PLANNING SPECIAL TRANSPORTATION SERVICES

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Within the past 20 years we have created for ourselves a type of dilemma in planning transportation services. On the one hand, we have increased our knowledge about travel through the use of computers, advanced statistical techniques, and increasing budgets. We know with great accuracy trips per capita, automobiles per household, riders per automobile, employment statistics, and hundreds of other numbers that should aid us in defining clearly what individual transportation needs are.

On the other hand, we also find that a large number of urban residents, especially those who are poor and do not have automobiles, are shortchanged in their trip-making ability. Although the Watts riots in Los Angeles were a highly visible example of dissatisfaction with present systems, experiences in many cities with varied population characteristics, including Baltimore, Nashville, Buffalo, and New York City, have shown that merely the ability to collect or use all of the data has not been enough. In fact, the reasons that so many people in cities have been handicapped in their ability to travel might be found by asking several questions: Are the data for planning satisfactory? Have we been unable to plan correctly? Do we lack the commitment within urban areas to plan and implement the plans correctly?

This paper is especially concerned with answers to the first 2 questions. Special services as used here will apply to transportation requirements that evolve from microstudies in large urban areas. The emphasis will be on deriving planning needs and not on specifying the resulting hardware recommendations.

IDENTIFYING AND DEFINING SPECIAL NEEDS

The term special services might be a misnomer, for what is really meant are transportation services tailored to specific needs of a group within a large area. The specific needs in this paper are those of the predominantly black lower and lower-middle classes who live in a geographically identifiable section of a major urban area. (The study analyzed here is based for the most part on data collected for the Buffalo area. The fact that conditions in Buffalo are not unique is amplified by data and analysis presented for Nashville in another report (8) from which additional data for this paper are taken.)

The primary step in a working plan is to identify real goals or needs on a personal basis so that the resident of the area in study can be made to feel that he is a part of that total plan. The next series of steps, of course, is to see if the goals as defined are attainable based on existing or forthcoming resources. It should be pointed out that all goals that are not obtainable cannot also be categorized as unrealistic. For example, a goal of the black ghetto dweller might be to have access to the same number of jobs in 20 minutes of travel time as his white suburban counterpart. This is a real, but presently unattainable, goal in many urban areas; it is not, as would often be categorized, unrealistic.

The Buffalo metropolitan area has many characteristics shared by industrial cities of similar size (population of more than 1 million) in the United States. Although the population of the city itself has stabilized, or actually declined slightly in the past 30

years, the suburban growth has been rapid. This suburban growth is not restricted to housing alone, but also includes industry. This has resulted in a large increase in the job market outside the city limits. The percentage of workers from the Buffalo inner city area working in suburban locations has increased from 18 to 27 percent in the period 1960 to 1968. However, it cannot be stated simply that people are moving where the jobs are. Simultaneously the percentage of the city population that is black has increased steadily, and in the last special census (1966) blacks represented 17.4 percent of the Buffalo city population, an increase of 4 percent above the 1960 census. During that period, total population of the city of Buffalo declined 10 percent. A further brief introduction to the black ghetto area of Buffalo can be made by noting that the median family income is 75 percent of the median city income, and that automobile ownership is half that of the city average. In similar figures for the Nashville model cities area, median income was 57 percent of that for metropolitan Nashville and automobile ownership was 62 percent. The Nashville figures are incorporated here because special services have already been recommended for that city, which is so similar in quantitative analyses to Buffalo.

Further data that will be studied in more detail in a later section indicate that in the black population a significantly fewer number of people hold occupations that can be classified as professional or managerial and that the houses they live in have either lower rental value or lower ownership value. It is the quantification of these general facts that are so well known to us that makes possible real analyses on a microlevel.

If the general goal of the urban black is to better his quality of life (without perhaps a corresponding change in the style of his life), specific goals and their immediate transportation requirements can also be identified. Some of these are given in Table 1.

What is evident from the list given in Table 1 is that generally there is no one form of transportation (other than the automobile) that is ideally suited to all trip needs. Current lack of adequate transportation is one factor in the total ghetto syndrome characterized by high unemployment, lack of adequate competitive markets, poor health care, and to a very large degree lack of cultural and social interchange. However, there is no implication that attainment of an automobile or provision of special services will in themselves raise income, increase culture, provide for better education, or hasten integration. These are social goals, and adequate transportation is only one piece of hardware through which these goals can be realized.

At the most minimal level, the special needs of blacks are those that will raise their standard of living as reflected in statistical values to that of the urban area as a whole.

PLANNING SERVICES BY USING AVAILABLE DATA

Readily available data, such as regular census data regarding income and occupational status or special census data regarding travel characteristics and automobile ownership, can be used in 2 major ways. The first is to identify a region of homogeneity, or similar characteristics, in which patterns of total travel behavior are somewhat predictable. The second is to use the data to develop causative relationships between population characteristics and travel. In a later section a combination of these uses is shown to provide a still more powerful method for isolating areas of special need.

TABLE 1
GOAL DELINEATION

General Goal	Transportation Requirement
Better job market	Bus service or special service to dispersed market from ghetto origin
Better health service	Rapid access to hospitals or clinics or mobile clinics
Wider market for necessary or luxury goods	Market type of vehicle service to dispersed shopping areas
Personal business improvement	Small vehicles on a call basis
Social-cultural improvement	Small vehicles on a call basis

An example of the first use is given in a close look at a one-square mile zone of Buffalo made up of portions of 5 census tracts. This zone, originally defined for use in a previous transportation study, is bisected by a major artery acting on a slight diagonal and is divided into a west portion, W, of predominantly white popu-

TABLE 2
POPULATION CHARACTERISTICS OF A SELECTED STUDY ZONE

Tract	Percent Nonwhite Population	Median Income ($)	Number of Households	Number of Households With No Automobile	Percent Professional-Managerial Workers
W1	0.2	8,000	1,053	318	45.0
W2	0.32	6,821	4,274	1,799	34.6
E1	34.5	4,706	4,169	1,983	13.5
E2	81.0	4,523	5,416	2,569	6.3
E3	1.0	4,591	4,035	1,616	17.1

Note: Population densities (adjusted to areas within zone) are for W, 11,000 persons/sq mi, and for E, 22,000 persons/sq mi.

lation and an east portion, E, of predominantly black population. The census tracts constituting this zone are designated W1, W2, E1, E2, and E3. (The notation is for simplification of use in this paper. The tracts are U.S. Bureau of Census tracts 31, 32, 66b, 67, and 68 for the Buffalo SMSA.) Table 2 gives pertinent tract characteristics to show the ability to develop homogeneous characteristics.

The second use is shown in Figure 1 in which the influence of median income on both total trips and trips by mode is shown for the city of Buffalo as divided into 5 homogeneous areas (1). Clearly, total trips and trips by mode are functions of median income. This in itself is well known and documented (2). What is to be emphasized here is that income data are relatively accessible and somewhat predictable on the basis of census trends, whereas trip-making statistics are generally available only through special studies.

Figure 1 also shows the problem of data aggregation. The filled-in points represent the city as a unit. Each of the other points represents a somewhat homogeneous subzone of the city. Work by Kouyoumdjian (1, 3) indicated that the choice of geographic divisions within the city for use in predicting causal parameters influencing trip-making could have significant effects. He compared trip data by mode from 3 rings originating from the CBD and made up of census tracts with the 5 zones mentioned earlier and with square-mile zones established by the Niagara Frontier Transportation Study. Although the best results in terms of predicting trips by mode as a function of population characteristics occurred uniformly in the 5 zones, selected because of homogeneous characteristics, a high degree of confidence can also be placed in the ring analysis for the innermost zone. When trips were broken into modes, i.e., automobile and bus, it was found that the indicators of automobile trip generation (income, population per zone, automobiles per household, and persons per household) did not yield the same confidence in bus trip generation. However, the best confidence was found in zones of highest population density, which corresponded to the zone of greatest use.

Further study has indicated (4, 5) that in Buffalo a significant number of blacks use, what can be characterized as an important additional mode, the ride. This factor in itself is important in work trips made by blacks, so that any consideration of special services to an area designated as transportation deficient must include methods for measuring trips as automobile rides. For example, of total work trips originating from a zone of predominantly black population ending in both that and adjacent zones, 48 percent were as automobile passenger; whereas of total trips originating from a predominantly white zone one mile from the first mentioned zone, only 17.6 percent were as automobile rider. It is significant to note also that both of these zones are radially within 1.5 miles from the CBD, and both have appreciably the same number of bus route-miles per square mile of area. What the data do not point out are the additional facts that the bus routes are predominantly CBD-oriented while the black blue-collar job market is not and that bus schedules do not adequately cover shift work.

Available data will provide to the planner information on job category on as accurate a basis as desired (census) and industry category and size (census, Polk, or similar survey) from which potential job routes can be established.

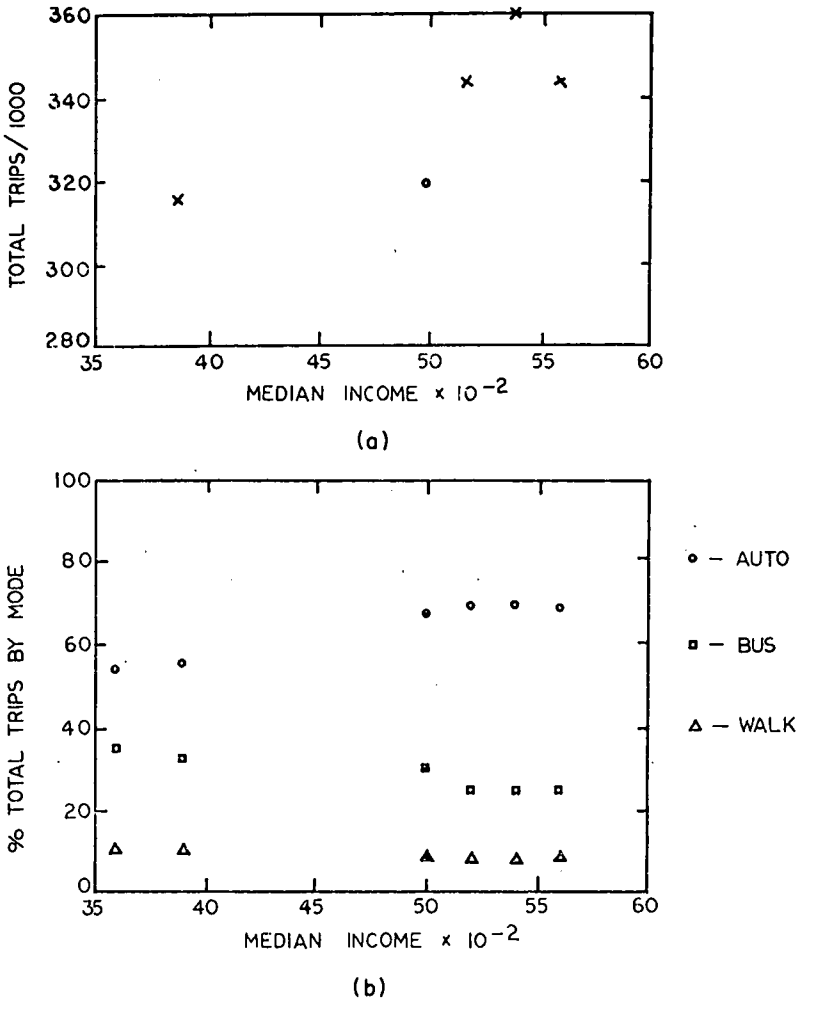

Figure 1. Trip distribution as a function of income for areas of Buffalo.

Because personal characteristics are becoming so important in quantifying need for special services, it becomes necessary to replot the available data in another form, that of continuous or contour maps. Figures 2 through 7 show contours of median income, percentage of households with no automobiles, percentage in area who have to work, percentage of males in professional or managerial positions, rent values, and home ownership values for the city of Buffalo. Isolating areas of low income, low automobile ownership, and low percentage of professional workers would give the planner a strong potential for establishing work-trip patterns. Although not done here, a study of contour development as a function of time would aid in establishing trends in future work-trip patterns, a great assistance in planning both major area and special services. For example, a growing pool of blue-collar workers living in the CBD coupled with a dispersion of blue-collar jobs in suburban areas as quantified in a previous section might be indicative of a large number of potential riders who would not take a CBD-oriented, highly centralized rapid transit system.

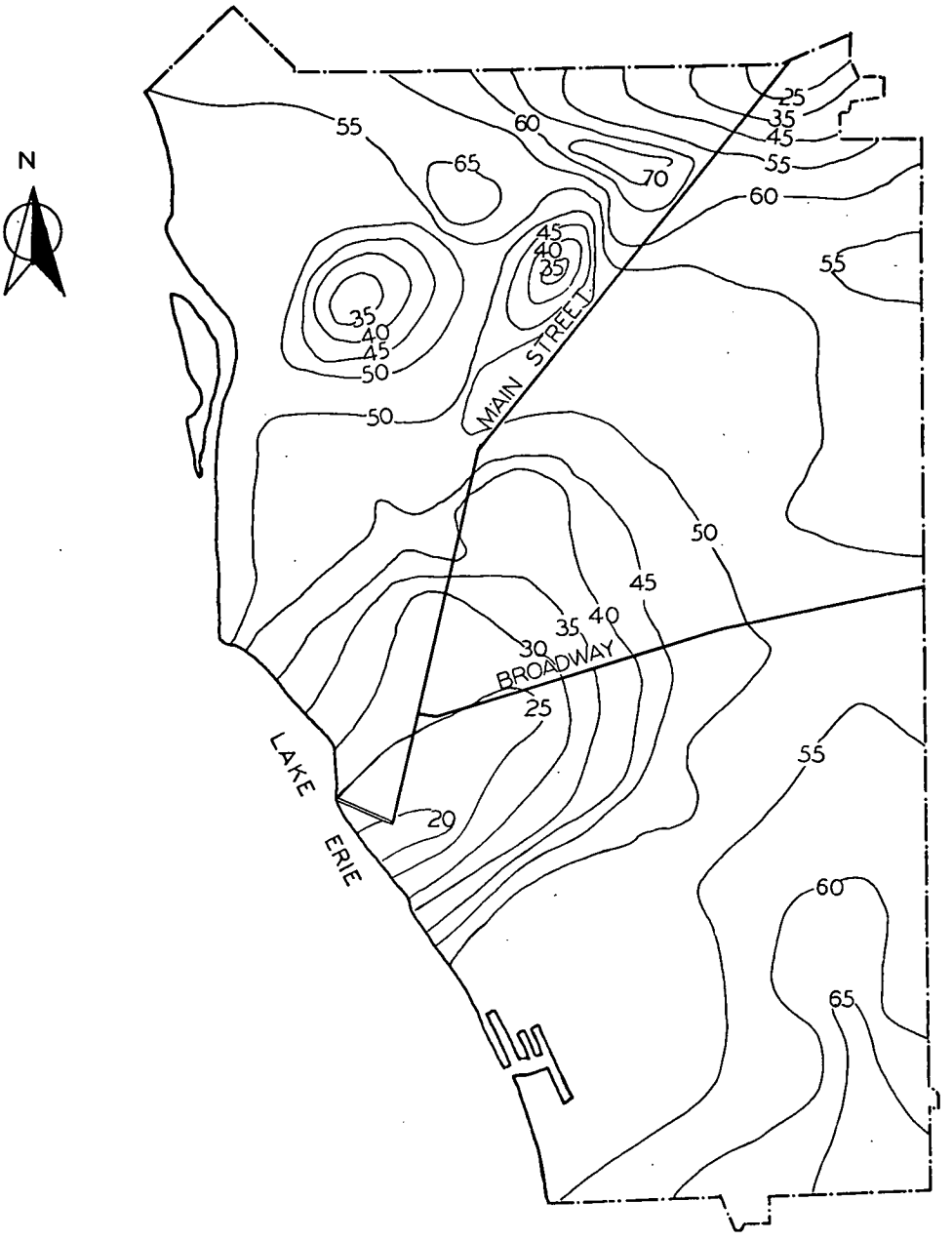

Figure 2. Median income in hundreds of dollars.

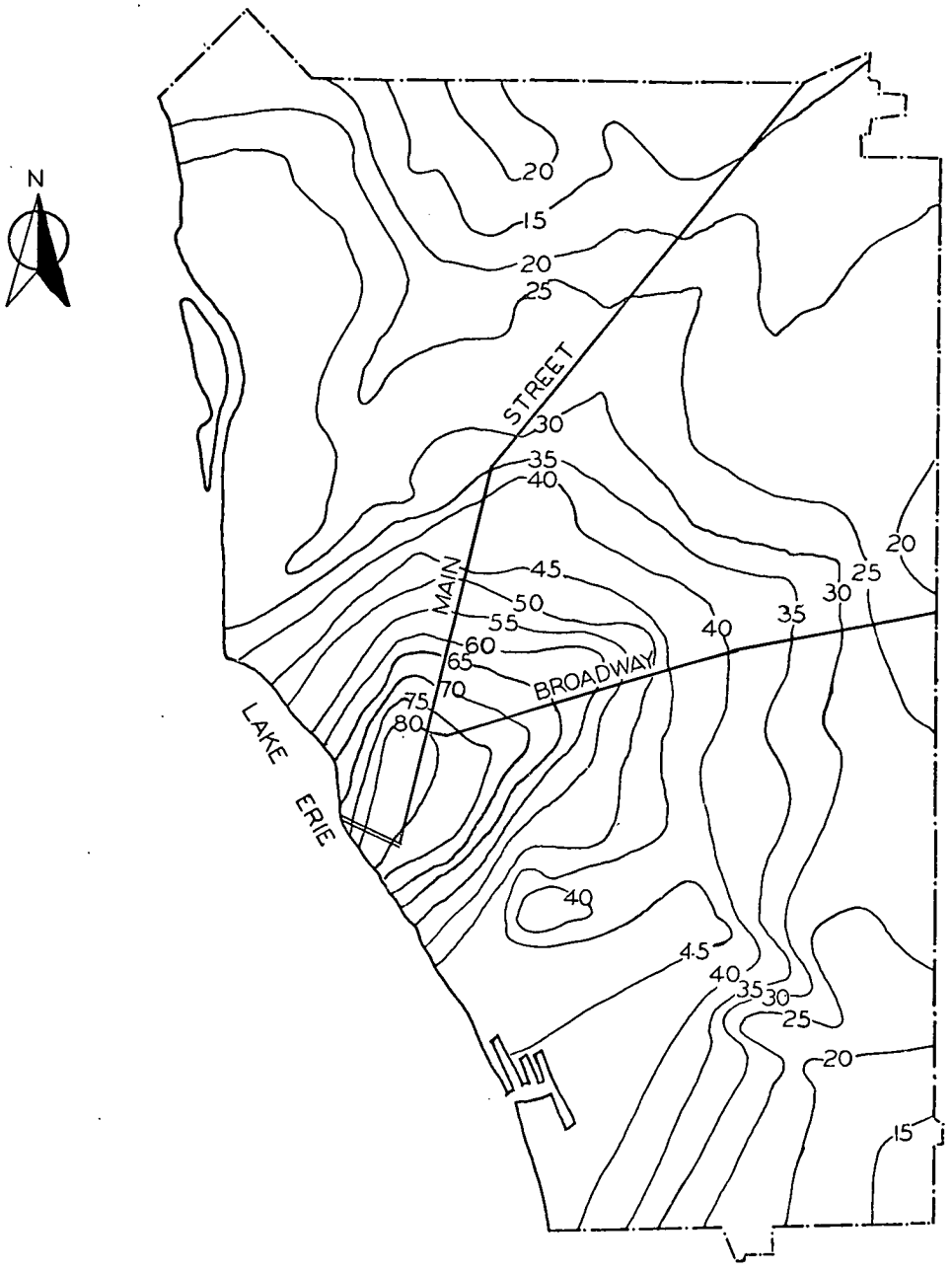

Figure 3. Percentage of households with no automobile.

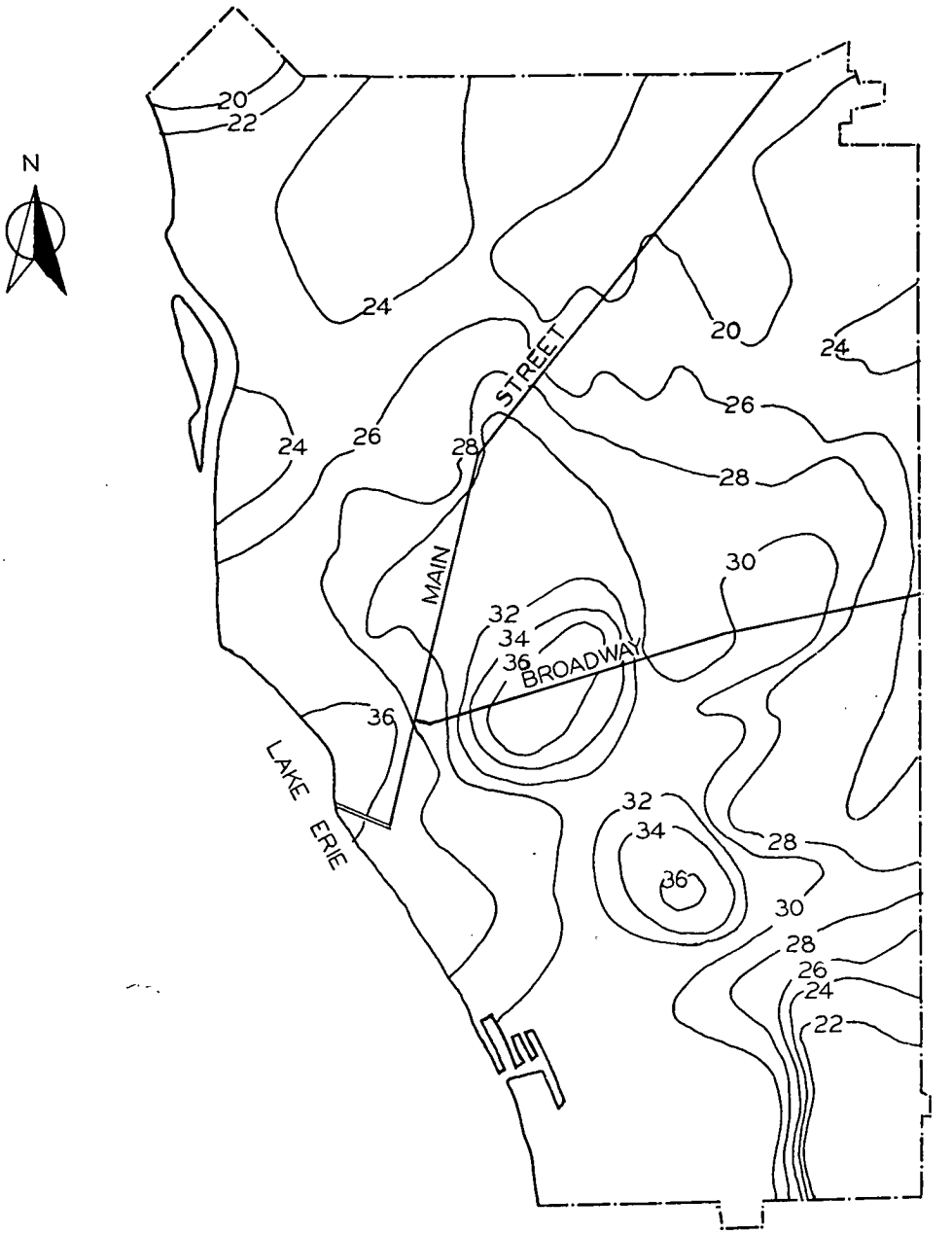

Figure 4. Percentage of work trips by bus.

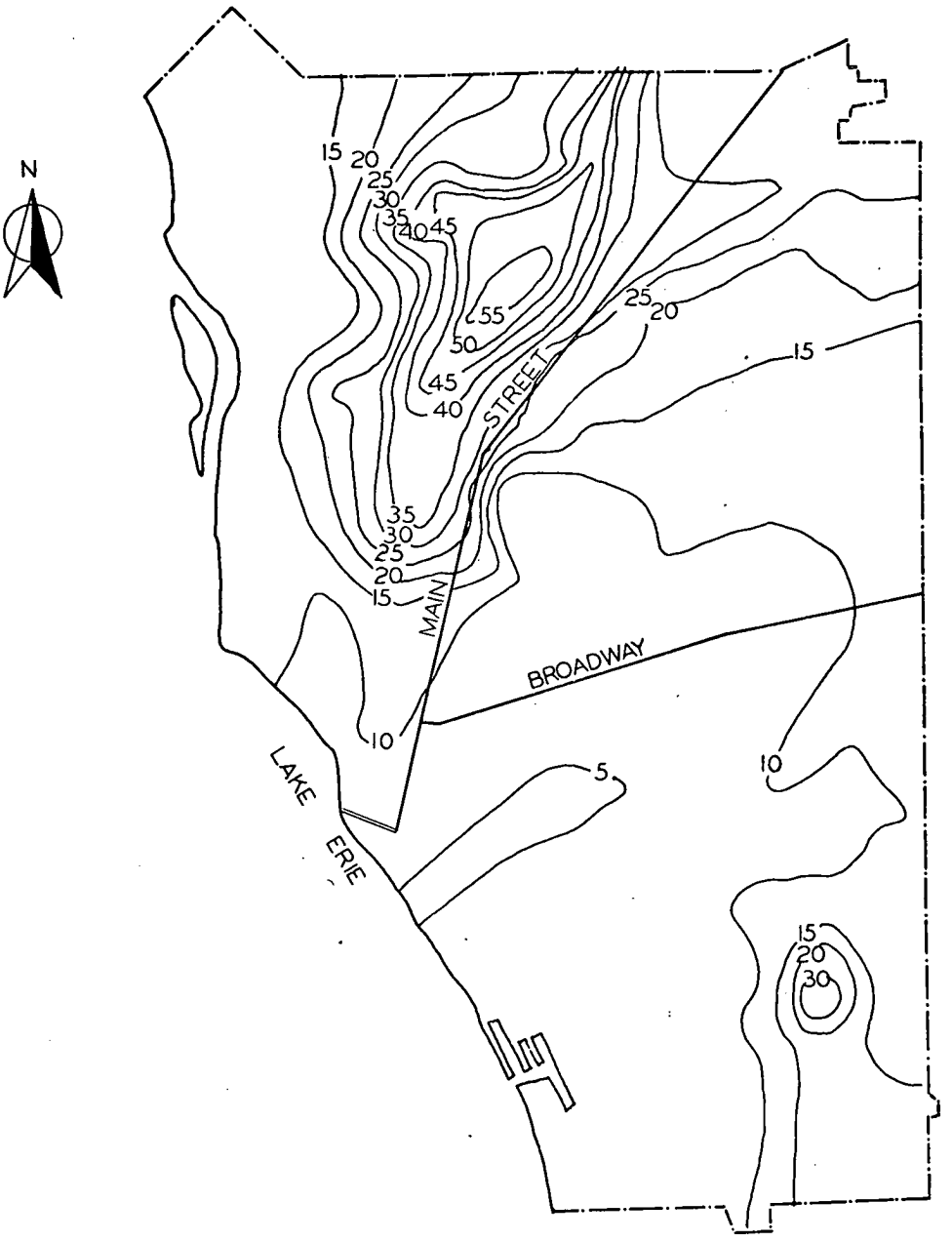

Figure 5. Percentage of male workers in the professional and managerial category.

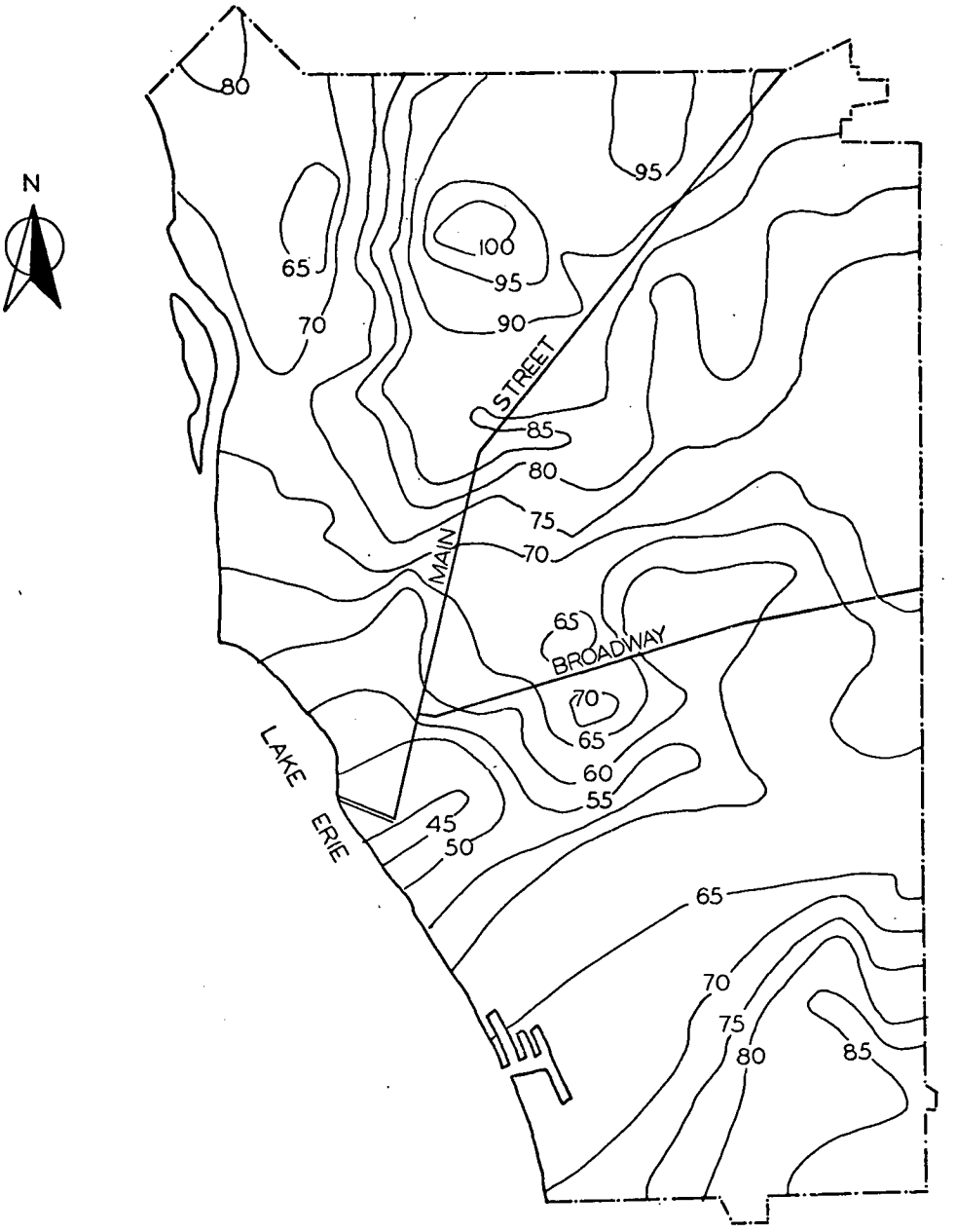

Figure 6. Rent value in dollars.

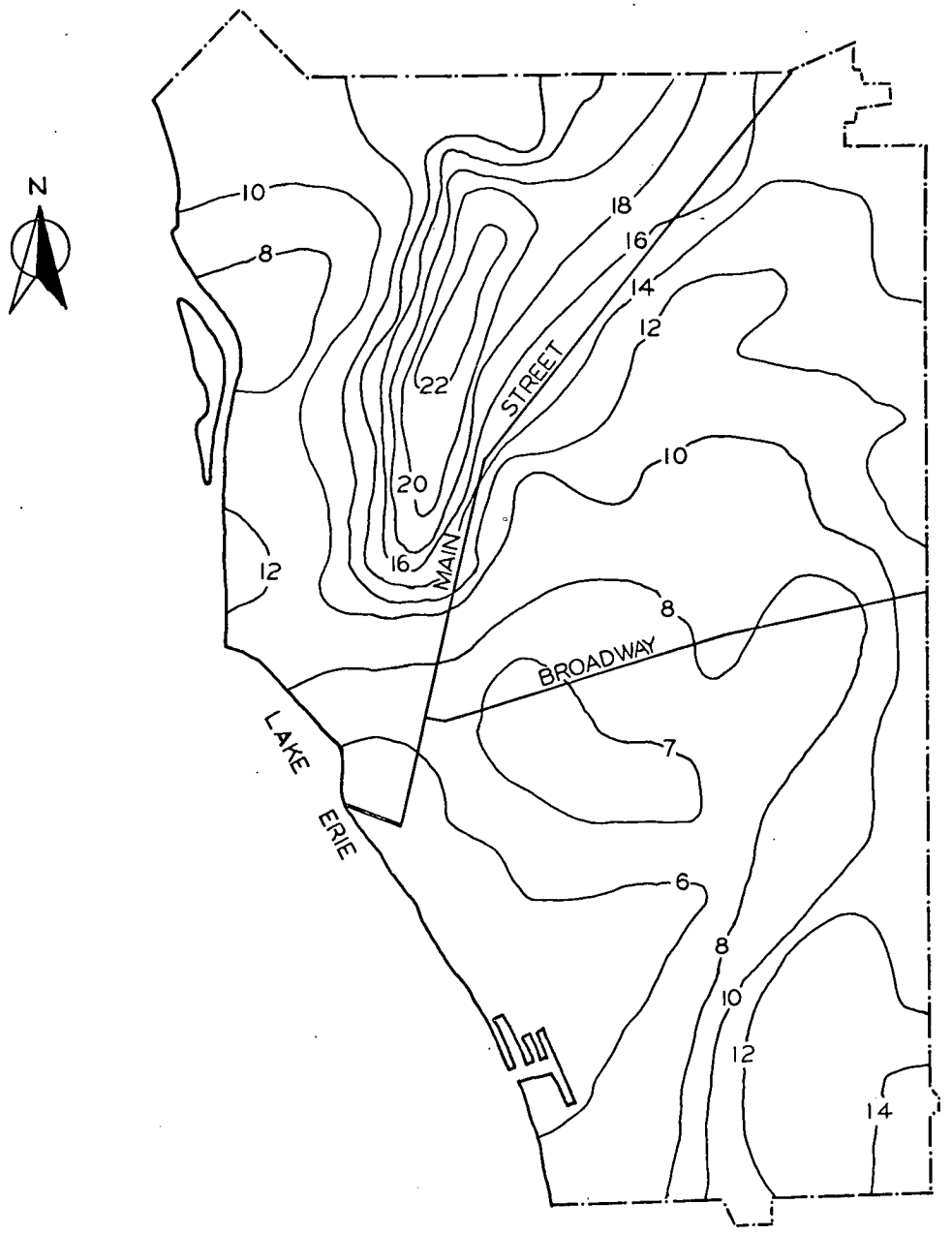

Figure 7. House value in thousands of dollars.

Development of contours of trip time by mode would indicate either the necessity or the willingness to travel a certain time by mode for a specified trip purpose. In Buffalo the average work trip is 18 minutes by automobile and 30 minutes by bus. More than 2 times as many jobs are accessible in 18 minutes of automobile travel(using the ghetto area as origin) than in the 30 minutes of bus travel. Although more jobs can be made available by longer bus trips, trips longer than 30 minutes are considered unfavorable, especially in an adverse climate. Corresponding figures of travel time by mode for Nashville indicate that 50 percent of the automobile trips reach work in less than 10 minutes and 80 percent in less than 20 minutes. By transit, only 7.6 percent of the total jobs are reached in less than 20 minutes, 58 percent in 40 minutes, and less than 80 percent after 60 minutes. There is no question that a greater balance between transit and automobile trips in terms of travel time must be reached to satisfy one of the major goals of improved employment stated earlier in the paper.

DATA COMBINATION FOR IMPROVED PLANNING

A recurring theme, thus far, has been that a close scrutiny and analysis of available data, combined with supplementary surveys where necessary, can indicate areas of concern for planning special services. At this point a further analysis technique is presented to illustrate how these techniques can be refined to define zones of first analysis for close scrutiny.

Figure 8 shows automobile ownership versus median income for the inner city tracts of Buffalo. (Recall that Figure 1 showed a dependence of both trip volume and trip mode on income.) Further, as the total number of trips per person decreases, the percentage

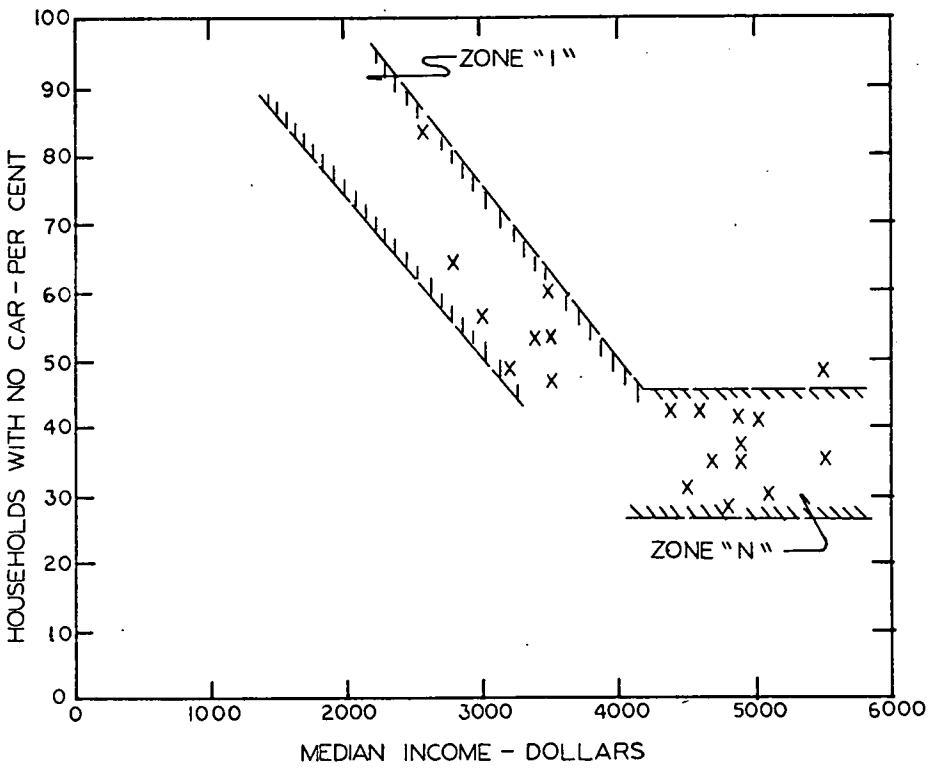

Figure 8. Percentage of households without automobiles versus median income in 1960 census-selected tracts in Buffalo.

of trips per person that are work trips increases. In the study of work trips, contours shown in Figures 2 through 7 and analyzed by the author (5) indicate that in zones of higher income a higher percentage of workers are professional or managerial and that the percentage of professional workers can also be linked to home ownership values. Thus, compilation of population characteristic data serves as a guide not only to the ability to predict mode of work trip but also to the probability of predicting class of work for workers originating from a given area.

A study of data shown in Figure 8 indicates that the data can be divided into 2 zones, I and N. (These indexes indicate the areas where the variable income has an influence on ownership, I, and where it appears independent of ownership, N.) As median income decreases from $4,000 to $2,000, the percentage of households with no automobile shows a significant increase from 40 to 80 percent. At a median income of more than $4,000, there is a greater stabilization of households with no automobile at 35 to 40 percent. This latter figure is somewhat above the national figure of 14 percent for incomes in that range, but in the tracts chosen a larger percentage of the population is elderly and retired and there is a large percentage of people who live within walking distance of work.

Kouyoumdjian (1) has shown that automobile ownership is the most important single variable in determining choice of mode for work trips in the Buffalo area. As the percentage of automobile ownership decreases within a given zone, the likelihood of a search for another mode for the work trip increases. It has also been shown that above a specific income ($4,000) there is little variance in automobile ownership with income.

Another study of trip-making (Fig. 1) has been replotted in schematic form (Fig. 9) to show zones similar to those shown in Figure 8. Here trips per person is seen dependent on income; above an ascertainable income, the number of trips made does not increase appreciably. The use of Figures 8 and 9 together indicate the importance of presenting an accurate description of income data for a large area. These income data can be plotted in contour as is shown in Figure 10, which is a more schematic representation of actual data shown in Figure 2. As these contours represent rather homogeneous areas of income (in this case derived from census tract data), it is possible to locate specific areas in the city within which the incomes are above or below the level

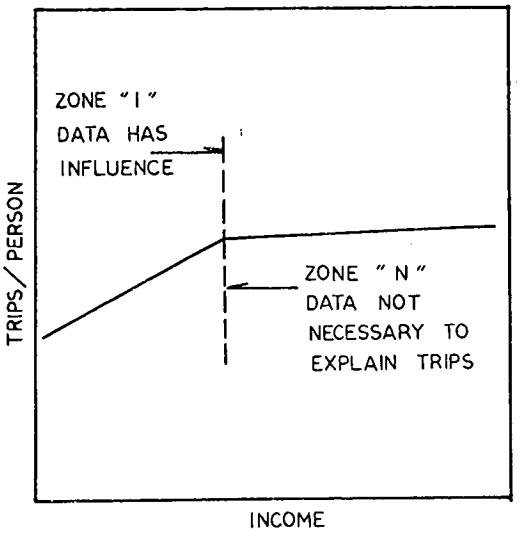

Figure 9. Schematic representation of data breakdown for use in planning.

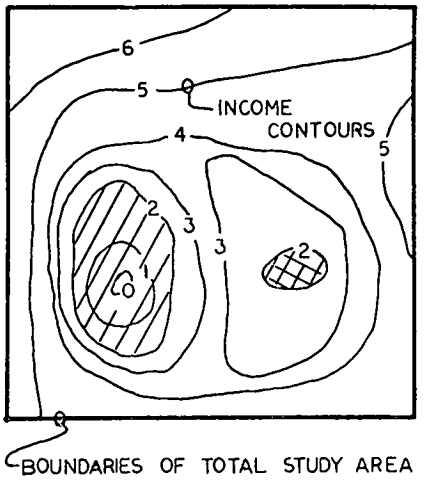

Figure 10. Contour curves used for designating regions of special study.

shown in Figures 9 and 10. It is possible to locate, through income data, areas of probable low automobile ownership or low trip-making. These areas are shown as shaded in Figure 10.

The use of delineating contour areas in planning is given in the following example. An often-used technique of deriving data for origin-destination studies in major area plans is to blanket the given area with a household survey usually ranging from 5 to 15 percent of the households in a random selection, uniformly applied method. Use of trip-generating parameters and income contours would indicate, prior to the survey, areas of special concern as noted earlier. As trips per person do not vary appreciably above a certain income, and as mode of travel is most likely to be by automobile above a certain median income, the actual sample size in areas designated on the contour map as corresponding to N can be decreased without a significant increase in reliability of results.

On the other hand, in areas of low income, low trip-making, and low automobile ownership, the survey numbers might be increased to establish a better reliability in both trip patterns and possible trip desires (latent demand). A 10 percent sample of population might be actually carried out as a 5 to 8 percent sample in high-income areas and as a 15 to 20 percent sample or a higher one in low-income areas, with survey questions appropriate to each of the areas of concern.

One large problem in past studies has been aggregation bias. Large desire lines shown through an area can mask out a more shotgun pattern of trips from that area to other zones. This is especially true in urban areas in which major expressways cut through ghetto areas. The aggregation of desire lines into the familiar pattern of the suburban lines becoming thicker until they block out the CBD and make it almost impossible to notice the desire for CBD-outward movement patterns at inward rush hours. Although the increased use of special surveys in designated areas would not change the desire line pattern, it would give greater and more reliable emphasis to the demand for other than CBD-directed transit. It has already been illustrated that, on a large scale, use of contour maps would help delineate homogeneous areas. The attempt to define homogeneous areas can be refined further in a block-by-block analysis using pertinent census data. Equations for determining homogeneity have been developed previously (5, 6) and are used to determine areas of like housing value or median income and to relate these to job type. In addition, the reliability of trip-generation data comparing large zones with small zones has been tested for 3 continuous square-mile zones in the inner city of Buffalo. By use of analysis of variance techniques, it was demonstrated at the $\alpha = 0.05$ level of acceptance that there is a significant difference in predictions of trips between zones when zones are considered as square-mile uniform areas or as subdivided into 5 or 6 subareas. This, of course, reconfirms previous findings on aggregation but also underlines the fact that aggregation bias can occur in either causative trip-generation models or through smear in gravity models. The aggregation of high automobile ownership with low automobile ownership or high income with low income yields gross averages that are usually detrimental to the low-income class. This averaging could give points on the N zone of the causative curves. The resultant analysis might easily mask the lack of ability of the low-income group to make trips.

DETERMINING SPECIAL SERVICE NEEDS

At this point we have seen that it is possible through a variety of techniques to isolate areas of special concern. It now becomes incumbent on the planner to establish what changes in or to the transportation system are necessary to help improve the quality of life of the ghetto resident.

One example of an existing modal split is given in Table 3, which compares mode of shopping trips for households owning and not owning automobiles. For food shopping, it is much more convenient or inexpensive in terms of bus fare (not food prices) for the households not owning automobiles to walk to shop within the neighborhood rather than to go by bus to a supermarket. On the other hand, of those that own automobiles, a third still choose to walk to shop. This may be a trip by necessity because the worker

TABLE 3
MODE OF FOOD SHOPPING TRIP

Automobile Owned	Trip End	Drive	Ride	Bus	Walk
Yes	In neighborhood	30	1	2	15
	Outside neighborhood	26	2	2	0
No	In neighborhood	2	1	3	33
	Outside neighborhood	2	4	2	2

Note: Data are from a 1968 summer survey by the Department of Civil Engineering, State University of New York at Buffalo and were assessed from a total sample of 32 households in U.S. census tracts 31, 32, and 33 in Buffalo (4).

in a one-automobile family may have the car at the time the trip is made. The inconvenience of using public transit for food shopping was pointed out in personal interviews. Although not adverse to the use of public transit, the shopper would prefer a vehicle that would be easier to enter and store packages in rather than a large bus.

In addition to shopping trips, trips of great importance or those frequently made include trips to church for both social and religious purposes, trips to the hospital, and trips to banks by the elderly on social security day. The latter trips were held extremely important by residents of the Buffalo model cities area. These trips, which are made to a diverse list of destinations, are made with greater difficulty, if at all, by households without automobiles than by those with automobiles. For example, a necessary trip by a mother to take her child to the clinic may never be made because of a variety of hindrances, including inclement weather and lack of cash for fare. Trips considered luxurious, such as trips to parks or theaters outside the rider's neighborhood, may also never be made because of the lack of an automobile. This latent demand is summarized extensively by Hoel et al. (7).

It is possible, through personal survey, to quantify trip modes by frequency, pure time, and trip purpose. This would then permit real hardware alternatives to be established and studied.

The study of the Nashville model cities area (8) pointed out that short-range goals included provision of public transportation service to the model cities residents that would allow them to reach cultural and recreational areas throughout the entire metropolitan area and that the service should be provided "at such reasonable speeds and costs that these factors will not become an impediment or detriment to their use."

An immediate suggestion resulting from studying special needs is to make existing public transit more responsive to intensified small area local needs. (An example of immediate response is the refusal of the Public Service Commission of New York to permit an additional 5-cent increase on the Buffalo public transit system without extensive hearings. All too often these increases have been routine.) This can be done readily through route additions or changes, service home changes, and increased and properly designed information services. Further hardware suggestions such as jitneys or dial-a-bus would evolve through the more exhaustive planning techniques applied to a small area.

CONCLUSIONS

In a time when we are planning for groups that are becoming increasingly articulate in defining their goals, we can no longer be seduced into thinking that data alone will solve all planning problems. It is possible through proper studies of trip-determining parameters to isolate areas of particular interest for special (micro) study. Contour maps combined with trip-making curves can show areas of potential neglect in large-scale planning. Isolation of these areas for intense study, coupled with gathering of trip-making data peculiar to the specific area, are then preliminary steps to be taken in a more traditional transportation analysis. A beneficial concept inherent in microarea analysis is that it does not have to be limited to poor areas, areas defined as having the greatest transportation neglect. An area with a high concentration of upper income but generally elderly population would be another example of a microarea that

may need special-service planning. Again, the use of contour maps, together with trip purpose and current mode choice, would be useful for such an analysis. The final product is a higher level of true transportation service to all the residents of the metropolitan area.

ACKNOWLEDGMENT

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