these systems include such benefits as:

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[87]Reese, James and Zane Thornton, "A Description of the Vermont-New Hampshire Medical Interactive Network," Paper presented at the National Telemetry Conference, Washington, D.C. (1971).

[88]Council on Rural Health, Health Care Delivery in Rural Areas: Selected Models. Chicago: American Medical Association (1970).

[89]Bain, H. W. and Gary Goldthorpe, "The University of Toronto "Sioux Lookout Project'--A Model of Health Care Delivery," Journal of the Canadian Medical Association, 107, (1972), 523-528.

[90](See Footnote 29, p. 35).

[91](See Footnote 64, p. 21).

[92](See Footnote 6 , p. 42).

[93]Florida Regional Medical Program, Emergency Medical Services, (1972).

[94]Groom, Dale, "Regional Medical Programs and Medical Care in Rural Oklahoma," The Journal of the Oklahoma State Medical Association, 63, (1970), 165-167.

[95](See Footnote 73, p. 24).

[96](See Footnote 85, p. 44).

(a) the ability of patients at community hospitals to be seen by specialists working elsewhere,

(b) the capability of transmitting heartbeat, respiration, blood pressure, and other information from mobile units or satellite stations to regional health centers for diagnosis, and

(c) the ability to conduct teleconferences among physicians from multiple locations to alleviate, in part, the problem of professional isolation in remote areas.

Two major experiments in the application of communication technology to the deliveries of health care to rural areas are underway in New Mexico, and Ontario, Canada (Phillips,[97] Bain and Goldthorpe,[98]). Medical clinics and satellite nursing stations s ffed primarily with paramedical personnel, are providing primary medical care when regional medical centers are located at great distances. The health personnel are limited in the types of services they perform, but are in close telephone or radio contact with licensed practicing physicians at a central hopsital. Although still in the experimental stage, this combination of paramedical personnel and communication with a regional medical center constitutes a tremendous potential contribution to solving the health care needs of rural residents.

There is little evidence in the literature that any attempt has been made to develop the potential contributions of communication facilities to enhancing rural area residents' access to other services. However, the possibility does exist that rural area residents could be served, with some limitations, via a communication system. Mental health counselling could be provided by telephone, such as emergency counselling services that presently operate in urban areas. There is also evidence which demonstrates that rehabilitation services can be effectively administered in rural areas by

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97 (See Footnote 64, p. 21).

98 (See Footnote 89, p. 45).

non-professionals (Kelso[99]). The use of indigenous aides in Wyoming illustrated that rehabilitation services could be made accessible to a greater range of clients.

RELATED PROBLEMS

The major focus of this literature review has been on the role of transportation in increasing the accessibility of essential human services to rural residents. Clearly, there are additional factors which constrict the ability of rural residents to utilize these services (Horvath (b),[1] Katz and Felton,[2] Larson[3]). In order to provide a framework for discussion, these additional factors are presented here under the broad categories of social-psychological, economic, and administrative elements which separately or in combination further intervene to make essential services more or less accessible to rural residents. No attempt has been made to thoroughly discuss all aspects of the above elements. Rather, they are viewed as intrinsic elements of a framework within which the transportation aspects of the problem must be viewed.

A distinction must be made here between accessibility, acceptability, and availability. Transportation, or lack of it, affects the accessibility of essential services. The availability of essential services are affected by agency funding and policy-making decisions. In order to make essential

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[99]Kelso, Robert, "The Wyoming Aide Project: Final Report," Wyoming Division of Vocational Rehabilitation. U.S. Department of Health, Education and Welfare Grant RD 1630-g, (1969).

[1]Horvath, William J. (b), "Organization and Management Problems in the Delivery of Medical Care," Management Science, 14, (1968), 275-279.

[2]Katz, Alfred H. and Jean Spencer Felton (eds.), Health and the Community: Readings in the Philosophy and Science of Public Health. New York: Crowell, Collier and MacMillan, Inc. (1965).

[3]Larson, Olar F., "Income and Welfare of Rural People--Agricultural Research Significant to Public Policy, Public Welfare, and Community Improvement," Rural Sociology, 30, (1965), 452-461.

services more acceptable to rural residents, the social and psychological attributes of rural residents must be taken into consideration. In addition, the system of providing essential services must be accommodated within the established network of rural government, whether informal or formal in organization, if the system is to be at all effective.

SOCIAL -PSYCHOLOGICAL

Agencies providing services to rural areas must take into account the social and psychological attributes of rural residents if they wish to provide services that are acceptable to their clients. Differences in the acceptance and utilization of health care facilities on the basis of social characteristics of the population have already been verified (Shannon, Bashshur, and Metzner,[4] Abernathy and Schrems[5]). In planning for the provision of new facilities, including improvements in accessibility through better transportation systems, the social differences must be interpreted relative to the acceptance and utilization of the services. Methods for assessing the impact of the differences as they apply to estimating existing needs and demands as well as prodicting the relationship in the future are essential (Swedner,[6] Horvath (b)[7]).

Some progress has already been accomplished in interpreting the differences in social characteristics as they relate to various services. It has been suggested, for example, that service provision systems which operate successfully in an urban area may not be successful in rural regions. Because many rural area residents are oriented toward primary groups

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[4] (See Footnote 10, p. 30)

[5] (See Footnote 6, p. 29).

[6] (See Footnote 93, p. 28).

[7] (See Footnote 1, p. 47).

(Kraenzel[8]), services which are offered from large impersonal institutions will problably not be readily accepted. Ginsberg[9] cautions that any service or program that is to succeed in a rural area may have to function as a primary institution.

Strong feelings of independence and resistance to outside influences are often attributes which characterize residents of rural areas and render them less likely to accept some essential services (Neiderfrank[10] Talkington,[11] Flack,[12] Rogers and Beal,[13] Reid[14]). Ginsberg[15] and Talkington[16] cite the significance of supporting and enhancing the prevailing patterns of established services in rural communities and the importance of channelling the effects through the rural community leaders when working to provide services.

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[8]Kraenzel, Carl F., "The Place of Public Services Including those for Mental Illness in Sparsely Populated Areas," in Development of Mental Health Services in Sparsely Populated Areas. Chevy Chase, Maryland: National Institute of Mental Health (1968).

[9]Ginsberg, Leon, "Rural Social Work," Encyclopedia of Social Work, 2, (1970), 1138-1144.

[10]Neiderfrank, E.J., Developing Programs for the Rural Handicapped, Agriculture Extension Service. Washington, D.C.: U.S. Department of Agriculture, (1970).

[11]Talkington, Larry W., "Outreach: Delivery of Services to Rural Communities," Mental Retardation, (1971), 27-29.

[12]Flack, Hans S., "Integrating the Rural Welfare Department into the Community," in Morton, Melvin (ed.), Can Public Welfare Keep Pace? New York: Columbia University Press, (1969), 134-150.

[13]Rogers, Everett M. and George M. Beal, "The Importance of Personal Influence in the Adoption of Technological Changes," Social Forces, 36, (1958), 329-335.

[14]Reid, Howard, "Rehabilitating the Culturally Disadvantaged in a Rural Setting--A Psychiatric Approach," in George Ayers (ed.), Rehabilitating the Culturally Disadvantaged. Mankato, Minnesota: Mankato State College, (1967).

[15](See Footnote 9, p. 49).

[16](See Footnote 11, p.49).

ECONOMIC

The economic aspects of accessibility to services can be approached by distinguishing between two facets of the problem: (1) the financial situation of the clients, and (2) the financial situation of the service agency. Considerable attention has been focused on the magnitude of the incidence of poverty in rural areas (see Burg[17] and Institute for Rural America[18] for bibliographies on the topic); and a relationship between poverty and a need for essential services is known to exist (Saltzman (b),[19] Bray,[20] Cobb,[21] Leveson, Ullmon and Wassall,[22] Strauss[23]). As indicated in the TRANSPORTATION section numerous experimental delivery systems that acknowledge, at least implicitly, that poverty creates a significant need for transportation assistance are being implemented in various rural areas. But a general solution to coping with the problem of poverty relative to accessibility is not yet available for application to all rural areas.

On the other side of the economic problem the service agencies are restricted by the size of their annual budgets. Working within the limits of their financial allocations, agencies must locate their facilities and administer their services in a manner such that maximum benefit can be derived.

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[17]Burg, Nan C., Rural Poverty and Rural Housing: A Bibliography. Monticello, Illinois: Council of Planning Librarians Exchange Bibliography No. 247, (1971).

[18]Institute for Rural America, Poverty, Rural Poverty and Minority Groups Living in Rural Poverty: An Annotated Bibliography. Lexington, Kentucky: Spindletop Research Association, (1969).

[19](See Footnote 77, p. 25).

[20]Bray, Howard, "The Costs of Malnutrition," Appalachia, 2, (1969), 1-7.

[21]Cobb, Charles N., "Community Mental Health Services and the Lower Socio-Economic Classes: A Summary of Research Literature on Out-Patient Treatment (1963-1969)," American Journal of Orthopsychiatry, 42, (1972), 404-414.

[22]Leveson, Irving, Doris Ullmon, and Gregory Wassall, "Effects of Health on Education and Productivity," Inquiry, 6, (1969), 3-11.

[23]Strauss, Marvin, "Health Care Planning," Hospitals, 43, (1969), 105-107.

Giving concrete definition to the nebulous area of maximum benefit and then determining the optimum locations and the service policies to implement, while working within the constraints of a budget, is a monumental endeavor requiring continuous updating (Long and Feldstein[24]). It has been strongly suggested earlier in this paper that the location of existing facilities and delivery systems are not optimum with respect to fulfilling the accessibility needs of rural residents. The extent to which the responsibility lies with the funding limitations of the various agencies or the levels of efficiency of operation needs to be determined. Feldstein[25] provides a basic literature source for analyzing efficiency from an economic point of view.

At the local, rural level shortages of agency funding are felt in a very practical sense. Lack of sufficient financing results in a shortage of trained professional personnel to deliver essential services. Those agencies that may be providing an essential service are often limited by inadequate supportive service networks (Hulek,[26] Stern, et al.,[27] Bitter,[28] National Citizen Advisory Committee,[29] Fowler[30]). Rehabilitation, mental health, and welfare services, particularly, require a network of related and supportive

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[24](See Footnote 5, p. 29).

[25]Feldstein, Martin S. Economic Analysis for Health Service Efficiency. Amsterdam: North-Holland Publishing Co., (1967).

[26]Hulek, Aleksander. "Vocational Rehabilitation of the Disabled Resident in Rural Areas," Rehabilitation Literature, 30, (1969).

[27]Stern, Walter, et al. "Helping All the Handicapped: State Planning and Vocational Rehabilitation," Rehabilitation Literature, 31, (1970).

[28]Bitter, James A. "Some Viable Service Delivery Approaches in Rural Rehabilitation," Rehabilitation Literature, 33, (1972), 354-358.

[29]National Citizens Advisory Committee on Vocational Rehabilitation. A Report to the Secretary of Health, Education and Welfare, (1968).

[30]Fowler, Irving. The Northern New York Rural Rehabilitation Survey Report. U. S. Office of Vocational Rehabilitation. Washington: Government Printing Office.

services such as medical, employment, vocational education, and physical therapy in order to be most effective. Communities with an inadequate tax base cannot support such a system and funds for state agencies are all too frequently channelled, to the detriment of rural communities, into urban areas, where the vast majority of users reside. Clearly, the existing limitations on agency funds account for some of the shortages in professional manpower required to supply a high level of service to rural areas. Blendon[31] has cited the need to finance innovative health care programs in poverty areas. For example, the use of paraprofessionals in such fields as medical care, rehabilitation, and mental health has been demonstrated to be one way of reducing the problem of manpower shortage and large salaries (Knauff,[32] Kelso[33]).

Increases in agency finances with minor reorganization could implement some very simplistic changes which would make rural services more available. One change may be to simply establish more convenient hours of operations. If services could be offered during traditional off-work hours, evenings and week-ends, families with a single automobile, which is used during the daytime hours by the breadwinner, would have a greater opportunity to take advantage of service (Knauff,[34] Nitzberg[35]).

The financial limitations at both the individual and the agency levels create barriers to the accessibility of services that must be overcome if adequate service levels are to be attained. The problems are more complex than may be suggested by the brief treatment they have received here. However, it appears that a more efficient use of existing financial resources

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[31]Blendon, R. J. "The Age of Discontinuity: The Financing of Innovative Health Care Programs in Poverty Areas," Johns Hopkins Medical Journal, 128, (1971), 24-29.

[32](See Footnote 81, p. 44).

[33](See Footnote 99, p. 47).

[34](See Footnote 81, p. 44).

[35]Nitzberg, Harold. "Casework Emphasis in a Rural Part-Time Clinic," Social Casework, 42, (1961), 170-175.

at both levels, when considered with other factors, will work toward reducing the rural accessibility problem.

ADMINISTRATIVE

It is not the purpose here to discuss the complexities of the organization and management of essential service agencies. One aspect, however, which has received only token attention as a means to improve the provision of essential services, is concerned with interagency coordinated administration of the several services. While many valuable studies have been directed toward individual agency organization and the delivery of services (Blum,[36] Horvath (b),[37] Revans[38]), few substantial studies have been completed on interagency coordination and its potential (for two exceptions see Baker and O'Brien,[39] and Klonglan and Paulson[40]). With the use of modern analytical techniques such as systems analysis and operations research the investigator is amply provided with the problem-solving tools. Thus far, however, there appears to be little support for interagency cooperation among top level administrators of the various agencies.

No doubt, the administration of the various essential service agencies is a much more complex element of the total essential services system than is suggested here. The central theme of this overview, however, has been the

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[36]Blum, H. L. "Research into the Organization of Community Health Service Agencies: An Administrator's Review," Milbank Memorial Fund Quarterly, 44, (1966), 52-93.

[37](See Footnote 1, p. 47).

[38]Revans, R. W. "Research into Hospital Management and Organization," Milbank Memorial Fund Quarterly, 44, (1966), 207-248.

[39]Baker, F. and G. O'Brien. "Intersystems Relations and Coordination of Human Service Organizations," American Journal of Public Health, 61, (1971), 130-137.

[40]Klonglan, G. E. and S. K. Paulson. "Interorganizational Coordination as a Policy for the Delivery of Health Services in Nonmetropolitan Areas," Paper presented at the annual meetings of Rural Sociological Society, Denver, Colorado, (1971).

role of transportation in improving accessibility to rural residents. The administrative aspects, just as the economic and social-psychological aspects, of the accessibility problem must be recognized in their roles as partial determinants of the type of delivery system that may be best for rural areas.

SUMMARY AND CONCLUSIONS

This paper represents an overview of the literature that has appeared in the last decade concerning the accessibility of essential services in rural areas. Its focus has been oriented toward the problems associated with excessive distance between clients and services and the role of transportation in alleviating these problems. The literature has been reviewed in respect to four broad and interrelated topics: demand for essential services, supply systems, transportations systems, and related problems of accessibility and utilization that are not the direct result of inadequate transportation facilities. The purpose of the review has been to identify and evaluate the literature and data sources available to the researcher, to identify and evaluate the literature on those aspects of the accessibility problem that have been receiving the major focus of attention, and to identify some of the neglected avenues of research that indicate a potential contribution to alleviating the problems.

Information Sources

By far the largest literature source on medical and allied research consists of the numerous articles published in the professional journals representing the various essential services. Of these, journals related to the medical profession are more numerous than the total of the other professionals combined. As can be expected with a large number of journals there is a considerable range in the content and quality of the work. Articles range from mere descriptive reports of rural health problems to the application of sophisticated analytical tools for problem solving purposes.

Publications of government sponsored projects and national agencies exhibit a consistently high level of quality research. Characteristically, a problem solving approach is utilized incorporating in-depth research and the application of contemporary analytical tools. Unfortunately these publications generally focus on specific topics of which only a limited number are directly relevant

to the topic considered here. Nonetheless, this information source constitutes a systematic and growing body of knowledge from which to borrow and extend tested concepts and analytical techniques. In addition, government agencies are a major source of systematically gathered and prepared data.

Professional journals of the transportation sciences provide sources of information on most aspects of transportation. Models presented in these journals provide a basis from which to design models specifically appropriate to improving overall accessibility to essential services for rural residents. Other relevant research foci of the transportation journals include technical and engineering aspects of transportation hardware, economic analysis of specific transportation systems, and logistics and efficiency of multi-modal accessibility systems.

Because of the many aspects associated with the problem of improving access for rural residents, numerous pertinent sources were discovered in the professional journals of various academic disciplines. The relevant articles generally occurred in an unsystematic fashion as rural areas, essential services, or transportation systems did not constitute the journals' major research focus. In the geographical journals, for example, the aspects of location analysis and the concept of dispersion are treated relatively frequently and constitute a significant contribution to this research effort. The number of direct applications of these concepts to solving essential service delivery problems, however, is small and requires exhaustive searching efforts to locate them. Likewise, journals in the sociology and operations research disciplines have their obvious contributions to make; although, again, locating the relevant articles requires a considerable amount of time and effort.

Existing Research Foci

As a result of the numerous and widespread sources of information on transportation, essential services, and rural areas, nearly all aspects of access to essential services in rural areas have received some attention. The quantity and depth of the research varies considerable, however, depending upon the aspect under investigation. A major focus on the research was on the identification of the problems of obtaining access to essential services in rural areas. Characteristically, although with numerous exceptions, barriers

such as isolation, poverty, and social inhibitions would be identified and explained with more emphasis on the problems than on the potential solutions. Similarly, the problem of a trained manpower shortage in rural areas was a major topic of research. Again the problem has been clearly identified and explained. As of yet, however, the relatively few strategies suggested for solving the problem have had only limited success.

A second focus of considerable research and publication effort, particularly in the last several years, was the documentations of a multitude of experimental accessibility systems. Delivery models ranging in magnitude and sophistication from complex communication networks to local volunteer transportation services were discussed. The vast majority of reports concentrated on the far more numerous small, local, single-agency experiments which exhibited varying degrees of success. The full utility of these models and their potential as elements of a comprehensive accessibility system remain, as yet, unknown.

Methods to improve emergency health services is a third area which has received considerable attention as a research and experiment effort. Through this effort significant progress in the level of services has been achieved by employing technological improvements, previously trained human resources, and innovative uses of already existing equipment such as helicopters and vans.

Potential Research Contributions

In spite of the existing and growing body of literature on access to essential services there are still some critical aspects of the topic that are practically untouched from a research and planning point of view. Three of these areas which are in need of attention are cited here. The first, though not necessarily in importance, is the development of a general model to assess the levels of the various types of demand for essential services discussed earlier in the DEMAND section--satisfied, latent, and induced. The model should be specifically designed for rural area service requirements and should possess the quality of being universally applicable with necessary modification. As a beginning, a model for the prediction of the several demands as they relate to the various individual services should be designed.

Second, and related to the first, is the development of a general model of optimum delivery capability that could be applied to any specific rural area. The model should incorporate the various modes of transportation and

accommodate as many of the essential services as is feasible. To begin, a model should be developed for a single service which has the capability of being applied to other essential services.

A third area, which has been severely neglected in the literature, would be concerned with research into the feasibility of obtaining interagency coordination and cooperation in the production and delivery of services. Such research could consider the potential benefits resulting from implementing concepts such as sharing delivery equipment, employing and training personnel for multi-agency services, and consolidating a combined demand for essential services that may make delivery to rural areas economically feasible as well as creating other potential external economies.

Some other areas of needed research include such topics as obtaining a more efficient use of existing supply systems, the development of new systems of supply, such as through the use of para-medical personnel and communications technology and the development of systems for diffusing information on essential services. A call for research on these topics should not suggest that no work is being done. There is no doubt, as illustrated in a review of the literature, that an effort is being made to improve delivery systems of essential services. Yet, for the residents of rural areas there is still a considerable distance to go.

III. THE STUDY REGION

This section describes the existing essential service system in the Capital Area Planning Council Region (Figure 2). A description of the region in general is followed by a discussion and analysis of existing transportation facilities. Recognizing the critical role of communications, both at the present and, more particularly, in the future, present and proposed communication facilities are then described. Facilities providing essential services are then examined and the section concludes with a discussion of existing facilities providing essential services.

THE REGIONAL SETTING

Physical Setting

Climate. For the major part of the year the climate is dominated by warm, moist southeasterly winds from the Gulf of Mexico. Annual rainfall decreases with increasing distance from the Gulf, ranging from 36.52 inches in the southeast (Fayette County) to 27.59 inches in the northwest (Llano County). During the winter northerly winds penetrate far enough southward to bring occasional snow and freezing temperatures; however, winter travel is seldom a problem.

Landscape. Geologically, the region is almost evenly divided by a fault zone (Balcones Fault) oriented in a north/south direction. The topography of the eastern half of the region consists of plains grading into rolling hills at the eastern boundary. The western half is characterized by steep hills, ravines, and rough surface terrain.

The region is bisected laterally by the Colorado River, which flows from the northwest to the southeast. Along its course a string of large artificial lakes have been created which are a major recreation resource of the region, and have encouraged the development of retirement and second-home communities in Llano and Burnet Counties.

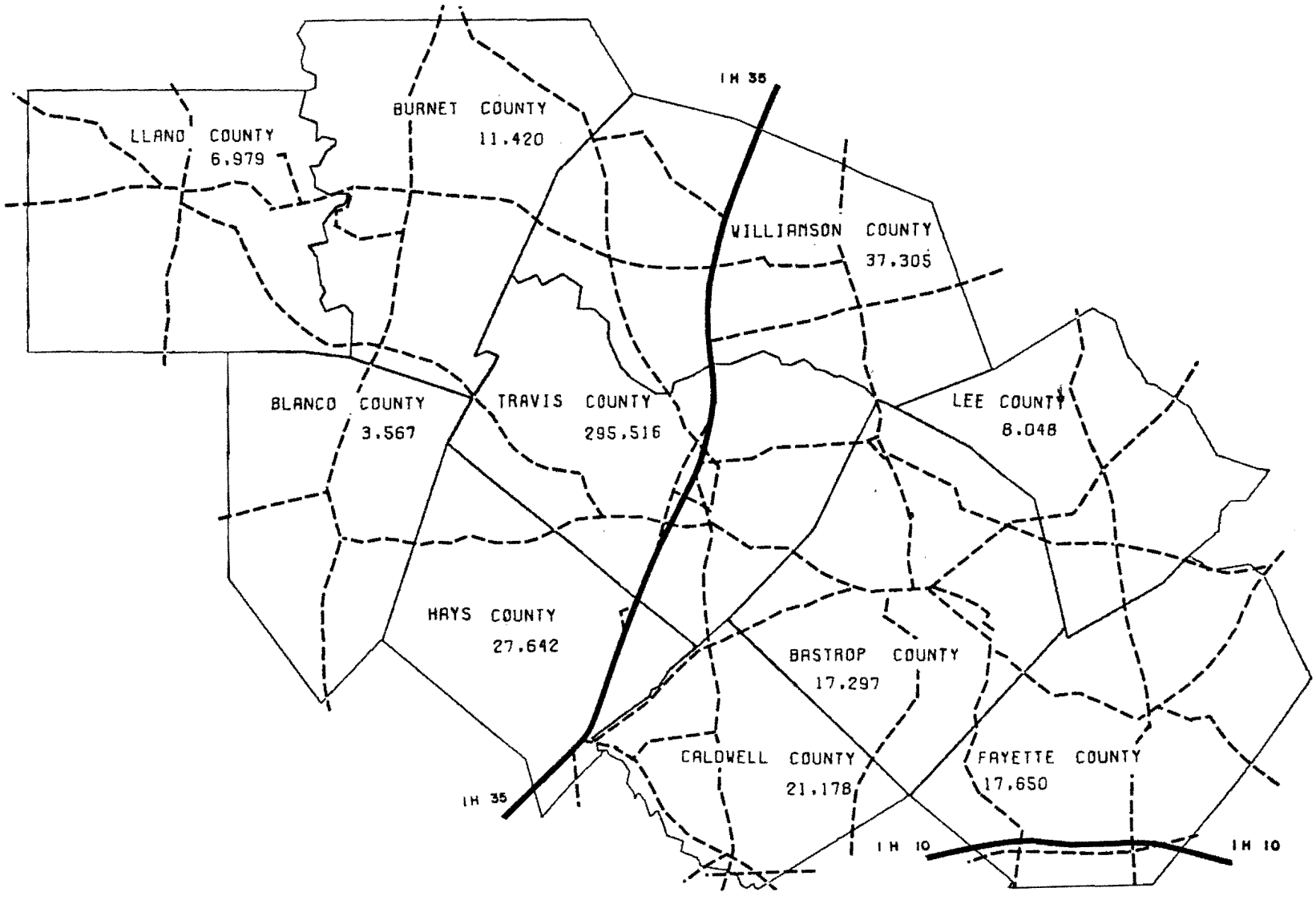

Figure 2. General CAPCO County Map

The Road Net. The region's highway system consists of interstate highways, state highways, farm-to-market roads, and county roads with Austin representing a focal point of the network. The major interregional highway, Interstate Highway 35, parallels the Balcones Fault and connects Austin, the region's central city, to the Dallas-Fort Worth and San Antonio regions. The eastern half of the CAPCO Region has a well developed hard surface road system and there are few locations that are inaccessible by such routes. The western section of the region, where the terrain is more rugged, has only a few widely spaced roads. Furthermore, the river and lakes bisecting the area present an additional barrier to north-south travel.

Population

Distribution. Total population of the CAPCO Region is approximately 450,000 but the distribution is heavily concentrated in the region's center (Figure 3). The three central counties, Williamson, Travis, and Hays, contain 71 per cent of the population, with Travis County alone accounting for 61 per cent of the region's total. The three western counties, Blanco, Burnet, and Llano, together, contain less than 5 per cent of the region's total. Bastrop, Caldwell, Lee and Fayette Counties, on the east, contain the remaining 24 per cent of the region's population.

Growth. The central counties of Travis and Hays have been experiencing steady population growth over the past four decades. In that same time period, all other counties were either losing population or remaining generally static, except for an upswing in some counties in the 1960-1970 decade. These counties were either those immediately adjacent to the continuously growing central counties (such as Williamson, Bastrop and Caldwell), or associated with recreational and retirement developments along the Colorado Lake system (Burnet and Llano Counties). The isolated counties of Blanco, Fayette and Lee have experienced a generally continuous population decline since the beginning of the century.

Density. Differences in the population densities among the CAPCO counties illustrate the rural/urban character of the region (Figure 4). The region's mean density of 52.67 people per square mile obscures existing dichotomy where nine of the ten counties have densities ranging from 4.96 to 41.26 people per

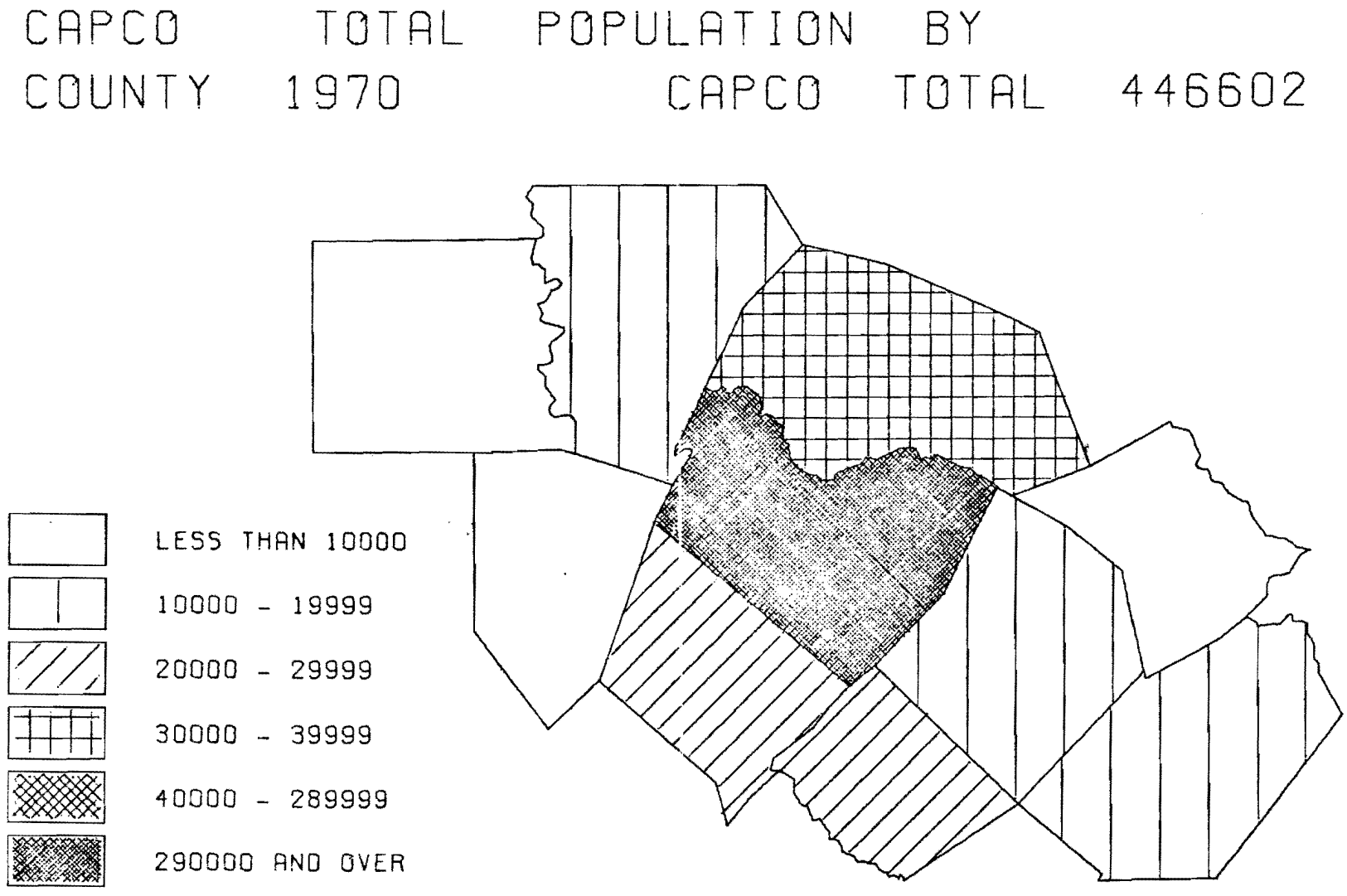

Figure 3. CAPCO Total Population

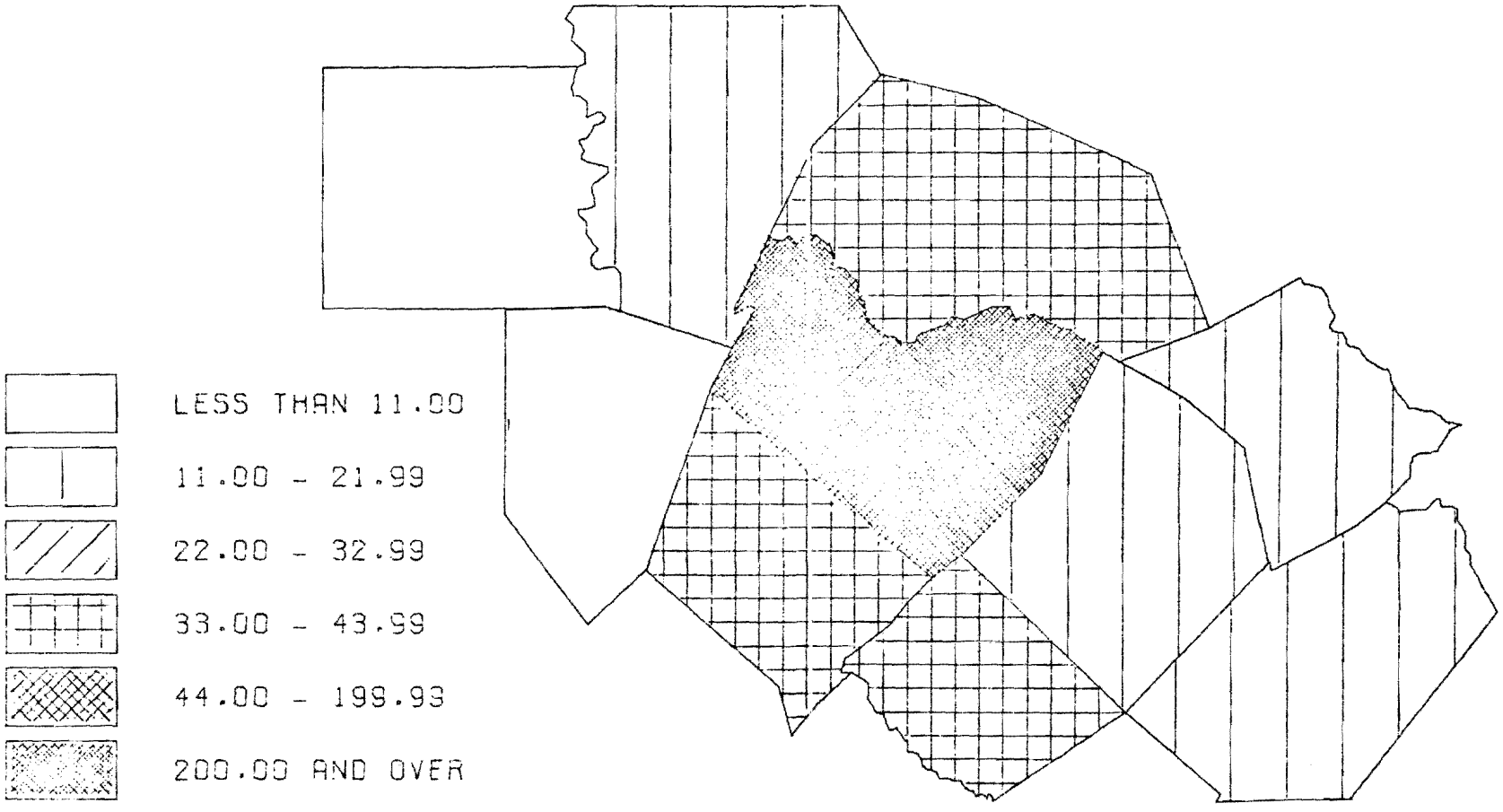

Figure 4. CAPCO Population Density

square mile, and one county, Travis, has a density of 291.15 people per square mile. Also, within Travis County, where more than 85 per cent of its population is concentrated in Austin, rural areas are easily distinguished from urban.

Urban. Approximately 75 per cent of the CAPCO region's population resides in cities of 2,500 or more people. The range among counties extends from 89.5 per cent of the population in Travis County, where Austin dominates the population distribution, to 0 per cent in Blanco County, where no cities of 2,500 or more population exist (Figure 5, 6).

Austin, the central city of the region, represents the largest single population concentration with 251,808 residents. The second largest city is San Marcos, in Hays County, with a population of 18,860 residents. Fourteen other small cities, ranging from 9.616 residents in Taylor (Williamson County) to 2,783 residents in Giddings (Lee County), are dispersed throughout the region. Numerous other incorporated or unincorporated communities of less than 2,500 population are also located within the region. The distribution of cities and small counties strongly favors the plans and rolling hills to the east of the Balcones Fault over the rugged, less accessible areas to the west.

Racial Composition. The three western counties, Blanco, Burnet, and Llano, house predominantly Anglo populations (Figure 7). None has more than 400 Blacks or Spanish surname residents, except for Burnet County with 938 Spanish surname residents (8.2 per cent of the population). Higher proportions of Black populations (26.2 per cent, 21.3 per cent, and 21.1 per cent respectively are found in the eastern counties of Bastrop, Caldwell, and Lee Counties, and Spanish surname population in Caldwell and Hays (32 per cent and 38 per cent respectively).

Age Structure. The age structures vary greatly among the counties of the region. The central counties, paralleling Interstate Highway 35, have noticeably younger populations than the eastern and western counties (Figure 8). These younger populations are located in counties that have been experiencing sustained, or recent, population growth. These counties are characterized by favorable accessibility, educational, and employment opportunities

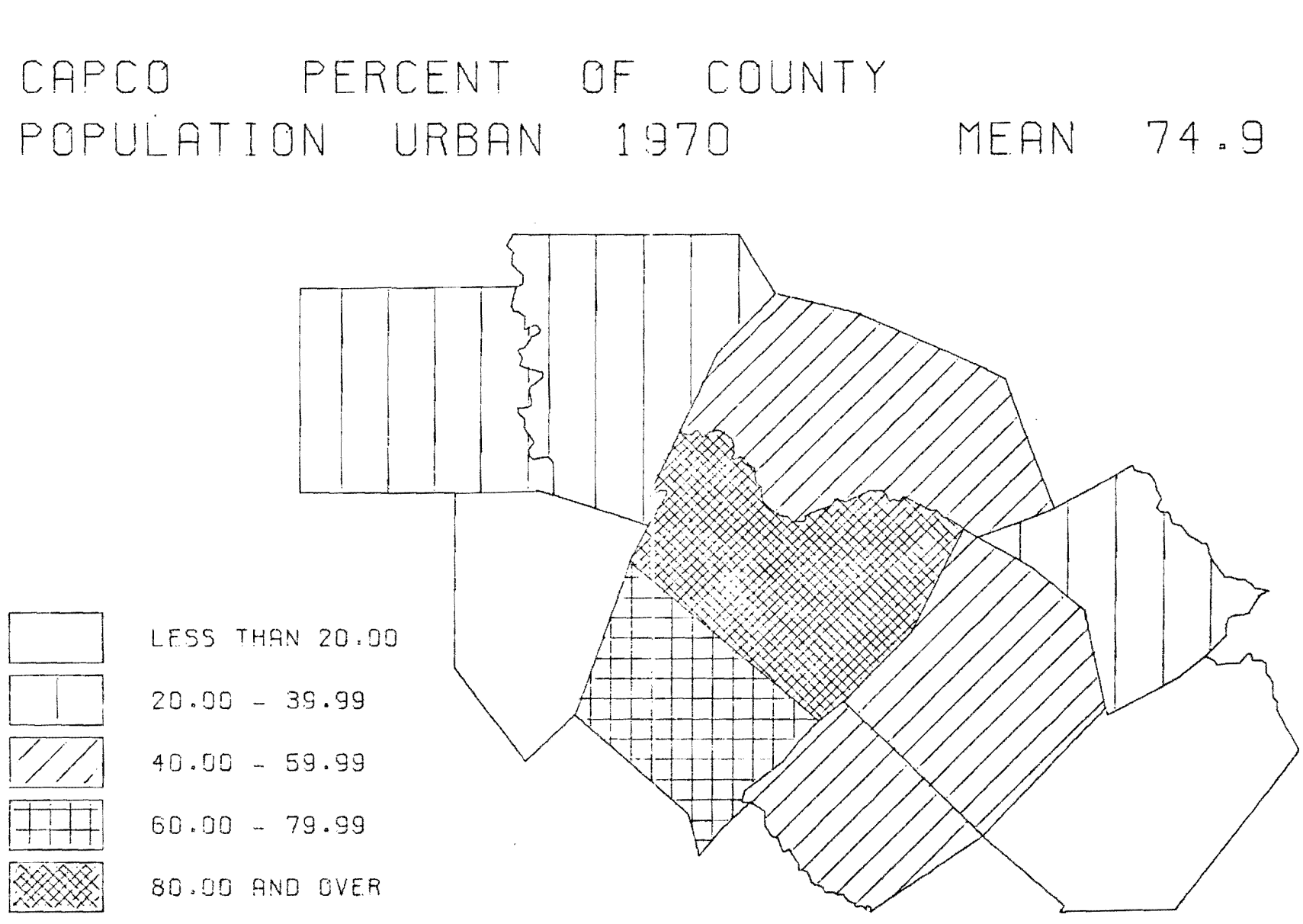

Figure 5. Percent of County Population Urban

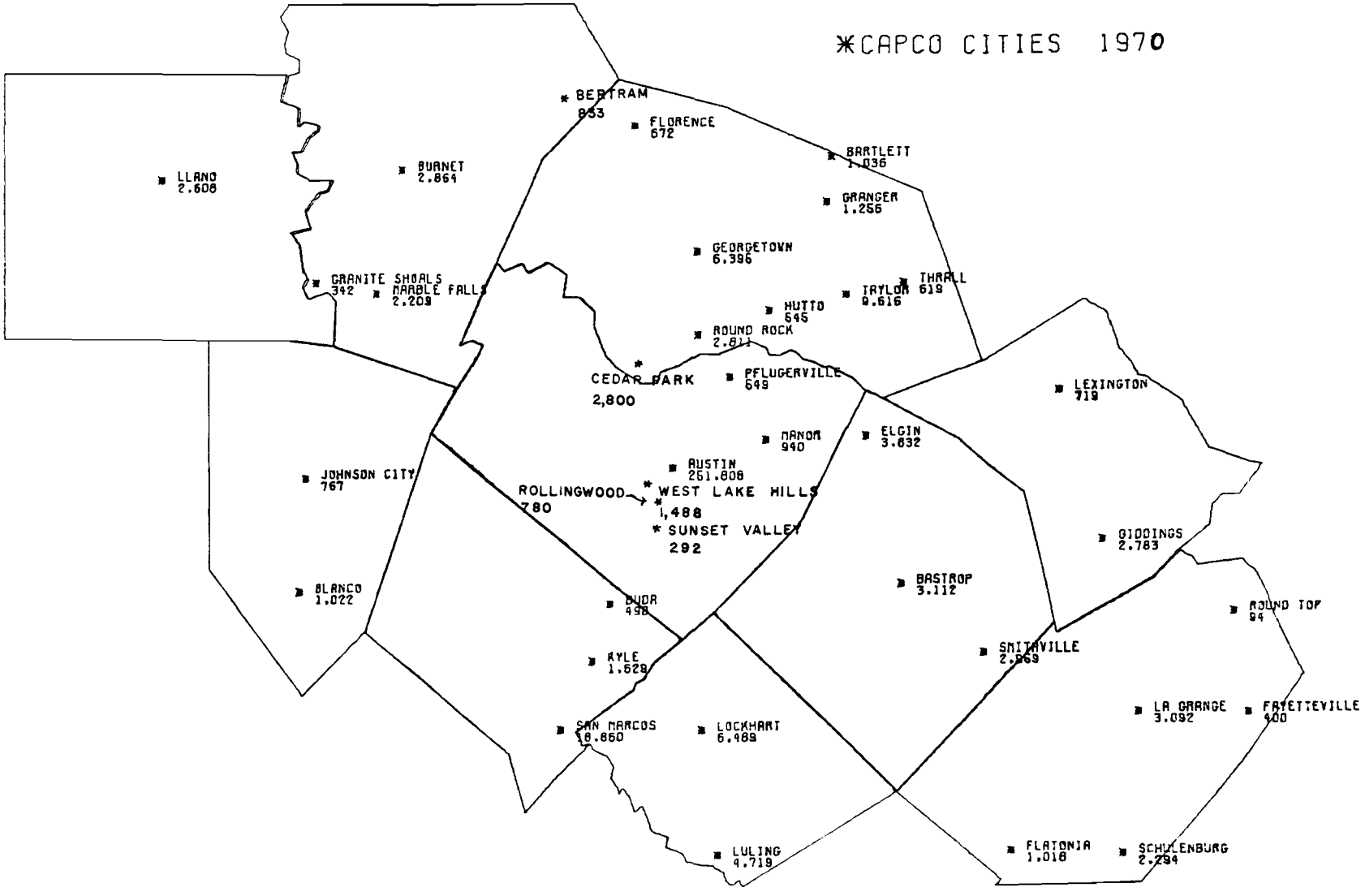

Figure 6. Cities in CAPCO

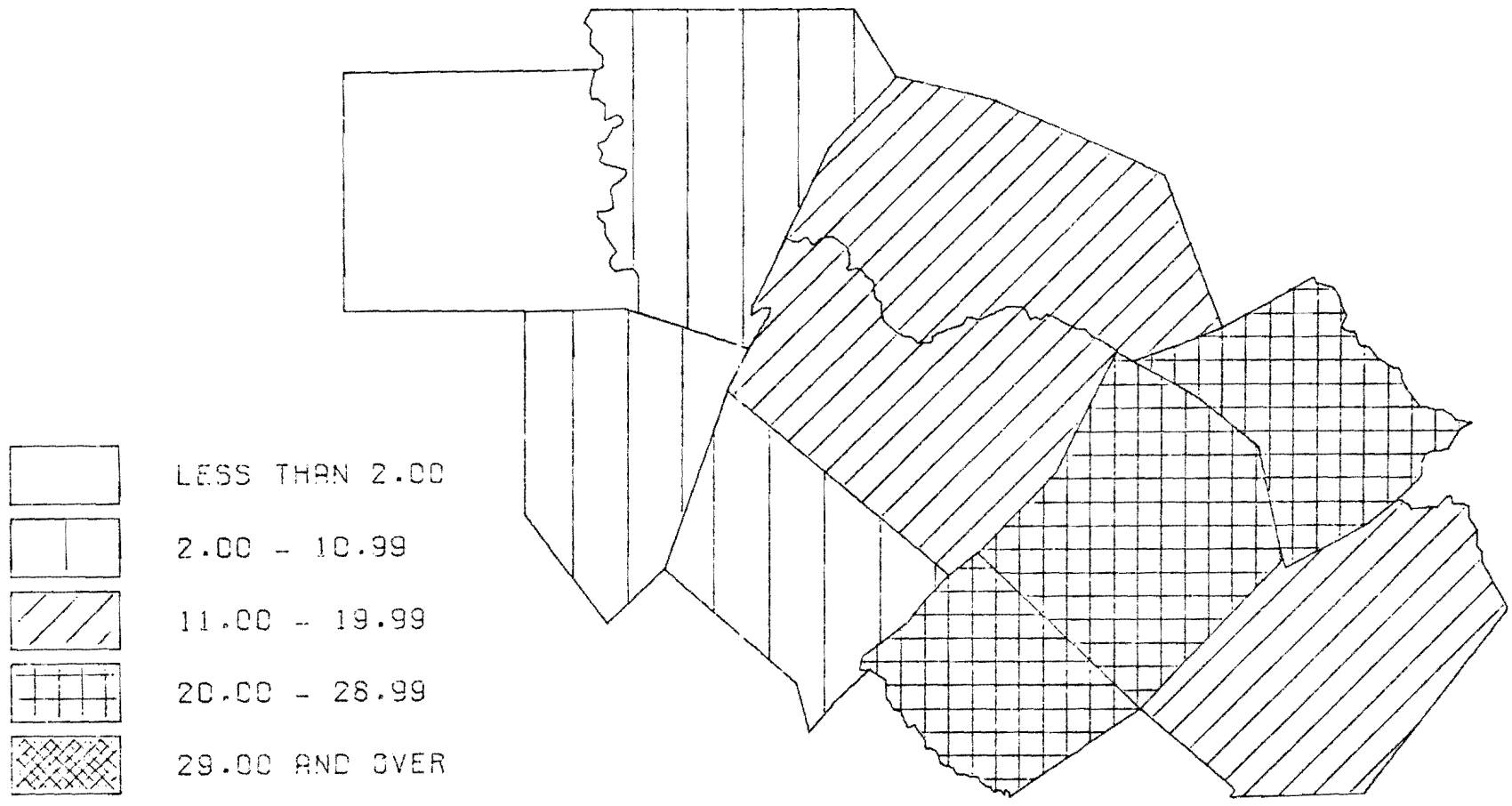

Figure 7. Percent of Population Black, 1970

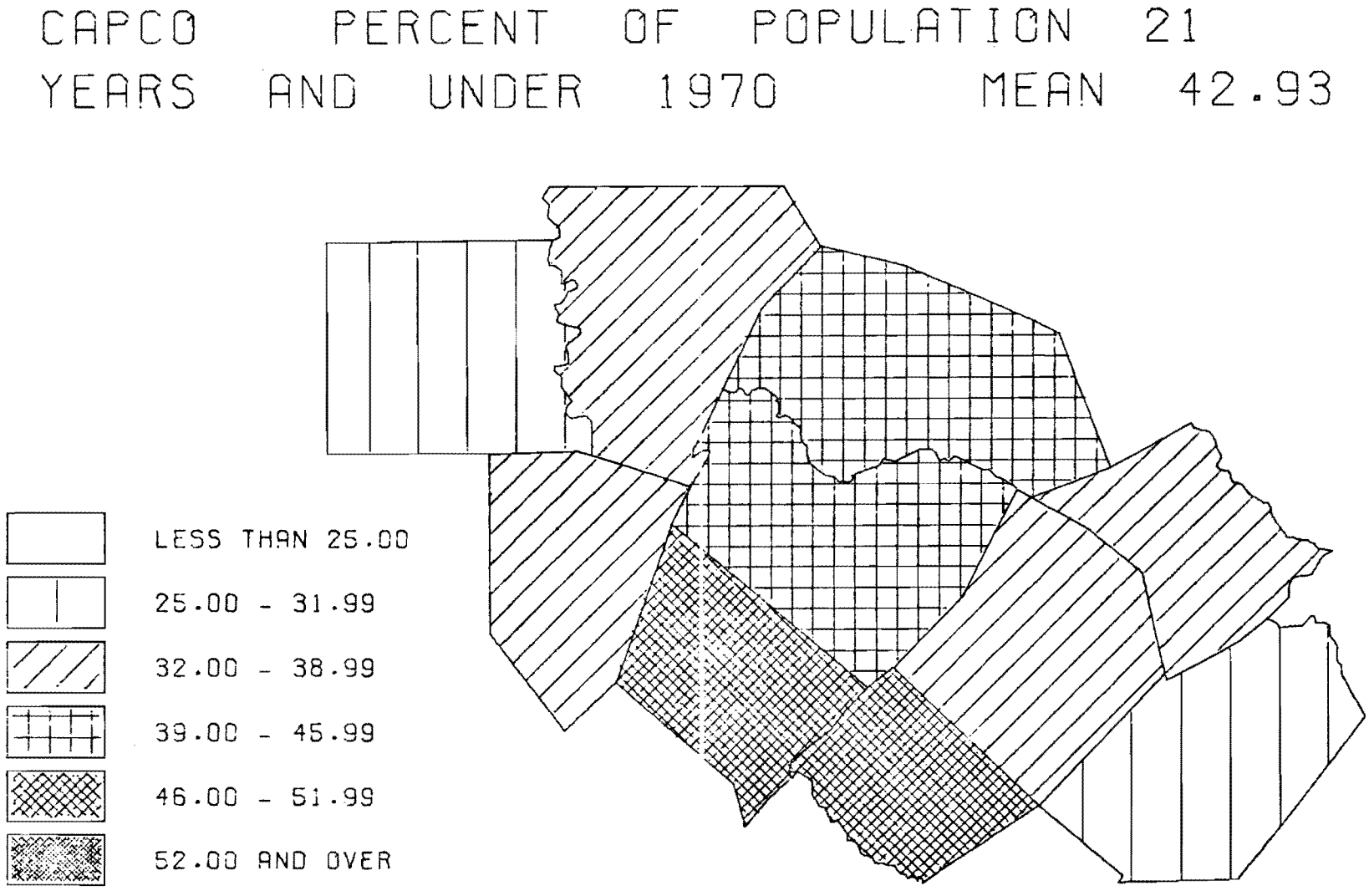

Figure 8. Percent of Population 21 Years and Under

associated with Interstate Highway 35. The older populations are found in the peripheral counties that have established trends of population decline.

Income

The median family income for Travis County is more than 20 per cent higher than for any of the other CAPCO counties (Figure 9). In addition, less than 15 per cent of families are below poverty level (Figure 10). In the sparsely populated rural counties of Llano, Lee, Bastrop, Caldwell, and Fayette, where median family incomes are below $6,000, over 25 per cent of the families are below poverty level (Figure 10). Welfare receipts also reflect the poverty areas with 6 per cent to 12 per cent of the populations in the five eastern counties receiving benefits, as compared to less than 6 per cent in the five western counties (Figure 11). Differences in the patterns of poverty as against welfare recipients are, however, apparent.

Economic Activity

Except for the central city, Austin, the region's economy is dominated by agriculture (Figure 12). The major economic activity in the hill country to the west of the Balcones Fault is low intensity ranching and farming, which is limited by the rugged terrain and dry climate. Tourism, stone processing, and hunting leases provide additional income to this area. Ranching and crop farming are also the major economic activity for the eastern half of the region, but a more favorable climate and terrain facilitate a more intensive level of farming than in the west. The Austin economy is dominated by government employment (40 per cent) with the remaining activities distributed among retailing, services, and light, high technology, manufacturing.

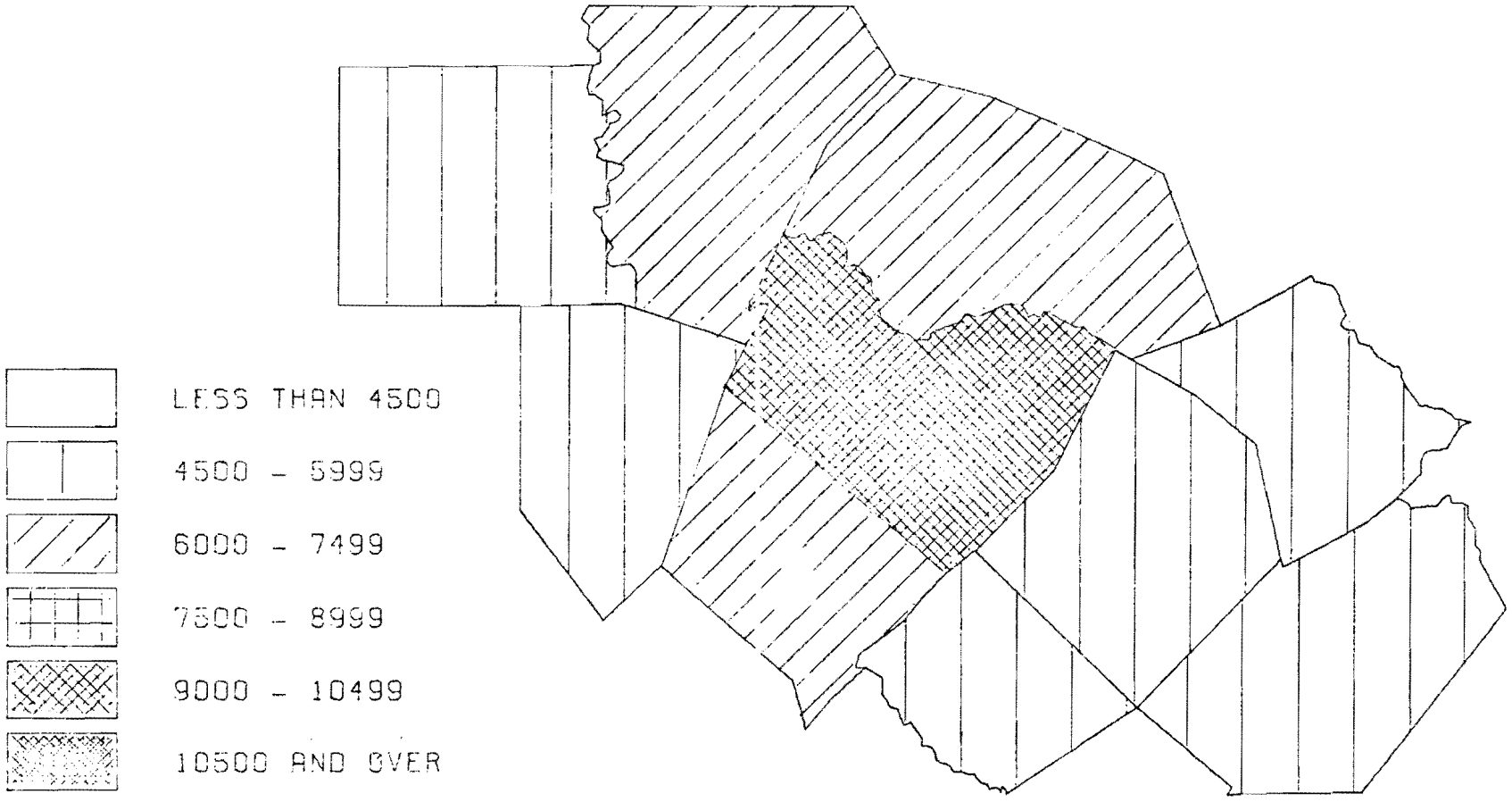

Figure 9. Median Family Income, 1970

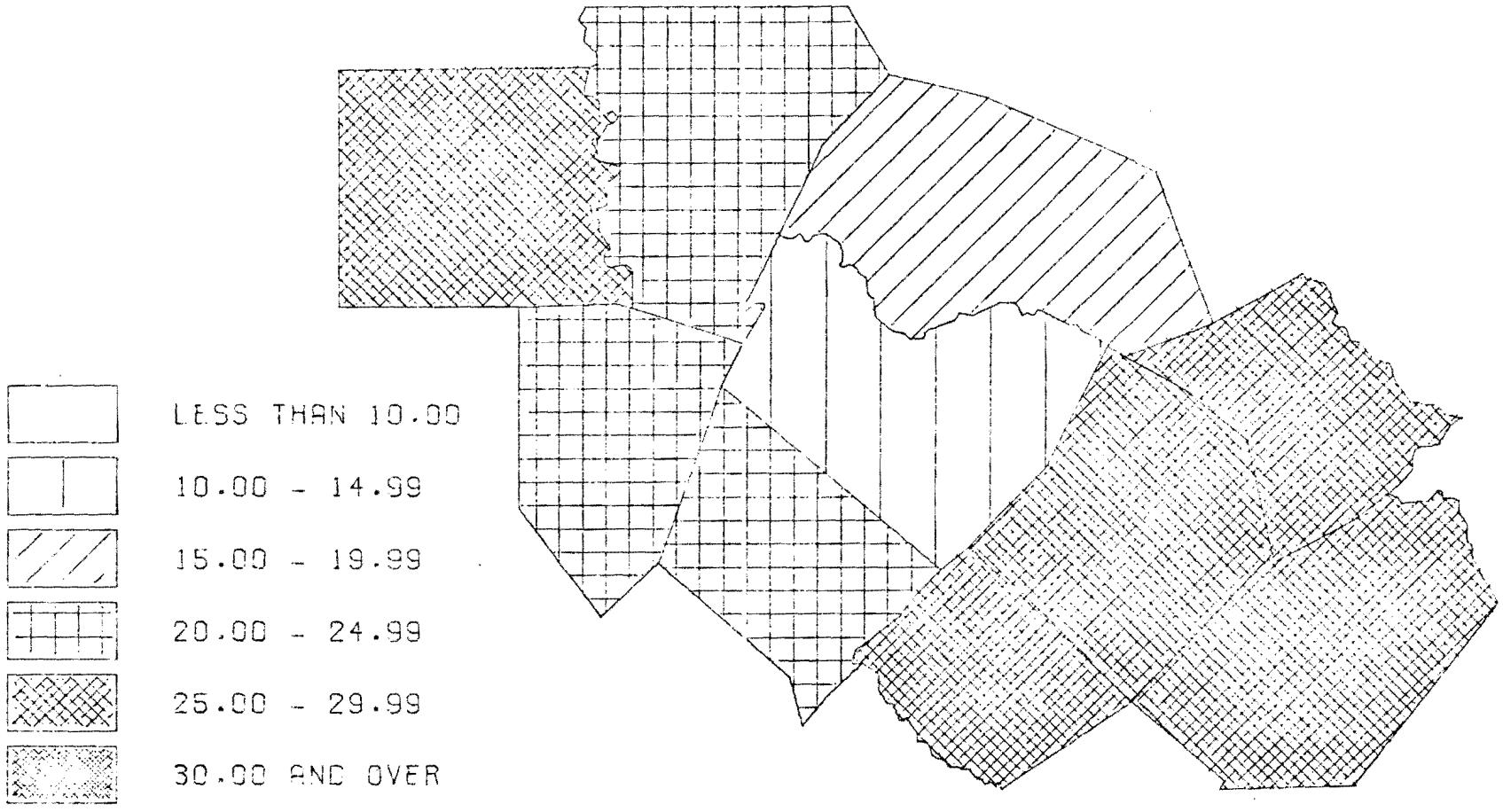

Figure 10. Percent of Families Below Poverty Level

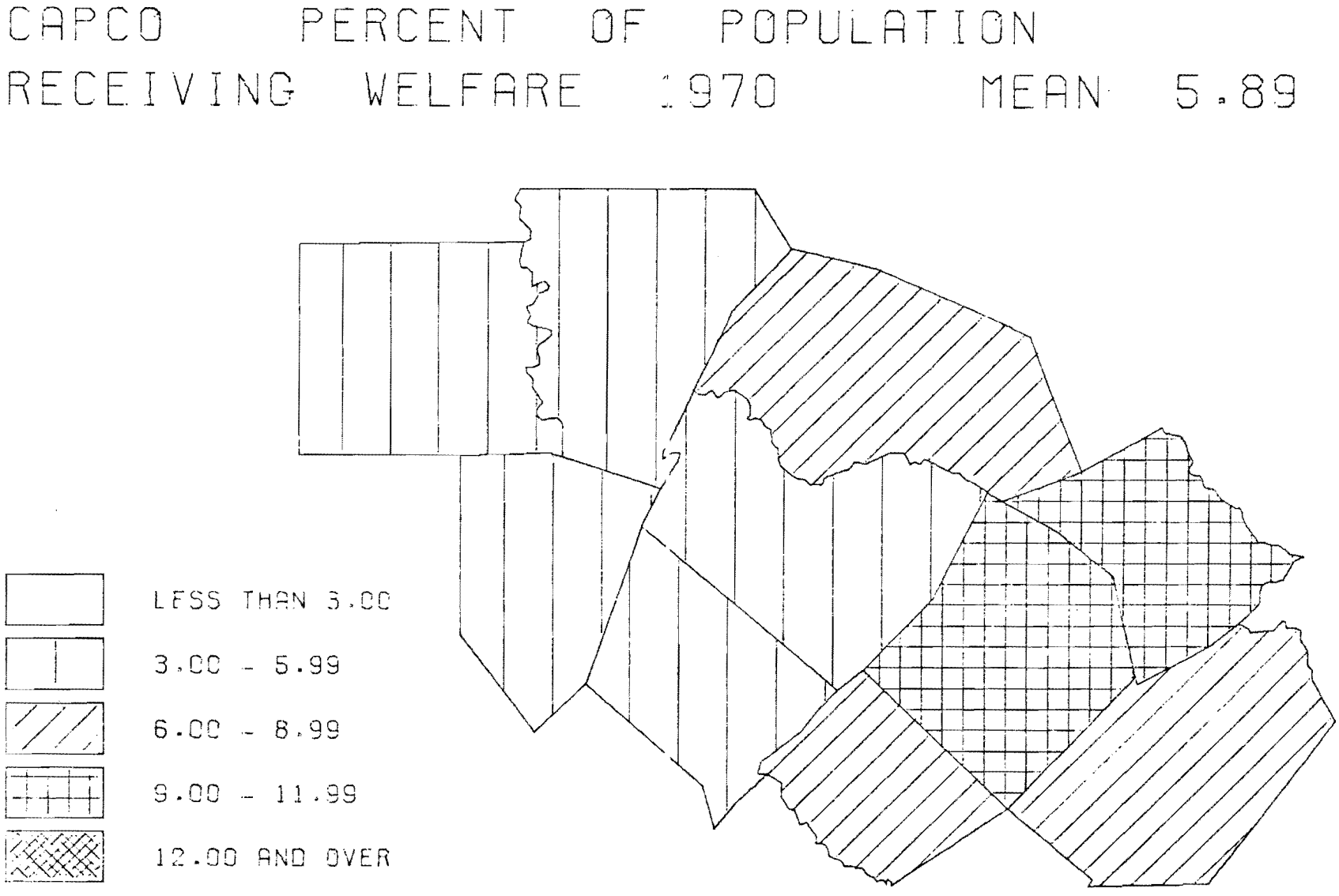

Figure 11. Percent of Population Receiving Welfare, 1970

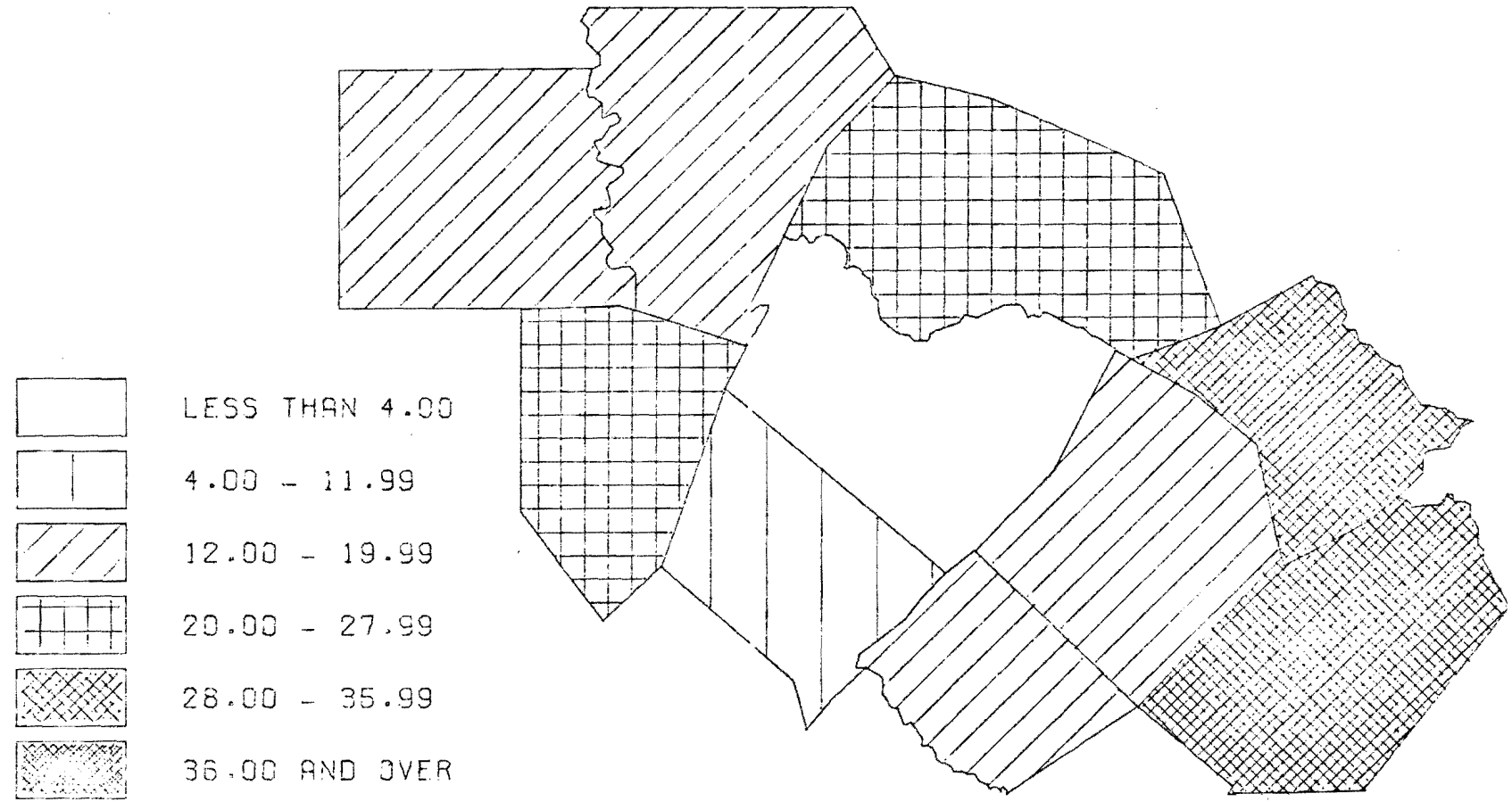

Figure 12. Percent of Labor Force Employed in Agriculture

THE TRANSPORTATION SYSTEM[1]

Buses[2]

Six private, regular-schedule bus systems operate within the CAPCO region: (1) Arrow Coach Lines; (2) Austin Transit Co.; (3) Continental Bus System; (4) Greyhound; (5) Kerrville Bus Co.; and (6) Transportation Enterprises Inc. With the exception of the last name, and Austin Transit, all are interstate or inter-regional carriers. Transportation Enterprises operates, under subsidy from the University, a shuttle service within Austin for The University of Texas. In addition, it operates a shuttle between Austin and San Marcos (31 miles to the south) linking residents of the former with Southwest Texas State University in San Marcos and residents of this city with The University of Texas and major shopping centers in Austin. Austin Transit Co. provides local service within the City of Austin under subsidy from the City Council and with equipment purchased through a grant from the U.S. Department of Transportation, Urban Mass Transit Administration.

With respect to the remainder of the region two conclusions can be drawn concerning the number of people served by regular-schedule buses:

(i) A surprisingly small percentage of the residents in population concentrations in the region is without daily bus service (Table 1, Col. 3).[3] Only two towns of over 1,000 population have no bus service (Bartlett and Granger in Williamson Co., Figure 13).

(ii) However, if the rural population is considered as unserved by these buses then between 40 per cent and 65 per cent of the population of most counties has no bus service (Table 1, Col. 4).

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[1]This section was prepared in part at the request of the Director for Regional Planning of the Capital Area Planning Council to aid in developing the Regional Transportation Plan.

[2]Information was obtained from Russell's Official National Motor Coach Guide, Cedar Rapids, Iowa: Russell's Guides Incorporated, October, 1973; from individual bus companies, and from the files of the Texas Railroad Commission, with the assistance of Judge Robert Whitehead, Examiner.

[3]A population concentration is any incorporated city, any urban place recognized by the Bureau of the Census or any community recognized in the Commercial Atlas and Marketing Guide, Chicago: Rand McNally Co., 1974.

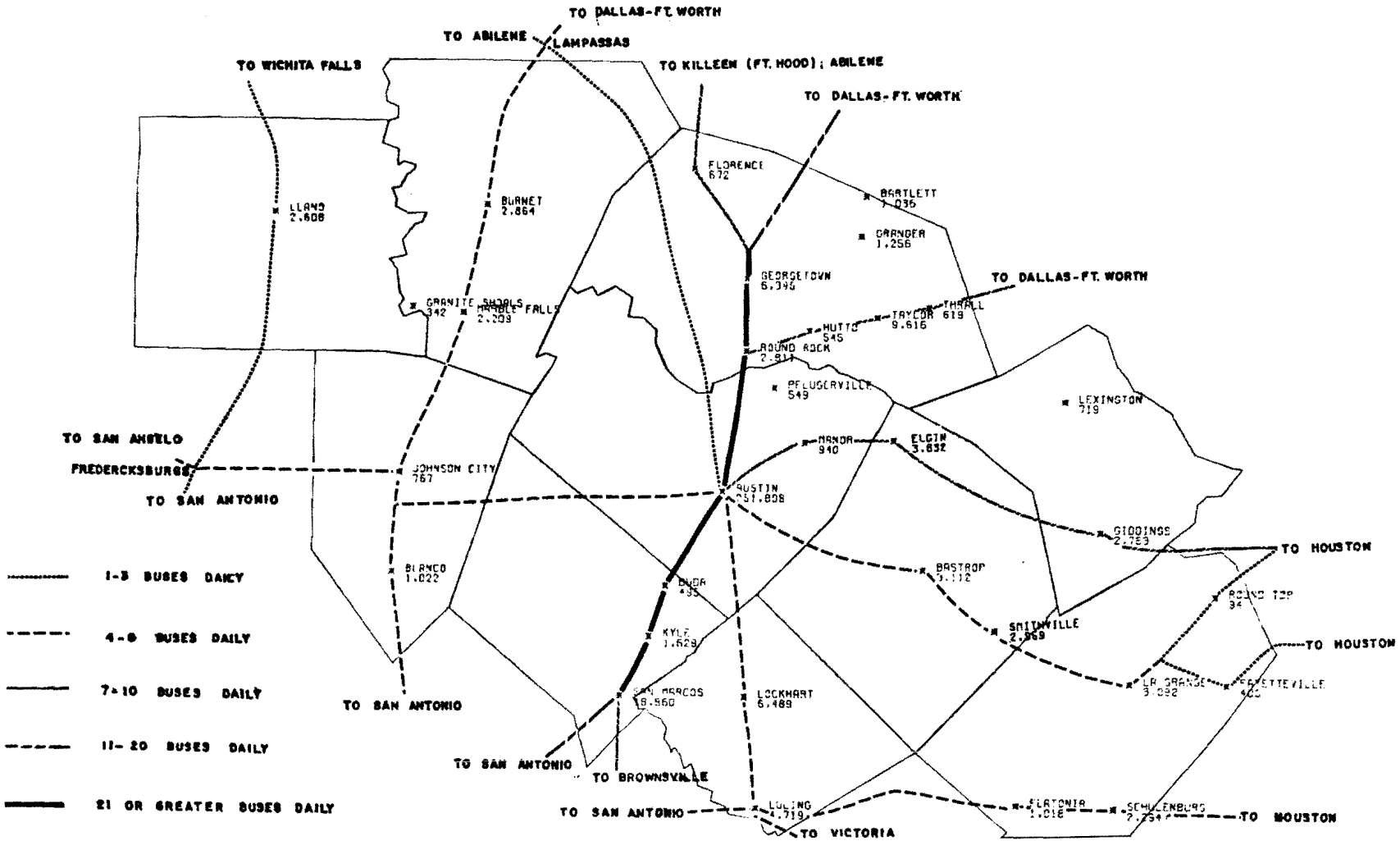

Figure 13. The Private Regular Schedule Bus System

TABLE 1. Availability of Regular Schedule Bus Services in CAPCO

County	1 Total Population	2 % Dispersed[a]	3 % of City Pop. Not Served	4 % of Total Pop. Not Served[b]
Bastrop	17,297	36%	36%	39%
Blanco	3,567	46%	2%	50%
Burnet	11,420	35%	30%	54%
Caldwell	21,178	37%	15%	46%
Fayette	17,650	49%	10%	54%
Hays	27,642	21%	3%	23%
Lee	8,048	49%	22%	65%
Llano	6,979	25%	50%	62%
Travis	295,516	12%	2%	14%
Williamson	37,305	33%	15%	43%

[a]The dispersed population encompasses all persons living outside of places recognized by the U.S. Bureau of the Census or by the Rand McNally, Commercial Atlas and Marketing Guide (Chicago: Rand McNally, 1974)

[b]The dispersed population is assumed not to be served

The frequency of buses and the network links is another consideration. These are less a function of intra-regional need patterns, rather they follow from location relative to routes linking the major metropolitan areas of Texas.

The most densely travelled network in Texas is the Dallas-San Antonio-Houston traingle and two vertices of this pass through CAPCO. The addition of other major inter-metropolitan routes leads to five major pathways through the CAPCO area (Figure 13):

North-South

(1) San Antonio-Austin-Dallas (bisects the region running north-south),

(2) San Antonio Fort Worth (through Blanco and Burnet),

East-West

(1) Houston-Austin-El Paso,

(2) Austin-Bryan/College Station, and

(3) Houston-San Antonio (extreme southern portion of the region).

The consequence of this system with respect to the network pattern is a radial set of routes which link the eastern counties to Austin. However, the western counties have a north-south pattern linking more to San Antonio than Austin. Thus, while Austin functions as the hub of the bus net for the eastern section of the region, this is not the case for the western portion.

The impact of location relative to major inter-city routes has a particularly marked impact on the frequency of bus service (Figure 13). For instance, towns lying along Interstate 35 linking Dallas with San Antonio have up to 28 buses per day because of its location on IH 35, as against Lockhart (6,489) and Burnet (2,864) which receive only four per day.

The times at which buses are available is also tied to the needs of the major metropolitan areas. For instance, residents of the two major western counties Burnet and Blanco must leave either at 4:00 a.m., or return home at 3:00 a.m. in order to conduct business in San Antonio, a two-hour bus ride, without spending the night in that city. The reason appears to be that the bus used links Dallas/Fort Worth with San Antonio and this six-hour trip is treated either as a day run or a night run between these cities.

Finally, it can be noted that counties with the largest portion of their population unserved by buses (e.g. Llano, Burnet and Lee) are those which lie furthest removed from the major inter-metropolitan routes (Figure 14).

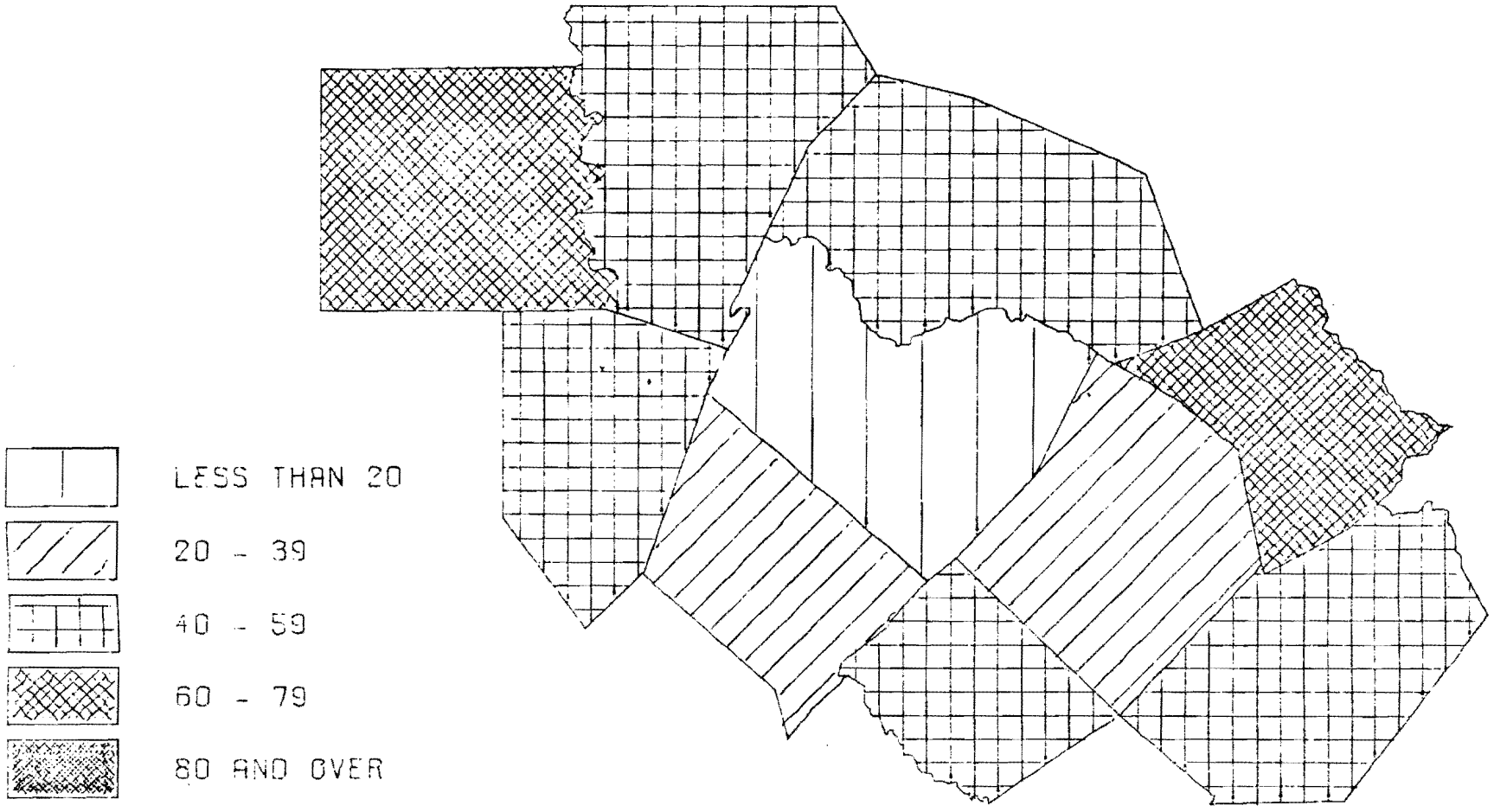

Figure 14. Percent of County Population Unserved by Buses

Taxi-Cab Service

Except for the City of Austin and surrounding areas of Travis County which were served by 109 cabs as of March, 1974, the remainder of the region, which has a population roughly equivalent to that of Austin, was served by 29 cabs. Five counties in the region had no cities with cab service (Figure 15). With the exception of Llano, these were the peripheral, low population, low density counties.

An examination of the population of cities with and without cab service, and the population per cab in multiple cab sites (Table 2) suggests some general patterns. One cab appears to serve between 2,000 and 3,000 people. However, an individual city appears to need a population of approximately 4,000 before cab service is offered since all cities above this size, and only one below, have service.

Community Action Agencies

Transportation availability through community action agencies in the region is quite varied. Three types of situations are evident: 1) where no transportation is available, 2) where transportation is available for limited groups, and 3) where general transportation is available.

Lee and Fayette counties in the east of the region have no community action agencies at present thus there is no transportation available through this source. This is despite the fact that Lee has one of the highest incidences of poverty in the region.

Through the Hill County Community Action Association transportation is provided in Llano by private cars belonging to aids. However, it is restricted to a once per week trip for the elderly to the Senior Citizen Center, stopping at other services (doctors, grocery store, etc.) at this time if needed, and to a daily trip for children participating in a Head Start Program. Areally, these services are restricted to Llano and the immediate surrounds.

Five counties (Hays, Caldwell, Blanco, Williamson and Burnet) have general transportation available to take elderly and low income persons to any services they require. This is accomplished by outreach workers utilizing their own private vehicles, with funding from the Office of Economic Opportunity.

Bastrop and Travis Counties again offer general transportation to the elderly and low income but utilize special vehicles. In the case of Bastrop

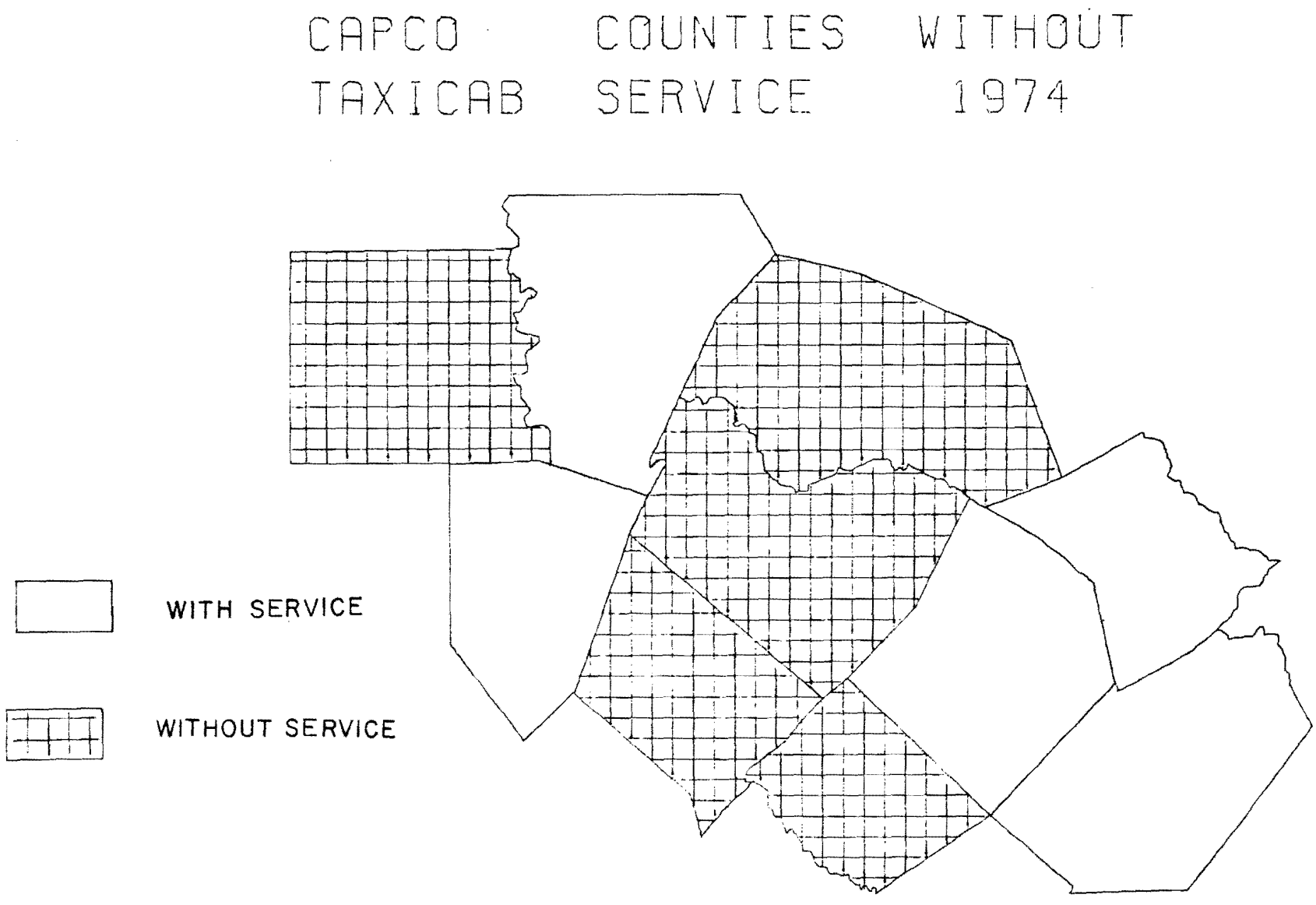

Figure 15. Counties with No Cab Service Available in Any City

TABLE 2. Cab Service for CAPCO Region

County	Cities Over 1,000 Pop.	Population	# of Cabs	Hours of Operation	Population Per Cab
Bastrop		17,297			
	Bastrop	3,112	0		
	Elgin	3,832	0		
	Smithville	2,959	0		
Blanco		3,567			
	Blanco	1,022	0		
Burnet		11,420			
	Burnet	2,864	0		
	Marble Falls	2,209	0		
	Bertram	1,175	0		
Caldwell		21,178			
	Lockhart	6,484	3	4:30 am-11 pm	2,161.3
	Luling	4,719	1	8 am-9 pm	4,719
Fayette		17,650			
	La Grange	3,092	0		
	Flatonia	1,108	0		
	Schulenburg	2,294	0		
Hays		27,642			
	San Marcos	18,860	5	5 am-9:30 pm	3,772
	Kyle	1,629	0		
Lee		8,048			
	Giddings	2,783	0		
Llano		6,979			
	Llano	2,608	1	6 am-Midnight	2,608
Travis		295,516			
	Austin	251,808	109	24 hours	2,310.1
	W. Lake Hills	1,488	0		
Williamson		37,305			
	Georgetown	6,395	1	5 am-10 pm	6,395
	Taylor	9,616	4	6 am-6 pm	2,404
	Round Rock	2,811	0		
	Granger	1,256	0		
	Bartlett	1,036	0		

two eight-passenger vans based in the cities of Bastrop and Elgin can be requested through the telephone by any person who has been certified not to have transportation. Funding is through revenue sharing monies. Within the city of Austin two buses are operated by the city's Department of Community Action. These make scheduled trips for Model Cities preschool children to child development centers and are available for special services to the elderly, low income, and model city residents at other times.

Throughout the counties of the CAPCO area state Welfare Department Case Workers provide transportation for their clients. This is by private car with reimbursement for gasoline through state funds. However, there are legal problems related to insurance, and state funds are officially for travel of the case worker, not the transportation of the client.

Although this review would imply the availability of some form of transportation in most regions for those unable to use an automobile, this is not entirely the case. It appears that the availability of transportation is still less than desirable (certainly by urban standards) to ensure accessibility to essential services. Furthermore, primarily as a consequence of limited resources CAA and Volunteer transportation programs tend to concentrate in the larger settlements in a county, to the detriment of the rural and hamlet resident. These several observations suggest the need for more detailed studies to substantiate the true extent of this rural transportation problem. Survey results will be reported in a later document.

COMMUNICATION SYSTEMS

Within the State of Texas there are three communication systems of interest to essential services. However, only two of these operate throughout the Capital Area Planning Council study area. These two comprise the common leased-line TEX-AN telephone network which services all state agencies, and the radio network of the Department of Public Safety (DPS). The third system which is neither state- nor region-wide comprises communication links for emergency medical services (EMS).

The TEX-AN System

Until 1974, each state agency in Texas contracted individually for its leased services, telephone and data, with the Southwestern Bell Telephone company and/or one or more of the smaller of the 108 Independent Telephone companies who do business in the state. In 1973 the Office of the Governor presented a plan to contract for a statewide leased long-distance system, called TEX-AN, to replace the services being provided under individual contracts (Office of Information Services[4]). On August 28, 1973 the Legislative Budget Board recommended to the Governor that he take action, subject to certain savings, to implement the system, and such was accomplished March 1, 1974.

The initial design of the TEX-AN system calls for four common controlled switching arrangements (CCSA), or switching centers, strategically located in Abilene, Austin, Dallas and Houston to serve all state government customers. The switchers are interconnected to form the trunking network. Most customers access the network through circuit arrangements that take full advantage of bulk-rate Telpak pricing. There are, however, a number of offices throughout the state where it is not economically feasible to provide direct network access lines. These offices gain access through local off-network access lines (LONALS) and off-network access lines (ONALS). LONALS terminate in the Abilene, Austin, Dallas, and Houston switching centers, from where they provide on-network to off-network and off-network to on-network calling within the exchange where a CCSA switcher is located. ONALS provides on-network to off-network and off-network to on-network calling to an exchange other than one in which a CCSA switcher is located.

The TEX-AN network has some important implications for the supply of essential services. TEX-AN will improve the telecommunications services to state offices in rural areas throughout the state. The system's ONALS and LONALS subscribers will have rapid, high-quality, relatively inexpensive access to urban facilities, for example, hospitals, medical specialists, and public health and welfare offices. Rural practitioners could use the system to request on-the-spot assistance in cases which exceed their capabilities,

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[4]Office of Information Services. TEX-AN The Texas Agency Network, Master Plan/Telecommunications, Austin, Texas: Office of the Governor, State of Texas.

facilities or authority provided they were ONALS or LONALS subscribers.

Specific advantages which may be realized with the advent of the TEX-AN system include: 1) transmission of medical information such as cardiograph and encephelograph signals, from a rural location to a cardiovascular clinic, 2) picture-phone services which will permit face to face interviews between, for instance, urban medical specialists and rural practitioners, and 3) a field social worker may arrange for consultations between clients in outlying areas and specialists at central headquarters.

Police Radio Networks

The Department of Public Safety operates a statewide radio network in the Very High Frequency band. The system is being expanded with help from a federal grant awarded under the Omnibus Crime Control and Safe Streets Act of 1968, as amended (Criminal Justice Plan for Texas[5], pp. 221). At present, the network is dedicated to law enforcement and links the many diverse agencies so involved. The CAPCO area is part of Region 6, District B of the DPS system with the major 24-hour fixed-station located in Austin.

Apart from its function of providing communications for law enforcement services, the role of the DPS network is unlikely to expand to include other services. The major state agencies in Texas are strongly autonomous bodies, and budget for projects which meet their own individual requirements, resulting in systems specifically designed for particular purposes which cannot easily be expanded to interagency networks.

Emergency Medical Systems

The Division of Civil Defense and Traffic Safety of the State Health Department works with hospital administrators to plan emergency medical communications systems and subsystems to meet the needs of urban and rural communities throughout the state. However, lack of funds has been the greatest barrier to the materialization of more than a handful of such systems. The only extensive network in the CAPCO region serves the New Braunfels-Seguin-San Marcos triangle, a part of which is located in the study region.

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[5]Criminal Justice Council. Criminal Justice Plan for the State of Texas. Austin, Texas: Office of the Governor, State of Texas (1973).

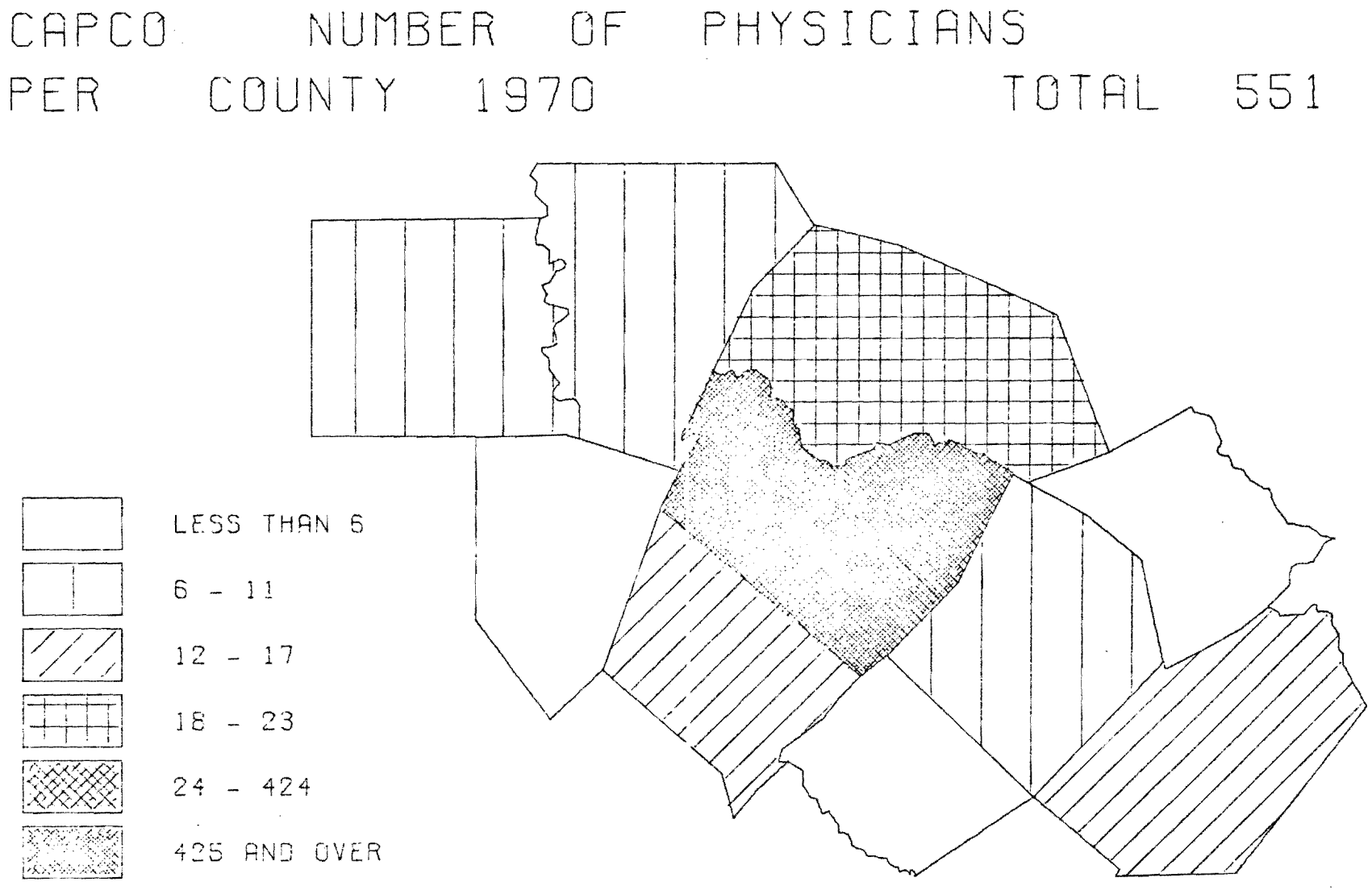

Figure 16. Number of Physicians per County

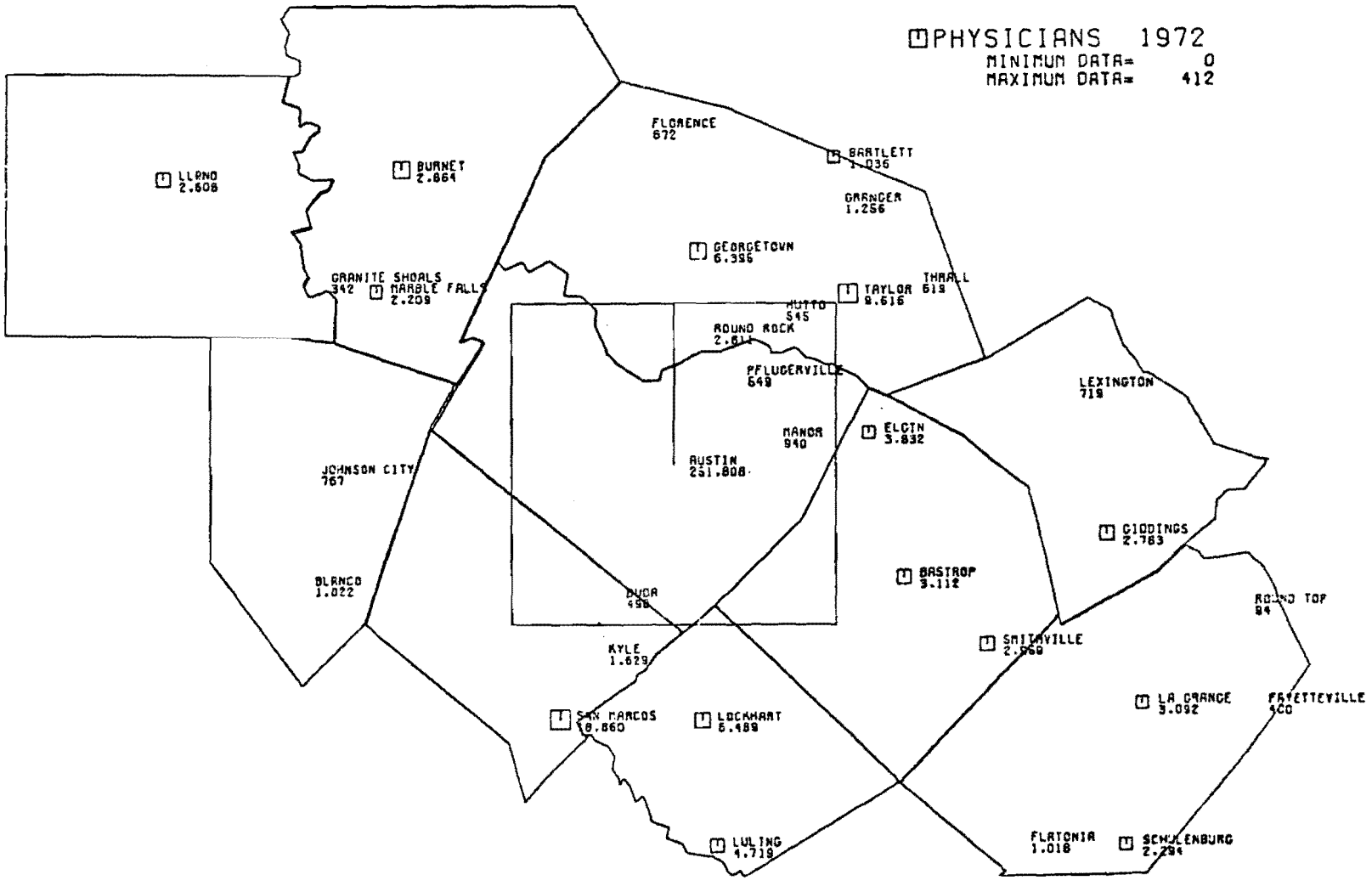

Figure 17. Number of Physicians by City of Residence

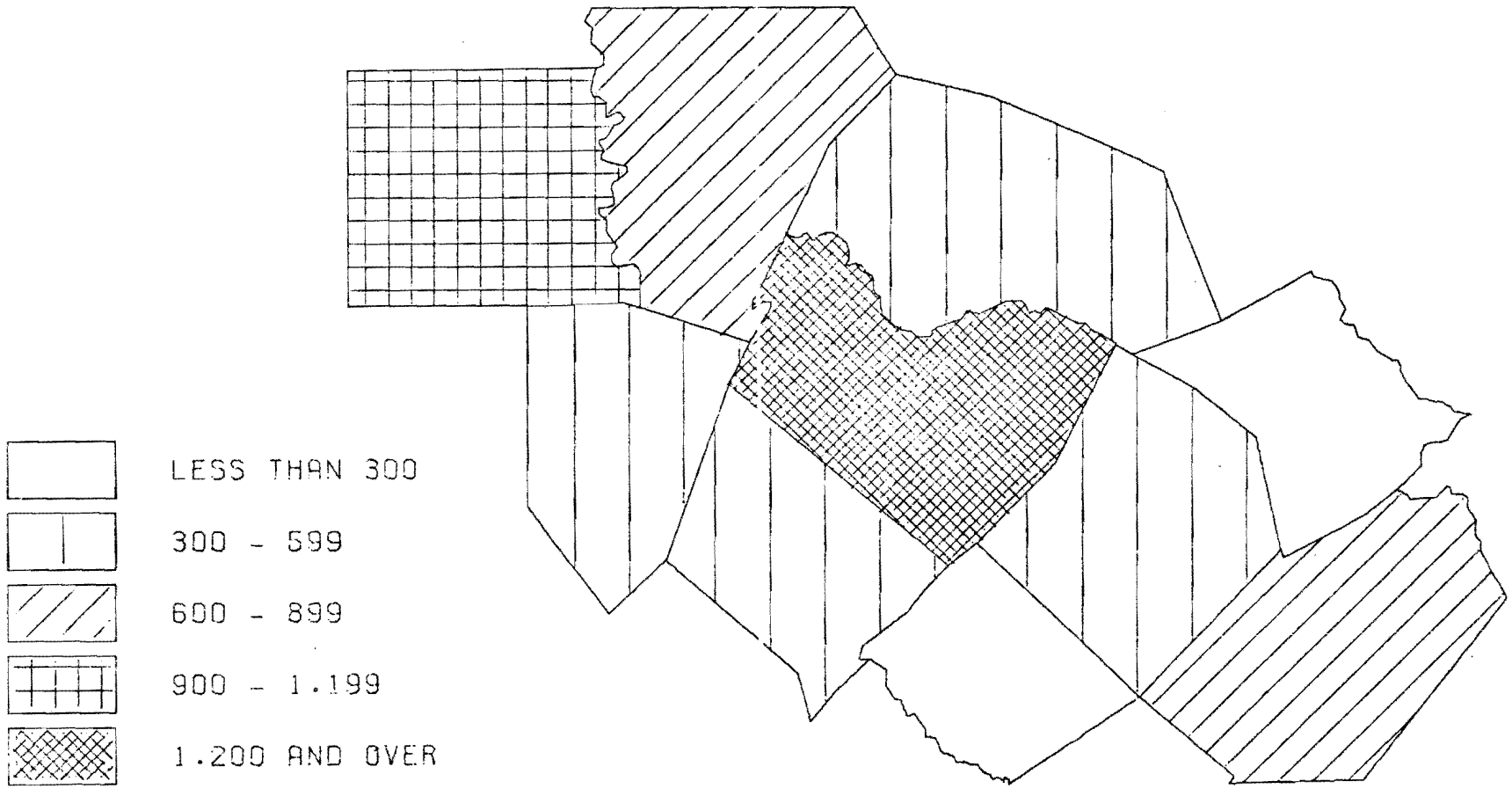

Figure 18. Number of Physicians per 1,000 Population by County

Most ambulances in CAPCO have radio equipment which is used for direct voice communication with their company headquarters--from whence all dispatching is accomplished. Radio-equipped hospitals can talk to ambulances, but, except for the few cases where the vehicles are operated by the hospital, the ambulance is not subject to hospital direction.

Although several CAPCO hospitals have ordered fixed-station equipment, at present only six of the region's 24 hospitals have an active radio communication capability, and only two of these can operate on more than one channel. At least three channels are normally recommended for an efficient system.

ESSENTIAL SERVICES FACILITIES

The supply of essential services within the CAPCO region reflects the dominance of Austin as the region's major activity center. In nearly all aspects of essential services provision, Austin is favored with more human and physical resources than its proportion of the region's population may warrent. On the other hand, it must be recognized that as a regional center Austin provides services for an area much larger than its own political boundaries.

Physicians

The distribution of physicians within the CAPCO region is similar to a pattern that has emerged for the nation in general. Physicians, like other highly-educated personnel, tend to prefer the amenities of urban living and thus locate in populated centers (Figures 16 and 17). Approximately 84 per cent of the CAPCO region's physicians (more than 400) are concentrated in the central city, Austin, which contains only 25 per cent of the region's population. In contrast, Blanco, Caldwell, and Lee counties have less than six resident physicians each. Similarly, physicians-population ratios vary considerably among the CAPCO counties ranging from 1.448 physicians per 1,000 population in Travis county to less than .300 per 1,000 in Caldwell and Lee coutnies (Figure 18). Furthermore, among nine of the CAPCO counties (other than Travis) where the number of physicians per county range from two to twenty-two (Figure 16)

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[6]Parts of this section have been prepared for use in the CAPCO Regional Health Plan, presently under preparation.

the loss or gain of one physician in any one county can have a major impact on health service availability.

Hospital Facilities

Each county in the CAPCO region contains at least one hospital (Figure 19). The largest facilities, providing the broadest range of health service functions in the region, are among the seven hospitals in or around Austin in Travis county. Two of these seven hospitals, the University of Texas Health Center and Bergstrom Air Force Base Hospital, have restricted access limited to university students and military personnel, respectively.

The number of licensed hospital beds in those cities with hospitals ranges from 1,538 in Austin to 15 in Johnson City (Figure 20). As is apparent from Figure 21 the number of licensed beds does not bear a strong relationship to population. The hospital bed-population ratio varies from less than 2 to more than 800 yet appears to bear little relationship to other characteristics of the counties such as total population (Figure 3), urban population (Figure 5) or income (Figure 9).

An examination of the county service ratios and occupancy rates among the CAPCO region's hospitals indicates the growing importance of Travis county as a regional medical center. The service ratio represents the percent of local hospitalized residents who chose to be hospitalized in their home county and the occupancy ratio is the number of patient days relative to hospital beds. The service ratios in Table 3 indicate the superior retention power Travis county hospitals exert over local hospitalizations as compared to the other CAPCO counties hospitals. Likewise, its power to draw patients from other counties has been growing as indicated by a steady increase in the percent of patients in Travis county hospitals from other counties (15 per cent in 1966 to 22.2 per cent in 1972).

Table 3 also indicates the generally lower occupancy rate of rural area hospitals. Smithville hospital in Bastrop county had the lowest occupancy rate in 1972 with only 10.7 per cent of its beds occupied. Travis county occupancy rates are lowered in part by the limited access restrictions at the University of Texas Health Center and Bergstrom Air Force Base Hospital (25.8 per cent and 49.2 per cent respectively). Brackenridge Hospital in Austin, the largest in the region, also had the highest occupancy rate (82.6 per cent)

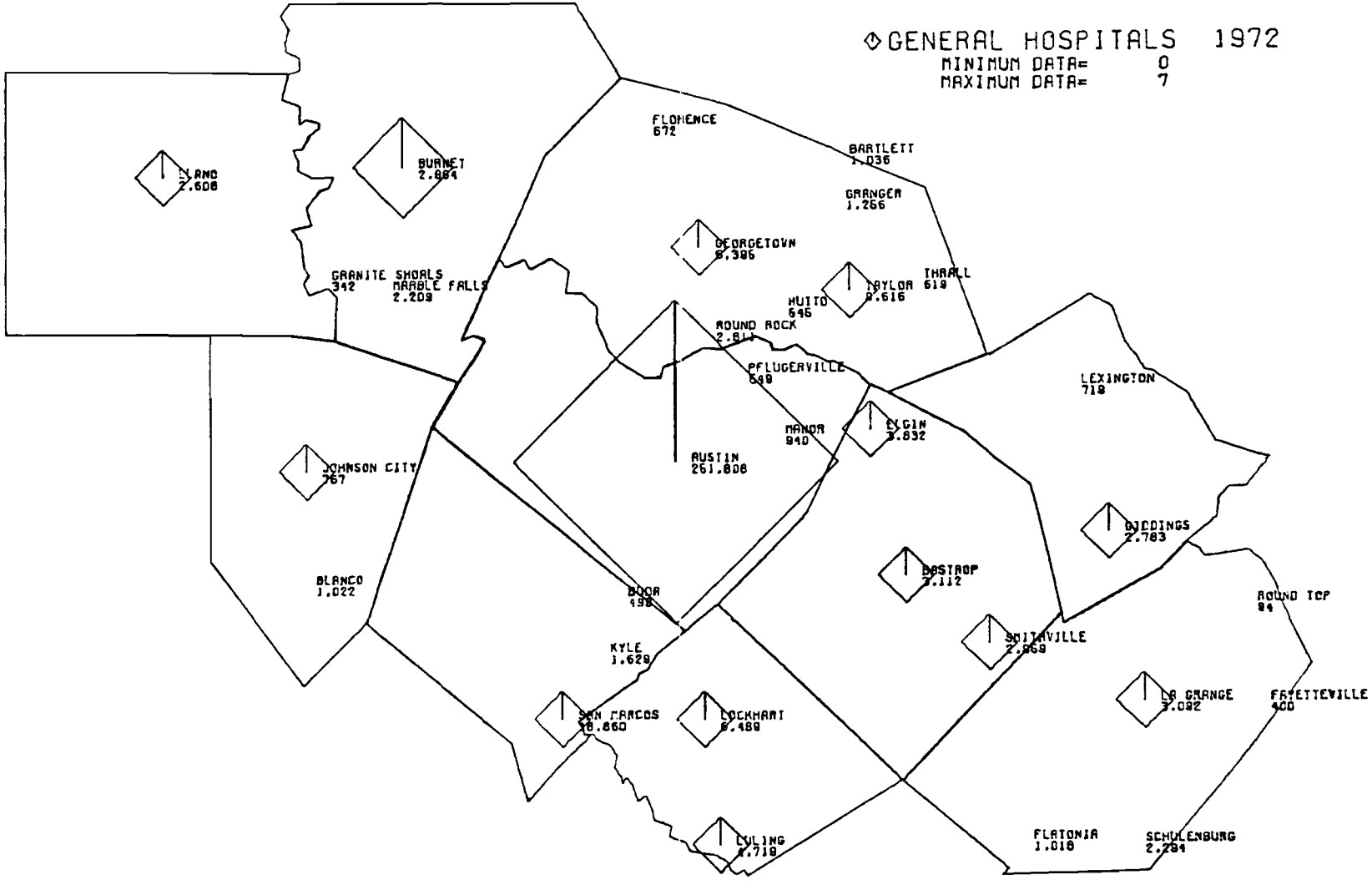

Figure 19. Number of Hospitals by City

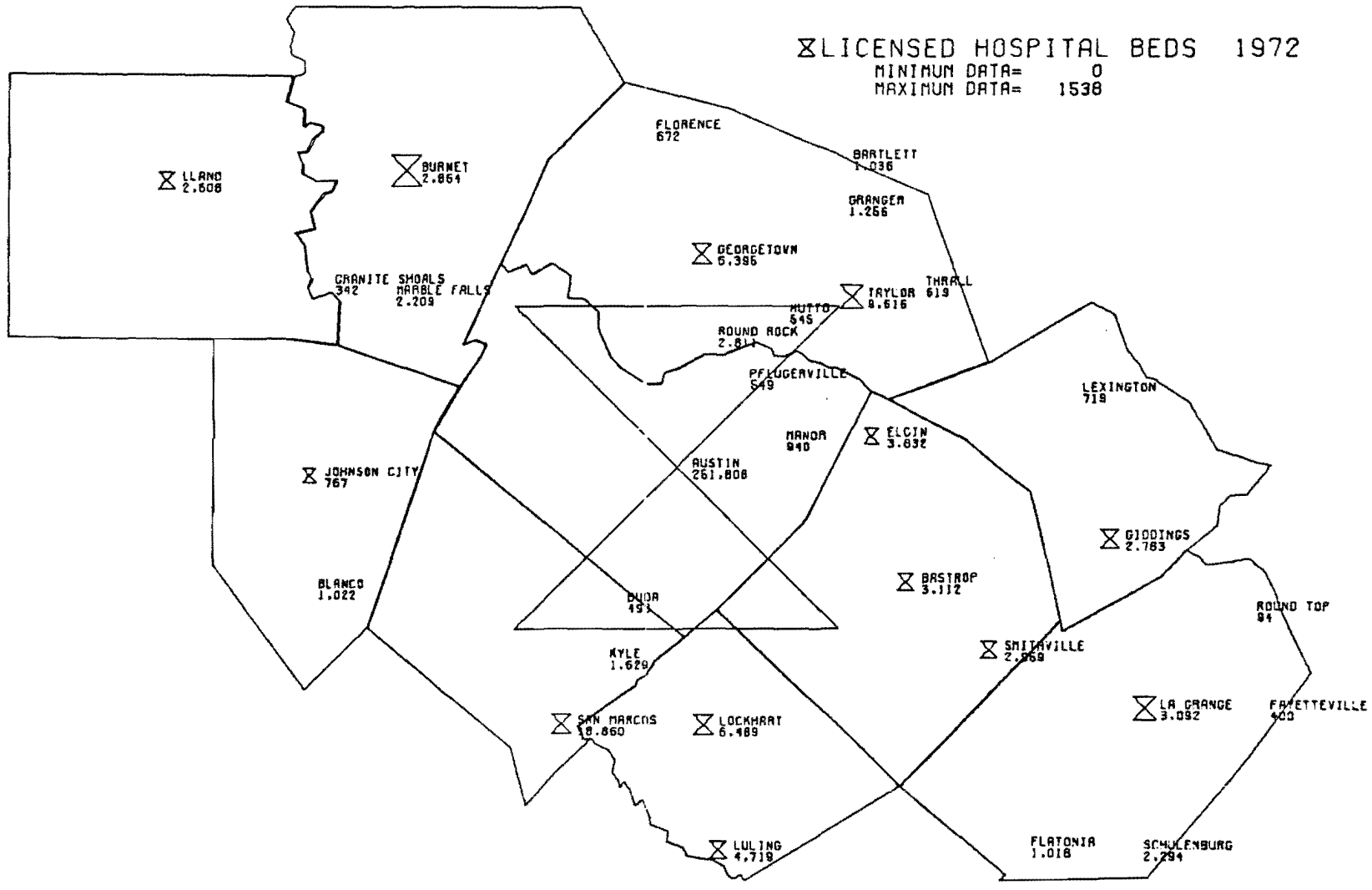

Figure 20. Number of Licensed Hospital Beds by City

Figure 21. Hospital Beds per 1,000 Population by County

TABLE 3. Service Ratio and Occupancy Rate of Hospital Facilities by County in the CAPCO region (1972)

County	Service Ratio	Occupancy Rate
Bastrop	36.9%	46.3
Blanco	38.5	39.7
Burnet	50.0	46.1
Caldwell	50.9	52.8
Fayette	35.8	75.5
Hays	33.3	70.8
Lee	61.1	49.7
Llano	54.5	56.6
Travis	90.6	65.4
Williamson	54.2	73.5

in 1972. The low occupancy rates, in general, suggest that the CAPCO region is provided with an excess of hospital beds. However, this conclusion must be tempered by the knowledge that occupancy rates are determined by actual utilization of facilities, which may or may not be an accurate representation of the population's actual need to use the facility.

County Health Departments

County Health Departments (CHD) supplement the existing health care delivery system in four of the CAPCO counties (Figure 22). In the city of Blanco the Blanco CHD provides general nursing leadership and consultation. The CHD's in Hays county (San Marcos), Travis County (Austin), and Williamson county (Georgetown) are more diversified providing nursing treatment and consultation services in several health problem areas such as home health, venereal disease, diabetes treatment, immunization, and others. Most noticeable, however, is the absence of county health departments in the majority of the region's counties.

Nursing Homes

Nursing homes are available in each of the CAPCO counties with Travis county having the largest number of both nursing homes and nursing home beds (Figure 23). The number of nursing home beds per 1,000 population are lowest in Travis and Hays counties reflecting, in part, the more youthful age structures of these two counties (Figure 24). The service and occupancy rates are considerably higher among nursing homes than among potential hospitals (Table 4). Unlike the case of hospitalizations, utilization data does not establish Travis county as a supplier of nursing home beds for patients from the other CAPCO counties. Additional bed construction in 1974 will lower the occupancy rates in some counties, which is of particular significance in Lee and Llano counties where occupancy rates in 1972 were in excess of 90 per cent.

Mental Facilities

Mental health facilities, for both mental illness and mental retardation, are highly concentrated in the City of Austin (Figure 25). Three facilities in Austin: Austin State School (1,484 capacity), Travis State School (1,650 capacity), and Austin State Hospital (1,693 capacity) are intended to serve the more intensive mental health care needs of the CAPCO region as well as a considerable area beyond its boundaries.

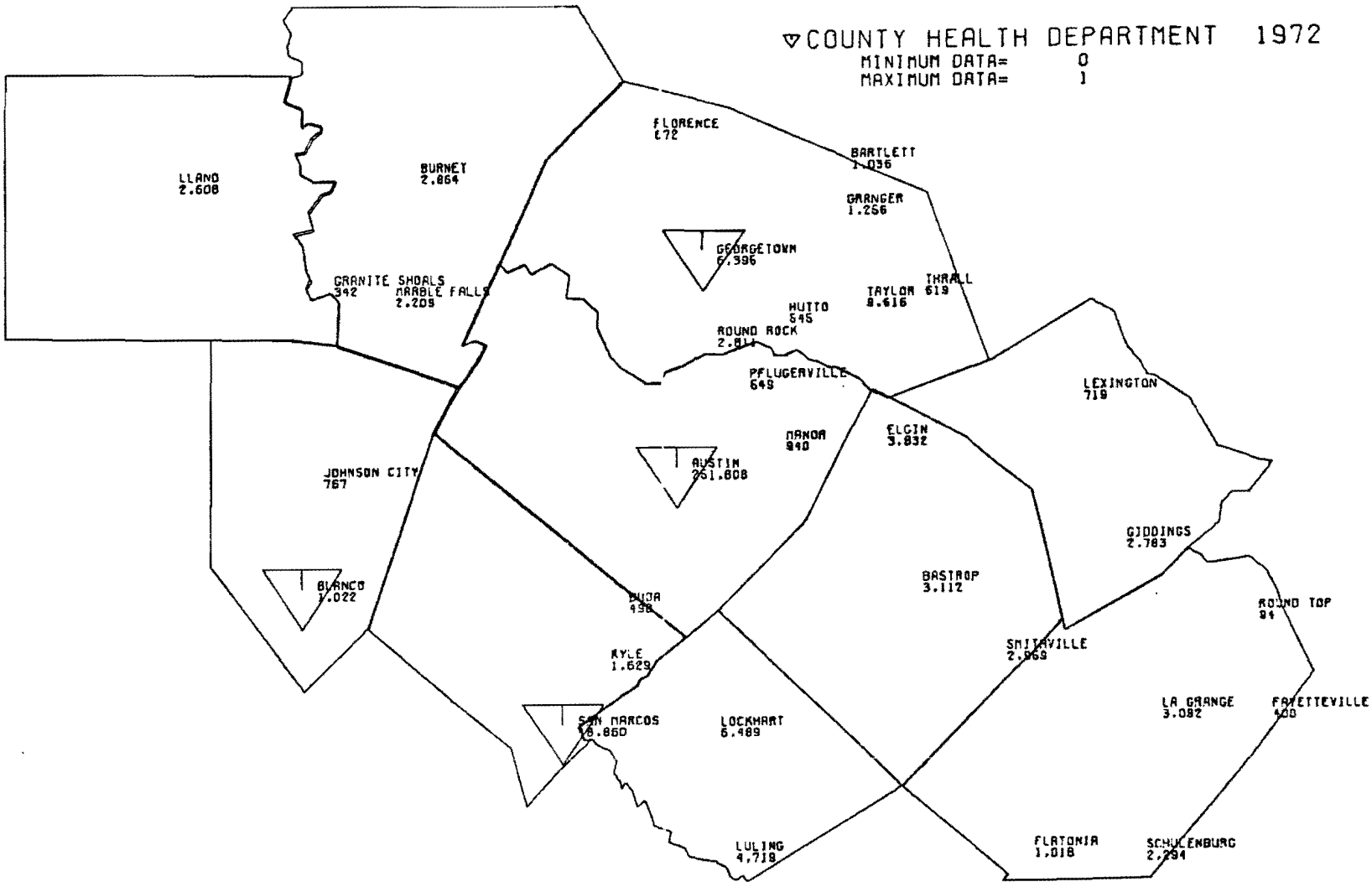

Figure 22. County Health Departments

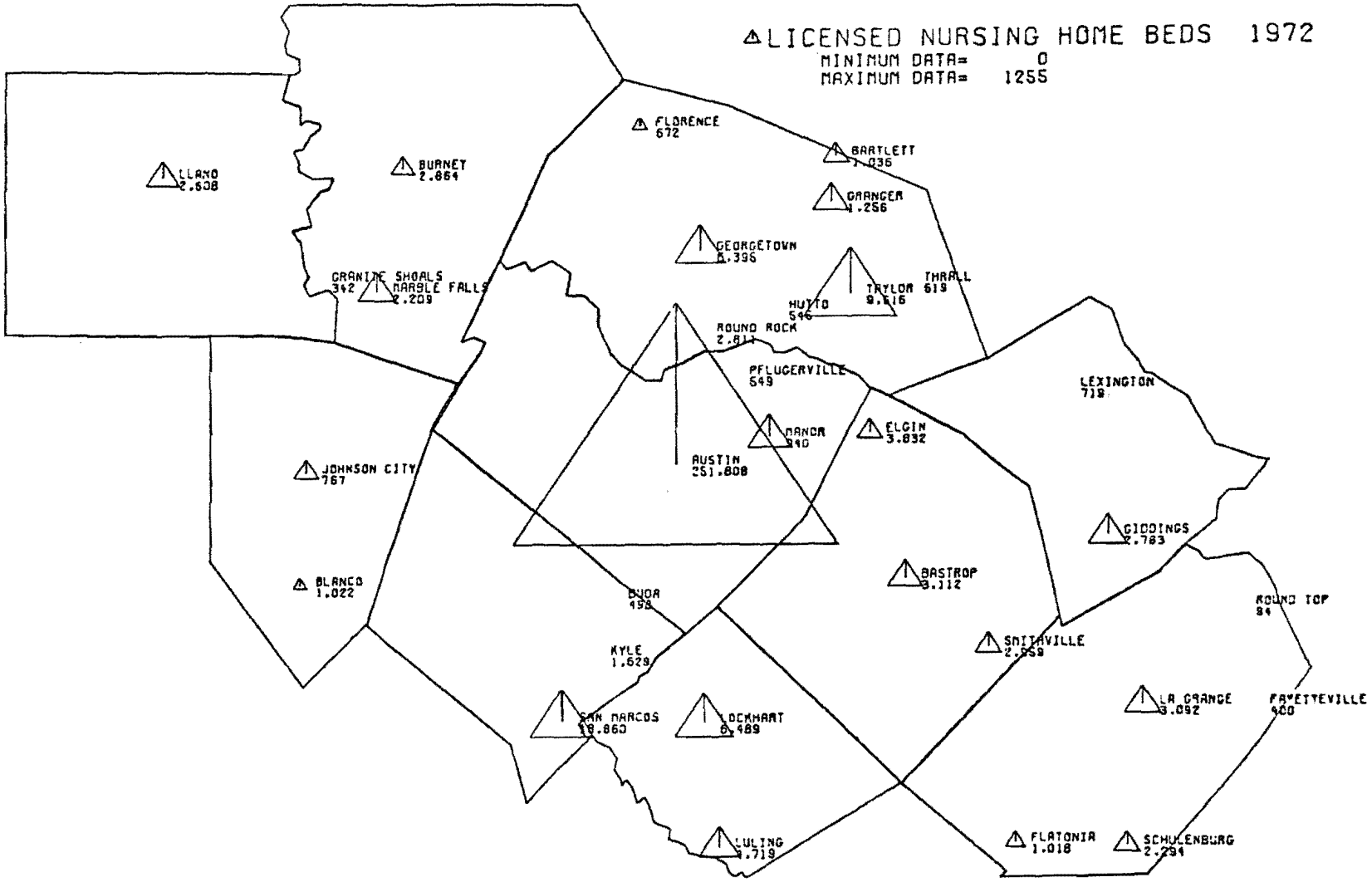

Figure 23. Nursing Home Beds by City

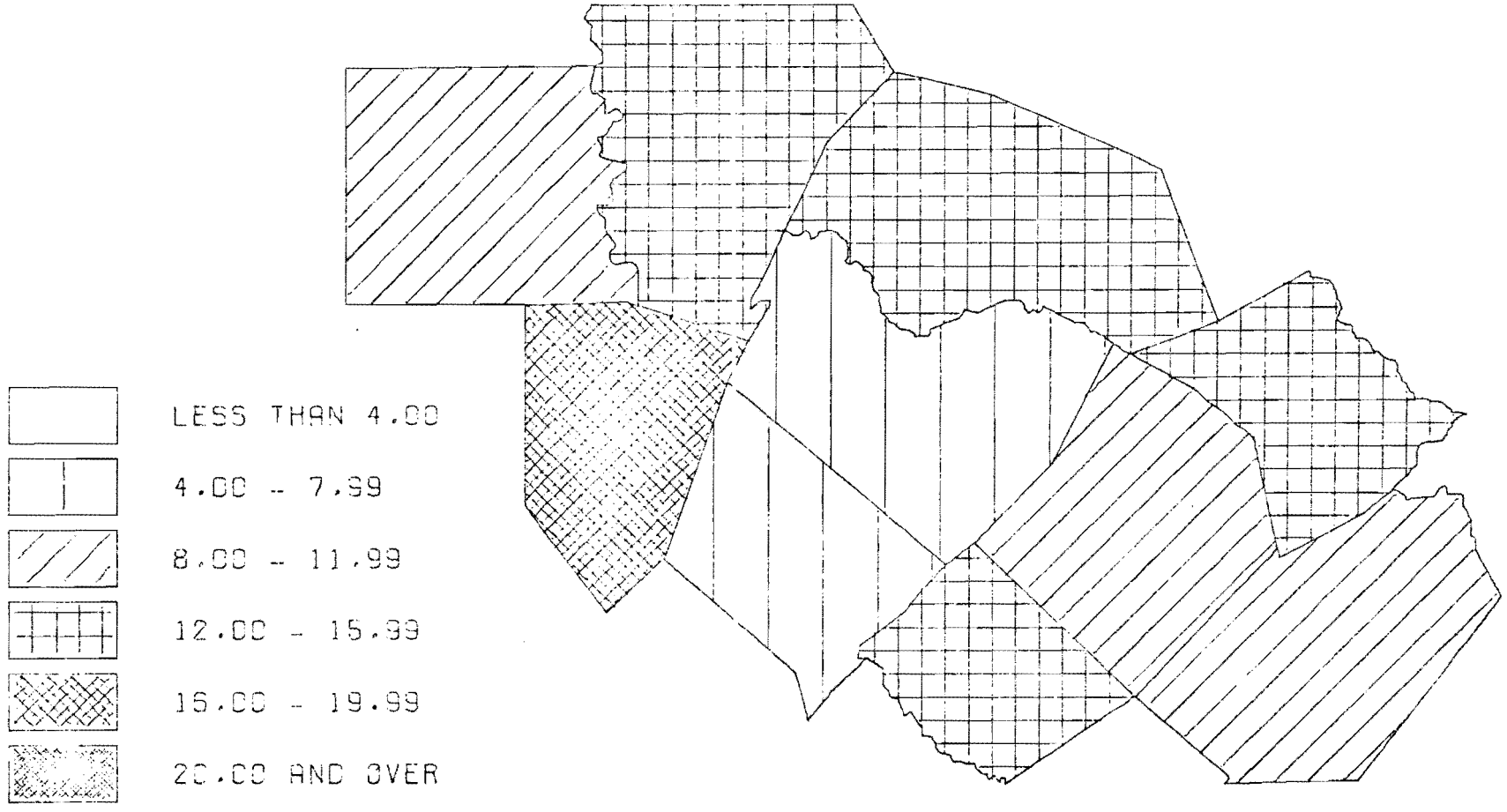

Figure 24. Nursing Home Beds per 1,000 Population by County

TABLE 4. Service Ratio and Occupancy Rate of Nursing Home Facilities by County in the CAPCO Region (1972)

County	Service Ratio	Occupancy Rate
Bastrop	80.9%	47.8
Blanco	96.7	77.8
Burnet	89.5	63.3
Caldwell	66.7	76.2
Fayette	80.1	88.7
Hays	60.6	54.2
Lee	96.0	92.6
Llano	92.0	92.5
Travis	74.8	83.6
Williamson	75.3	83.4

Table 4.4 Service Ratio and Occupancy Rate of Nursing Home Facilities by County in the CAPCO Region (1972)

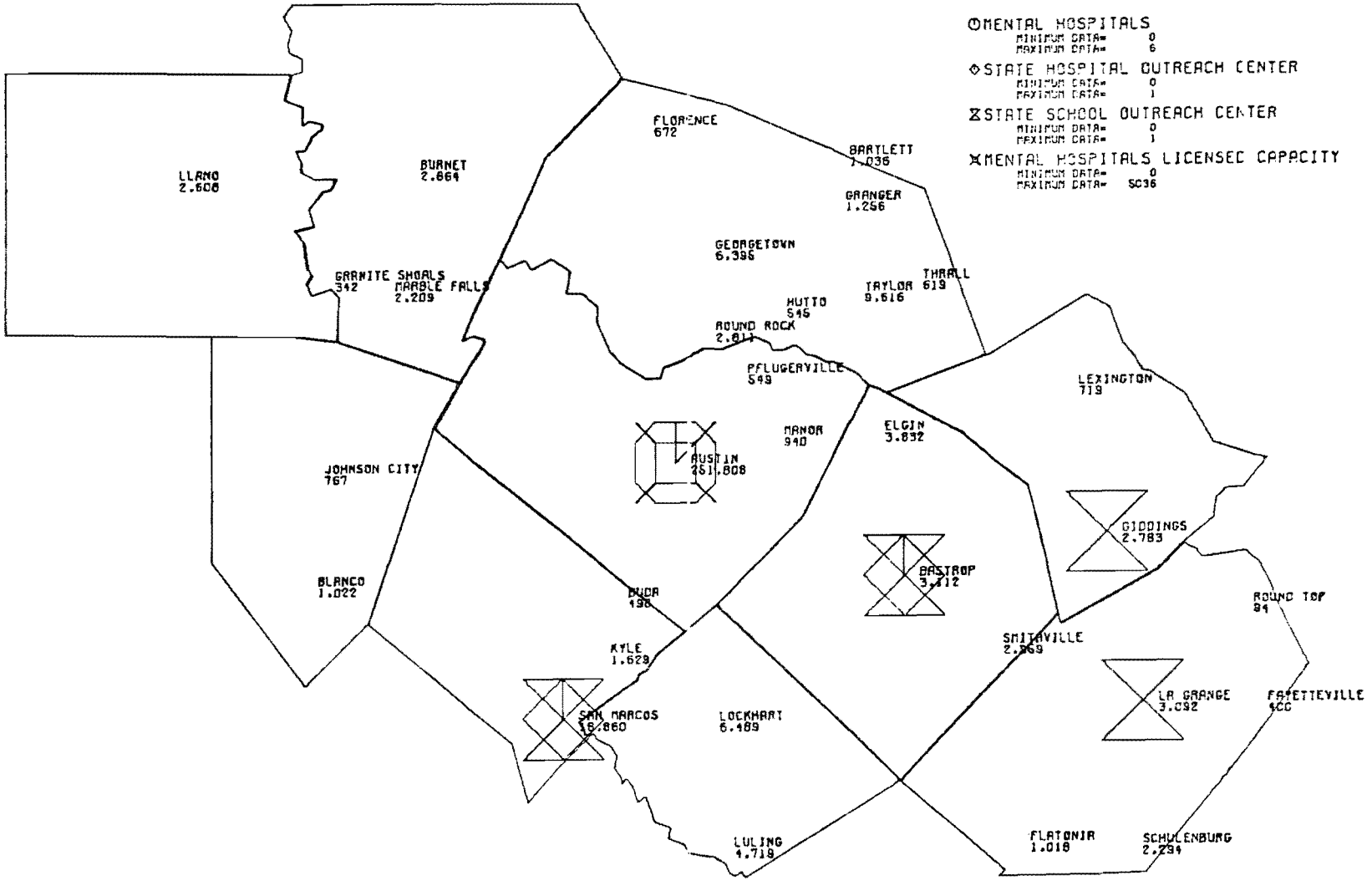

Figure 25. Mental Health Facilities

Some attempts to decentralize mental health services to improve accessibility have resulted in locating state hospital and state school outreach centers in some rural areas. In addition five Human Development Centers have been located in the City of Austin. These outreach and development centers have as their purpose treatment of the mentally ill and mentally retarded within the community, treatment for the patient returning from institutional care to the community, and prevention of institutionalization. The programs of these centers are far-ranging including treatment of such problems as severe mental illness, drug abuse, and marital family relationship problems. Four rural cities in the region have at least a state school or a state hospital outreach center. However, five of the ten CAPCO counties have no mental health facilities within their boundaries (Figures 25).

CONCLUSION

The dominance of Austin as the activity center of the CAPCO region is clear. It is further accentuated by the city's administrative function as the capitol city of Texas. In addition to the major essential services described above the city of Asutin contains more than 130 individual health, social, and rehabilitation service units with programs that serve clients at one or more of the state, regional (CAPCO and others), or local levels. An obvious benefit of this concentration of essential services is a high level of availability in the Austin area. From a regional point of view, however, an unsolved problem is concerned with extending services to distant, lightly populated areas.

IV. ESTIMATING DEMAND FOR ESSENTIAL SERVICES

Rather than develop separate proceedures for estimating satisfied demand (i.e. existing usage of facilities) and latent demand (i.e. demand unsatisfied as a consequence of deficiencies in the present supply system, particularly the transportation system) an integrated methodology is proposed. This methodology is designed to meet two major specifications which should help insure its implementation by governmental agencies. First the design criteria used in guiding the development of the methodology will be discussed. A description of the integrated methodology will then follow concluding with an example application of the methodology to estimate satisfied demand for hospital care.

DESIGN CRITERIA

Provide Useful Planning Information

The methodology should be of use to governmental planning agencies at the county, COG, or state level and of ancillary value at the federal level by assuring more rational planning of federally funded programs. To this end, the methodology should be capable of indicating the amount of latent demand for essential services, because knowledge of its magnitude and location would be critical for planning additional services. It should be capable of providing the necessary inputs for planning new delivery systems, particularly with respect to transportatin implications which are often ignored. To identify the transportation implications for a rural/urban region the methodology must be able to estimate demand for essential services at the level of small rural communities. Currently, Council of Government planning is at the county level which is much too large a division to identify transportation implications of existing or planned supply systems. To be of lasting usefulness the methodology must be capable of indicating the impact of changing environmental parameters, such as demographic characteristics of the population, on the demand for essential services. Thus, the methodology must have the potential to predict the future demand for essential services for

all locations in a region based on projected changes in the region's demographic character.

Easily Implemented

The methodology should be capable of implementation by local, regional and state government agencies. Such a criterion suggests that the methodology should use as input, readily available data. Local agencies frequently do not have the funds for undertaking major surveys and generally need to work with data they already have or can obtain from other sources without high out-of-pocket expenditures. The methodology should be relatively simple so that its process could be readily understood by users who did not possess extensive training in model building. Such an approach would improve the likelihood of acceptance and utilization of the methodology by local government agencies. Also, the users would be more aware of the limitations in the methodology and thus reduce the possibility of misinterpretation of the results. The methodology should also be capable of ready updating to provide timely reports on the effect of changes in the environmental parameters on the demand for essential services.

THE METHODOLOGY

The use of a survey or questionnaire to estimate satisfied and latent demand is rejected because it fails to meet the design specifications. Instead, an approach using census data at the enumeration district level will be combined with national usage rates cross-classified by pertinent demographic characteristics to yield an estimate of demand either satisfied or total (latent = total - satisfied) for each enumeration district in the planning region. The enumeration district is selected because it is the smallest areal unit for which census data is available in rural areas. For transportation implications it is critical that the smallest possible areal unit be utilized.

The discussion begins with an examination of the origins of satisfied versus latent demand. The methodologies to estimate satisfied and latent demand are then described separately, however, it will be clear that conceptually the methods are identical with only the selection of usage rates differing.

Total Demand

The origins of satisfied versus latent demand, which together constitute total demand, may be ascertained by examining the barriers which must be overcome by an individual in order to satisfy an existing need. These barriers are assumed to operate for a specific individual, with given socio-economic and demographic characteristics, who is faced by a given supply system configuration. They may be expressed as a series of questions which can be posed for the individual and which, in general, must be answered in the affirmative for a given instance of need to be satisfied (Figure 26).

We begin by posing the question as to the existence of symptoms of a need for an essential service (Figure 26). If answered in the affirmative, then nine barriers must be overcome for that service to be actually used. First, the symptoms must be recognized, either from information already possessed by the individual, from new information received by the individual from external media sources such as the radio, T.V. or education classes, or by an outreach worker. Secondly, the need to interact with a service facility must be recognized by the individual.

These first two barriers depend upon the individual himself. The remaining barriers relate both to the individual and to the characteristics of the service supply system. Thus, the third barrier relates to knowledge of service availability; the fourth concerns the individual's ability to pay for the service; the fifth concerns the availatility of transportation resources to reach the location of the service facility;[1] the sixth barrier asks whether the service is open at the time the individual needs, or is able to reach, the facility location; the seventh concerns eligibility to use the facility. The eighth asks whether the facility has the capacity to serve that individual on that occasion; and the ninth is concerned with problems of discrimination on racial, ethnic, religious, or socio-economic grounds. Recognizing that no one barrier in and of itself may be sufficient to deter

[1] A more detailed consideration of transportation barriers can be found in: J. E. Burkhardt and C. L. Eby "Need as a Criterion for Transportation Planning, "Highway Research Record, No. 435, 1973, 32-41

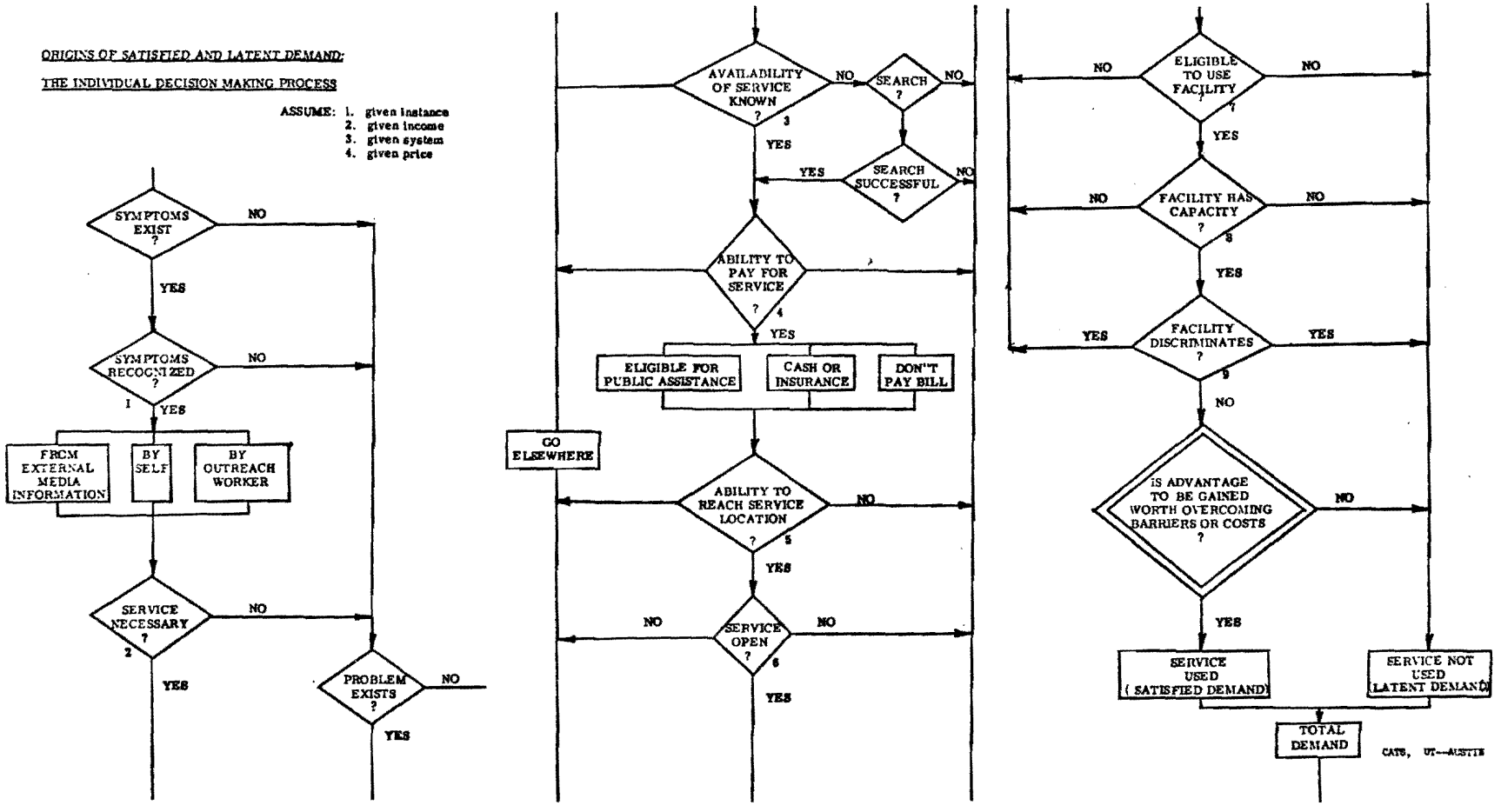

Figure 26. The Origins of Satisfied Versus Latent Demand

usage of facilities, the tenth and last barrier asks whether or not two or more of the earlier barriers in combination could lead to this situation. Only when all these barriers have been overcome will the service actually be used.

Where a barrier may exist with respect to the use of a particular facility a feedback loop of "Go Elsewhere" is available. If this cannot overcome barriers then the service system is not utilized.

The above framework relates to a given instance of service need. If over a period of time the number of instances of service usage is summed satisfied demand is obtained. Similarly, summing the number of times the service was not used gives latent demand. Together, satisfied plus latent demand equals total demand.

Satisfied Demand

The methodology for estimating satisfied demand is illustrated in Figure 27. The only input requirements are census data by enumeration district and actual usage rate of the service by household or per person. The actual usage rates are cross-classified by factors such as age, sex, race and income that influence the demand for the essential service of interest. These usage rates can be obtained from several primary data sources at the national or local level. One such national survey of health data is collected periodically by the National Center for Health Statistics. Thus this methodology will permit local government agencies to take advantage of data from major national surveys of the population to plan regional service systems avoiding the high cost of conducting individual surveys.

Applying these usage rates to the population by enumeration district results in an estimate of satisfied demand for the service at the enumeration district level within the planning region. Recall that this estimate may be based on usage rates derived from a national survey and thus it must be calibrated for the specific region of interest. Calibration is accomplished by comparing the total estimated demand for the region (summing all the enumeration district demands) with the sum of all the client visits from the region to service facilities serving the region over a specified period of time (e.g. one calendar year). The national usage rates are then uniformly adjusted to bring these sums into ageement.

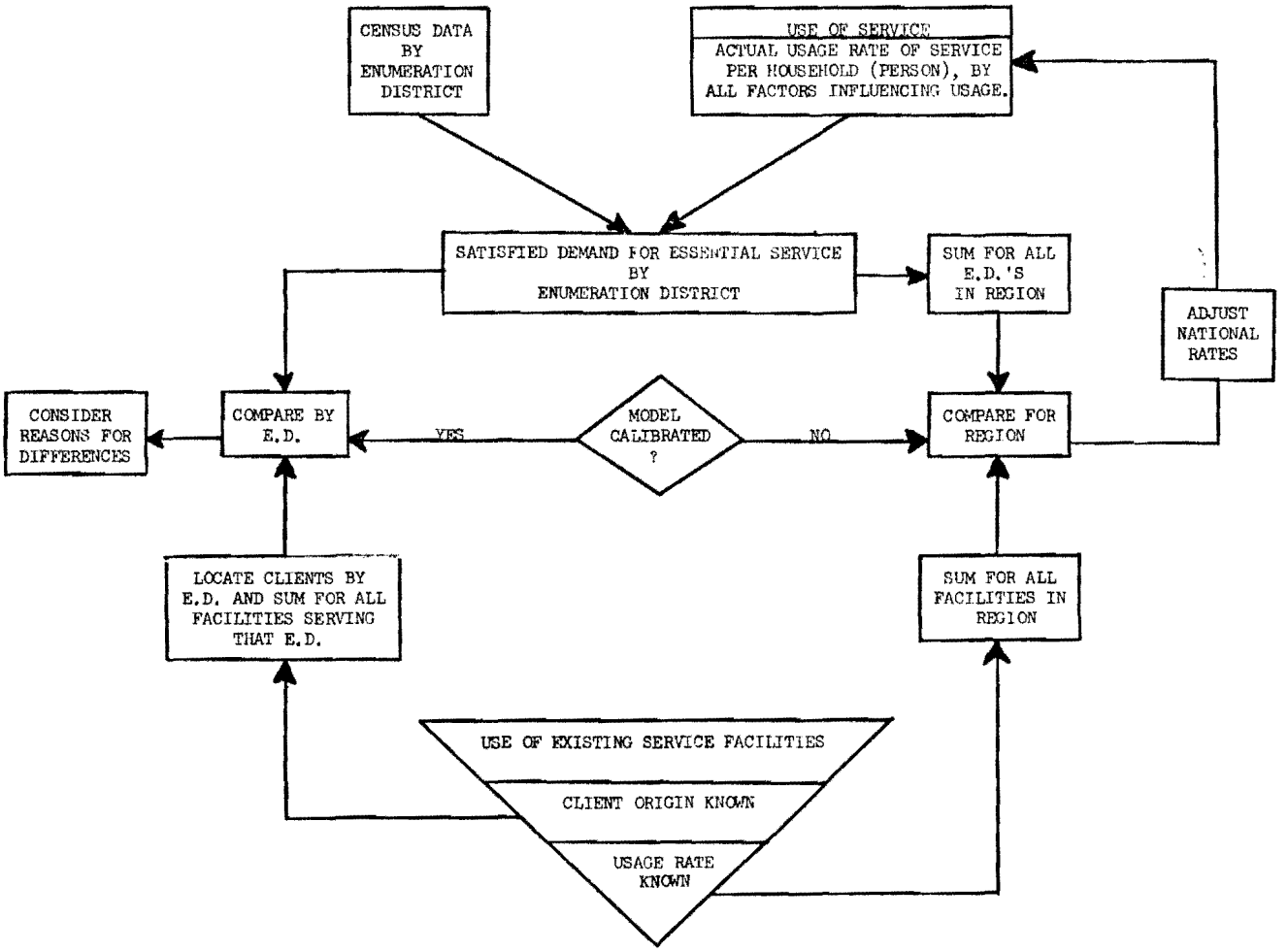

Figure 27. Estimating Satisfied Demand for Essential Service

If the complete address of clients using the service facilities are known, then a study of the deviations of actual demand from predicted demand by enumeration district may be accomplished. These client addresses may be located by their enumeration district of residence using a program similar to the Bureau of Census ADMATCH system, adapted for use in rural areas by relying upon community name or zip code. For each enumeration district, clients are summed for all facilities serving that district. This provides data on actual usage by enumeration district that may be compared to the model's estimated demand for the district.

Latent Demand

The methodology for estimating latent demand is illustrated in Figure 28. The structure is similar to that of the satisfied demand model in that usage rates by household or per person are applied to census data by enumeration district. It differs in that the usage rates selected are those that would appear most likely to exist in a barrier free environment. Such barriers to service could include lack of knowledge of service, ability to pay, transportation availability, discrimination and others. The selection of barrier free usage rates is very subjective and at best will be based on some reasonable expectations. For example, a white family with comprehensive health insurance, available transportation and located close to medical facilities, is unlikely to be seriously affected by environmental barriers to health service. The usage rate of such households could provide an estimate of barrier free hospital usage rates. However, the family may also be more healthy than the average.

Given such barrier free usage rates the model applies these rates, differentiated by characteristics bearing only on the rate of usage such as age and sex, to the population yielding an estimate of total demand for the service by enumeration district. By inputting the estimates of satisfied demand per enumeration district, an estimate of the latent demand per enumeration district can be obtained by subtraction.

Future Projections

Forecasting demand for essential services in the future may be accomplished by making changes in either the usage rates or the characteristics of the

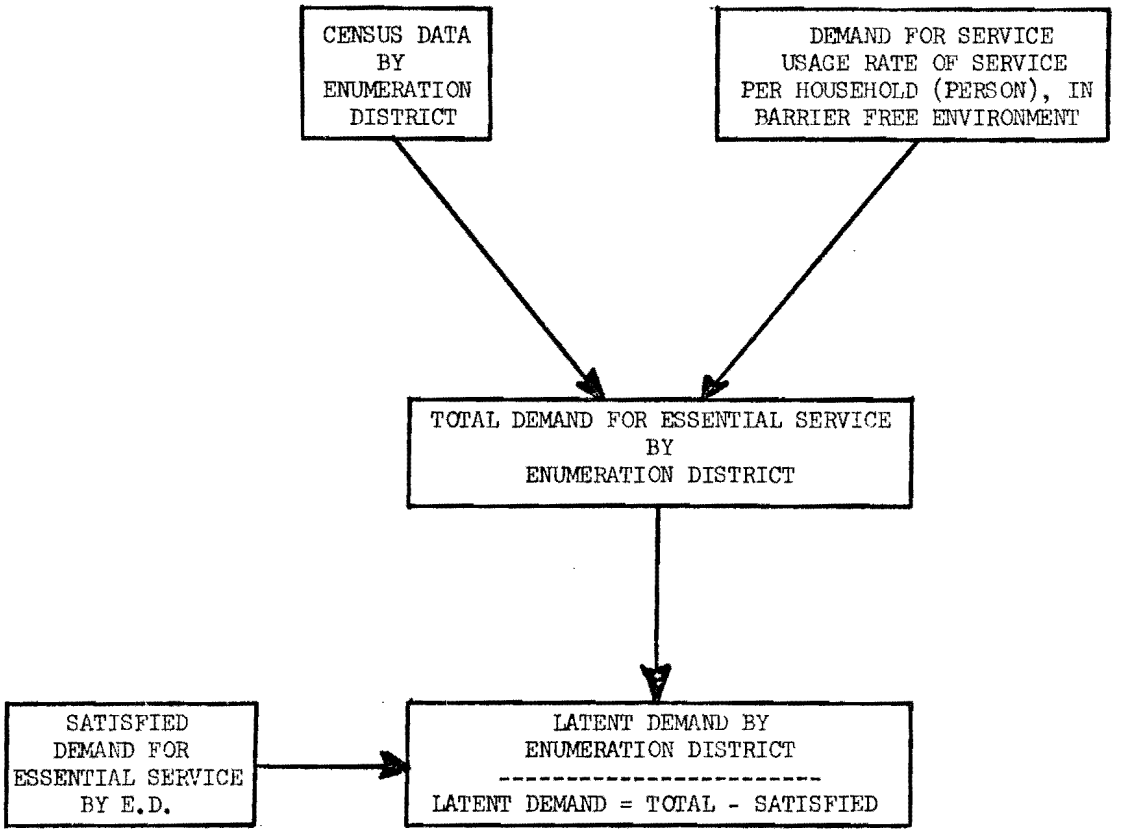

Figure 28. Estimating Latent Demand for an Essential Service

region's population. Expected trends in the usage rate of services can be readily incorporated into the model's data input. Changes in the demographic character or projected population trends for the region may be made to the census data by enumeration district. Rural areas have shown a steady trend of declining population together with a characteristic aging of the remaining population. These factors would suggest significant future changes in the demand for services in rural areas that should be accounted for in any projection.

ESTIMATING SATISFIED DEMAND FOR HOSPITALIZATION

Estimating the demand for hospital care is of particular interest to local planning agencies (i.e. B agencies) because of their responsibility under the Hill Burton Act to determine the need for new hospital construction or additions to bed capacity in their area. The process of determining demand for hospitalization will provide a severe test of the methodology because of the inherent problem of migration. The hospital to which a patient is admitted is the decision of the physician and very often for reasons of his convenience but also based on the availability of specialized facilities. Thus, special care must be taken to account for in and out migration for the region as a whole and between locations within the region when actual hospitalizations are compared to model estimates. However, as mentioned earlier, considerable information on hospital usage is regularly collected by national surveys and by local and state planning agencies. In particular, in Texas a one day patient-origin survey is conducted once every two years by the state Department of Health. The results of this survey will be used to account for patient migration. Thus, the necessary data is available to generate estimates of satisfied demand for hospitalization and compare these estimates with actual usage data collected from the region's hospitals. The steps in generating these estimates and their comparison follows.

Calculation of Estimates

Information on the usage rate of hospitals per person is obtained from

a national survey conducted by the National Center for Health Statistics.[2] The influence of age and sex on these usage rates is illustrated in Figure 29. However, the data was recorded by persons hospitalized by number of episodes per year. Thus some manipulation is required to obtain number of hospitalizations per year because each episode is treated as a new admission to a hospital. The data presented in Table 5 is obtained from the survey with the last column being the expected number of hospitalizations per 1,000 population per year using the value of 3 to represent the 3+ category. The resulting expected number of hospitalizations will thus be a conservative estimate. An elementary computer program is written to read the computer tapes containing the census data on age and sex for each enumeration district in the region. Using the expected number of hospitalizations per year from Table 5 the estimated demand for annual hospitalizations by enumeration district is calculated. A flow chart of this program is contained in Figure 30 and the program listing may be found in the Appendix A.

Migration

The Capital Area Planning Council region consisting of the 10 counties surrounding Austin, Texas is also the Austin Health Planning Region. As illustrated in Figure 31 each county has at least one hospital with several counties having 2 or 3 hospitals. Austin with 7 hospitals is designated the regional medical center. Table 6 contains information on the bed capacity and the number of admissions for calendar year 1970 for each hospital in the region. An analysis of the patient-origin surveys conducted over the past several years reveals considerable migration of patients within the region, principally from the outlying counties into Travis county with a net out-migration for the region. The migration data by county for the one day survey conducted on December 2, 1970 is summarized in Table 7. The migration phenomenon is so extensive that any attempt to compare actual admissions for hospitals in a county (region) to the estimate generated by the methodology for the county (region) must explicitly account for this characteristic

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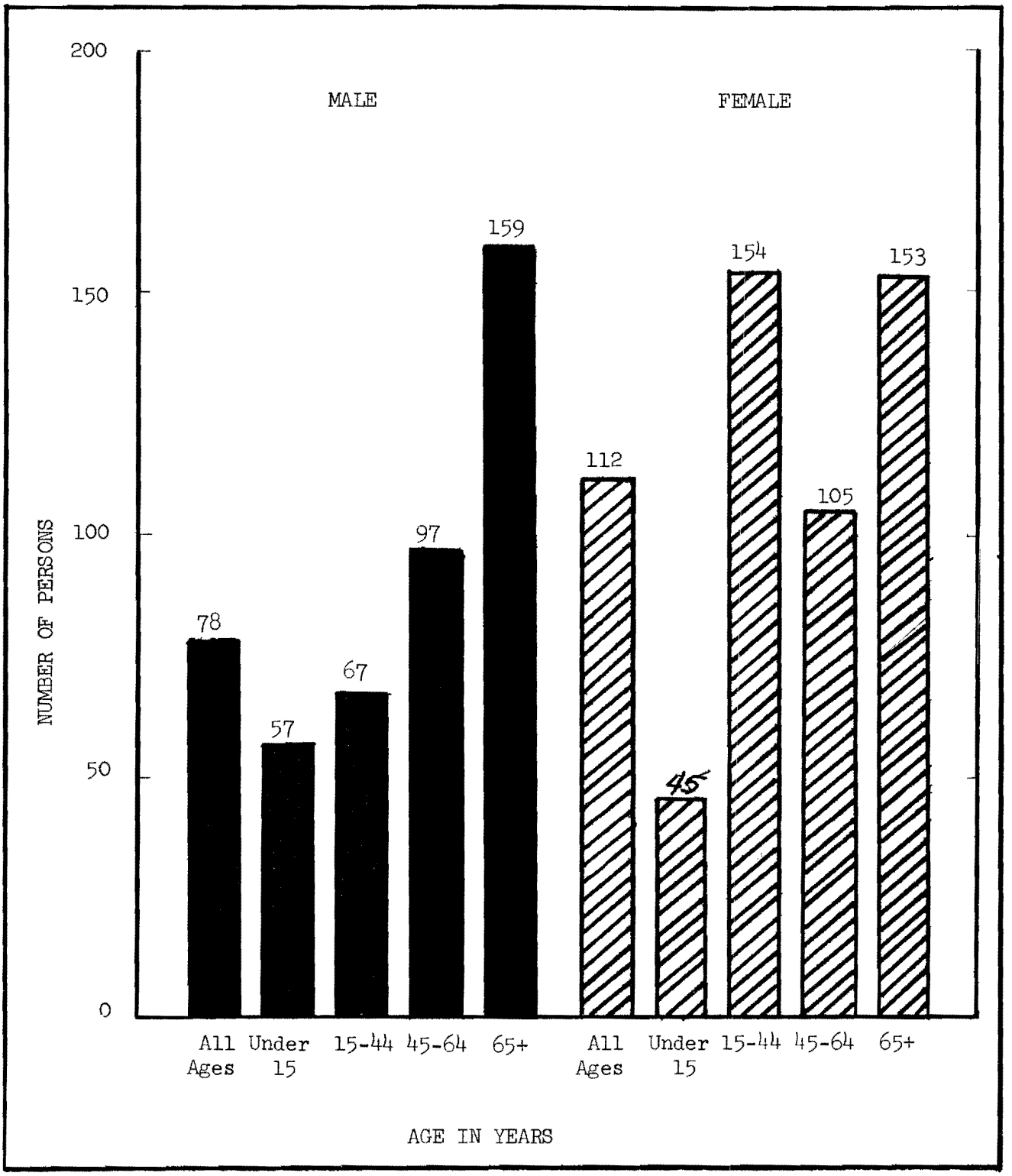
[2]Persons Hospitalized by Number of Hospital Episodes and Days in a Year, DHEW Publication No. (HSM) 72-1029. Vital and Health Statistics - Series 10, No. 64, U.S. Department of Health, Education and Welfare, December 1971.



Source: See Footnote 2, page 109.

Figure 29. Number of Persons Hospitalized per 1,000 Population per Year, By Age and Sex

TABLE 5. Number of Persons Hospitalized per 1,000 Population per Year

Sex	Age	Number of Episodes				Expected Number Hospitalized
		None	1	2	3+	
Male	Under 15 Years	943.3	51.6	3.9	*	59.4
	15-24	940.1	53.3	5.8	*	64.9
	25-44	928.3	62.1	7.0	2.5	83.6
	45-64	902.5	78.9	13.1	5.4	121.3
	65 and Over	841.4	124.6	24.7	9.4	202.2
Female	Under 15 Years	955.3	40.9	3.1	*	47.1
	15-24	846.4	136.4	13.8	3.4	174.2
	25-44	844.9	135.1	16.1	3.9	179.0
	45-64	894.7	87.8	13.5	4.0	126.8
	65 and Over	847.3	119.3	22.9	10.4	196.3

*Figure does not meet standards of reliability or precision (more than 30 percent relative standard error)

Source: Persons Hospitalized by Number of Hospital Episodes and Days in a Year, DHEW Publication No.(HSM) 72-1029. Vital and Health Statistics - Series 10, No. 64, U.S. Department of Health, Education and Welfare, December 1971.

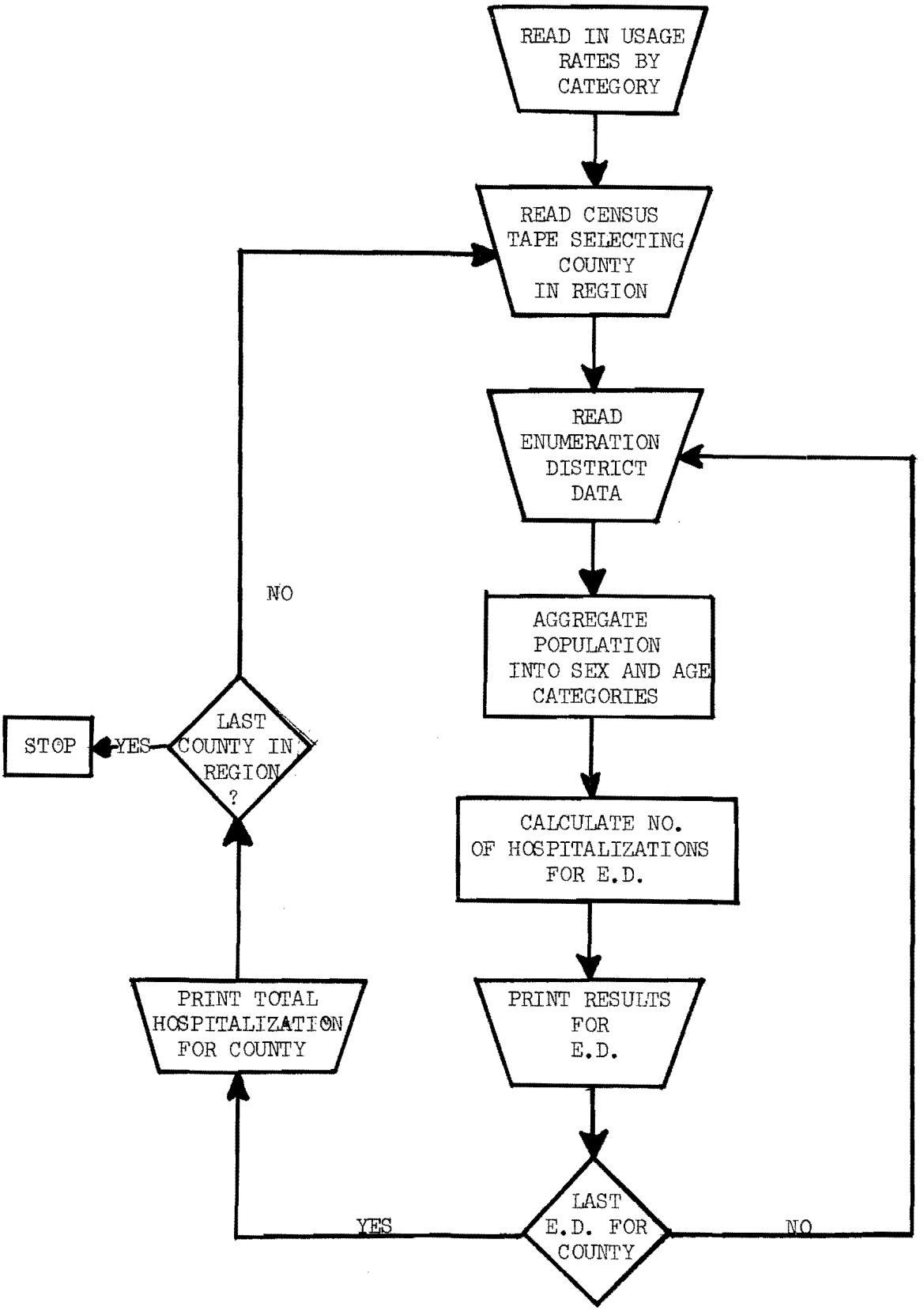


Figure 30. Flow Chart of Demand Estimation Program

```
      PROGRAM HOSPIT(INPUT,OUTPUT,      TAPE5=INPUT,TAPE6=OUTPUT,
     1TAPE11)
      DIMENSION XMRTC(10),XMSTC(10),MRTC(10),MSTC(10),MRT(22),MST(22),
     1HM(10),HF(10),DMDM(10),DMDF(10)
      DIMENSION DATA(300)
      INTEGER DATA
      JPJ=0
      NCOUNT = 0
      DMDTOT = 0.0
      PRINT 239
  239 FORMAT(1H1,23X,*TOTAL*,/2X,*COUNTY    ED NO, HOSPITALIZATION MALE
     11       MALE 2       MALE 3       MALE 4    FEMALE 1    FEMALE 2    F
     2EMALE 3    FEMALE 4*)
      KOUNTP=2
      ICXP=0
 1000 J=IOP(2HRR,11)
      IF(J.EQ.1) GO TO 910
      IEF=IOP(2HRB,11,DATA(1),250)
 1001 NCC=DATA(3)
      ICXP=ICXP+1
      IF(NCOUNT.EQ.0) NCOUNT=NCC
      IF(NCC.EQ.NCOUNT) GO TO 209
      PRINT 219,NCOUNT,DMDTOT
  219 FORMAT(///,10X,*TOTAL HOSPITALIZATION FOR COUNTY NUMBER *,I5,
     1* IS *,F15.5)
      DMDTOT=0.0
      NCOUNT = NCC
      PRINT 239
      JPJ=0
      KOUNTP=2
  209 CONTINUE
      NED = DATA(16)
      DO 201 J=1,22
      JD=J+63
  201 MRT(J)=DATA(JD)
      DO 202 J=1,22
      JD=J+85
  202 MST(J)=DATA(JD)
C     POPULATION IS BROKEN DOWN INTO FIVE CATEGORIES WITHIN THE TWO SEX
C     GROUPINGS.  THESE VALUES ARE STORED IN MRTC=FOR MALES= AND MSTC=FOR
C     FEMALES=.
      DO 100 I=1,10
      MRTC(I)=0
  100 MSTC(I)=0
C     UNDER 15 YEARS OF AGE.
      DO 200 I=1,6
      MRTC(1)=MRTC(1)+MRT(I)
```

```
  200 MSTC(1)=MSTC(1)+MST(I)
C     15 - 24 YEARS OF AGE.
      DO 300 I=7,14
      MRTC(2)=MRTC(2)+MRT(I)
  300 MSTC(2)=MSTC(2)+MST(I)
C     25 - 44 YEARS OF AGE.
      DO 400 I=15,16
      MRTC(3)=MRTC(3)+MRT(I)
  400 MSTC(3)=MSTC(3)+MST(I)
C     45 - 64 YEARS OF AGE.
      DO 500 I=17,20
      MRTC(4)=MRTC(4)+MRT(I)
  500 MSTC(4)=MSTC(4)+MST(I)
C     65 YEARS OF AGE AND OVER.
      MRTC(5)=MRT (21)+MRT (22)
      MSTC(5)=MST (21)+MST (22)
C     READ IN HOSPITALIZATION PER 1000 POPULATION BY AGE AND SEX
C     HM(4)=MALE FREQUENCY BY AGE AND HF(4)=FEMALE FREQUENCY BY AGE
      DATA (HF(I),I=1,5)/47.1,174.2,179.0,126.8,196.3/
      DATA (HM(I),I=1,5)/59.4,64.9,83.6,121.3,202.2/
C     HOSPITALIZATION FIGURES ARE PRINTED OUT FOR THE ENUMERATION DISTRICT
C     (TOTAL), AND ALSO BY THE VARIOUS SEX AND AGE BREAKDOWNS.  TOTAL
C     USAGE FIGURES FOR THE COUNTY ARE ALSO PRINTED.
      DMD=0.0
      DO 600 I=1,5
      DMDM(I)=0.0
      DMDF(I)=0.0
      XMRTC(I)=MRTC(I)
  600 XMSTC(I)=MSTC(I)
      DO 800 I=1,5
      DMDF(I)          =XMSTC(I)*HF(I)*.001
      DMDM(I)          =XMRTC(I)*HM(I)*.001
  800 DMD=DMD+    DMDF(I)+DMDM(I)
      DMDTOT=DMDTOT+DMD
      KOUNTP=KOUNTP+2
      IF(KOUNTP.EQ.62) JPJ=1
      PRINT 900, NCC,NED,DMD,(DMDM(I),I=1,4),(DMDF(I),I=1,4)
  900 FORMAT( /,2X,I5,5X,I5,3X,9F12.3)
      IF(JPJ.EQ.0) GO TO 1000
      PRINT 290
  290 FORMAT(/)
      PRINT 240
  240 FORMAT(     23X,*TOTAL*,/2X,*COUNTY    ED NO. HOSPITALIZATION MALE
     11       MALE 2       MALE 3       MALE 4     FEMALE 1    FEMALE 2    F
     2EMALE 3    FEMALE 4*)
      JPJ=0
      KOUNTP=2
      GO TO 1000
  910 CONTINUE
      PRINT 219,NCOUNT,DMDTOT
      END
```

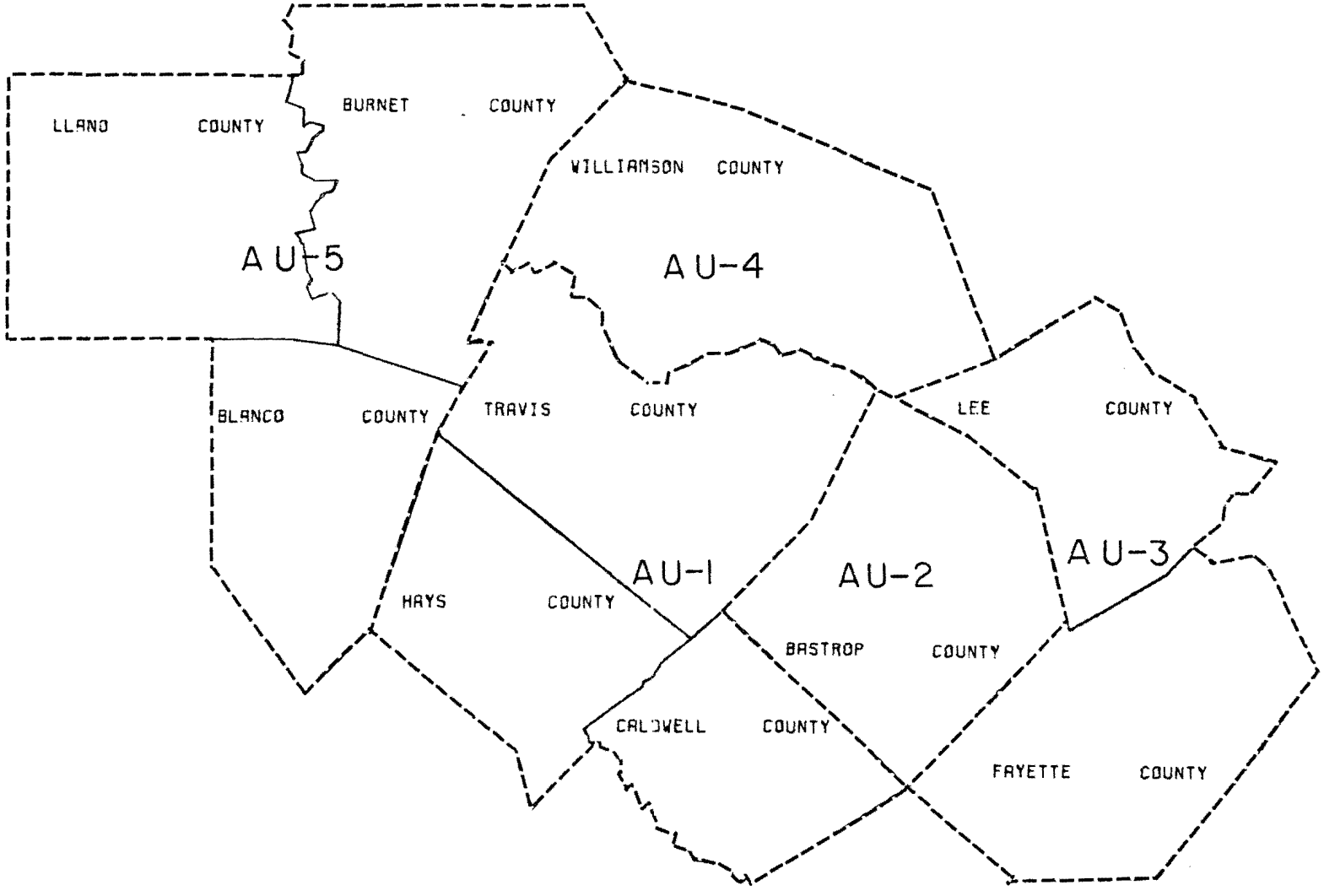


Figure 31. The Austin Hospital Planning Region

TABLE 6. Hospital Admissions for the Year 1970

County	Hospital	Beds	Admissions
Bastrop	Bastrop Memorial	25	819
	Fleming Memorial (Elgin)	20	535
	Smithville Hospital	25	391
Blanco	Johnson City Hospital	15	256
Burnet	Sheppard Memorial (Burnet)	69	1366
Caldwell	Davis Memorial (Luling)	30	735
	Lockhart Hospital	42	1014
Fayette	Fayette Memorial	60	1865
Hays	Hays Memorial (San Marcos)	40	2091
Lee	Lee Memorial (Giddings)	34	727
Llano	Llano Memorial	27	658
Travis	Brackenridge Hospital	344	10398
	BAFB Hospital	50	2145
	Holy Cross Hospital	148	4490
	Mt. Carmel Hospital	28	572
	Seton Hospital	152	6046
	Shoalcreek Hospital	280	1602
	St. David's Hospital	256	9285
Williamson	Georgetown M & S	42	1497
	John's Community (Taylor)	59	2342

Source: Texas 1971 State Plan for the Construction and Modernization of Hospitals and Related Medical Facilities, Texas State Department of Health, Austin, Texas.

TABLE 7. Percent Migration by County of Persons Seeking Hospitalization for the Year 1970

To / From	Bastrop	Blanco	Burnet	Caldwell	Fayette	Hays	Lee	Llano	Travis	Williamson	Outside Region
Bastrop	66.6								20.4	9.3	3.7
Blanco		41.7							16.6		41.7
Burnet			65.5						21.8		12.7
Caldwell				49.0					27.5		23.5
Fayette					55.C				8.7		36.3
Hays				1.8		52.8			34.5		10.9
Lee	6.0				21.2		36.4		18.2		18.2
Llano			14.3					47.6	14.3		23.8
Travis	0.3			0.1	0.1	0.3			92.5	0.4	6.3
Williamson			1.0	1.0					25.2	60.2	12.6
Outside of Region*	4.8		2.4	3.6	11.9		7.7		6.8	7.9	

*As a percent of total hospitalizations in county

Source: Area Hospital Patient-Crigin Study, Capital Area Planning Council, December, 1973.

of health delivery systems. To this end a formula is derived to predict total annual hospital admissions by county using the following notation:

H_i = Total Annual Admissions for Hospitals in County i

C_i = Predicted Annual Hospitalizations for County i Based on Population by Age and Sex

P_{ij} = Proportion of County i Residents Hospitalized in County j (Note: P_{ii} is often defined as the "service ratio" or proportion of local residents hospitalized locally)

Q_i = Proportion of County i Residents Hospitalized Outside Planning Region

M_i = Proportion of Total Annual Admissions to Hospitals in County i from Outside Planning Region

Total annual admissions for hospitals in a county will consist of annual hospitalizations for residents in the county less out migration (into surrounding counties or outside planning region).

$$H_i = C_i - C_i \sum_{j \neq i} P_{ij} + Q_i + \sum_{j \neq i} P_{ji} C_j + M_i H_i$$

$$= C_i P_{ii} + \sum_{j \neq i} P_{ji} C_j \qquad 1/(1-M_i)$$

Results

Table 8 summarizes the calculations of predicted total annual admissions for hospitals by county and for the entire planning region. On a regional basis the total annual admission figure is within 7/10 of 1 percent of the actual total number of hospital admission for the CAPCO region. No attempt was made to calibrate the results because the prediction so closely matched the actual data.

Although the methodology estimated hospitalizations at the enumeration district level, the sub region comparison must be made at the county level because the patient-origin data is recorded by county of residence. An extensive analysis of the differences between actual and predicted hospitalizations by county will not be discussed here, however, a few general observations concerning health care delivery will be made. First, these differences

TABLE 8. Comparison of Satisfied and Actual Demand for Hospitalizations for the Year 1970

Census Number	County	C_i	P_{ii}	$\sum_{j \neq 1} P_{ji} C_j$	M_i	H_i	Actual	Difference	% Difference
21	Bastrop	2063	.666	157	.048	1608	1745	(137)	-7.8
31	Blanco	441	.417	0	.000	184	256	(72)	-28.1
53	Burnet	1422	.655	175	.024	1129	1366[a]	(237)	-17.3
55	Caldwell	2286	.490	133	.036	1300	1949	(649)	-33.3
149	Fayette	2242	.550	242	.119	1674	1865	(191)	-10.2
209	Hays	3139	.528	98	.000	1755	2091	(336)	-16.1
287	Lee	988	.527[c]	0	.077	564	727	(163)	-22.4
299	Llano	918	.476	0	.000	437	658	(221)	-33.6
453	Travis	32,633	.925	4104	.068	36,789	34,538[b]	(2251)	6.5
491	Williamson	4383	.602	322	.079	3214	3839	(625)	-16.3
				Entire Region		48,654	49,034	(380)	-0.7

[a]Allen Clinic Excluded
[b]U.T. Health Center Excluded
[c]Average for Years 1966, 1968, 1970, 1972

should not come as a surprise because this phenomena of variations in health care delivery among small regions is well documented.[3] Furthermore, the accuracy of the prediction is very sensitive to the county service ratio "P_{ii}" figure that is based on only one day's data. A consideration of past service ratios for the years 1966, 1968, 1970 and 1972 reveals that this r ratio is not a stable figure. This fact prompted the use of an average "service ratio" for Lee county because the ratio given for 1970 was much too low compared to other years. Finally, a possible explanation for the general level of poverty in these areas prompting physicians to more frequently hospitalize their patients to insure Medicare payment of fees.

ESTIMATING THE DERIVED TRANSPORTATION DEMAND

It is of interest to estimate transportation requirements associated with a particular service delivery system. Although transportation demand is not the only measure of effectiveness of a delivery system, it is a particularly important one. The procedure described here attempts to predict the travel by individuals seeking a service engendered by a given service delivery system.

Figure 32 illustrates the steps used to estimate the derived transportation demand. As shown, it requires as input the demand for service by enumeration district, using demographic data from census enumeration districts and national usage rates to estimate demand for service as described previously in this section.

For our purposes, demand for a service is aggregated to the level of the census enumeration district. All demand from an enumeration district is assumed to originate at its geographical centroid. This level of aggregation was chosen because the enumeration district is the smallest unit for which population data can reasonably be obtained. The district is still small enough that point to point travel distances are meaningful.

The service delivery system is represented by a specified number of

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[3]Wennberg, John and Alan Gittelsohn, "Small Area Variations in Health Care Delivery," Science, Vol. 182, (December 14, 1973) pp. 1102-1108.

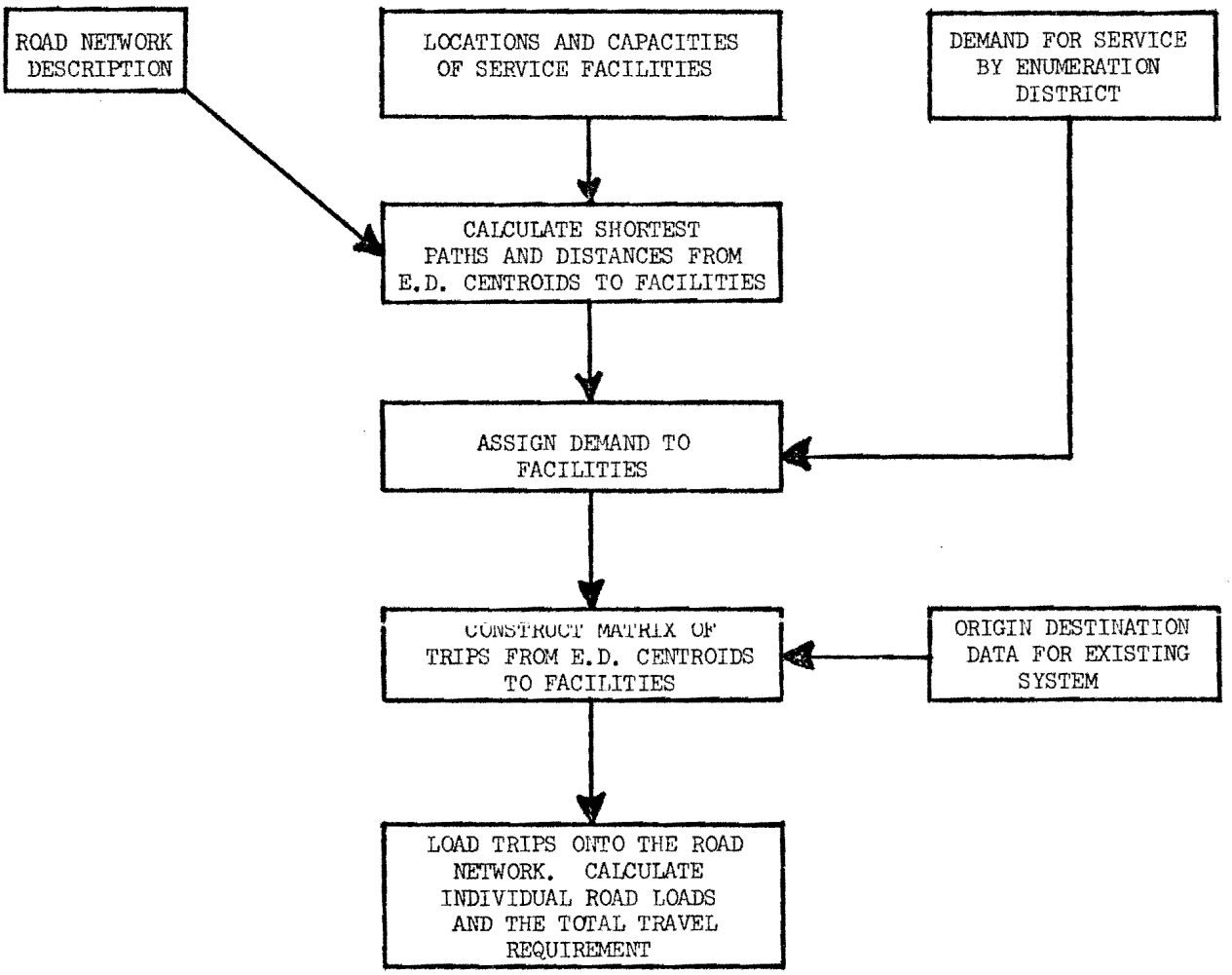

Figure 32. The Derived Transportation Demand Model

service facilities located in the area. Service facilities are described by their location and capacity. The location of a facility can be at either an enumeration district centroid or at a community within the study area.

Persons who require the service must travel from their residence to a facility. The travel requirement associated with such a trip is measured by the shortest road distance from the centroid of the enumeration district in which the person resides to the location of the facility. If there are several facilities in the area providing the same service, one must determine an assignment of the person to a facility which reflects a realistic representation of a person's decision process or perhaps some assignment procedure by a government agency. The current proceedure uses the simplistic assumption that persons travel to the closest facility. All travel takes place on the road network of the study area. Thus, an accurate representation of the road network must be input to the model.

The road network is represented by sets of nodes and links. A node is an intersection of two or more roads or a measuring point along a road. The latter case occurs particularly at county boundaries. A link is a road segment which begins at a node and ends at a node. A link is characterized by an identifying symbol and a length in miles. The representation of the road system in the ten county area requires approximately 400 links.

The input data required for the procedure consists of the rate of demand for the service for each enumeration district, the location of each service facility, and the links of the road network. The location of the service facilities are specified by node numbers in the road network. The first step in the computer procedure is to read this data.

The second step in the procedure is to find the shortest path over the road network from each enumeration district centroid to each service facility. This process is accomplished with a standard shortest path algorithm.

The third step in the procedure is to assign the demand to service facilities. There are a number of ways that this process might be conceived. The most realistic approach depends on the particular service delivery system under study and degree of choice available to the consumer. For instance, in a health care delivery system, the individual often has considerable

latitude on the choice of his personal physician. Thus, the assignment of demand to facility would have to reflect the uncertainties involved. Alternatively, for vocational rehabilitation services, individuals may be assigned to particular offices, thus the assignment model could have a deterministic rule. The current procedure assigns demand to the closest service facility. Although this is the most simplistic procedure more complex ones are easily substituted. A procedure is currently under development to incorporate facility capacities into the assignment rules.

The fourth step in the procedure is to calculate transportation requirements for the service facility plan and the assignment rules. This is accomplished by loading the travel requirements as determined in step 3 onto the shortest paths determined in step 2. This process determines a travel demand for each link in the road network and an estimate of total travel demand in person miles.

The derived transportation demand procedure has been programmed for the computer. The approach described here is similar to that introduced by the Federal Highway Administration for traffic assignment in urban areas. Efforts are currently under way at the University of Texas to adapt the FHA traffic assignment programs for the local computer, however, these have not yet been successful. It is likely, moreover, that the derived transportation demand procedure program written for this research will admit greater flexibility for experimentation than the more complex traffic assignment programs written for the FHA.

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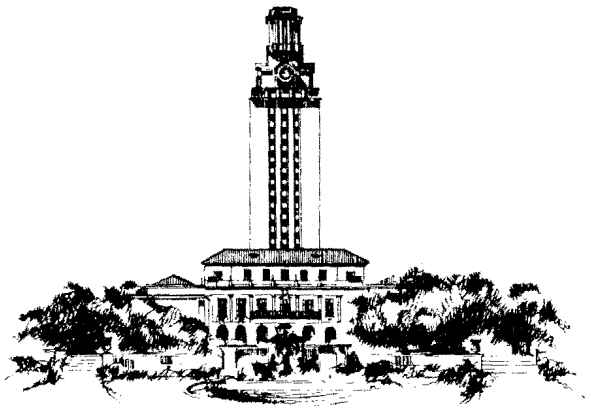

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