To the Graduate Council:

I am submitting herewith a thesis written by J. Vann Cunningham entitled "Residential Location Patterns and Worker Inmigration Associated with the Construction of Electrical Generating Facilities." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

Kenneth B. Kenney, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

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Graduate Studies and Research

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RESIDENTIAL LOCATION PATTERNS AND WORKER INMIGRATION ASSOCIATED WITH THE CONSTRUCTION OF ELECTRICAL GENERATING FACILITIES

A Thesis

Presented for the

Master of Science in Planning

Degree

The University of Tennessee, Knoxville

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June 1979

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ACKNOWLEDGMENTS

I wish to acknowledge my debt to the many people who assisted me in developing this research effort. First were the members of my thesis review committee, Dr. Kenneth B. Kenney, Professor George Bowen and Mr. H. Brown Wright. I want to express my gratitude to Dr. Kenney who, while serving as my thesis advisor, enhanced my appreciation of the theoretical difficulties associated with this area of research and for his careful and considered editorial suggestions. I owe a considerable debt of gratitude to George Bowen whose classes stimulated an interest in both quantitative methods and spatial structure and to H. Brown Wright who encouraged the use of TVA's Construction Employee Survey data base. Secondly, I would like to express my appreciation to the members of the Regional Planning Staff at TVA, particularly George DeVeny and Dr. Jay Lowe. George DeVeny's considerable knowledge of TVA construction worker behavior was an invaluable resource and Dr. Lowe graciously spent many hours discussing ideas presented in this thesis. Thirdly, I would like to thank Larry Bray and Carlton Murphree for their assistance with statistical and computer analyses. Finally, I owe a considerable debt to Al Voelker of Oak Ridge National Laboratory who served as a constant source of intellectual stimulation and support throughout this project.

I have borrowed liberally from those mentioned and cannot thank them enough for their contributions. Much of the strength of this

research results from those contributions; the weaknesses are obviously my own.

ABSTRACT

This study explores some of the major factors affecting the spatial distribution of inmigrating workers associated with the construction of major electrical generating facilities in the Tennessee Valley. Multiple regression techniques are used to develop predictive residential location models for blue-collar, white-collar, family, nonfamily, and total inmigrating work forces. The total inmigrant model is applied to extra sample data and proves a potentially useful forecasting tool. The implications of the findings for impact assessment and mitigation are examined. The study suggests that, regardless of the strategy adopted, examination of worker residential location patterns potentially facilitates the development of more effective impact assessment and mitigation programs.

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CHAPTER I

INTRODUCTION

Limited research on the residential location behavior of inmigrating workers during the construction of major electrical generation facilities represents a serious obstacle for forecasting the potential socioeconomic impacts on the local area. The paucity of information on the relevant factors involved in the residential location and spatial distribution of inmigrating workers among communities forces assessors to rely largely upon subjective analysis and expert judgment. Increasing local opposition and demands for mitigation assistance, based upon fears that an influx of population during construction will place "undue burdens" on local housing, schools, community facilities and services, emphasize the need for a better empirical understanding of the factors which influence the inmigrating workers' residential location decisions.

The provision of a better empirical basis for forecasting the location patterns of inmigrating workers associated with the construction of large-scale energy facilities is particularly important because size and spatial distribution of the inmigrating construction labor force have been identified as primary factors determining the extent and intensity of socioeconomic impacts (Policy Research Associates, 1977). A direct relationship has been established between the construction of major facilities and the influx of new population. Where a project is accompanied by a population influx, new demands may be expected upon the local services and institutions (Shields, 1975). The ability of the

local area to meet additional demands without suffering adverse impacts is largely a function of the size of the existing infrastructure relative to the associated population influx (Policy Research Associates, 1977).

The potential for social impact problems is inherent in constraints on the siting process which tend to relegate such facilities to the metropolitan hinterland. Some siting factors, such as proximity of load demand centers and accessibility to major transmission line and transportation corridors, have a tendency to pull proposed facilities toward more urbanized areas with less potential secondary socioeconomic effects. Other factors, however, such as nuclear safety regulations governing the distance at which nuclear power plants may be located from population concentrations and in the case of fossil fuel facilities, environmental constraints related to air quality, tend to push generating facilities into the less developed rural areas beyond the periphery of major metropolitan areas. Consequently, the need to understand the inmigrating workers' residential behavior is further intensified by the relatively rural siting pattern characteristic of both fossil fuel and nuclear electrical generation plants.

I. SCOPE AND DELIMITATIONS

The study consists of an exploratory analysis of the major factors affecting the spatial distribution of the migrant labor force associated with the construction of electrical generating facilities. Essentially, the problem is characterized as a special case of a residential location or community choice decision.

In order to clarify the proposed analysis, a brief description of the inmigrating workers' residential location decision may be helpful. Movement of a worker during the construction of a power plant may be characterized as an example of work-place constrained migration. Since the work site is selected prior to the employment of the inmigrating worker, potential residential locations are obviously limited to those within commuting distance of the site. Furthermore, since the previously cited environmental and institutional constraints tend to force the location of generating facilities into the relatively rural areas of the metropolitan hinterland, the mover is often faced with a choice between a residential location close to the site in a small town or rural area or a residential location at a greater distance from the site in a larger city.

Four basic questions are proposed for empirical examination in the present study.

(1) Are there identifiable community characteristics which tend to systematically attract or repel significant numbers of movers?

(2) What effects do specific worker characteristics have upon the residential location pattern?

(3) Do characteristics of the project or site affect the residential distribution?

(4) What effect does distance between residential location opportunities and the work site have upon the spatial distribution of the inmigrating workers?

These questions provide a basic framework for the study. In the next section, they are examined in more detail within the context of related studies on residential location.

CHAPTER II

A REVIEW OF RELATED LITERATURE

A growing body of literature focused upon the problem of determining the factors which influence residential location and journey to work has accumulated in the fields of human ecology, planning, transportation, and urban economics since the 1940's. Generally, the research has centered on residential location and journey to work relationships in the context of urban areas; however, more recently, some attention has been given to these problems in nonurban or rural contexts, particularly in migration studies and social impact assessments. A variety of theoretical and empirical approaches have been attempted in both urban and rural areas, with varying applicability to the problem of determining the factors influencing the residential distribution of inmigrating power plant employees during construction. Most of these approaches can be classified into three basic types; "gravity" models, "market forces" models, and a group of studies based upon a variety of socioeconomic, demographic, environmental factors and/or individual preferences which may be loosely termed disaggregated location models.

I. GRAVITY MODELS

Several investigators have suggested that the relationship between residential location and journey to work can be analyzed in terms of a basic gravity model derived from an analogy with Newtonian physics. In the development of this model, Stewart (1948) argued that "demographic

force" or the attracting force between two places equaled the result of multiplying a constant times the product of the population masses of the two places divided by the square of the distance between the masses. Stewart defined "demographic force" as $F = G\ (N_1\ N_2\ /\ d^2)$, where N_1 and N_2, the populations of areas 1 and 2, are the demographic analogs of the physical masses, d is the distance between them, and G is a constant of proportionality corresponding to the physical gravitational constant. Similarly, Zipf (1946) asserted that the attractive force between two communities or areas within a community is directly proportional to the population sizes of the two areas and inversely proportional to the distance between them. He argued that the number of people who move between two places with populations P_1 and P_2 and with the shortest transportation distance between them equal to D is proportional to the ratio P_1P_2/D and the attractiveness of an individual community is proportional to its ratio of P/D relative to that of an alternative community. It should be apparent that Zipf's attractiveness formula is mathematically equivalent to Stewart's formula with the exponent on distance set to unity.

Applied to the residential location/journey to work problem, the basic gravity model, in its simplest form, relates residential location to a single employment center, usually the central business district (CBD). In these models, it is generally specified that the number of workers residing in an area (W_{it}) is a function of $(K)(P_i)(W_t)/D_{it}^z$, where K is a constant of proportionality, P_i is the population of place i, W_t is the size of the employment at the work place and D_{it}^z is some

measure of the distance, raised to some exponent z, between place i and the center of employment.

The basic gravity model may be transformed into a log linear form, $\text{Ln } W_{it} = \text{Ln } {}_{p}i + b_2 \text{ Ln } W_t - z \text{ Ln } D_{it}$, permitting the model's parameters to be estimated by multiple regression. This form of the model indicates that the attractiveness of an area or community, as a potential residential location, is greatest when the population of the area and size of the employment center are large and the distance between them small. Studies utilizing gravity models both in log linear and "classical" forms have examined the residential distribution and journey-to-work patterns of workers associated with major energy facilities.

In a recent study by Konkel (1977), the journey-to-work patterns for a large nuclear power plant (1,680 employees) under construction in New England were examined in context of a gravity model. The analysis was conducted for 64 cities and towns surrounding the site. The 1970 population for each town and the total plant employment were used as proxies for attractiveness, respectively. Driving time was selected as the measure of distance. The gravity model was transformed into a log linear form and the parameters estimated by multiple linear regression. Konkel found that trips varied directly with the size of the city population weighted by trips per capita* and inversely with driving time. The gravity model was able to account for a substantial amount of

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*See Isard (1960) for a discussion of weighted measures of "mass" in gravity models.

the variance (R^2 = .61), and both the coefficients for population times trips/capita and driving time were significant at the .01 level.

Contrary to the classical gravity model, Konkel's research indicated that Stewart's assumption that the exponent on distance was a constant equal to two was questionable. He reported an exponent of .586 for distance as measured by driving time for the above-described model. Furthermore, plotting the actual number of worker trips, holding population constant, against driving time indicated that the exponent varied over different driving time ranges. Disaggregating by driving time ranges: 8 to 27 minutes, 28 to 60 minutes, and 61 plus minutes, Konkel found that the exponent over the first two ranges was approximately 1.08. The disaggregated models for the first two ranges produced R^2 values of .73 and .66, significant at the .01 and .31 levels, respectively. In the last driving time range, the amount of variance explained by the model was somewhat lower (R^2 = .42), and only weighted population variable was significant. As a result, Konkel concluded that the value of the exponent varied over different driving time ranges and was also affected by the specification of the attractiveness variable. Noting the difficulty of accurately specifying the variables in the model, he suggested that improving the accuracy of the model might require the addition of other variables and calibration to local conditions.

While indicating support for gravity-potential hypotheses concerning the journey-to-work patterns of the construction labor force, Konkel's research tends to be of limited applicability to the critical questions concerning the residential distribution of inmigrating workers. The analysis is limited by data constraints to patterns associated with the

total construction labor force. This constitutes a serious limitation because, as indicated previously, many of the most important potential impacts are related to the size and spatial distribution of the inmigrating work force during construction. Although he has suggested that the conclusions of his study might be applied to forecasts of municipal services and housing impacts, several recent studies of the commuting patterns of construction workers have indicated that the spatial distribution of the inmigrating workers differs somewhat from that of the local commuters. This suggests the need to disaggregate the labor force by local versus nonlocal workers. At most, it appears that forecasts based on the application of "gravity potential" concepts to the overall distribution of the total work force may be useful for identifying potential transportation impacts and perhaps the extent of the spatial distribution of some economic effects.

In another example of a gravity model application, the relative attractiveness of communities as potential residential locations for inmigrating construction workers was predicted for 14 major construction sites in 8 Western states (Mountain West Inc., 1976). They hypothesized that the relative attractiveness of communities could be measured by observing the relative number of inmigrating workers from each project locating in each community. It was assumed that the attractiveness of a community was directly related to the size of the community and inversely related to the distance separating the community from the work site. As in the Konkel study (1977), the 1970 population was used as the measure of community "mass"; however, distance was measured in "best route"

highway mileage. The model was transformed into a log linear form and the parameters estimated by multiple linear regression. The model was tested in the following form:

$$\log NL_s - \log NL_t = (\log C_s - \log C_t) - b(\log D_{sj} - \log D_{tj})$$

where:

$\log NL_s - \log NL_t$ is the logarithmic transformation of the ratio of number of nonlocal workers locating in community s relative to the number locating in community t;

$\log C_s - \log C_t$ is the logarithmic transformation of the population sizes of communities in the project area;

b is the exponent for distance;

$\log D_{sj} - \log D_{tj}$ is the logarithmic transformation of the distances between the communities and the project.

When the community choice model was run, the actual number of nonlocal inmigrants locating in each community was estimated by taking each community's attractiveness factor divided by the total of the attractiveness factors for all communities. The ratio of the community attractiveness factor relative to the total of the attractiveness factors was then multiplied by the total nonlocal work force to determine each community's share.

The regression analysis for the overall model revealed that the relationship between distance and community attractiveness was approximately linear. The coefficient for distance was .849. Although the distance coefficient was statistically significant, they were unable to explain more than 26.5 percent of the variance in the residential location distribution of the total nonlocal work force at the 14 projects.

Disaggregation of the projects by region generally improved the explanatory power of the model; however, the coefficient for distance exhibited considerable instability. The coefficient ranged from .306 to 1.661, suggesting that the effect of distance on community attractiveness varies substantially from area to area. The regression analysis generally supported distance and population size as partial determinants of community attractiveness; however, they concluded:

> Region-specific characteristics . . . have to be taken into account before much progress can be made in predicting the communities where nonlocal construction workers will choose to locate.

Chalmers (1977) further tested the community choice model at 12 Bureau of Reclamation water resource development projects in the Western United States. The regression results indicated a direct relationship between population size and community attractiveness and inverse relationship with distance. Although the independent variables were statistically significant, the extremely low explanatory power of the model (R^2 = .07), and the small number of observations emphasized the need for taking into account additional community characteristics and for obtaining additional observations on more and larger projects.

Borcz (1977) predicted the residential location patterns of inmigrating construction workers at six large power plants in the Tennessee Valley. Contrary to the previously cited studies, Borcz primarily examined the gravity model in its "classical" forms as defined by Stewart and Zipf. Population and size of the nonlocal employment at the projects were used as attractiveness factors. Three types of

distance measures were examined—air miles, road miles, and estimated travel time. Travel time estimates were based upon projected automobile speeds on different types of roads.

Gravity models were examined at both county and city levels. The models produced mixed results. In the county level model, county population and distance between the plant site and the geographic centers of the counties, measured in air miles, produced very poor fits between the actual and predicted location distributions of the inmigrating workers. Borcz concluded that the scale of resolution at the county level was too coarse to permit an adequate differentiation of worker locations. Consequently, she examined gravity model formulations at a city level.

The city level models performed considerably better than the county-based gravity models. Borcz found that the city level gravity model performed best when distance was measured in road miles with an exponent of two; however, she noted major problems with the model. She found that, regardless of the measure of distance use, the model consistently overestimated the attractiveness of cities with large populations at all distances and underestimated attractiveness of smaller places.

Interestingly, Borcz found that by constraining cities with large populations to a level of 10,000 considerable improvements in predictive accuracy could be obtained in the model. For example, at the Browns Ferry Nuclear Plant location in north Alabama, the gravity model, using road miles squared and the actual population size for each city, estimated

that the city of Huntsville would attract an amount of inmigrating workers approximately 6.7 times greater than that actually observed. Of the total inmigrating work force at Browns Ferry, only 27 workers actually located in Huntsville; however, the unconstrained gravity model had predicted that 184 workers would do so. Reestimating the model with Huntsville's population constrained to a level of 10,000 resulted in a prediction of only 29 workers. Similar improvements in the results were also obtained at other projects by constraining the maximum level of population for large cities to 10,000 in the model.

The results of the above studies raise questions concerning the basic assumptions of the gravity model. Borcz's study indicates that the assumed relationship between place size or "mass" and attractiveness may be questionable. In the basic gravity model, it is assumed that the greater the "mass" of a unit, the greater the amount of attractive force it will exert at a given distance. Furthermore, in its "classical" form, the model implies that the relationship between mass and attraction is linear when the model is transformed into a logarithmic form. Borcz's work, on the other hand, indicates that large places (at least as measured by population) may not be inherently more attractive as residential locations for inmigrating workers. Her results suggest that there may be population thresholds above which cities of differing population sizes may be of equal attractiveness to the inmigrating workers and that the threshold level may be relatively small. Chalmers (1977b) also indicates that one should question whether or not "the larger towns are genuinely more attractive than the smaller towns." If

not, he suggests it may be necessary to replace community size with a judgmental weighing factor for attractiveness in the model. It is apparent from this review that the appropriate specification of the "mass" or attractiveness factor remains a problem for planners and social impact analysts attempting to use gravity models to predict residential location related impacts for major energy facilities in rural areas.

The role of distance in the gravity model also presents some problems. While most analysts using the gravity model agree that distance is an impedence or friction factor for various types of human interaction, there is considerable disagreement among the various disciplines concerning its exact interpretation. Several theorists suggest that distance is a proxy for an individual's costs (Beckman, 1976; Isard, 1960; and Olsson, 1965). Urban and regional economists tend to view these costs in terms of dollar transport costs; however, transportation planners argue that costs should include the concept of travel time costs (Dickey, 1975). They argue that time spent traveling constitutes a type of opportunity cost. They also point out that physical and psychological factors play a role in the effect distance may have on interaction. Physical comfort may affect not only the distance one is willing to travel but also the mode by which one travels. Psychological factors affect the perception of distance, and it is even suggested that distance factors may reflect the effects of social distance between different cultural and social groups (Isard, 1960). In an even more radical interpretation, Stouffer (1940) suggests that the decline in

attractiveness with distance is not a function of distance at all, but rather a function of the relative numbers of intervening opportunities.

Questions have also been raised concerning the appropriate exponent for the distance factor. Transportation analysts have viewed the exponent on the distance variable as a measure of the value the individual places on time or transportation expenditures and have generally treated the exponent as a variable (Dickey, 1975). Stewart (1948), on the other hand, asserted on theoretical grounds that the exponent is a constant equal to two; i.e., that the attraction between two places varies inversely with the square of the distance between them. Borcz's (1977) analysis, using "classical" gravity approaches, tended to show support for Stewart's position. However, the results of both the Mountain West, Inc. (1976) and Konkel (1977) studies indicated that the exponent may deviate substantially from two when estimated empirically by linear regression. Their works suggested that sensitivity to distance varied with region-specific characteristics, such as regional population densities. Workers, during the construction of major energy facilities, appeared to be less sensitive to the effects of distance when the project was located in areas with lower population densities, such as the Western United States and Maine.

In summary, while the gravity models were able to account for some of the variance in the inmigrating construction workers' residential location distributions, substantial amounts of the variance remained unaccounted for by population and distance. Although the gravity model analyses tended to confirm that population and distance are factors

which should be taken into account when attempting to forecast the spatial distribution of inmigrating workers' residential locations for impact analysis, they have not clearly established that a "gravity" type relationship pertains between these variables. The results of these studies indicated that in attempting to develop adequate models of the residential location behavior of the inmigrating workers, planners should take into account additional factors and consider alternative formulations to the gravity model.

II. MARKET FORCES MODELS

While efforts in the field of social impact analysis to forecast the residential location distribution of inmigrating workers have relied largely upon either gravity models or expert judgment, residential location analysts in the field of urban economics have been attempting to explain residential location distributions in terms of market forces. Urban economists have formulated a set of mathematical models of the urban land market based upon rent theory.

As in the application of the basic gravity model, economists attempt to simplify their analysis by assuming an abstract monocentric city, a homogeneous population, undifferentiated land characteristics, and equal transport in all directions. In these models, the optimum residential location is generally derived from a tradeoff relationship between accessibility and site space. Alonso (1960, 1964), Muth (1969), Mills (1969), and Wingo (1961), have argued that an individual consumer with a given income and pattern of tastes will seek to balance commuting costs

against the costs of acquiring larger amounts of cheaper land at a greater distance from the central business district. They argued that an individual is willing to pay more rent per unit of space when the costs of transport are lower and less rent when the transport costs are higher. It is assumed that land costs are highest at the center as a result of competitive bidding for accessibility, that land costs decline with distance from the center, and that commuting costs increase.

Although each of these authors differs in approach to the basic problem, they all derive the equilibrium residential location by equating the marginal totals of rent (land price) and transport costs. For example, Alonso (1960) has described the tradeoff function in terms of bid-rent curves. Whereas profitability determines the level of bid-rent curves for the urban firm, Alonso indicated that levels of satisfaction are the relevant criteria for residential location. The bid-rent curves have been constructed so that the individual will be equally satisfied at any point or location along the curve. Within each curve, the individual has theoretically balanced the increased costs of commuting greater distances by reducing the bid price of land at a rate just sufficient to maintain a given level of satisfaction. Consequently, he argued that for each individual there should be a family of bid-rent curves corresponding to varying levels of satisfaction with the lower curves yielding greater satisfaction, since they indicate lower prices.

It should be apparent that each bid-rent curve is a function of rent versus distance from the central business district. The slope of the rent curve is determined by the transport costs for the potential

user. Steeper curves for a potential user indicate a greater sensitivity to transport costs. All things being equal, it is expected that users with steeper bid-rent curves will occupy more centrally located sites. These authors conclude that competition between potential users with differential sensitivity to transport costs, both within and between land uses, determines the locations which the competing potential users will in fact occupy.

The urban economists' models of residential location behavior are essentially microanalytic, in that they attempt to explain the residential behavior of the individual household. They argue that the form of the urban spatial structure results from the combined effects of a number of decisions by individual households concerning the tradeoff between accessibility and residential land area. As Kain expresses it, they assume that:

> The (individual) household decides how much residential space to consume by using the price of residential space (i.e., the total of location rent and transport costs), the price of all other goods, its preference for residential space, its preference of all other goods, and its income in a more or less conventional utility analysis.

This model assumes that the individual household maximizes its utility; therefore, once the amount of residential land to be consumed by the household has been determined, the household's optimum residential location is uniquely determined by the point at which the cost for consuming that amount of residential land is minimized.

There have been relatively few attempts to empirically verify economically derived market force models of residential location behavior.

Part of the difficulty in verifying these models empirically stems from their microanalytic approach. Inherent in this approach is the need to obtain information on individual household's preference structures and income. Proponents of these models recognize that this need imposes severe data constraints upon attempts to empirically verify their model; however, they suggest that this limitation may be circumvented by assuming that "similar" households have similar preference structures and that one may define these implicit preference structures by examining the actual residential location behavior of different "classes" of household.

In an empirical test of these models, Kain groups individual households in Detroit into relatively homogeneous classes on the basis of income, sex, race, family size, and residential density characteristics. He assumes that households with similar demographic characteristics have similar preference structures.

Kain's empirical findings generally supported the model. Based upon this model, he found that households located at varying distances from their workplaces according to their transportation costs, space consumption, and incomes as expected. The model best explained the journey-to-work/residential location behavior for workers whose place of work was located in the central business district. As expected, the residences of higher income workers in the CBD were located at a greater distance from the workplace; and on the average, these workers consumed greater amounts of residential space at all distances from their workplace. He found that the relationships were strongest for the areas

nearest the CBD "where the location rent function with distance from the workplace is probably very steep." He found that the relationships were much weaker when the place of work was located on the periphery of the urban area.

Implications for Impact Analysis

The urban economist's models of residential location behavior are based upon forces present in the urban land market. In part, the models depend upon a "rent gradient" of declining rents outward from the central business district. Theoretically, the rent gradient occurs as a result of competition for access to the center of employment concentration; and the spatial distribution of different land uses, including residential, develops as a consequence of the varying needs of competing potential users for access. Given the relatively rural location of most generating plants, it is unlikely that a rent gradient centered upon the work site exists as a result of competition for proximity to a power plant.

Although the urban economist's model of residential location behavior is not directly applicable to rural work sites, this does not entail a lack of significance for residential location analysis in rural areas. On the contrary, the model suggests several factors which may influence the inmigrating worker's residential location. As in the case of the previously-described gravity models, the market forces models emphasize the importance of length of the journey-to-work as a major determinant of residential location. The model suggests that inmigrating

workers should be sensitive to the distance between potential residential locations and the work site. It also suggests that workers at various income levels should exhibit differential sensitivity to distance. Higher income workers should be less sensitive to the distance between work site and potential residential location than lower income workers. If, as the economists assume, residential space is a superior good whose consumption increases with income, then higher income workers should also tend to locate in lower density residential areas. Furthermore, Kain (1975) indicates that a variety of sociodemographic factors should affect the workers' residential space preferences and therefore their space consumption. Finally, although the assumption of a rent gradient probably does not apply in the rural areas surrounding generating plants, the costs of consuming residential space may well remain a key factor in the residential location decision for the inmigrating worker during construction. Each of the factors implicit in the market focus models will be examined in greater detail in the following review of disaggregated models of residential location behavior.

III. DISAGGREGATED RESIDENTIAL LOCATION MODELS

Disaggregation of residential location models has been proposed as an alternative approach for overcoming some of the limitations of gravity models and market forces models (Ayeni, 1976). While gravity and market approaches mask the diversity of residential location behavior, the disaggregation approach recognizes that both mover populations and housing markets are highly differentiated. In the case of the gravity model, this

is the result of its inherently aggregative nature. The gravity model is macro-analytic in form and treats the deviation of the individual's location behavior from the norm as a random error which is "cancelled out" in the aggregate (Isard, 1960). In contrast, market forces models are not inherently aggregative. They generally have a micro-analytic focus, attempting to explain residential location behavior in terms of the individual household's needs and preferences concerning transport and housing, the competitive supply and demand for housing, and individual resource constraints. In practice, however, the focus on the individual household imposes data demands that are often difficult to meet. In order to facilitate empirical solutions to these models, their proponents are forced to make simplifying assumptions which permit the use of aggregate data (Kain, 1975). Thus, the micro-economic theories are often examined in a macro-analytic research context. Although gravity models are macro-analytic in nature and lack a substantial theoretical basis and market forces models are micro-analytic with considerable theoretical support, it appears that both suffer from similar short-comings in practice.

As an alternative to these approaches, disaggregated residential location models start with the assumption that both movers and housing markets are highly differentiated and attempt to disaggregate to an appropriate level as "dictated in the main by the availability and reliability of the data set" (Ayeni, 1976). Within the context of disaggregated residential location models, several factors tend to emerge potentially affecting residential location behavior. First,

there are the characteristics of the community, particularly its housing. Community characteristics are considered the basis of a community's relative attraction as a potential residential location. The characteristics of the mover's household generally comprise the second factor. It is generally assumed that the characteristics of the mover's household determine the basic specifications for a residential unit and location. The journey to work or distance between home and the work site often emerges in disaggregated residential location models as a constraint on residential location. In some cases, the characteristics of the mover's origin are also included. The relationship between these factors and their relative importance in the literature are reviewed in the following sections.

Effects of Community Characteristics on Residential Location

There are several community characteristics identified in the literature as potential factors influencing residential location. They include, among others, the size of community, characteristics of the housing stock, residential environment, local public services and legal constraints on development. These factors are reviewed in more detail in the following sections.

Community size. In the discussion of gravity models, it was pointed out that among migration analysts it has commonly been assumed that community attractiveness is directly related to population size (Shaw, 1975). This assumption has generally been based upon the hypothesis that economic opportunity, particularly employment, is strongly

correlated with population (Greenwood, 1975). In a recent review of the literature, Greenwood (1975) indicated that analyses of gross migration trends have generally tended to show support for the city size-attractiveness hypothesis. However, considering the emphasis placed upon economic factors in these studies, a basic question arises of whether larger cities are inherently more attractive than smaller places in the absence of economic incentives.

Recent trends in nonmetropolitan growth and studies in city size preferences indicate that larger size may not necessarily be linked to greater attractiveness, particularly when economic factors are absent (Beale, 1976).

Since 1970, nonmetropolitan areas have grown at a much more rapid rate than metropolitan areas, with the majority of growth occurring in counties with places of less than 10,000 population and the highest growth in those with no place greater than 2,500 population (Fuguitt and Beale, 1975). Furthermore, the growth in these areas has only been weakly related to economic factors. Beale (1976) indicates that noneconomic factors appear to be playing an important role in this trend.

Similar trends are found between metropolitan areas also. Beale and Fuguitt (1975) found that small to medium sized metropolitan areas were more attractive to migrants than larger metropolitan areas. Disaggregating by population size, they discovered that areas of less than 750,000 population experienced increased attractiveness to population growth while reduced inmigration or outmigration typically occurred in metropolitan areas above this size.

Beale and Fuguitt's findings concerning the attractiveness of relatively smaller places is consistent with the results of a number of location and city size preference studies. It will be recalled that Lansing et al. (1969) found that among metropolitan residents rural residential locations were preferred. Gallup Polls taken in 1966 and 1970 indicated an increasing trend toward preference for small towns and farm locations over cities and suburbs.

Although the results of the opinion polls have reported for some time now Americans' strong preference for living in smaller cities, towns, and rural areas rather than in large cities, the relationship between city size and attractiveness is not straightforward. Hansen (1973), in a criticism of the Gallup studies, indicated that the distinction between small towns and cities was ambiguous, since it was unclear whether intermediate-sized cities would be considered a city or a small town. In an examination of community satisfaction among a sample of movers associated with a national labor mobility project, Hansen found that overall satisfaction tended to increase with city size up to a point and then decrease with increasing size. The greatest satisfaction was with cities of between 50,000 and 500,000 population. He concluded that this suggested evidence for a preference for "intermediate"-sized cities, although "intermediate" was not very large.

Hansen (1973) also questioned the meaning of "small town" to the respondents of the Gallup Polls. He suggested that the perception of a small town's attractiveness may vary significantly depending on whether or not the respondents had in mind a small town in an extremely isolated

setting or on the periphery of a major metropolitan area. There is some evidence that Hansen's concern is justified. Size of place preference studies by Fuguitt and Zuiches (1975), De Jong and Sells (1974), and De Jong (1977) indicate that although the vast majority of people express a preference for a small town or rural environment, they also want it to be near a metropolitan center. When asked to indicate location preferences by degree of proximity to a city of over 50,000 population, they found a marked preference for "smaller towns and rural areas within commuting distance (about 30 miles) of a large city." However, when actual location behavior was compared to expressed preferences, De Jong (1977) found a striking discrepancy between actual and preferred locations by size of place, with only a very small percentage of movers attaining their preferred size of place. He concluded that although there is a widespread preference for smaller sized places and amenities associated with these places, a number of social and demographic factors may tend to inhibit many people from satisfying their preferences.

The implications of these studies of the relationship between community size and residential attractiveness for the behavior of the inmigrating workers associated with the construction of energy facilities are interesting. If the workers subscribe to the same values as the overall population, then they may also prefer "smaller towns and rural areas within commuting distance of larger cities." The tendency to locate power plants in the rural areas of the metropolitan hinterland and the general residential mobility of the workers would tend to facilitate attainment of these preferences. Furthermore, the economic

incentives located in larger cities are also absent since the worker's job needs are satisfied by employment at the project prior to selection of a residential location. The implication is that the concentration of inmigrating worker residential locations in relatively small places may reflect a worker's preference for small towns and rural areas, as well as the distribution of "opportunities."

A study conducted at a North Dakota power plant construction project appears to provide some support for the hypothesis that relatively small places can satisfy the residential preferences of inmigrating workers (Leholm, Liestritz, and Wieland, 1976). They found that there appeared to be a relationship between inmigrating workers' ratings of community services and the size of community. While 28 percent expressed dissatisfaction with services in communities of less than 1,000 population, only 6 percent were dissatisfied with towns of 10,000 to 35,000 population and greater. Although all of the towns in the study were relatively small (under 35,000), overall, 92.2 percent were satisfied. This suggests that the community size necessary to satisfy the needs of the majority of workers is relatively small.

Borcz's (1977) gravity model predictions also lend some support to this hypothesis. It will be recalled that she found that constraining the size of larger cities to 10,000 population significantly improved the accuracy of the gravity model predictions. This appears to be consistent with Beale and Fuguitt's finding that places below 10,000 population are attracting the greatest growth and the finding that the majority of people prefer a rural or smalltown residential location.

Community housing characteristics. Urban residential mobility studies indicate that the availability of vacant housing units is an important factor in determining the residential attractiveness of a community. There are two types of vacancies—those created by households moving from existing units, and net additions to the housing stock created by new construction. Simmons (1974) has found that in urban areas the two types of vacancies have different effects upon residential attractiveness. He indicates that patterns of residential movement are more sensitive to the effects of new housing construction, largely as a result "of the extremely uneven distribution of new housing opportunities." Simmons draws the conclusion that "at any one point in time or location in space an influx of new housing may dominate certain aspects of the housing market and profoundly alter the movement pattern."

Similarly, spatial biases created by the construction of new housing also appear to be an important factor in the spatial distribution of inmigrating workers' residences during the construction of large facilities. A community impact analysis conducted by the Army Corps of Engineers (1971) indicated that the spatial distribution of the residential locations of the inmigrating workers associated with the construction of two major defense facilities was substantially affected by the provision of temporary housing. At peak construction, approximately 40 percent of the total inmigrating population located in two communities. The report concluded that this pattern of residential locations was largely the result of the provision of temporary housing in those communities.

Similar results were obtained in a field survey at TVA's Sequoyah Nuclear Plant. The survey was conducted in an attempt to determine the predictive accuracy of the gravity models previously described in Borcz (1977). As previously indicated, Borcz found fairly large discrepancies between the actual residential distribution and those predicted by the gravity model. From the field check, it appeared that part of the error in the predictions of the model could be accounted for by the construction of three large mobile home parks in the area near the site. The temporary housing areas were developed early in the project construction period and attracted approximately 30 percent of the total inmigrating workforce. This produced a considerable bias in the spatial distribution of the inmigrating workers' residential locations.

In addition to the effects of differences between communities in their "raw" availability of housing units, the potential residential attractiveness of an area may be affected by variations in the type, quality, and costs of housing units available. Urban housing studies indicate that both the supply and demand for housing are highly differentiated. Housing stock varies by type, for example, mobile home, conventional single family, or multi-family; by size or number of rooms; by age; and by costs. The housing preferences of potential consumers are also differentiated. As a result, these factors combine to create a variety of housing submarkets.

Although housing stocks are varied and potential consumers are also varied in both their housing tastes and in their ability to act on these tastes, housing preference studies conducted since World War II indicate

a continuing preference for single over multiple family housing (Lansing, Mueller, and Barth, 1964; Rossi, 1955; Butler et al., 1966). A nationwide survey conducted in 1963 indicated that 67 percent of the population in metropolitan areas lived in single family housing units; however, 83 percent preferred to do so. Furthermore, while 20 percent of the families living in metropolitan areas preferred to shift from a multi-family unit to a single family unit, only 3 percent wish to make a move of the opposite kind. Lansing, Mueller, and Barth (1964) concluded that the "widely prevailing preference for single family housing" was responsible for part of the movement to the suburbs experienced in most urban areas during the post-war years.

At the present time, there is very little data concerning the housing preferences of inmigrating workers during the construction of major projects. However, examination of the actual patterns of residential distributions by type of housing indicates that they may differ significantly from the national norms described by Lansing. The inmigrating workers during construction appear to have a much greater propensity to locate in mobile home units compared to the national average (Mountain West Research, Inc., 1975; TVA, 1967-1977). Whereas, according to the 1970 Census, only 3 percent of the housing units occupied were mobile homes, approximately 37 percent of the units occupied by the inmigrating construction employees at 21 power plants were mobile homes. The difference between the inmigrating workers' distribution and that of the nation appears to occur largely at the expense of conventional single family units. Single family units accounted for approximately 67 percent of

the units occupied nationally in 1970; however, in the construction project sample, they only account for 34.5 percent.

Although it may be argued that this pattern is the result of the distribution of housing opportunities rather than differential housing preferences among the inmigrating workers, this does not appear to be the case. Mountain West Research, Inc. (1975) compared the distribution of inmigrating workers by housing type at 14 energy facility construction projects in the Western United States against the housing type distribution for all other inmigrating population. They found that while only 31.9 percent of the other inmigrating households located in mobile homes, 53.4 percent of the project worker households located in mobile homes. Although the housing market in the area was extremely tight during the construction of these projects, the differences between the housing type distribution of the inmigrating workers and the other inmigrating population indicates that a larger portion of the inmigrating workers chose to live in mobile homes. This conclusion was also supported by the workers expressed housing preferences. Of the 53.4 percent of the inmigrating workers who actually located in mobile homes, 72 percent indicated that this was their preferred housing type. In contrast, only 53 percent of the other inmigrating population living in mobile homes and 50 percent of the long-term residents indicated that mobile homes were their preferred housing type. The housing type preference distribution of the other inmigrating population was much more similar to the actual housing type distribution of the long-term residents than it was to either their actual distribution or those of the construction population. This suggests that

willingness to accept mobile homes may be an important factor in determining the relative attractiveness of various communities as potential residential locations for the inmigrating workforce during the construction of major energy facilities.

Earlier it was suggested that cost is also an important factor affecting residential location. Support for this position was shown when dissatisfied inmigrating workers were asked to indicate why they were not living in their preferred housing type (Mountain West Research, Inc., 1975). Of the dissatisfied workers, 42.7 percent indicated that the housing was available but too expensive. This led the authors to conclude that although there was some pentup demand for single family housing, "a large part of the dissatisfaction with housing stems from cost rather than availability considerations."

In addition to the previously described housing factors, tenure characteristics may also affect the relative attractiveness of an area as a potential residential location. Research indicates that tenure orients a household toward either the rental or purchase markets (Rossi, 1955; Butler et al., 1969). The majority of households seek only housing of the tenure type currently occupied by the household. Renters tend primarily to seek housing from the rental markets and owners from the purchase market. When a change of tenure does occur, the flow is generally unidirectional, from rental to purchase units. However, there is one important exception to this tendency. A nationwide survey by the Highway Research Board (Butler et al., 1969) found that the largest proportion of households shifting tenure from ownership to rental

occurred among the households inmigrating from other metropolitan areas. The report indicated that "although the most common form of previous tenure for this group was owner occupancy, many of the families moved for reasons of job change into unfamiliar markets." In this group, 16 percent shifted from owner to rental occupancy. "In no other mover group was such a phenomenon so apparent."

The findings concerning the effects of tenure on residential choice may be of particular significance in predicting the residential location distribution of the inmigrating workers associated with the construction of power plants, since previous experience indicates that they tend to rely more heavily upon rental units to satisfy their residential needs and they are often faced with a job related move into an unfamiliar housing market.

Residential environment. At the present time, the possible effect of the residential environment on potential community attractiveness for inmigrating workers has not been examined; however, urban residential location studies suggest its importance. Under residential environment, these studies consider both the physical characteristics of a community such as noise, crowding, dirt, traffic, density, amount of green or open space, rural versus an urban setting and so forth, and the social characteristics such as reputation, social composition of the residents, and social status considerations. Rossi (1955) in an early study of the factors affecting residential attractiveness, found that although costs were the primary consideration the residential environment played an

important role in determining the relative attractiveness of different units. He found that social composition and neighborhood reputation were almost as important as the amount of dwelling unit space. Of the physical characteristics, open space was identified as the most important factor.

Butler et al. (1969) also found that the quality of the residential environment was an important factor in both existing neighborhood satisfaction and in the selection of a new unit. The Butler study found that higher residential quality defined by "a better general appearance, better repair of dwelling units on the street, a lower noise level, less traffic, and being more solidly residential in land use," was strongly associated with the current residents' neighborhood satisfaction. Similarly, when households who expressed moving intentions in the national survey were asked to indicate their preferred tradeoffs between neighborhood quality, dwelling unit desirability, and accessibility, the "survey suggested that metropolitan households overwhelmingly prefer better neighborhood quality with either a less desirable housing unit or less accessible location over a less desirable neighborhood with either a better housing unit or better accessibility."

Another facet of the residential environment affecting residential attractiveness is density. Lansing, Mueller, and Barth (1964) found a strong preference for lower density residential environments. Of their respondents who had moved during the previous five years, 42 percent had moved farther from the center of the metropolitan area. Furthermore, 45 percent of all metropolitan residents expressed a preference for a

residence in a very rural setting over the suburbs. The desire for residential locations in less dense areas was generally explained in terms of escaping from negative characteristics of the physical environment such as noise, traffic, dirt and crowding. They conclude that while status considerations do play a role in the attractiveness of residential locations in rural surroundings, the popularity of outdoor recreation, dissatisfaction with small lots, and a positive value on closeness to the out-of-doors, open spaces, and informal living are also important factors.

Although most of the evidence concerning the effects of residential environmental characteristics on residential attractiveness is derived from studies of housing preferences in urban areas, some evidence can be found in rural settlement studies. Bohland (1973) found that residential environmental factors were second only to accessibility in importance for determining the desirability of potential residential locations. He found that the aesthetic quality of the residential environment emerged as an important factor influencing the "selection of alternative rural residential sites." Specific factors emerging included openness, nature, and greenery. The emphasis was on physical characteristics; however, the concern was expressed less in terms of the aesthetic qualities of a particular site than it was in a rural-urban environment dichotomy. This was particularly true of ex-urbanites. Among this group, a positive residential environment was characterized as "isolated, widely separated dwellings and locations removed from the congestion of higher density areas." As found in the urban studies, "crowding or adjacency to others was viewed as a negative quality."

Although none of the studies of inmigrating worker behavior have specifically examined the effects of the residential environment on community attractiveness, Konkel (1977) does suggest some potential support for this hypothesis. In examining the predicted residential distribution of the labor force based upon the gravity model, Konkel found that the accuracy of the predictions were improved somewhat if a dummy variable indicating whether or not the community was a coastal town was included in the model. Although not a direct test, his results may reflect an amenity or residential environment effect.

In summary, Bohland's findings concerning the effects of the residential environment on the relative attractiveness of rural residential sites may be of particular significance given the relatively rural siting pattern of major energy facilities. In addition, Lansing's findings concerning the interrelationship between density and residential environmental quality may also be important if inmigrating workers share the predominant preference for lower density, rural settings found among metropolitan movers.

Local public services. One factor distinguishing between communities is the level of local public services provided. Attempts have been made to link residential location to local public goods and services. Tiebout (1956) in a classic study on the optimal production of local public goods and services, provides the first systematic exposition of the relationship between households' preferences for local public goods and services and residential location. Tiebout suggested that the decision to locate in a

particular community reflects a preference for one particular bundle of goods and services (at a particular price) over all others. According to Tiebout's model, fully mobile consumers select their residential location from a set of communities, each offering a different bundle of local public services and prices (taxes), in accordance with their income and preferences for outputs of local public services. There are a number of limiting assumptions attached to this model, including:

(1) Full household mobility.

(2) Perfect knowledge of the differences between communities.

(3) A large number of alternative communities from which to choose.

(4) No employment or journey-to-work constraints.

(5) No externalities.

(6) For each bundle of services, there is an optimum city size.

(7) Communities attempt to stabilize their populations at the optimum size.

Under these assumptions, Tiebout's model yields a market-type solution to the problem of determining the level of expenditures on local public services. "By voting with their feet" or locating in the community offering the bundle of public services and taxes best suited to their tastes and income, the consumers reveal their preferences in a spatial economy. As in the case of the private markets' shopping trip, residential mobility reveals the consumers' preferences and promotes an allocation of resources based upon individual tastes and income.

Tiebout's model is an "ideal type" and as such is unlikely to be fully realized in the "real" world. The restrictive nature of his

assumptions, while facilitating a theoretical solution, make it particularly difficult to verify the model empirically. In reality, households are rarely if ever fully mobile. On the contrary, several empirical and theoretical works suggest that journey to work acts as a constraint in residential location. Externalities also present a potential problem. Since residents in one community may benefit from capital investments made in another, communities are not entirely independent. And, finally, while theoretically there may be a tendency for communities to seek an optimum size, there is little evidence that they in fact do so.

Restrictive assumptions notwithstanding, if Tiebout's model has any validity, then there should be some evidence that local public services do affect residential location. The findings of several studies have a bearing on this question. A study by Oates (1969) indicated support for the Tiebout hypothesis when educational expenditures are used as a proxy for the quality of local public services. Oates' findings were also supported in studies by Butler et al. (1969) and Ermuth (1973). The study by Butler et al. found strong preferences for "good schools with high taxes to lower taxes with less desirable schools." Ermuth's study indicated that proximity to elementary schools was the only proximity factor important in the preferences of the majority of the groups included in his study.

The above findings may be interpreted as providing partial support for Tiebout's model; however, the question arises immediately as to the appropriateness of educational expenditures as a proxy for local public

services. The selection of educational expenditures as a proxy can only be justified if they behave similarly to other public services in the potential consumers' preference structure. Butler et al. indicate an almost universal attachment to good quality schools. It is somewhat unlikely that this value extends to other public services in the same manner. Ermuth's study provides some support for this hypothesis. He found that when public schools were included with other public services, the schools variable behaved differently from the other public service variables in predicting residential satisfaction. A preference for proximity to schools was expressed in eight of fourteen residential areas compared to five for other public services; and, in only two of the areas was a preference for both expressed. Friedman (1975) obtained similar results when educational expenditures were considered with other local public services and the effects of local public services on residential location compared to the effects of the housing services. Friedman found that compared to the effects of the amount of housing services available for consumption in an area, the effects of local public goods and services on residential attractiveness were negligible.

> Our main conclusion is that local public goods and services are only marginally important in determining the residential choice and that the most important determinant of a household's residential choice is the quantity of housing that it can obtain in a city.

Friedman's and Ermuth's results suggest that educational expenditures are not a particularly good proxy and that public services are not a major factor in determining residential location. Part of the difficulty may rest in Tiebout's assumption that the bundles of local public

services are fixed for each community and that the addition of a household does not affect the level of services. If, as suggested by Tiebout, communities sought to reach and maintain an optimum size, then the fixed bundle assumption might hold true. But, in reality, public officials are aware of growth areas and tend to respond accordingly. Kain (1975) states it this way:

> A large number of researchers have emphasized the role of good quality public services and schools in determining residential location; (however), an explanation of residential location in these terms is at best an oversimplification and at worst may be basically incorrect. It is my belief that (governmental services) are less of a determinant of residential choices than are collective residential choices a determinant of the quality of governmental services.

Kain's research indicates a spatial distribution of the demand for residential space by different income groups. He concludes that "if the quality of governmental service is a derived demand," then the observed relationship between residential location and public services (particularly education), could be explained "as the result of an admittedly imperfect (housing) market." The problem is particularly acute when education is used as a proxy for local public goods and services, since as Lansing has noted, "We know that new schools are built to serve (developing) outlying areas, so that the wish to be close to schools will hardly deter people from moving." Given the "overwhelming" preference for better quality schools, the association between better schools and growth areas may indicate that the demand for good schools is more effective for households in these areas than in other areas.

It is difficult to assess the applicability of Tiebout's model to the residential location behavior of inmigrating workers during the construction of major energy facilities for several reasons. First, at the present time, none of the studies of inmigrating workers residential location behavior have examined the question specifically. Secondly, the model is urban based and the majority of sites for energy facilities are located in relatively rural settings. Third, empirical attempts to verify Tiebout's model yield mixed results. Finally, the assumptions of the model are quite restrictive.

Although there are a number of limitations to Tiebout's model, there is still some reason to believe that the model may be relevant to the residential location situation of the inmigrating workers during the construction of power plants. In the eastern United States, the inmigrating workers are generally faced with a number of alternative communities as potential residential locations. Furthermore, these communities may be expected to vary in the level and quality of locally provided public goods and services, which may be viewed as basically fixed during the relatively brief period of construction. Given the worker's greater mobility and willingness to utilize mobile homes, the worker is faced with a potential multiple tradeoff situation between alternative bundles of local public goods and services, journey to work accessibility, and housing. Therefore, the hypothesis that the level and quality of local public goods and services may be of some importance in the choice of a community of residence cannot be dismissed a priori.

Legal constraints on residential development. There are a number of potential legal constraints on residential development. Foremost among these are zoning ordinances, subdivision regulations, building or housing codes, and health or sanitation regulations. Scott (1975) indicates that these regulations, either individually or in concert, can "effectively cause the market to respond inefficiently or inequitably to housing demand." This may occur either as the direct result of prohibiting certain types of development or indirectly by contributing to increased costs of development through the imposition of higher development standards than developers would otherwise meet.

One example of the exclusionary use of zoning is found in those communities which are zoned in their entirety for large-lot development. Historically, such communities have been successful in effectively precluding multifamily residential development (Leven and Rose, 1975). Similarly, some zoning ordinances specifically prohibit mobile homes anywhere in the community or restrict their location to mobile home parks. The primary result of restrictive zoning ordinances is a limited supply of multifamily and rental housing and an extreme bias in their development toward those areas with less restrictive controls (Leven and Rose, 1975).

In contrast to the potential direct effects of zoning, the supply of housing generally is indirectly affected by building codes, subdivision regulations and health codes through increased costs (Scott, 1975). In some cases, complex building and housing codes contribute directly to the costs of development by requiring professional licensed contractors.

Often the contractors must acquire additional engineering and architectural assistance in order to meet the codes. Clawson (1974) indicates that strict enforcement of health and sanitation regulations would in many cases preclude development of subdivisions utilizing septic tank/field line waste disposal systems. Subdivision regulations generally require the preparation of a plat, usually based upon a survey conducted by a licensed surveyor. In some cases, they may even require the developer to donate buildable land for public purposes. In addition to these more or less direct effects on the costs of development, there is also the possibility of administrative delays in processing. Scott (1975) concludes that the "additive result of the foregoing items is the effective escalation of the costs of finished housing." As a consequence, in many cases builders seek out areas with relatively lower standards or weaker enforcement.

Effects of Household Characteristics on Residential Location

Previously-described gravity and market forces models emphasize aggregate or "typical" patterns of residential behavior. With the exception of the role of household income differences, little attention is given in these approaches to differential patterns of residential behavior which may be found among households with differing social, demographic, and economic characteristics. As a consequence, the diversity of residential location behavior tends to be masked by these approaches. One alternative for overcoming this limitation is to disaggregate the mover population by the various characteristics of the

households. Examination of the spatial distribution of household groups with particular characteristics may reveal patterns which differ significantly from the overall pattern of residential location behavior. Studies utilizing this approach identify several characteristics of households as potential factors affecting residential location behavior, including stage in the family life-cycle, socioeconomic status, sex of the household head, and race. Since the primary objective of this review is to identify factors which might affect the residential location behavior of inmigrating workers associated with the construction of electrical generating facilities, attention will be focused upon the effects of stage of family life-cycle and socioeconomic status upon residential behavior. The effects of sex and race will not be examined since at present the construction industry tends to be dominated by white male workers.

Family life-cycle. The concept of family life-cycle, generally a combined index of some or all of the demographic characteristics of age, marital status, household composition and size, is employed in a number of studies as a potential determinant of residential behavior. The use of a composite measure of family life-cycle is largely justified by the high level of interaction found between the component variables (Simmons, 1974). For example, it is generally recognized that ageing is accompanied by changes in social roles and related attitudes and behavior. Lansing and Kish (1957) argue that many of these changes can be related to the individual's movement through various stages of the family life-cycle.

They suggest that the stages of the family life-cycle should be defined in terms of critical events in the individual's life, such as marriage and household formation, birth of a child, entry of children into school, exit of the last child from the household, and the loss or death of a mate. They demonstrate both theoretically and empirically that a composite family life-cycle variable is a superior predictor of a variety of consumptive behavior, including single family homeownership, compared to its individual component variables.

Changes in household composition or size create pressures which may precipitate residential mobility. Simmons (1974) indicates that passage through the family life-cycle creates stress on the individual or household which may be compensated by either adjustment at the existing location or by movement to a more satisfactory environment. The decision to move to a "more satisfactory environment" involves not only an assessment of the requirements of the household in terms of the residential unit itself but also of the household's needs and preferences for particular residential environmental and accessibility characteristics. The basic specifications for a new housing unit are largely determined by the stage of the family life-cycle in which the household is currently located or the stage to which it anticipates a move in the immediate future. Choice of a particular unit is determined by the household's needs, preferences, and resource constraints (Butler et al., 1969). Limited income may force a potential buyer or renter to decide between housing units with varying amounts of preferred features in order to obtain an acceptable price or rent. For example, young households

entering the primary childrearing stages of the family life-cycle generally express a preference for a single family unit in a low density, high quality residential environment; however, households at this stage also tend to have more limited earning power. In order to fulfill their need for greater space created by the presence of children, these households may have to accept an older unit located closer to the central city than they would otherwise find preferable (Butler et al., 1969).

In the selection of a residence, the emphasis placed upon the various elements of the housing package varies throughout the family life-cycle. Households in the early stages of the family life-cycle, either single persons or young married couples with no children, are somewhat more likely to select multifamily units with greater access to the services and facilities of the central city (Lansing, Mueller and Barth, 1964). On the other hand, there appears to be an overwhelming preference among households in the childrearing stages for single family units in low density suburban or rural settings. Exit of the last child or loss of a mate reduce the need for space, permitting other preferences to be satisfied. Older households in these categories may relocate more easily in smaller, more centrally located units.

The relative attraction of various residential areas for households with differing needs, preferences and resources is clearly reflected in the ecological structure of the city (Berry and Horton, 1970). In the urban environment, households in different stages of the family lifecycle tend to be somewhat segregated. The residential areas of the city are

highly differentiated by levels of familism (Sabagh, Van Arsdol, and Butler et al., 1969). As suggested previously, within the spatial structure, young single person or married couple households exhibit a locational pattern which differs from households with children. Young single individuals or married couples tend to locate in higher density residential areas close to the city center and work place. In contrast, households with children tend to be found in lower density suburban locations. Although some households in each stage of the family life-cycle are found in most areas, households with children are much less likely to be located in areas with relatively higher concentrations of young single persons (Lansing, Mueller and Barth, 1964). In addition to the relationship to childrearing, age of the household head also appears to affect residential behavior. In most areas of the city, age of the head of household is positively related to home ownership for all households. The proportion of residents owning their homes generally tends to increase with the age of household head throughout the child-rearing years, declining only slightly for older households without children. Residential location patterns for older households without children are subject to somewhat greater variation than found in other groups. Although areas with higher concentrations of older households without children can be identified, these households tend to be inter-mixed to a greater extent with households in the later stages of child-rearing. To a much lesser extent, older households can be found in the less suburban, higher density areas occupied predominantly by single persons and young married couples without children.

Family life-cycle, as a determinant of residence related behavior, appears to be primarily related to the propensity to move and selection of the type of unit rather than selection of a specific residential location (Simmons, 1974; Butler et al., 1969). Ageing, changing household composition and size provide strong stimuli for residential mobility. Increasing household size may create pressures motivating a household to seek a housing unit with greater space; however, while this determines a basic specification for a new unit (i.e., greater space), it does not of necessity imply any locational constraints. Given adequate resources, it may be possible to satisfy the household's need for space in a number of ways at various locations. Finally, in discussing family life-cycle as a determinant of residential behavior, it should be noted that while "typical" patterns have been identified for households in the various stages of the family life-cycle, other factors, such as the socioeconomic status of the household, sex of the household head, and ethnicity may intervene in the process. These factors may in some cases reinforce the patterns described above or in other cases prohibit their expression for particular groups.

Socioeconomic status. Residential behavior has also been related to the household's socioeconomic status. Two conceptually distinct dimensions of socioeconomic status related to residential behavior can be identified, standard of living and style of living. Standard of living refers to the household's resources for potential consumption of goods and services and is primarily determined by income level. Styles

of living, on the other hand, refer to distinctive patterns in the consumption of socially valued prestige goods. Lifestyle appears to be more closely related to the head of the household's occupation and educational level rather than income. Although empirically lifestyles and living standards are highly related, the distinction between these dimensions has implications for residence related behavior.

The basic relationship between standard of living or income level and residential location has been discussed previously. Income was identified as a fundamental element in the economists' models of the urban land market (Alonso, 1960; Mills, 1969; Muth, 1969; Wingo, 1961). In the context of these models, the individual's residential location is determined by the costs of transport, rent (land price), the individual's preference for space, and income. In an urban land market where rents are highest at the center and lowest on the periphery, Alonso (1960) indicates that, given two individuals with a preference for low density living but different income levels, the wealthier individual will be located at a greater distance from the center on a larger lot but less expensive land. He attributes this to the fact that at any given location the higher income individual can buy more land; therefore, proportionately he is less affected by changes in transportation or commuting costs than by changes in land price. Consequently, he buys larger lots in low density suburban areas.

The empirical support for Alonso's model appears greatest when one examines the residential location behavior of households with either a very high or low standard of living. As expected, high income

households generally locate at a greater distance from the city center in lower density areas of single family housing (Kain, 1975). Low income households, on the other hand, are generally concentrated in the medium to high density areas of the central city where they are more likely to utilize a multifamily unit (Lansing, Mueller, and Barth, 1964). While patterns for high and low income households are generally as expected, middle income households deviate from expected patterns.

Bennet Berger (1956) has suggested that in an affluent society the differences between upper and lower middle class households are less a matter of standard of living than of style of living. He contends that it is not the quantity of goods consumed which distinguishes between these groups but rather the type of goods and manner of their consumption. Differences in style of living appear to be drawn along educational and occupational lines, particularly blue-collar versus white-collar occupations, rather than strictly income. This suggests that contrary to Alonso's model, lower income, white-collar households should tend to exhibit residential consumption patterns which are more similar to higher income, white-collar households than to blue-collar households at similar income levels.

Studies of journey to work and residential location appear to support Berger's position. Kain (1975) finds that when occupations are ordered by medium income, "the order generally accords with the hypothesis" that lower income workers live closer to the city center than higher income workers; however, he indicates that the ordering is not perfect.

> Lower percentages of sales workers and clerical workers reside in inner rings than their incomes would lead us to expect. By contrast, a higher proportion of operatives resides in inner rings (closer to the city center) than is consistent with their income rankings.

He concludes that reversing the order of the two pairs of occupations, i.e., placing the lower income, white-collar occupations with the higher income, white-collar occupations above the higher income, blue-collar occupations, would produce a more consistent order.

Wheeler (1967), in a study of residential location, place of work, and occupation, also found that residential location patterns of lower income, white-collar groups tended to be more similar to higher income, white-collar groups than to other lower income groups in blue-collar occupations. He found that higher status workers tended to be concentrated in suburban areas, located farther from the CBD and workplace. Lower status, blue-collar workers were concentrated in higher density residential areas closer to the CBD and workplace. As might be expected from their relatively higher incomes, craftsmen traveled greater distances and had greater representation in the suburbs than other blue-collar occupations, although at lower levels than white-collar households with similar incomes.

Evidence from a study by Duncan and Duncan (1955) partially conflicts with these findings. They found that, while the residential distribution of most lower income, white-collar occupations resembled those of higher income, white-collar households, the lowest paid white-collar workers, e.g., clerical workers, were more closely related to higher paid, blue-collar craftsmen. However, when they examined the

concentration of occupational groups in areas of "low rent" housing, the relationship was consistent with Kain's and Wheeler's findings. They found that the degree of low rent concentration was inversely related to the socioeconomic status of the occupation group. All of the white-collar occupation groups, including clerical workers, were relatively concentrated in high rent areas. Conversely, blue-collar households were found in lower rent areas. Craftsmen were concentrated in low rent areas in substantially higher proportions than clerical workers in reverse of their relative income positions. This reflected the fact that, while clerical workers earned less income than blue-collar craftsmen, they tended to spend a larger proportion of their income for rent. Although craftsmen have considerably higher incomes on the average than clerical workers, it appears that clerical workers aspire to residential values similar to higher income, white-collar households.

In summary, a positive relationship generally exists between socioeconomic status and distance from the center city or workplace. A greater home/work separation is usually associated with higher rather than lower socioeconomic status occupations. While all socioeconomic groups appear to be density adverse, the effective demand for low density residential environments is much greater for high income, white-collar households. The relationship between income and residential location is strongest for households in the lowest and highest income groups, with low income groups found in higher density, inner city areas and with high income groups predominantly located in low density, high value suburban areas. For middle income groups, it appears that the social

status or prestige associated with a blue-collar or white-collar occupation is a more important determinant of the residential location patterns than income. In general, a positive relationship prevails between socioeconomic status and the concentration of higher rent, single family units. Households headed by workers in white-collar occupations are much more likely to live in single family units located in lower density environments, regardless of income.

Journey to Work

The journey to work is one factor often identified in the literature as a potential influence upon residential location behavior. The role of journey to work or the distance between home and the work site in determining residential location is somewhat problematic. Both theoretical and empirical studies generally include the journey to work as a constraint on residential location. There is, however, considerable disagreement concerning the relative importance of journey to work compared to other factors potentially affecting the residential location decision.

The previously-described gravity model and urban land market studies conducted by economists and planners tend to place considerable emphasis on the importance of the journey to work (Alonso, 1960; Wingo, 1961; Mills, 1969; Muth, 1969). They argue that since frequent trips are required between the household's residence and the work site, a certain degree of access to the place of employment is an important requirement for a residential location. Furthermore, since time and monetary costs

are associated with commuting, they suggest that "rational" commuters will tend to select a residential location which minimizes these costs.

Although journey to work is generally included in studies using the disaggregated residential location approach, much of the empirical evidence suggests economists and planners may have over emphasized its importance in determining residential location (Ermuth, 1973; Butler et al., 1969). Studies of commuting and residential location behavior indicate that a number of social, economic, and demographic factors affect the distance traveled between home and work, such as sex, age, size of household, family income, social status, and race. Distance between home and work is shortest for women, youths, and small households and greatest for white-collar workers, very low and very high income persons, larger households, males, and blacks (Butler et al., 1969; Guest and Cluett, 1976; Kain, 1975; Lansing, Mueller, and Barth, 1964). When a residential move is made in an urban area, the new location is as likely to be farther from the work site as it is to be nearer (Lansing, Mueller, and Barth, 1976). When households are asked to specify factors important in selecting a new housing unit, location and employment accessibility are mentioned much less often than residential environment and characteristics of the housing units themselves (Rossi, 1955; Lansing, Mueller, and Barth, 1964).

The limited empirical evidence on the residential location behavior of inmigrating workers associated with the construction of power plants suggests that journey to work may be somewhat more important than indicated in the above-described urban studies (Chalmers, 1977a and

1977b; DeVeny, 1977; Leholm et al., 1976; Mountain West Research, Inc., 1975). Although there appear to be regional factors affecting the distance from the site at which workers locate, these studies indicate that the majority of workers locate close to the site. Gravity model analyses (Borcz, 1977; Konkel, 1977) of worker residential location behavior also tend to support the hypothesis that the relative attraction of a community declines with distance from the work site.

Effects of "Origin" Characteristics on Residential Location Behavior

Analyses of spatial interaction behavior, for example, trip generation or migration, typically include as explanatory variables the characteristics of the origin as well as the destination (Greenwood, 1975; Shaw, 1975; Dickey, 1975). Similarly, residential location studies have also given some limited attention to conditions at the mover's origin (Butler et al., 1969). In both migration studies (Shaw, 1975) and residential location analyses (Butler et al., 1969), the findings indicate that conditions in the area of origin tend to affect the propensity to move more so than selection of a new residential location. This suggests that studying the conditions at the inmigrating worker's point of origin may be more useful in developing a mobility model than a location model.

While migration and residential location studies suggest the role of origin characteristics is limited to providing the motivation for mobility, the concept may have wider implications if the selection of a new residential location is viewed as a search process. In the

introduction to this paper, it was suggested that the movement of workers into the area surrounding the site of an electrical generating facility could be viewed as an example of work place constrained migration; that is, workers hired from areas outside the commuting region have their work place fixed prior to migration and selection of a new residential location. Thus, the inmigrating worker is employed at the project and must then institute a search for an acceptable residential unit. In this context, the project or work site may be viewed as the "origin" of the worker's search for a new residential location.

While relatively little attention has been given to the effects of project characteristics on the residential distribution of inmigrating power plant construction workers, some urban research has been conducted. In a study by Schnore (1965) concerning the relationship between plant characteristics and the journey to work, the average distance traveled from home to work was found to increase with the size of the plant's employment. Schnore also found that second and third shift employees showed a tendency to travel farther than first shift workers. Since workers on first shift generally have greater seniority and therefore employment security, he theorized that the pattern exhibited by the relatively more "marginal" workers might represent a response to other employment opportunities. By locating at a greater distance from the work site, accessibility to alternative sources of employment in nearby cities may be increased.

Two implications for studying inmigrating worker behavior may be drawn from Schnore's research. First, Schnore's results suggest that as

the size of the construction work force increases at a given project the average distance traveled by the inmigrating workers should increase. Secondly, since the stage of project construction is related to both the level of job skills required and the workers' potential job tenure, stage of construction may be expected to affect the inmigrating workers' residential location distribution.

CHAPTER III

A PROPOSITIONAL INVENTORY OF RESIDENTIAL LOCATION FACTORS

In this chapter, propositions are presented concerning the factors which potentially influence the residential location behavior of the workers who move into the area surrounding the construction sites of major electrical generating facilities. These propositions are generally based upon the findings discussed in the review of the residential location, mobility and preference literature.

In the introduction, four factors are introduced as a guide for empirical exploration. The first factor consists of the characteristics of the inmigrating work force. It is hypothesized that the workers' characteristics determine the basic specifications for a residential unit and location. The second factor comprises the community characteristics. They are considered the basis of a community's relative attraction as a potential residential location. The project's characteristics constitute the third factor. The fourth factor, distance to the work site, represents a major constraint on residential location. The relationships between these factors and their relative importance are the central questions of this research.

The following propositions represent the working hypotheses which guide this study. They are stated in terms of the relationships between worker inmigration and the factors discussed above. They vary somewhat in generality. General propositions are offered when a factor is

hypothesized to affect the overall residential location distribution of a project's inmigrating construction work force. More specific propositions are given when it is hypothesized that a factor differentially affects the distribution of significant subgroups of inmigrating workers. The working hypotheses represent the expected relationships. It should be noted that in some cases worker residential location behavior is expected to differ from patterns described in the literature.

I. PROPOSITIONS FOR RESIDENTIAL LOCATION BEHAVIOR

Distance to the Work Site

A. General Propositions

1. Worker migration into a community tends to decrease as the distance to the work site from the community increases.
2. The tendency to locate close to the work site is differentially related to the inmigrant's social, economic, and demographic characteristics.

B. Specific Propositions

1. White-collar inmigrants are less likely to locate close to the project construction site.
2. Younger inmigrants are less likely than older inmigrants to locate close to the work site.
3. Inmigrants who are employed longer are less likely than short-term migrants to locate close to the work site.
4. Inmigrants accompanied by children are less likely to locate close to the work site.

5. Larger households are less likely than smaller households to locate close to the work site.

Community Size

A. General Propositions

1. Worker inmigration tends to increase at a decreasing rate with the size of the community.
2. Inmigrating workers tend to prefer residential locations in rural areas or small communities under 50,000 population.
3. The relationship between community size and worker inmigration is differentially related to the inmigrant's household size and composition, occupational status, and age.

B. Specific Propositions

1. Families with no children are more likely to locate in larger communities.
2. Inmigrants with very large households are more likely to locate in larger communities.
3. White-collar inmigrants are more likely than blue-collar inmigrants to locate in larger communities.
4. Younger inmigrants are more likely than older inmigrants to locate in larger communities.

Housing Availability

A. General Propositions

1. Worker inmigration increases with the number of vacancies in the community.

2. Worker inmigration increases with the size of a community's total housing stock.

B. Specific Propositions

None

Residential Density

A. General Propositions

1. Worker inmigration is inversely related to residential density.
2. The relationship between residential density and inmigration is differentially related to the inmigrant's occupational status, age, job tenure, household composition, and stage in the family life-cycle.

B. Specific Propositions

1. White-collar inmigrants are less likely to locate in communities with higher residential densities.
2. Younger households in the early stages of the family life-cycle are more likely to locate in communities with higher residential densities.
3. Households in the primary childrearing stages of the family life-cycle are less likely to locate in communities with higher residential densities.
4. Length of employment at a project site is related to residential density of the inmigrant's community.
5. There is no significant relationship between residential density and the size of the inmigrant's household.

Housing Costs

A. General Propositions

1. Communities with lower housing costs tend to attract a larger proportion of a project's inmigrating work force.
2. The effects of community housing costs are differentially related to the inmigrant's occupational status and job tenure.
3. No significant relationship exists between community housing costs and the inmigrant's age, stage in the family life-cycle, or household size and composition.

B. Specific Propositions

1. White-collar inmigrants are more likely than blue-collar inmigrants to locate in communities with higher median housing values or rents.
2. Inmigrants who have been employed longer at a project site are more likely than short-term migrants to locate in communities with higher median housing values and rent.

Housing Tenancy

A. General Propositions

1. Worker inmigration increases with the proportion of a community's housing stock in rental units and decreases with the proportion in owner occupancy.
2. The effects of housing tenancy on inmigration are differentially related to the inmigrant's occupational status, job tenure, age, household composition and size.

B. Specific Propositions

1. Blue-collar inmigrants are more likely than white-collar inmigrants to locate in communities with higher proportions of rental units.
2. Short-term migrants are more likely than long-term migrants to locate in communities with higher proportions of rental units.
3. Younger workers are more likely to locate in communities with higher proportions of rental units.
4. Inmigrants whose household composition consists of a single person or roommates are more likely than inmigrants with families to locate in communities with a higher proportion of rental units.
5. Smaller households are more likely than larger households to locate in communities with higher proportions of rental units.

Type of Housing Unit

A. General Propositions

1. Worker inmigration increases with the proportion of the community's housing stock in mobile homes and conventional single family units, and decreases with the proportion in multifamily units.
2. The community's mixture of housing types differentially affects worker inmigration according to the inmigrants'

occupational status, job tenure, age, stage in the family life-cycle, household composition, and size.

B. Specific Propositions

1. White-collar inmigrants are more likely to locate in communities with higher proportions of single family units and less likely to locate in communities with higher proportions of multifamily and mobile home units.
2. Short-term inmigrants are more likely to locate in communities with higher proportions of mobile homes and multifamily units.
3. Older inmigrants are more likely than younger inmigrants to locate in communities with higher proportions of single family units.
4. Inmigrants with children are more likely than inmigrants in other stages of the family life-cycle to locate in communities with higher proportions of single family units and mobile homes and lower proportions of multifamily units.
5. Large households are more likely than smaller households to locate in communities with higher proportions of single family housing.

Housing Stock Diversity

A. General Propositions

1. Worker inmigration increases with the diversity of a community's housing stock.

2. The effects of the diversity of a community's housing stock are not significantly related to the inmigrant's social, economic, or demographic characteristics.

B. Specific Propositions

None

Age of the Community's Housing Stock

A. General Propositions

1. Worker inmigration decreases as the age of the community's housing stock increases.
2. The effects of housing age are differentially related to the inmigrant's occupational status and job tenure.

B. Specific Propositions

1. White-collar inmigrants are more likely than blue-collar inmigrants to locate in communities with newer housing.
2. Inmigrants who have been employed at a project for a longer period of time are more likely than short-term inmigrants to locate in communities with newer housing.

Local Public Services

A. General Propositions

1. Inmigration increases as the level of local public services increases.
2. The effects of local public service levels on inmigration are differentially related to worker occupational status, job tenure, age, and household composition.

B. Specific Propositions

None

Educational Expenditures

A. General Propositions

1. Worker inmigration increases with the level of a community's educational expenditures per pupil.
2. The effects of educational expenditures on inmigration are differentially related to the inmigrant's household composition.

B. Specific Propositions

1. Inmigrants with children are more likely than others to locate in communities with higher levels of educational expenditures per pupil.
2. Educational expenditures are unrelated to the inmigrant's occupational status, job tenure, age, and household size.

Land Use Controls

A. General Propositions

1. The presence of land use controls in a community tends to inhibit worker inmigration.
2. Land use controls are unrelated to the inmigrant's social, economic, and demographic characteristics.

B. Specific Propositions

None

Project Characteristics

A. General Propositions

1. Size of a project's inmigrating work force is related to the distance at which new inmigrants locate from the work site.

2. The project's stage of construction is related to the inmigrating workers' residential location pattern.

B. Specific Propositions

None

CHAPTER IV

METHOD AND MATERIALS

This study is an exploratory analysis of some of the major factors influencing the spatial distribution of inmigrating workers during the construction phase of a fossil fuel or nuclear power plant project. The problem is analyzed within the framework of the four questions previously posed. In order to accomplish this, data are required for inmigrating workers indicating the community in which they located and their characteristics, worker characteristics, project characteristics, and finally the distance from place of residence to work site.

The analysis is based upon data from several sources. Data concerning the inmigrating workers' characteristics and residential location are based upon surveys of employees conducted by the Tennessee Valley Authority during the construction of six electrical generating plants. Data concerning project characteristics are based upon both published and unpublished reports by the Tennessee Valley Authority. Data on community characteristics are taken primarily from the fourth count 1970 Census of Housing and Population tapes and published reports. Some data are based upon local and state reports and local informants. In addition to the data from the sources cited above, distances between residential communities and work site are estimated from appropriate commercial atlases.

I. TVA PROJECT SURVEYS

Since 1968, the Regional Planning staff of TVA's Navigation Development and Regional Studies Division has conducted surveys of workers during construction of new electrical generating facilities. The surveys were designed to provide information concerning the distribution of the construction work force between commuters and inmigrating workers, the extent to which the inmigrating workers were accompanied by their families, the residential location of the inmigrating workers, and the type of housing selected. A total of twenty-two worker surveys have been conducted covering seven power plant construction projects, listed in Table 1. The location of these projects is indicated in Figure 1.

The analysis will be limited to six projects: Bellefonte, Brown's Ferry, Hartsville, Cumberland, Sequoyah, and Watts Bar. Data from Paradise are no longer available at a detailed level; therefore, it will be eliminated from further consideration.

Description of the Worker Survey Questionnaire

The survey instrument consists of a simple one-page questionnaire divided into two parts. The first part is composed of three questions, answered by all workers. Question 1 provides basic information about the worker—name, age, identification number, and occupation. Questions 2 and 3 provide the basis for determining the proportion of inmigrants versus commuters in the labor force and the residential location of the inmigrants. In the context of these surveys, inmigrating workers are

Table 1. Name and Location of Surveyed Projects

Project Name	
Bellefonte Nuclear Plant	8 miles northeast of Scottsboro, Alabama
Brown's Ferry	11 miles west of Athens, Alabama
Cumberland Steam Plant (coal-fired)	25 miles west of Clarksville, Tennessee
Hartsville Nuclear Plant	50 miles northwest of Nashville, Tennessee
Paradise Steam Plant (coal-fired)	35 miles west of Boling Green, Kentucky
Sequoyah Nuclear Plant	20 miles north of Chattanooga, Tennessee
Watts Bar Nuclear Plant	20 miles northeast of Dayton, Tennessee

Figure 1

Project Location Map

defined as "any construction employee whose (community) at the time of the survey was different from that before he started work on the project." Completion of the second section is restricted to inmigrants only and currently consists of four questions related to the inmigrating worker's housing accommodations, tenancy, and household size and composition.

A recent copy of the survey instrument has been included as Figure 2. Earlier versions of the instrument differed slightly from the included form in that additional questions concerning the inmigrant's housing preferences were included. These items were dropped subsequently from the form as a result of lower response rates for these items and the attendant lack of reliability.

Administration of the Questionnaire

A total of eighteen surveys, conducted at six project sites, have been included for analysis in this study. The surveys have been organized into three groups, based upon their relationship to the size of the construction labor force. Fourteen surveys were conducted at projects in the period prior to peak employment. Two were conducted at peak employment, and there have been two post-peak surveys.

Administration of the questionnaire consisted of preparing an adequate number of questionnaires to cover all employees at the project. The questionnaires were then sent to the project, where the personnel office broke them down into appropriate-sized groups for each craft. They were then passed down through channels until every employee received one. The questionnaires were subsequently collected by supervisors over a period of one to two weeks.

SURVEY OF CONSTRUCTION PROJECT IMPACT

Large construction projects create a need for more housing and schools near the construction site. You are requested to provide information for a TVA survey to find out more about these needs. Your cooperation in filling out the appropriate parts of this form will be appreciated and the information given will be kept completely confidential. Please return the form to the person who handed it to you.

Please do not write in this column.

1. Name _____ Age _____
   Job Title _____ Man No. _____
   Annual _____ Trades and Labor _____ 1

2. Where did you live before beginning work on this project?
   City _____ State _____

3. Where are you living now?
   City _____ State _____ 2 3 4

CONTINUE WITH THE QUESTIONNAIRE ONLY IF YOUR ANSWERS TO 2 AND 3 WERE DIFFERENT

Please check the item which applies to your case.

4. I am living in (a) a boarding room ____, (b) an apartment ____, (c) a mobile home ____, (d) a house ____. 5

5. I (a) own ____, (b) rent ____. 6

6. I am living in the project area (a) by myself ____, (b) with roommates ____, (c) with my family ____. 7

ANSWER THE NEXT QUESTION ONLY IF YOU ARE LIVING IN THE PROJECT AREA WITH YOUR FAMILY

7. How many children are living with you? _____ . Of these, how many are in grade school _____, high school _____, college _____? 8 9 10 11

Figure 2. An example of the TVA Construction Worker Survey form.

With the exception of the initial Cumberland and Paradise surveys and the Hartsville surveys, no attempt was made to account for 100 percent of the questionnaires; therefore, it would be difficult to estimate any sampling bias which might exist in the data. Despite these problems, the large sample size and excellent response rates lend considerable confidence to the results. As indicated in Table 2, the questionnaire has been administered to a total of 37,144 employees at projects included in the present analysis and that 27,706 usable responses were obtained, yielding an aggregate response rate of 74.6 percent. Although, as indicated in the table, there were some variations in response rates from project survey to project survey, all project surveys had rates in excess of 50 percent—a substantial rate in the social sciences.

II. COMMUNITY DATA

The universe of communities included in this study consisted of all communities receiving inmigrating workers at peak construction for each project. Secondary data concerning community characteristics were acquired for a total of 168 communities. Data on community characteristics were obtained primarily from the 1970 Census of Housing and Population. The 1970 Census provided a variety of housing and population data for "places." The Census defined a place as a concentration of population. Data were available for all incorporated places and for unincorporated places with a population of 1,000 inhabitants or more.

Table 2. Questionnaire Distribution and Response Rate

Project Name	Year	Construction Phase	Total Employment	Response	Response Rate
Bellefonte	1975	pre-peak	900	650	.72
Bellefonte	1976	pre-peak	2,200	1,350	.61
Bellefonte	1977	pre-peak	3,550	2,110	.59
Browns Ferry	1969	pre-peak	2,500	1,700	.68
Browns Ferry	1971	peak	3,200	2,500	.78
Browns Ferry	1973	post-peak	2,100	1,800	.86
Cumberland	1968	pre-peak	544	544	1.00
Cumberland	1969	pre-peak	1,450	1,100	.76
Cumberland	1971	peak	2,900	1,500	.52
Cumberland	1973	post-peak	725	625	.86
Hartsville	1978	pre-peak	4,400	3,900	.89
Sequoyah	1970	pre-peak	1,100	846	.77
Sequoyah	1972	pre-peak	2,200	1,477	.67
Sequoyah	1974	pre-peak	1,600	1,300	.81
Sequoyah	1977	peak	2,800	1,903	.68
Watts Bar	1973	pre-peak	475	400	.84
Watts Bar	1974	pre-peak	1,700	1,500	.88
Watts Bar	1976	pre-peak	2,800	2,500	.89
TOTAL	ALL		37,144	27,706	.75

Where possible, community characteristics were based upon place data; however, for unincorporated places with population of less than 1,000 inhabitants, it was necessary to obtain data by estimation. In general, enumeration districts were used as a proxy for small places. Where a small place is included in an enumeration district with a large area or is split between enumeration districts, community characteristics were estimated based upon data for the unincorporated portion of the county. For example, if population growth rates were unavailable for an unincorporated place of less than 1,000 population and an enumeration district did not approximate the community, then the growth rate for the county, exclusive of the unincorporated places, was applied. This estimation procedure no doubt introduced some error into the analysis; however, only a small minority of communities (18 out of 168) required estimation.

III. VARIABLES

In this section, the variables included in this study are briefly described. The variables are organized in relationship to the four factors previously discussed.

There are six variables describing the worker's characteristics—age, household size, household composition, family life-cycle, occupational status, and job tenure. Data for these variables were obtained from the worker surveys. Variables related to worker characteristics are:

1. Age—the worker's age measured in number of years.

2. Household composition—variable indicates whether the worker lives alone, with roommate, or with a family.
3. Household size—estimated number of persons in a household based upon household composition and number of children.
4. Family life-cycle—stage in the family life-cycle based upon immigrant's age and household composition.
5. Occupational status—hourly workers are classified blue-collar; salaried workers are classified white-collar.
6. Job tenure—measured by length of time at site; workers included in more than one survey at a project are classified as long-term workers.

Data for variables related to the characteristics of the communities will generally be drawn from the 1970 Census; however, several variables require field collection either by direct observation or from local secondary sources. Variables related to community characteristics and their sources are:

1. Community size—number of persons residing in community in 1970; 1970 Census of Population, Rand-McNally Commercial Atlas (1975).
2. Gross residential density—total number of dwelling units divided by total community acreage; County Highway Maps, 1970 Census of Housing, and field observation.
3. Legal constraints—dummy variables indicating the presence of zoning ordinances or subdivision regulations either prohibiting

or restricting mobile home development; Tennessee State Planning Office, Alabama Development Districts.

4. Vacancy—number of vacant units in 1970; 1970 Census of Housing.
5. Unit type—percentage of housing stock in single family, apartment, and mobile home units; 1970 Census of Housing.
6. Housing age—percentage of units constructed after 1950; 1970 Census of Housing.
7. Cost—median value owner-occupied units or mean monthly rent; 1970 Census of Housing.
8. Diversity—index measuring the diversity of the housing stock; calculated from 1970 Census data.
9. Tenure—percentage of owner-occupied units; 1970 Census of Housing.
10. Local public services—percentage of units with public sewer (1970 Census of Housing); number of police per capita (Law Enforcement Planning Districts); fire insurance rating; and public water system (TVA Division of Water Management).
11. Educational quality—per pupil expenditure; State Reports on Education.

Two variables characterize each project:

1. Project size—the total number of employees at a project at the time of the survey.

2. Project stage—a dummy variable indicating the stage of construction; prior to peak employment (pre-peak), at peak employment (peak), and after peak employment (post-peak).

Journey to work is measured in road miles from the work site to the approximate geographic center of a community. Since workers in fact are quite likely to distribute themselves throughout a community, and for that matter the surrounding area, the geographic center was chosen as the most likely point to minimize the measurement error inherent in using a single reference point to represent an area. Distance is based upon the "best route" road mileage as indicated in The Rand-McNally Standard Highway Mileage Guide, 1973. Rand-McNally indicates that "best route" mileage is not necessarily the shortest possible driving distance for an automobile; however, it is assumed that this better reflects the combined effects of comfort, driving time, and distance.

IV. STATISTICAL ANALYSIS

The statistical analysis consisted of three stages. In the initial stage, the relationships described in the working hypotheses among the predictor variables and between each predictor variable and the residential location distribution were explored with bivariate statistical procedures. Investigation of the relationships between the inmigrating workers' characteristics and the characteristics of the residential communities was accomplished by sub-dividing the inmigrant population into distinctive socioeconomic and demographic groups and

cross-tabulating the distribution of these groups with various community characteristics. The function of this step was essentially descriptive. Analytical inferences were based primarily upon the means of each community characteristic computed for each sub-group of the worker population. The differences between means were tested for statistical significance using analysis of variance (F test) and t tests. A hypothesis of no relation between two factors was rejected if the computed value of the appropriate test statistic, either F or t, was sufficiently large to be significant at the .05 significance level. Investigation of the relationships between each individual predictor and the overall residential location pattern was based upon a bivariate correlational analysis. The dependent variable was the percentage of the total inmigrating project work force locating in a given community. Predictor variables included the community characteristics, project characteristics, and the journey to work. The objective of the initial stage of the statistical analysis was to examine the evidence for association between the individual predictor variables and residential location patterns and to provide an assessment of the strength of the association.

After obtaining a measure of the degree of association between the variables in the bivariate analysis, the second stage determined the amount of variation accounted by each predictor variable, controlling for the effects of other predictor variables. This was accomplished by examining the bivariate relationships, and then successively entering other "test" predictor variables to determine their effect on the basic

relationship. The degree of dependence between two factors, controlling for the potential effects of the third, was determined on the basis of a partial correlation analysis. In order to compute the correlation coefficients for the categorical variables (occupational status, job tenure, household composition, land use controls, water system and project stage), dummy variables were created by assigning the value of 1 to the following classifications of these variables: white-collar occupation, long-term employee, mover with family or children, and communities with zoning, sub-division regulations, water systems, and to each stage of project construction. All other classes were assigned a 0 value. Values of 1 through 7 were assigned to the stages of the family lifecycle. Fire insurance ratings ranged in value from 1 to 10. For the purposes of this analysis, it was assumed that the stages of the family lifecycle and fire insurance ratings could be treated as interval level data.

In the first two stages of the statistical analysis, the intent was to build up a pattern of relationships out of the sequence of simple statistics as the analysis proceeded. In the last stage of the analysis, this pattern of relationships was combined with the theoretical assumptions set out in the conceptual framework as a basis for specifications for preliminary models of the residential location process for inmigrating workers during the construction of major energy facilities. Separate models were estimated for the overall inmigrating worker population and significant sub-groups. The models were linear, recursive and estimated using ordinary least squares regression. An attempt was

made to cross-validate the models by projecting the residential distribution of the inmigrating work force among twenty primary impact communities at the Hartsville project. Since data from the Hartsville project were not included in estimating the models, this provided the basis for an independent assessment of validity, accuracy and stability of the modeled relationships.

CHAPTER V

FINDINGS—RESIDENTIAL LOCATION AND CHARACTERISTICS OF THE WORKER, COMMUNITY, JOURNEY TO WORK AND PROJECT

A number of factors affecting the spatial distribution of the inmigrating workers at five electrical generating facility construction projects in the Tennessee Valley are examined in this chapter. The analysis is focused upon evidence for associations between predictor variables and worker residential location patterns. Predictor variables include the characteristics of the communities surrounding the projects, the journey to work, and the project characteristics. The effects of the predictors on inmigrant location are examined in the context of the socioeconomic and demographic characteristics where appropriate. In addition to examining the bivariate relationships between the predictors and worker inmigration, an effort is made to provide an assessment of the strength of the association between each individual predictor variable and worker residential location patterns, controlling for the effects of other significant predictors. The primary objective of the analysis undertaken in this chapter is to identify a pattern of relationships useful for specifying an elementary model of inmigrating worker residential location behavior.*

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*Note that the analysis for community characteristics and journey to work relationships is limited to data from the survey closest to peak employment at each project. The rationale for limiting analysis to data

I. JOURNEY TO WORK

Since journey to work is strongly emphasized in a number of residential location models, its effect on the inmigrating worker residential location behavior was examined in some detail. Review of the residential location literature suggested that distance to work acts as a constraint on residential location; therefore, it was hypothesized that a negative relationship exists between a community's distance to the work site and worker migration into the community.

In addition to examining the overall relationship between distance and inmigration, an attempt was made to determine whether any significant differences existed in the journey to work patterns of major groups of workers. Disaggregation of the inmigrant population by occupational status, job tenure, age of worker, family life-cycle stage, household size, and composition was expected to show that white-collar workers, younger workers, long-term migrants, and those with children or very large households were less affected by distance to work.

Examination of the data indicates strong support for the hypothesis that the attraction of a community as a residential location is reduced considerably as the distance to the work site increases. Inmigrating workers locate an average of 17.0 miles from the work site. A frequency distribution showing the distance between the movers' community of

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from surveys near peak is based on two factors. First, peak employment is generally recognized as the construction stage during which the greatest potential for adverse socioeconomic impacts exists; and, secondly, using only one survey from each project avoids double counting respondents present for more than one survey at a project.

residence and the work site indicates that 39 percent of all movers located in communities within 10 miles of the work site, another 30 percent between 10 and 20 miles away, and another 16 percent between 20 and 30 miles. The majority of workers in all mover groups locate in communities within 15 miles of the work site.

The correlation coefficient between the community's distance from the work site and the proportion of total inmigrants locating in a community also indicates support for the hypothesis that distance to the work site is negatively associated with inmigration. The correlation coefficient is -0.51 and is statistically significant at the 0.001 level.

Although the majority of workers in all mover groups locate close to the work site, there are significant differences in the strength of this tendency (see Table 3). As expected, the differences are related to the inmigrating worker's occupational status, length of employment, age, stage in the family life-cycle, household size, and composition. Workers with higher occupational status tend to locate farther from the work site. The mean distance between the work site and the community is 18.1 miles for white-collar movers compared to 16.6 miles for blue-collar movers. Blue-collar movers are much more likely than white-collar movers to locate within 10 miles of the site and much less likely to locate over 20 miles away.

Age is also related to the distance movers locate from the site. Distance to work is negatively related to the worker's age. Movers under the age of 35 located an average of 18.1 miles from the work site,

Table 3. Percentage of Movers by Journey to Work Distance and Mean Distance by Worker Characteristics

Predictor	0-5 Miles	6-10 Miles	11-15 Miles	16-20 Miles	21-25 Miles	26-30 Miles	Over 30 Miles	Number	Mean (F or t)
All Workers	6.1	33.0	25.5	5.0	10.6	5.1	14.7	3,305	17.0
Occupational Status									
Blue-Collar	7.8	33.9	24.2	5.7	9.0	4.4	15.0	2,412	16.6
White-Collar	1.2	30.6	29.0	3.1	14.9	7.2	14.0	893	18.1 (F=10.0**)
Job Tenure									
Long-Term	4.3	41.9	22.0	3.9	8.7	6.6	12.6	437	16.2
Short-Term	6.7	31.2	25.7	5.4	10.8	4.7	15.5	2,445	17.2 (NS)
Age of Mover									
Under 35	3.7	32.1	24.6	4.5	13.9	5.6	15.6	1,541	18.1
35 and Over	8.1	33.8	26.3	5.4	7.7	4.6	14.0	1,764	16.0 (F=23.6***)
Household Composition									
Single	8.8	40.6	24.9	5.2	9.0	2.9	13.5	591	14.0
Roommates	14.2	34.9	32.9	4.7	7.0	1.5	4.7	401	11.9
Family-No Child	4.1	33.3	24.5	4.5	10.8	5.4	17.4	666	17.8
Family-Young Child	3.7	31.0	27.5	4.8	14.3	5.7	13.0	455	17.2
Family-Older Child	3.9	31.4	25.9	5.4	11.6	6.7	15.1	889	17.7 (F=26.7***)
Family Life-Cycle									
Young Single	3.9	37.8	24.9	4.3	14.2	3.9	11.2	233	16.3
Young Family-No Child	1.7	31.3	23.1	3.4	17.3	6.1	17.0	294	19.2
Young Family-Young Child	3.3	30.1	28.4	4.6	15.2	6.3	12.2	395	17.2
Young Family-Older Child	3.8	35.0	23.2	5.2	11.5	5.5	15.8	366	17.7
Older Family-Child	4.3	29.7	27.1	5.7	11.3	7.0	14.9	583	17.6
Older Family-No Child	5.9	34.9	25.5	5.4	5.4	5.6	17.7	372	16.7
Older Single	12.0	42.5	24.9	5.9	5.6	2.2	7.0	358	12.6 (F=18.6***)
Household Size									
1	8.8	40.6	24.9	5.2	9.0	2.9	8.6	591	14.0
2	4.0	33.4	24.4	4.5	10.8	5.4	17.4	667	17.8
3	3.6	30.8	29.5	3.6	13.2	6.5	12.6	522	17.2
4	3.9	34.1	25.4	6.5	11.8	6.1	12.2	508	16.9
5	3.4	26.8	27.8	7.3	11.2	4.5	19.6	179	18.6
6 and Over	5.2	27.6	17.2	3.7	14.2	9.7	22.4	134	20.1 (F=10.2***)

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

NS Not significant.

while those 35 and over were found in communities an average of only 16.0 miles from the site.

There also appears to be significant differences in distance to work related to the mover's household composition. It was expected that presence of children in the household would reduce the tendency to locate close to the work site; however, it appears that the presence or absence of the worker's family regardless of its childrearing status is a more important factor in determining the distance to the work site. Inmigrants who live alone or with roommates tend to locate much closer to the work site than those accompanied by a family. The average distance to the work site of 11.9 miles for migrants who live with roommates is the lowest of all groups. By comparison, the mean distances for migrants with families but no children and those with children are 17.8 miles and 17.5 miles, respectively. While the difference between the means of migrants with families and those without is statistically significant, there is no significant difference between families with children and those with no children.

The journey to work relationships with age and household composition are altered somewhat when examined in the context of the migrant's stage in the family life-cycle. While both younger and older workers without families tend to locate closer to the work site than workers with families, the tendency to locate close to the site is much stronger for older workers without children. Among migrants with families, both age and children appear to be related to the distance at which workers locate. Younger movers with families but no children are most likely to

locate farther from the work site. Their mean distance to work (19.2 miles) is significantly higher than the mean for all families (17.6 miles) and the overall mean of 17.0 miles.

The family life-cycle data also suggest that the failure to find significant differences between movers whose household composition consists of families with children and those with no children is partly the result of the intervening effect of age. While the mean distance for all families without children is 17.8 miles, the mean for younger families without children is 19.2 miles, but only 16.7 miles for older families in the post-childrearing stage. Except for younger families with no children, disaggregation of the population by stage in the family life-cycle indicates that, as expected, movers in the child-rearing stage are more likely than those without children to locate farther from the work site. Among the groups with children, differences between means are not statistically significant.

Intuitively, large households have special housing needs which may be difficult to meet in the relatively limited housing markets generally found in rural areas surrounding power plant construction projects. This suggests that large households should tend to locate farther from the work site. The data generally support this hypothesis. Movers with very large households tend to locate considerably farther from the work site. The mean distance for households of 6 or more persons is 20.1 miles compared to only 14.0 miles for single person households. Examination of the frequency distribution for all household sizes indicates the proportion of larger households (20.8 percent) locating

in communities over 30 miles from the work site is relatively large compared to all inmigrating workers (12.8 percent).

The frequency distribution also indicates an exception to the overall positive relationship between distance to work and household size. As suggested by the analysis of the family life-cycle and household composition data, two-person households are more likely to locate over 30 miles from work. This suggests the relationship between household size and distance to work depends partially upon the household's stage in the family's life-cycle and composition.

In summary, it appears that distance to work does act as a constraint on worker residential location. Workers in all groups tend to locate in communities close to the work site. The strength of this tendency, however, varies somewhat between inmigrant groups. As expected, white-collar workers, younger workers, and those with larger households are more likely on the average to locate farther from work. The tendency to locate close to the work site is strongest for blue-collar workers, one-person households and workers over 35 years of age. Unexpectedly, the presence of children in the household appears to have little effect on distance to work. It appears, rather, that the presence or absence of the inmigrant's family is the more salient household composition characteristic. Surprisingly high proportions of both younger and older families without children locate in communities over 30 miles from work. This trend may reflect a tendency for these households to include a high percentage of second workers employed at other locations.

II. COMMUNITY SIZE

Historically, the city size hierarchy has been related to the distribution of social and economic opportunities. Employment, housing, cultural amenities, and institutional opportunities typically have been considered relatively more abundant in larger cities. In response, there has been until recently a steady migration flow from the smaller towns and rural areas to the larger cities. This fact has led many researchers and theorists to the conclusion that cities, particularly large cities, are inherently more attractive to migrants than small towns or rural areas.

Although historical migration trends have generally supported this conclusion, there is some evidence that past migration trends inadequately reflect the residential preferences of most people. Recent surveys reveal a prevailing preference for residential locations in small towns and rural areas. The discrepancy between past migration behavior and stated residential location preferences suggests that the residential location behavior of many people may have been constrained by the lack of various types of opportunities, particularly employment, in smaller towns and rural areas.

In the case of the power plant construction worker, the employment incentive to locate in larger cities is largely eliminated by the siting pattern. As previously discussed, safety regulations and environmental constraints tend to push large generating facilities into rural areas away from larger cities. At the same time, other factors, such as, the

need for proximity to load demand centers, limit the distance at which a facility may be feasibly located from a city. As a result, in the Tennessee valley, the inmigrating worker often has a choice of locating in a small town or rural area in close proximity to the work site or in a larger city at some distance from the site. If power plant construction workers share the "prevailing" preference for residential locations in smaller towns and rural areas, then the siting pattern should tend to facilitate acting upon that preference.

It should be noted, however, that while the siting pattern largely removes the employment incentive for locating in larger communities, various other incentives may remain, particularly for those groups with special housing needs or strong preferences for goods and services usually limited to larger cities. If there are size thresholds below which some services are not available or if housing and city size are related, then a positive relationship may still be expected between city size and worker inmigration. If inmigrating workers share the preference for small towns but are constrained in their location by limited capacity, then it may be expected that the proportion of inmigrating workers will increase at a decreasing rate with the size of the community.

The above hypothesis suggests a nonlinear relationship between community size and inmigration such that as community size increases, it reaches a point beyond which it produces less and less effect on worker residential location behavior. The existence of such a relationship may be tested by transforming the nonlinear independent variable to a

linear form; e.g., in this case by taking the logarithm of city size, and computing the correlation coefficient between the transformed variable and the dependent variable. If the correlation between the transformed city size and the proportion of movers is significantly higher than the correlation with the raw values for city size, then we may conclude that the logarithmic model gives a better fit than the linear model using the untransformed values.

The data appear to support this hypothesis. The computed correlation coefficient between the untransformed community size values and the percent of inmigrants indicates a very weak positive relationship. In contrast, transforming community size to a logarithmic form results in a substantial increase in the strength of the relationship between community size and inmigration. The log-transformation increases the coefficient from 0.04, not statistically significant, to 0.23, significant at the 0.004 level. The increase in the size of the coefficient shows some support for the hypothesis that inmigration increases at a decreasing rate with the size of the community; however, the association is surprisingly weak considering the theoretical importance attached to this variable in many migration models.

One possibility for accounting for the relatively weak relationship with log-community size is that one or more variables may act to suppress the relationship. One likely candidate for a suppressor variable is distance to work. As previously noted, siting constraints tend to force power plant construction projects into more rural locations. As a result, one would expect to find community size and

distance to work positively correlated. This is in fact the case. Community size has a positive correlation of 0.43 with distance to work. Since distance from the community to the work site is negatively associated with inmigration, it may suppress the effect of community size. This hypothesis may be stated more clearly in the following form: Community size exhibits a weak relationship with inmigration because community size is positively related to the community's distance from the work site which in turn is negatively related to inmigration. Hence, community size should be positively related to inmigration when the effects of distance to work are removed.

In order to determine if distance to work suppresses a potentially important relationship, the partial correlation coefficient, removing the effects of distance, has been computed between log-community size and the percent of inmigrants locating in each community. The results indicated that distance does indeed mask a rather strong relationship ($r = 0.52$) between inmigration and log-community size. At any given distance to work, the log of community size explains approximately 27 percent of the variance in the inmigrating work force's residential location pattern. Furthermore, the partial correlation coefficient for log-community size ($r = 0.52$) is substantially higher than the partial for untransformed variable ($r = 0.15$), indicating strong support for the hypothesis that the relationship between community size and worker inmigration is positive and nonlinear.

Previously, it was suggested that, if the inmigrating work force shared in the general populace's preference for residential locations in

rural areas or small towns under 50,000 population, then the siting pattern should tend to facilitate its satisfaction. The positive relationship between community size and worker inmigration appears to contradict this hypothesis; however, examination of the distribution of inmigrating workers by size of community shown in Table 4 indicates that 91.7 percent of all inmigrants located in communities with less than 50,000 persons. In fact, the largest percentage of workers (34.8 percent) located in communities with populations of 7,500 to 14,999 persons. Communities with populations under 2,500 persons attracted the second highest percentage of inmigrants, 33.7 percent.

Table 4. Inmigrant Frequency Distribution by Size of Community

Community Size	Percent of All Inmigrants
Less than 2,500	33.7
2,500-7,499	15.0
7,500-14,999	34.8
15,000-49,999	8.2
100,000 and over*	8.3
Total	100.0
Number	3,305

*Note that there are no cities with populations between 50,000 and 100,000 within commuting distance of these sites.

The locational pattern is partially the result of the spatial distribution of various size communities. Of the 158 communities surrounding the projects, 89 had populations of less than 2,500 persons compared to only 17 with over 15,000 population. Thus, the 33.7 percent

of the inmigrants who located in towns under 2,500 population are distributed over a much larger number of communities. In addition, Table 5 indicates that much of the attraction of these communities is the result of the proximity to the project sites. Of the 54 communities under 2,500 persons located over 30 miles from a project site, none attracted more than 2.5 percent of a project's inmigrating work force.

Compared to the communities under 2,500 population, the inmigrating workers showed a stronger tendency to locate in communities of 7,500 to 14,999 population. While only 11.2 percent of the communities under 2,500 attracted more than 10.0 percent of a project's inmigrants, 80 percent of the communities with populations of 7,500 to 14,999 persons did so. Furthermore, the tendency to locate in communities of this size is not substantially weakened by the presence of a large city (over 100,000 population) within 30 miles commuting distance of the site.

The data indicate the positive relationship between community size and inmigration results from a rapid increase in the rate of worker inmigration with community size to a level of approximately 15,000 population. Between 15,000 and 50,000 population, the increase in the rate of inmigration appears to level off. Above 50,000 population, it appears that inmigrating workers are relatively indifferent to further increases in community size.

Although the location pattern reflects a complex interplay of the effects of distance to the work site, the inmigrating workers' residential needs, and the communities' capacities, these results suggest that the inmigrating workers' preferences concerning the size of an

Table 5. Percentage of Total Inmigrants Locating in Each Community by Percentage of Communities, Size,and Distance to the Work Site

Percentage of Total Inmigrants Locating in Community	Percentage of Total Communities in Each Size Class and Distance to the Work Site									
	Less than 2,500		2,500-7,499		7,500-14,999		15,000-49,999		100,000 and Over*	
	Less than 30 Miles	30 Miles and Over	Less than 30 Miles	30 Miles and Over	Less than 30 Miles	30 Miles and Over	Less than 30 Miles	30 Miles and Over	Less than 30 Miles	30 Miles and Over
0-2.49	78.3	100.0	40.0	96.0	---	91.7	---	85.7	---	71.4
2.5-4.9	4.5	---	20.0	---	---	8.3	---	14.3	---	14.3
5.0-9.9	6.6	---	30.0	4.0	20.0	---	---	---	---	14.3
10.0-19.9	4.5	---	---	---	20.0	---	50.0	---	---	---
20.0-29.9	4.5	---	10.0	---	20.0	---	50.0	---	100.0	---
30 and Over	2.2	---	---	--	40.0	---	---	---	---	
All Communities	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number	47	42	10	25	5	12	2	7	1	7

*Note that there are no cities with populations of 50,000 to 100,000 within commuting distance of these projects.

acceptable residential community may not be significantly different from those of the general population. Those workers who prefer to locate in very small communities may experience the effects of local capacity constraints; however, communities under 50,000 population generally appear to be capable of satisfying the inmigrating worker's residential needs. Specifically, the workers' preferences, the interrelationship between community size and various types of amenities, and the spatial distribution of the communities surrounding the project sites apparently combine to make communities in the 7,500 to 14,999 population range particularly attractive residential locations for a large percentage of inmigrating workers.

In addition to hypotheses concerning the overall effect of city size on inmigrating worker residential location behavior, hypotheses may be formulated for specific mover groups. Since city size is related to the availability of social and economic opportunities, such as employment, housing types, recreation, cultural events, and so forth, it is expected that those groups for which past research indicates a strong tendency for more than one member of a household to be employed, or special housing needs, or stronger preferences for urban amenities will be more likely to locate in larger cities. It is hypothesized that the positive relationship between city size and inmigration is stronger for families with no children, workers with very large households, white-collar, and younger workers.

As shown in Table 6, the frequency distribution of each group by city size and the mean community size for each group indicate that while

Table 6. Percentage of Inmigrating Work Force by Worker Characteristics and Community Size

Mover Characteristics	Percentage of Movers by Community Population								Number	Mean (F Value)
	Less than 1,000	1,000-2,499	2,500-4,999	5,000-7,499	7,500-14,999	15,000-29,999	30,000-49,999	100,000 and Over		
All Workers	19.2	14.5	6.3	8.7	34.8	1.3	6.9	8.3	3,305	18,553
Occupational Status										
Blue-Collar	22.2	16.3	5.6	6.1	33.9	1.6	6.9	7.4	2,412	17,252
White-Collar	11.2	9.5	8.2	15.9	37.2	0.6	6.9	10.5	893	22,069 (F=10.9***)
Job Tenure										
Long-Term	17.4	16.5	7.1	7.1	40.5	0.5	4.8	6.2	437	15,030
Short-Term	19.8	14.7	6.2	8.7	33.3	1.6	7.5	8.4	2,445	18,962 (F=4.13*)
Age of Mover										
Under 35	15.9	11.9	6.4	10.4	35.4	1.8	6.7	11.4	1,541	22,716
35 and Over	22.1	16.8	6.2	7.3	34.2	0.9	7.0	5.5	1,764	14,916 (F=36.5***)
Household Composition										
Single or Roommates	20.5	16.3	3.5	3.6	43.1	0.7	5.7	6.9	992	16,350
Family-No Children	19.4	14.4	8.1	8.7	32.4	0.8	7.8	8.4	666	18,406
Family with Children	17.8	12.4	6.5	12.4	34.3	1.6	7.1	8.1	1,344	18,013 (NS)
Family Life-cycle										
Young Single	12.9	11.2	5.6	3.6	46.4	1.3	6.4	12.4	233	23,980
Young Family-No Child	14.6	10.9	9.9	12.6	33.0	1.0	6.8	11.2	294	21,974
Young Family-Young Child	14.4	11.9	6.1	11.9	38.0	1.0	7.1	9.6	395	20,018
Young Family-Older Child	19.9	13.9	6.0	13.9	28.4	3.3	5.7	8.7	366	19,002
Older Family-Child	20.9	11.8	7.4	12.3	32.2	1.0	8.2	6.0	583	16,034
Older Family-No Child	23.1	17.2	6.7	5.6	32.0	0.5	8.6	6.2	372	15,590
Older Single	23.7	20.4	3.6	3.1	39.1	0.3	7.0	2.8	358	11,134 (F=4.41***)
Household Size										
1	19.5	16.8	4.4	3.4	42.0	0.7	6.8	6.6	591	16,199
2	19.3	14.5	8.1	8.7	32.4	0.7	7.8	8.4	667	18,382
3	17.8	11.9	5.6	12.1	38.5	1.1	4.8	8.2	522	17,728
4	17.3	11.8	6.5	14.2	33.9	1.4	7.5	7.5	508	17,424
5	19.0	12.8	6.1	13.4	25.7	3.4	12.8	6.7	179	17,540
6 and Over	27.6	15.7	11.9	8.2	17.2	2.2	8.2	9.0	134	22,117 (NS)

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

NS Not significant.

most movers locate in smaller communities, the strength of this tendency varies among mover groups. As expected, white-collar workers, young single workers, and young families without children exhibit the strongest tendency to locate in larger communities, particularly places with more than 100,000 population. Overall, the relationship between community size and both age and family life-cycle appears to be negative. While young single workers are most likely to locate in larger cities, older single workers are least likely to do so. Surprisingly, there does appear to be a significant relationship between either household size or composition and the size of the community where the mover locates. Although more households with 6 or more persons locate in large cities, the differences between mean community sizes are not statistically significant for the various household size classes.

Although the uncontrolled associations between community size and mover characteristics are generally as expected, a difficulty emerges when one attempts to interpret the meaning of these associations. Since community size and distance to the work site are significantly correlated, it is difficult to decide how much weight to attach to community size as an explanation of the variation in the residential location distribution of the different mover groups.

In view of the relationship between these variables, it is highly desirable to measure the effects of community size with the communities' distance to the work site held constant. This may be accomplished by employing a partial correlation analysis. The results of this analysis are shown in Table 7. It will be seen that controlling distance reduces

the extent of the association between community size and occupational status, age of the mover, and stage of family life-cycle. The extent of the reduction is least in the case of occupational status. White-collar movers remain slightly more likely than blue-collar movers to locate in larger places. Similarly, the negative association remains between community size and the mover's age; however, there is no longer a significant relationship with family life-cycle in the absence of the effects of distance. As a result of controlling for distance, weak but statistically significant negative relationships emerged between community size and both household size and composition. Inmigrating workers with families and larger households are slightly less likely to locate in larger places when the effects of distance are removed.

Table 7. Association between Selected Inmigrant Characteristics and Community Size; Controlling for the Effects of Distance to Work

Inmigrant Characteristics	Correlation with Inmigrant Characteristics		
	Distance to Work	Community Size	Community Size; Distance Controlled**
Occupational Status*	0.10	0.13	0.09
Job Tenure*	NS	-0.03	NS
Age of Mover	-0.14	-0.12	-0.07
Household Composition*	0.17	NS	-0.08
Family Life-Cycle	-0.20	-0.10	NS
Household Size	0.12	NS	-0.07

*Dummy variables for Occupational Status (0 = blue-collar, 1 = white-collar); Job Tenure (0 = short-term, 1 = long-term); Household Composition (0 = no family, 1 = family).

**First order partial correlation coefficients.

III. COMMUNITY HOUSING AVAILABILITY

Housing Vacancy

Urban residential mobility research indicates the amount and spatial distribution of newly constructed housing units are key factors in determining the size and direction of growth. In the urban area, the presence of large amounts of new vacant housing can dominate the housing market at any one time and their uneven distribution may be responsible for creating significant spatial biases within a market area. Outside major metropolitan areas, the housing situation may be somewhat different. Availability of new vacant housing units may be relatively limited in small towns and rural areas (Tweeten and Brinkman, 1976). For workers desiring housing types other than mobile home units, such factors as limited housing credit availability and lack of an experienced housing construction industry in rural areas may necessitate locating in communities with any available vacancies. This suggests communities with greater amounts of vacant units will tend to attract more workers.

Initial examination of the relationship between housing vacancy and worker inmigration reveals a weak positive correlation. The correlation coefficient of .06 is not statistically significant. However, it should be noted that there is a very strong relationship ($r = 0.97$) between the size of a community's population and the amount of vacant housing. Since it has been previously established that distance to the work site tends to suppress the effect of community size on worker inmigration, a similar relationship may be expected between distance and housing vacancy.

The data appear to support the hypothesis that inmigration is positively related to the availability of vacant housing units in a community, when the effects of distance to work are controlled. As expected, distance to work is positively correlated with housing vacancy but negatively related to worker inmigration. Removal of the effects of distance from the relationship between vacancy and inmigration increases the correlation between these variables from .06 to .20, indicating that inmigrants are more likely to locate in communities with more available vacant units.

Housing Vacancy, Total Housing Units, and Community Size

Although the data appeared to support the hypothesis that communities with greater amounts of vacant housing attract more inmigrating workers, the relationship's relative weakness is somewhat surprising given the theoretical importance of this variable. Decay in the accuracy of the data over time is one factor which may account for these results. The vacancy data are based upon the 1970 Census of Housing. By contrast, the inmigration data are based upon surveys taken between 1971 and 1977. Given the fluctuation and instability of the housing construction industry, it is quite likely that 1970 vacancy data inadequately reflect the housing availability at the time of the surveys. The results may indicate a need for a less volatile measure of housing availability.

Two variables are suggested as potential proxies for available housing units—the size of the community's population and the total number of housing units. In the communities surrounding the TVA projects,

the 1970 Census of Housing indicates that housing vacancies are strongly associated with both the size of the community's population and its total housing stock (see Table 8). While all three variables are highly interrelated, the relationship between total housing units and total vacancies is strongest. The correlation coefficient of .99 is nearly perfect, indicating that in 1970 the total number of housing units was an excellent proxy for housing vacancy.

Table 8. Association between Housing Vacancy, Total Housing Units, and Community Size

Variable	Number of Housing Units	Total Vacancies
Community Size	.97	.97
Number of Housing Units		.99

Nonlinear Effects of Vacancy and Total Housing on Worker Inmigration

In discussing the relationship between community size and inmigration, it was noted that, although residential preference studies indicate a "prevailing" preference for small town or rural locations, worker inmigration was positively related to community size. The data indicated that the form of the relationship is nonlinear and that inmigration increases at a decreasing rate with the size of the community. Since it was assumed that community size's positive relationship with inmigration might be based in part upon a relationship between

population and housing availability, the possibility was explored that a nonlinear relationship also pertains between worker inmigration and either total housing units or total vacancies.

If the form of the relationship is the same as with community size, then transforming total housing units and total vacancies to a logarithmic form should increase the strength of the association with inmigration. Data presented in Table 9 confirm that the relationship between inmigration and both total units and total vacancies is similar to that of community size. Log transformations of both variables resulted in substantial increases in their correlation with worker inmigration. In addition, both transformed housing variables were more strongly associated with inmigration than log-community size.

Table 9. Relationship between Community Size, Total Housing Units, Vacancy, and Inmigration; Controlling Distance to Work

	Correlation between Inmigration and Predictors			
	No Control Variables		Distance Controlled	
Predictors	Untransformed	Log Transformed	Untransformed	Log Transformed
Community Size	0.04	0.20	0.18	0.52
Total Housing Units	0.06	0.23	0.21	0.60
Vacancies	0.06	0.21	0.20	0.57

Similarly, as in the case of log-community size, holding distance to work constant resulted in additional increases in the strength of the association of inmigration with both transformed variables. Controlling

distance also indicated that not only is total housing potentially a good proxy for housing vacancy, it is also more strongly related to inmigration than the size of a community's population. While at any given distance log-community size accounted for approximately 27 percent of the variance in the distribution of inmigrating workers, log-housing and log-vacancy accounted for 37 percent and 33 percent, respectively.

In conclusion, the results of this analysis suggest that the positive relationship between community size and inmigration is partly the result of the interrelationship between population and housing. In the communities surrounding the TVA construction projects, both the size of the housing stock and the number of vacancies tend to increase as the size of the population increases. In addition, the nonlinear form of the relationship with worker inmigration holds for housing as well as population, indicating that the effect of housing on inmigration is relatively greater for smaller communities. As the size of the community increases, it appears that it reaches a point beyond which increased housing has less effect on worker residential location. While the exact point at which this occurs is unknown, the fact that inmigrating workers are concentrated in communities of between 7,500 to 15,000 persons suggests the threshold may be relatively low. Finally, the results reveal that both population and housing are potentially good proxies for housing availability. This is particularly important since current estimates for population and housing are usually more readily available from standard sources than is vacancy information.

IV. RESIDENTIAL DENSITY

Many households seeking a new residence include residential density as an important criterion defining a satisfactory residential environment. Most of these movers regard higher residential density environments unfavorably. As a result, worker inmigration to the communities surrounding power plant projects is expected to be inversely related to the communities' residential density.

The residential densities of the communities surrounding the TVA construction projects are generally relatively low. Gross residential densities range from less than 0.1 to 2.5 dwelling units per acre (d.u.s./acre). The mean gross residential density is 0.77 d.u.s./acre. The majority of workers in all groups locate in communities with gross residential densities in the range of 0.2 to 1.0 d.u.s./acre. Contrary to expectations, communities with higher residential densities, over 1.0 d.u.s./acre, attract the second largest number of workers.

Although initial examination of the data appears to indicate some inconsistency with other studies of the effect of residential density on residential location behavior, it should be noted that these studies generally include large metropolitan areas. These areas, particularly in the northeastern United States, are highly urbanized and extremely dense in comparison to cities in the Tennessee Valley. While larger cities in the Northeastern Urban Complex range in population density from 15,000 persons per square mile to 50,000, the highest population density for a city included in this study is only 4,300 persons per square

mile, below "average" for the northeast. Communities in medium to high categories for the south are by these standards characterized as "low to average" density.

While cities with relatively higher residential densities in this region do have some intensely developed residential areas, their development pattern generally consists of a diverse mixture of residential environments, including subdivisions with lots ranging upward in size from 0.25 acres to 3 acres, higher density areas with low-rise apartments, or moderate high-rise apartments with open space. The mixture of residential environments raises the possibility that inmigrants may be able to satisfy a preference for lower density residential environments even in relatively higher density communities. If so, inmigrating workers' preferences concerning residential density may not be significantly different from those expressed by movers in other studies.

The interrelationships between residential density, community size and distance to work may also affect the above results. Table 10 indicates that all three variables are positively correlated. The association is strongest between community size and residential density. Larger communities tend to be both more dense and farther from the work site. Inmigration's relationship with both size and density is weakly positive. The relationship with distance to work is somewhat stronger and negative.

Further examination of these relationships in a partial correlation analysis indicates that controlling for the effects of distance results in an increase in the strength of the association between inmigration

Table 10. Correlation Coefficients for Residential Density, Community Size, and Distance to Work with Worker Inmigration

	Log-Community Size	Distance to Work Site	Worker Inmigration
Residential Density	0.75	0.30	0.10
Log-Community Size		0.43	0.20
Distance to Work Site			-0.50

and both community size and residential density. First order partial correlation coefficients for size and density with inmigration remain positive when the effects of distance are removed. However, controlling the effects of community size results in an increase in only the strength of the association between distance and inmigration. The association with density is reduced in strength with the removal of the effects of size. Furthermore, removal of the effects of size indicates that the relationship between inmigration and residential density is negative, as hypothesized. When both community size and distance to work are controlled, the relationship between residential density and inmigration remains negative and increases slightly in strength. The findings indicate that, at any given size and distance, inmigrating workers are more likely to locate in communities with lower residential densities.

The strength of the negative relationship between inmigration and residential density was expected to vary with the workers' occupational status, age, household composition, family life-cycle stage, and tenure. White-collar migrants, older migrants, those in the later stages of the family life-cycle and households with children were considered less likely to locate in communities with higher residential densities. Younger households, either single persons or families without children, and blue-collar workers were expected to be less density adverse. The background information concerning the relationship between density and job tenure was insufficient for asserting a directional hypothesis; however, it was expected to be significant. No significant relationship was expected between residential density and household size.

Analysis of the bivariate relationships between density and the workers' occupational status and household composition indicated that, contrary to expectations, white-collar inmigrants were more likely than blue-collar inmigrants to locate in communities with higher residential densities and that residential density patterns for migrants with children were not significantly different from those of inmigrating families with no children (see Table 11). The results did suggest, however, that the pattern for all inmigrants with families was significantly different from that of workers unaccompanied by a family. Migrants whose households consisted of a single person or roommates were less likely than those with a family to locate in communities with higher than average densities.

The bivariate results for inmigrant age and family life-cycle characteristics were more consistent with the working hypotheses. As expected, residential density was negatively related to both age and family lifecycle. Migrants under 35 years of age were more likely to locate in communities with higher residential densities. In relationship to family life-cycle, the data also confirmed the hypothesis that younger households, either single persons or families without children, were more likely than migrants in the later stages of the family life-cycle to locate in higher density communities. While family life-cycle relationships tended to be as expected, the relationship appears to be strongly affected by the worker's age. Among workers with families in the primary childrearing stages of the family life-cycle, younger families exhibited a stronger tendency to locate in higher density

Table 11. Percentage of Selected Inmigrant Groups by Residential Density and Mean Density

Inmigrant Characteristics	Percentage of Inmigrants in Communities with Lower Density	Average Density	Higher Density	Number	Mean Density (F Value)
All Workers	8.9	67.5	23.6	3,305	.77
Occupational Status					
Blue-Collar	9.5	70.5	20.0	2,412	.73
White-Collar	7.5	59.2	33.3	893	.87
					(F=46.1***)
Job Tenure					
Long-Term	8.2	74.4	17.4	437	.71
Short-Term	8.8	66.7	24.5	2,445	.77
					(F=4.22*)
Age of Mover					
Under 35	8.2	62.5	29.3	1,541	.85
35 and Over	9.5	71.8	18.7	1,764	.69
					(F=73.9***)
Household Composition					
Single or Roommates	5.3	77.3	17.4	992	.71
Family-No Children	12.5	63.1	24.5	666	.77
Family with Children	11.4	64.0	24.6	1,344	.78
					(F=2.41*)
Family Lifecycle					
Young Single	6.0	66.5	27.5	233	.86
Young Family-No Child	10.2	58.8	31.0	294	.86
Young Family-Young Child	7.8	65.3	26.8	395	.81
Young Family-Older Child	10.4	60.4	29.2	366	.82
Older Family-Child	10.8	65.4	23.8	583	.73
Older Family-No Child	14.2	66.4	19.4	372	.69
Old Single	7.0	82.4	10.6	358	.61
					(F=10.0***)
Household Size					
1	6.6	76.1	17.3	591	.71
2	12.4	63.1	24.4	667	.77
3	8.6	65.9	25.5	522	.78
4	8.9	65.4	25.8	508	.79
5	11.2	58.7	30.2	179	.79
6 and Over	16.4	58.2	25.4	134	.75
					(F=NS)

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

NS Not significant.

communities. Older migrants with or without families or children were much less likely to locate in communities with higher than average residential density.

The data also indicated some support for the hypotheses concerning residential density and the workers' job tenure and household size characteristics. The inmigrants' job tenure was, as expected, significantly related to the residential density of the communities in which they located. The data indicated that the relationship between residential density and the length of time employed at the project was negative. Workers employed longer at a project were less likely to locate in higher density communities. As expected, there was no significant relationship between household size and residential density.

The pattern of relationships changed considerably when the intervening effects of distance to work and community were controlled (see Table 12). The differences in the residential density patterns were no longer statistically significant for occupational status, job tenure, household composition and size. The interrelationships between residential density and both age and family life-cycle were statistically significant at the .05 level, but trivial.

In conclusion, the data showed some support for the overall hypothesis that worker inmigration was negatively related to residential density. With distance to work and community size controlled, inmigrating workers were slightly more likely to locate in communities with lower residential density. The weakness of the relationship was somewhat surprising; however, several factors may account for it, including the

Table 12. Association between Worker Characteristics and Residential Density; Controlling Community Size and Distance to Work

Mover Characteristics	Correlation with Residential Density Control Variables			
	None	Distance Only	Size Only	Distance and Size
Occupational Status	.12	.08	.04	NS
Job Tenure	-.04	-.04	NS	NS
Age of Mover	-.16	-.11	-.10	-.08
Household Composition*				
Family/Nonfamily	.05	NS	.06	NS
Children/No Children	NS	-.03	NS	NS
Family Life-Cycle	-.12	-.04	-.08	-.04
Household Size	.04	NS	.05	NS

*Dummy variables for household composition (0 = no family, 1 = family; 0 = no children, 1 = no children).

NS = not significant.

imprecision inherent in the density measurement, the comparatively lower densities of cities in this region, or the diversity of residential environments found in the region's larger communities. Finally, little support was shown for hypotheses related to specific worker characteristics. Overall, the weak negative relationship between worker inmigration and residential density does not appear to be related to the workers' socioeconomic or demographic characteristics.

V. HOUSING TENANCY

If, as the residential location literature suggests, prior tenancy experience orients an inmigrant toward either the purchase or rental housing market, then the proportion of a community's housing stock in each tenancy type may affect the workers' residential location behavior. Since inmigrating workers at power plant construction projects are usually temporary residents and are relatively unfamiliar with local housing markets, it is not surprising that they select rental units much more often than the general population. If inmigrating workers are oriented more heavily toward the rental market, then worker inmigration may be expected to increase with the proportion of a community's housing stock in rental units and to decrease with the proportion in owner occupancy.

In the communities surrounding the project sites, the prevalent housing tenancy consists of owner occupied units. The proportion of the housing stock in renter occupancy ranges from 12 to 50 percent. The mean renter occupancy is 34.0 percent. Examination of the

intercorrelation between worker inmigration and the communities' housing tenancy characteristics reveals a weak tendency for inmigration to increase with the proportion of rental housing units. The correlation coefficient between percentage of total units in renter occupancy and worker inmigration is only 0.13. While the sign of the coefficient is as expected, the relationship is extremely weak and statistically significant at only the 0.06 level.

The relationship between housing tenancy and inmigration may be affected by community size and distance to work. Table 13 suggests that the direction of the relationship between rental tenancy and both community size and distance is positive. The relationships, however, are not very strong. The strongest association is found between rental tenancy and community size. Larger communities tend to have a slightly higher percentage of rental units and to be located farther from the work site. While the bivariate relationship between inmigration and both size and rental tenancy is weakly positive, the negative relationship between inmigration and distance to work is considerably stronger.

Table 13. Correlations between Rental Tenancy, Community Size, Distance to Work, and Worker Inmigration

Predictors	Community Size	Distance to Work	Percent of Total Work Force
Renter Occupancy	0.26	0.06	0.13
Community Size		0.43	0.20
Distance to Work			-0.50

Controlling for the effects of distance to the work site in a partial correlation analysis results in an increase in the strength of the association between worker inmigration and both community size and rental tenancy (see Table 14). The increase in the strength of the association with inmigration resulting from controlling distance is substantially greater for community size. The association between inmigration and rental tenancy remains rather weak. When both community size and distance to the work site are controlled, the association between inmigration and rental tenancy is reduced in strength and the coefficient is not statistically significant.

Table 14. Association between Selected Predictors and Worker Inmigration; Controlling Distance to Work and Community Size

	Correlation Coefficients with Worker Inmigration Control Variables			
Predictors	None	Distance to Work	Community Size	Distance and Size
Renter Occupancy	0.13	0.18	0.08	0.06
Community Size	0.20	0.52	NA	NA
Distance to Work	-0.52	NA	-0.65	NA

NA = Not applicable.

In addition to the relationship between housing tenancy and the overall pattern of worker inmigration, the effects of the community's housing tenancy characteristics were also examined in the context of the inmigrating work force's social, economic, and demographic characteristics. The hypothesis was proposed that the effects of housing tenancy on inmigration are differentially related to the inmigrant's occupational

status, job tenure, age, household composition and size. Based upon the findings discussed in the literature review, it was expected that blue-collar inmigrants, short-term migrants, younger migrants, inmigrants unaccompanied by families, and smaller households would be more likely than others to locate in communities with higher proportions of rental units.

The results of this analysis were consistent with the overall findings concerning the relationship between inmigration and housing tenancy. With the partial exception of the workers' ages, the bivariate relationships between housing tenancy and the workers' characteristics were not significant. In the age relationship, the mean percentage of the total housing units in renter occupancy tended to be higher for those communities attracting younger inmigrants; however, when the effects of community size were controlled, the association between rental tenancy and age was no longer statistically significant.

Although not a direct test of the hypothesis that prior tenancy experience orients a migrant toward either the rental or purchase housing market, these results suggest that the tenancy characteristics of a community's housing stock are not particularly strong predictors of the inmigrating workers' residential location behavior. In light of the previously described relationship between community size and indicators of housing availability, the reduction in the predictive power of housing tenancy brought about by controlling community size may indicate that the slight tendency shown by the inmigrating workers to locate in communities with more rental units reflects overall housing availability

more so than an orientation toward the rental housing market. On the other hand, the data may be interpreted equally well as an indication that part of the attraction of larger communities is based upon the positive relationship between community size and rental housing.

VI. COMMUNITY HOUSING TYPE CHARACTERISTICS

In this section, an attempt is made to determine the effect the type of housing found in a community has on worker inmigration. The effects of three housing types are examined—conventional single family units, multifamily units, and mobile homes. The review of the residential location literature indicated that the widely prevailing preference in the general population is for single family housing over multifamily. The most common change in housing type occupied by a household is from multifamily to conventional single family units. Mobile homes are utilized to a lesser extent by the general population. Inmigrating workers at energy facility construction projects appear to share the general preference for single family living but not necessarily for the conventional single family housing unit. The combined utilization of conventional single family units and mobile homes by inmigrating workers is as great or greater than that of the general population; however, mobile home usage by inmigrating workers accounts for a substantially higher proportion of their total housing. These factors suggest that the mixture of housing types in a community may affect worker inmigration. It is hypothesized that worker inmigration generally increases with the proportion of a community's housing stock in mobile homes and conventional

single family units, and decreases with the proportion in multifamily units.

The average inmigrating worker located in a community with 83.3 percent of the housing stock in single family units, 12.0 percent in multifamily housing, and 4.7 percent in mobile homes (see Table 15). Comparison of the communities, in which the workers located, with the total area within commuting distance of the projects indicates that the communities attracting inmigrating workers tend, as expected, to have higher proportions of mobile homes and conventional single family units and lower proportions of multifamily units than the overall region. The greatest difference between the housing type distributions of the project communities and the overall commuting region is in multifamily units. The average proportion of multifamily units in project communities is 12.0 percent compared to 17.0 percent in the total region.

Table 15. Comparison of Housing Type Distributions for Project Communities and Commuting Region

Housing Type	Percent of Total Housing Units	
	Project Communities	Commuting Region
Single Family	83.3	79.0
Multifamily	12.0	17.0
Mobile Home	4.7	4.0

Examination of the intercorrelations between worker inmigration and the communities' housing type characteristics indicates that the relationships are extremely weak. The correlation coefficient ($r = .12$)

between inmigration and multifamily housing is not statistically significant. The correlation coefficient between single family housing and inmigration is -.15, statistically significant at only the .05 level. In addition to the lack of strength shown in the relationships, the direction of the relationships between inmigration and both single family and multifamily are opposite that expected. While the sign of the relationship between mobile homes and inmigration is positive, as expected, the correlation coefficient is trivial ($r = .01$).

The lack of significant relationships between housing type and inmigration may be partially a consequence of interrelationships between the types of housing found in the community, housing tenancy characteristics, size, and distance to the work site. Analysis of the effects of housing tenancy indicated that owner occupancy is weakly negatively related to worker inmigration, when the effects of size and distance are controlled. Since owner occupancy has a moderate positive association with single family housing and a negative association with multifamily housing (see Table 16), the unexpected negative relationship between inmigration and single family housing and positive relationship with multifamily housing may represent the confounding effects of housing tenancy, size, and distance.

In order to measure the effects of housing type independently of the other community characteristics, the effects of the other predictors are successively controlled in a partial correlation analysis. Examination of the uncontrolled associations indicates that both community size and distance are more strongly related than the housing types to worker

Table 16. Association between Housing Type, Owner Occupancy, Distance to Work, and Worker Inmigration

Predictors	Community Size	Owner Occupancy	Single Family	Multifamily	Mobile Home	Worker Inmigration
Distance to Work	0.43	-0.06	-0.22	0.33	-0.35	-0.52
Community Size		-0.26	-0.70	0.78	-0.46	0.28
Owner Occupancy			0.55	-0.52	0.12	-0.13
Single Family				-0.93	0.16	-0.15
Multifamily					-0.51	0.12
Mobile Home						0.01

inmigration (see Table 17). Distance to the work site is the strongest predictor. Controlling the effect of distance increases the strength of relationships with inmigration for all of the remaining variables. The associations with inmigration remain negative for owner occupancy and single family housing and positive for multifamily housing. In addition, controlling distance results in the emergence of a weak negative relationship between mobile homes and inmigration. While all of the relationships increase in strength, the positive relationship between community size and inmigration remains stronger than housing variable relationships.

Table 17. Partial Correlations for Housing Type with Worker Inmigration; Controlling Owner Occupancy, Community Size, and Distance to Work

	Partial Correlations with Worker Inmigration Control Variables		
Predictors	Distance to Work	Distance to Work, Community Size	Distance to Work, Community Size, Owner Occupancy
Single Family	-0.30	0.09	0.14
Multifamily	0.35	-0.08	-0.13
Mobile Home	-0.20	-0.01	-0.01
Owner Occupancy	-0.18	-0.06	
Community Size	0.52		

Controlling the effects of both distance and size results in a reduction in the strength of the association with inmigration for all four remaining variables—owner occupancy, single family housing, multifamily housing, and mobile homes. Although none of the second

order partial correlation coefficients are statistically significant, the relationships between inmigration and both single family and multifamily housing reverse signs. The coefficients suggest that the relationship with worker inmigration is positive for single family housing and negative for multifamily, as hypothesized. The direction of relationships with owner occupancy and mobile homes remained negative.

When owner occupancy, community size and distance to the work site are controlled, inmigration's positive relationship with single family housing and negative relationship with multifamily housing tend to increase slightly in strength. The relationship with mobile homes was unaffected, remaining insignificant ($r = -.01$). Although the coefficients for both multifamily housing and single family increased in size, the relationships with inmigration are extremely weak. The partial correlation coefficient for single family housing ($r = .14$) is statistically significant at only the .05 level. The partial coefficient for multifamily housing ($r = .13$) is not significant.

In summary, the data show some weak support for the hypothesis that, when the effects of community size, distance to the work site and housing tenancy are controlled, worker inmigration tends to increase with proportion of a community's housing stock in conventional single family units and decrease with the proportion in multifamily units. Mobile homes apparently have no independent effect on worker inmigration apart from the effects of community size and distance. Finally, the relationship between owner occupancy and single family housing apparently reduces the attraction of communities with larger amounts of single family housing for most inmigrating workers.

In addition to exploring the overall relationship between worker inmigration and the types of housing found in the communities surrounding the power plant construction projects, the effects of housing type on inmigration were also examined in the context of the worker's social and demographic characteristics. This step was undertaken because past research indicates that, in the general population, persons in differing social, economic, and demographic groups are not equally distributed among areas with different housing types. Age of head of household, occupational status, household size, and the child-rearing stages of the family life-cycle tend to be positively associated with residential locations in lower density single family suburban areas and negatively associated with higher density multifamily residential areas. If the inmigrating workers behave similarly to the general public, then the effects of the community's mixture of housing types on inmigration should be differentially related to the occupational status, age, household size, and family life-cycle characteristics of the inmigrating work force.

While it was expected that worker inmigration would exhibit a positive relationship with single family housing and a negative relationship with multifamily housing for all workers, the tendency to locate in single family areas was expected to be stronger among white-collar inmigrants than among blue-collar inmigrants. The results of a correlational analysis of the uncontrolled associations between the percentage of the community's housing stock in each housing type and the percentage of the inmigrating blue-collar and white-collar work forces locating in each community, as shown in Table 18, were inconsistent

Table 18. Association between Percentage of Inmigrating Work Force by Worker Characteristics with Community Housing Types, Size and Distance to the Work Site

Inmigrating Worker Characteristics	Zero Order Correlation Coefficients					
	Single Family	Multi-family	Mobile Home	Owner Occupancy	Community Size	Distance to Work Site
All Workers	-0.15	0.12*	0.01*	-0.13*	0.20	-0.52
Occupational Status						
White-Collar	-0.17	0.17	-0.07*	-0.13*	0.25	-0.36
Blue-Collar	-0.13*	0.09*	0.05*	-0.13*	0.17	-0.53
Age of Mover						
Under 35 Years	-0.18	0.17	-0.04*	-0.15	0.25	-0.44
35 Years and Over	-0.11*	0.07*	0.05*	-0.11*	0.15	-0.53
Job Tenure						
Long-Term	-0.10*	0.06*	0.05*	-0.08*	0.20	-0.51
Short-Term	-0.16	0.13*	0.00*	-0.14	0.16	-0.48
Household Composition						
Single or Roommates	-0.10*	0.05*	0.08*	-0.11*	0.14	-0.54
Family	-0.15	0.13*	-0.02*	-0.13*	0.20	-0.46

*Not statistically significant; all other coefficients are significant at the 0.05 level or less.

with both the general hypothesis and the specific hypothesis concerning the directions of the blue-collar and white-collar relationships. The results indicated that the relationship of single family housing with both blue-collar and white-collar inmigration was negative and the relationship with multifamily housing positive, opposite that expected. Little significance can be given to these findings, however, since it has already been demonstrated that the relationship between inmigration and housing type is affected by housing tenancy, community size, and distance to the work site.

The results of controlling for the effects of these intervening variables in a partial correlation analysis were more consistent with the overall expectations, as shown in Table 19. Both blue-collar and white-collar inmigration exhibited a weak positive association with single family housing; however, there was essentially no difference in the strength of the relationship with inmigration between the two groups. Both coefficients with single family housing showed a low level of statistical significance (.05). Although the direction of the relationship with multifamily housing was negative as expected for both blue-collar and white-collar inmigrants, only the coefficients for the blue-collar workers was statistically significant. This suggests that when the effects of distance, size, and tenancy are removed, the blue-collar workers are less likely to locate in communities with higher proportions of multifamily housing.

Similar results were obtained when the relationship between housing type and the inmigrating worker's age was examined. It was expected

Table 19. Partial Correlation between Worker Inmigration and Housing Type; Controlling for the Effects of Housing Tenancy, Community Size and Distance to the Work Site

Inmigrating Worker Characteristics	Third Order Partial Correlation Coefficients; Controlling Distance, Size and Owner Occupancy		
	Single Family	Multifamily	Mobile Homes
All Workers	0.14*	-0.13	-0.01
Occupational Status			
White-Collar	0.14*	-0.09	-0.06
Blue-Collar	0.15*	-0.16*	0.02
Age of Mover			
Under 35 Years	0.15*	-0.11	-0.04
35 Years and Over	0.14*	-0.15*	0.01
Job Tenure			
Long-Term	0.16*	-0.16*	0.01
Short-Term	0.14*	-0.12	-0.02
Household Composition			
Single or Roommates	0.15*	-0.17*	0.04
Family	0.14*	-0.11	-0.04

*Significant at the .05 level; all others are not significant.

that older workers would be more likely than younger workers to locate in communities with higher levels of single family housing and lower levels of multifamily housing. When the effects of the intervening variables were controlled, the data failed to indicate a significant difference between age groups in relation to single family housing. Both older and younger workers showed slight tendency to locate in communities with higher levels of single family housing, statistically significant at the .05 level. Some support was shown, however, for the hypothesis that older workers are less likely than younger workers to locate in communities with higher levels of multifamily housing. Although the relationship was negative for both groups, it was slightly stronger for the older workers.

Inmigrating workers with families were expected to be more likely to locate in communities with higher proportions of single family housing and lower proportions of multifamily housing; however, the data indicated that there was basically no difference in the tendency of workers with families and those without families to locate in communities with higher levels of single family housing. Both groups exhibited a weak positive relationship with single family housing. Furthermore, when the effects of size, distance, and tenancy were removed, single workers and those with roommates showed a stronger aversion to communities with multifamily housing than did workers with families. The negative relationship between multifamily housing and inmigration by workers without families was significant at only the .05 level.

Although the residential location literature contained no information on the relationship between length of employment and the type of housing, it was considered possible that employees who were employed longer in the area might be more oriented toward single family areas and less toward multifamily. Although the positive relationship between long-term worker inmigration and single family housing is slightly stronger than the short-term workers' relationship, the difference does not appear to be significant. The negative relationship with multifamily housing, however, does appear to be significantly stronger for long-term workers. While both long-term workers and short-term workers exhibit a weak tendency to locate in areas with single family housing, long-term workers are less likely to locate in communities with multifamily housing.

A similar analysis was conducted for family life-cycle and household size. The overall relationships were similar to those reported above. For all household sizes and stages of the family life-cycle, single family housing tended to be positively related to inmigration and negatively to multifamily housing. The differences between household sizes and stages of the family life-cycle were not statistically significant. The type of housing found in the communities surrounding the construction projects is apparently unrelated to the residential location behavior of workers with different household sizes and stages in the family life-cycle.

It may be concluded that the type of housing found in a community is a weak predictor of worker inmigration. Of three housing types considered (conventional single family, multifamily, and mobile homes),

only single family housing appears to affect the residential location behavior of the total inmigrating work force. Inmigrating workers in all social and demographic groups are slightly attracted to communities with higher proportions of single family housing; however, both the strength and statistical significance of this relationship is relatively low. In addition, it appears that the attraction of communities with single family housing is negatively affected by the positive relationship with owner occupancy. Multifamily housing appears to be slightly negatively related to inmigration by four groups: blue-collar workers, older workers, long-term employees, and those unaccompanied by families. The results for older workers and long-term workers were as anticipated; however, white-collar workers and workers with families were expected to be less likely to locate in communities with higher levels of multifamily housing. Finally, the presence of mobile homes in a community appears to have no affect on the workers' residential location behavior.

VII. HOUSING VALUE, RENT, AND QUALITY

Since both the quantity and quality of housing are related to costs, it seems reasonable to examine their potential effects on the inmigrating workers' residential location behavior in the same section. Microeconomic models of the residential location process suggest that there are four primary factors involved in the selection of a new residential unit: (1) the quantity and quality of housing services desired by the household, (2) the relative costs of housing units, (3) the cost of commuting, and (4) the household resources or income. Theoretically,

"rational" consumers attempt to maximize their consumption of residential space while minimizing total rent and transport costs within household income constraints. This suggests that a community's housing costs and quality, as well as its distance from the work site, may affect its attraction as a potential residential location.

Investigation of this issue presents some problems. As Friedman (1975) points out, measuring the quantity of housing services available in a community to a potential resident is extremely difficult. Direct information on the quantity of housing services is generally not available from standard sources. Constructed indices suffer from theoretical and empirical shortcomings (Friedman, 1975). In light of the difficulties inherent in measuring the quantity of housing services available in a community, no direct measure of this variable is included in this study.

Similarly, community housing quality also presents measurement problems. While detailed ratings of housing conditions were reported in the 1960 Census, housing condition data in 1970 are basically limited to the presence or absence of plumbing facilities. Since a high proportion of most of the communities' units have all plumbing facilities, this variable is not a particularly useful relative measure of housing quality at the community level.

In the present study, age of the community's housing stock is selected as the proxy for the quality of housing services available in the community. Age is generally related to the condition of a unit. While there are exceptions, older houses tend to be in poorer condition

and more difficult to maintain. The measure used is the proportion of a community's housing units constructed since 1950. It is assumed that communities with higher proportions of newer housing units potentially offer a higher quality of housing services. Indirectly, newer construction may also reflect the quantity of housing services available, since community growth factors are inherent in this measure.

Three working hypotheses are proposed. First, communities with lower median housing rents or values tend to attract larger proportions of a project's inmigrating work force. Secondly, worker inmigration increases with the proportion of a community's housing stock constructed since 1950. Finally, the effects of these variables are differentially related to the occupational status and job tenure characteristics of the inmigrating workers.

Consistent with expectations, the majority of all inmigrating workers located in communities with median rents and values below the regional average (see Table 20). The trend was strongest in relationship to rents. Of all inmigrating workers, 76.7 percent located in communities with below-average rents, compared to only 52.0 percent in communities with below-average values. The difference in the strength suggests that community housing values and rents may function differently with respect to worker residential location behavior.

The effects of the age of the housing were less consistent with the proposed hypotheses (see Table 21). Although a substantial proportion (46.5 percent) of the inmigrating workers located, as expected, in communities with newer housing stocks, the majority (53.5

Table 20. Worker Characteristics and Community Housing Value and Rent Levels

Mover Characteristics	Community Median Rent Levels: $62 and Under	Community Median Rent Levels: Over $62	Mean Rent (F Value)	Community Median Value Levels: $12,500 and Under	Community Median Value Levels: Over $12,500	Mean Value (F Value)	Number
All Workers	76.7	23.3	56	52.0	48.0	12,283	3,305
Occupational Status							
Blue-Collar	80.8	19.2	54	55.3	44.7	11,924	2,412
White-Cotlar	65.4	34.6	62	43.1	56.9	13,254	893
			(F=128.7***)			(F=101.7***)	
Job Tenure							
Long-Term	81.9	18.1	55	53.3	46.7	12,240	312
Short-Term	76.2	23.8	56	52.6	47.4	12,197	1,927
			(F=4.5*)			(NS)	
Age of Mover							
Under 35	73.3	26.7	58	49.8	50.2	12,565	1,541
35 and Over	79.6	20.4	54	54.0	46.0	12,038	1,764
			(F=25.9***)			(F=19.7***)	
Household Composition							
Single or Roommates	82.8	17.2	54	53.7	46.3	11,837	992
Family	74.2	25.8	57	50.6	49.4	12,515	2,010
			(F=5.1***)			(F=6.8***)	
Family Lifecycle							
Young Single	76.0	24.0	58	49.8	50.2	12,287	233
Young Family-No Child	68.7	31.3	59	47.6	52.4	12,910	294
Young Family-Young Child	75.9	24.1	58	50.1	49.9	12,542	395
Young Family-Older Child	74.6	25.4	57	51.6	48.4	12,507	366
Older Married-Child	74.3	25.7	57	50.3	49.7	12,588	583
Older Married-No Child	76.3	23.7	55	53.2	46.8	12,069	372
Older Single	88.3	11.7	51	57.5	42.5	11,480	358
			(F=5.7***)			(F=6.5***)	
Household Size							
1	83.4	16.6	53	54.5	45.5	11,798	591
2	73.0	27.0	57	50.8	49.2	12,438	667
3	77.2	22.8	57	50.6	49.4	12,545	522
4	74.0	26.0	58	46.9	53.1	12,787	508
5	69.8	30.2	58	51.4	48.6	12,508	179
6 and Over	75.4	24.6	55	63.4	36.6	11,764	134
			(F=4.59***)			(F=6.1***)	

*Significant at the .05 level.

**Significant at the .01 level.

***Significant at the .001 level.

NS Not significant.

Table 21. Worker Characteristics and Age of Community Housing

Mover Characteristics	Age of Community Housing			Mean Percentage of Housing Constructed Post-1950
	Older	Newer	Number	
All Workers	53.5	46.5	3,305	55.5
Occupational Status				
Blue-Collar	57.0	43.0	2,412	54.2
White-Collar	44.1	55.9	893	59.2 (F=86.6*)
Job Tenure				
Long-Term	53.8	46.2	437	55.3
Short-Term	54.2	45.8	2,445	55.3 (NS)
Age of Worker				
Under 35	51.7	48.3	1,541	56.3
35 and Over	55.0	45.0	1,764	54.8 (F=9.59*)
Household Composition				
Single or Roommates	54.5	45.5	992	54.1
Family	52.2	47.8	2,010	56.3 (F=4.76*)
Family Life-Cycle				
Young Single	51.1	48.9	233	55.5
Young Family-No Child	51.0	49.0	294	57.2
Young Family-Young Child	50.6	49.4	395	56.3
Young Family-Older Child	55.2	44.8	366	57.0
Older Married-Child	50.6	49.4	583	56.7
Older Married-No Child	54.3	45.7	372	54.5
Older Single	58.4	41.6	358	53.3 (F=4.1*)
Household Size				
1	55.5	44.5	591	54.1
2	52.9	47.1	667	55.7
3	51.1	48.9	522	56.1
4	48.4	51.6	508	57.8
5	54.7	45.3	179	56.4
6 and Over	63.4	36.6	134	55.0 (F=4.0*)

*Significant at .001 level.

NS Not significant.

percent) of all inmigrants located in communities with older-than-average housing. The possibility that this anomalous finding reflects a relationship between quality and costs will be examined shortly.

The data indicated some support for the hypotheses related to inmigrant characteristics. The effects of housing cost and housing age varied as expected with the workers' occupational status. The results were consistent with past studies, indicating that white-collar workers generally locate in areas with newer housing and higher average values. White-collar workers were more likely than other mover groups to locate in communities with higher rents and values and newer housing. Among white-collar workers, 34.6 percent located in communities with higher-than-average rents and 56.9 percent with higher housing values compared to 19.2 percent and 44.7 percent, respectively, of all blue-collar workers. With respect to housing age, 55.9 percent of the white-collar workers located in communities with more newer housing compared to 43.0 percent of the blue-collar workers and 46.5 percent of all workers.

There were several unexpected findings. It was assumed that a longer period of employment at a project site would facilitate purchasing a home in the local area and building an equity. Since purchase of a home generally represents a substantial investment, long-term employees were expected to locate in communities with above-average housing quality and value. The results failed to support these hypotheses. There was no significant difference in either the housing age or value in the communities where short-term and long-term migrants located. Differences between mean rents exhibited a low level of statistical

significance (0.05). The direction, however, was opposite that expected. Short-term migrants showed a slight tendency to locate in communities with higher average rent.

In addition to the unexpected findings related to the workers' job tenure, the effects of housing age and costs were found to vary with several other worker characteristics. Workers over 35 years of age were more likely than younger workers to locate in communities with older housing and lower value. Inmigrants whose household composition consisted of a single person or roommates were also less likely than workers with families to locate in communities with higher value and newer housing. The relationships with family life-cycle were much less clear. Mean community rent appeared to be negatively related to family life-cycle, with workers in the later stages locating in communities with lower average rents. In contrast, lower average community housing values were found among both young single workers and workers in the later stages of the family life-cycle. The highest average housing value was found in those communities in which young workers with families without children located. The relationship of housing age to family life-cycle was similar to that of housing value. Young single workers and workers in the later stages of the family life-cycle were more likely than workers in the primary childrearing stages to locate in communities with older housing stocks. Age of housing and costs appeared to be nonlinearly related to household size. Both small and large households were more likely than medium size households to locate in communities with older housing and lower average value.

In summary, all three community housing variables—age, value, and rent—appear to be associated with worker residential location; however, it is difficult to interpret the meaning of these associations. The difficulty arises from the fact that all three variables are themselves interrelated. That is, communities with newer housing also tend to have higher average rents and values. The intercorrelations are not perfect but they are substantial, as shown in Table 22. The problem is intensified by the fact that the housing variables, particularly median rent and value, are also related to community size and distance to work. Larger communities tend to have higher average housing values and rents and to be located farther from the work site.

Table 22. Association between Housing Age, Housing Costs, Community Size, Distance to Work, and Worker Inmigration

Predictors	Median Value	Median Rent	Community Size	Distance to Work	Worker Inmigration
Newer Housing	0.62	0.59	0.17	0.07*	0.11*
Median Value		0.78	0.46	0.22	0.13*
Median Rent			0.57	0.19	0.13*
Community Size				0.43	0.20
Distance to Work					0.53

*Not statistically significant; all other coefficients are significant at the 0.05 level or less.

The problem then becomes one of determining the relative effects of each of these variables on the residential location behavior of the various inmigrant groups. In order to measure the effects of the three housing variables (age, value, and rent), the effects of the stronger

predictors are successively controlled in a partial correlation analysis.

As previously indicated, the uncontrolled association between inmigration and all three housing variables is positive and negative with distance to work. As shown in Table 23, both community size and distance to work are more strongly related than the housing variables to worker inmigration. The weak positive relationships between inmigration and the housing variables are statistically significant for only three groups: white-collar workers, younger workers, and those accompanied by their families.

Controlling for the effects of the strongest predictor, distance to the work site, results in an increase in the strength of the association between inmigration by all worker groups and both community size and the three housing variables—age, value, and rent (see Table 24). The association with inmigration for all four variables remains positive when the effects of distance are removed. Community size continues to be more strongly related to inmigration than the housing variables. Although the strength of the relationships increases, the basic pattern of association with the various inmigrating worker groups remains stable. The housing quality and cost variables are most strongly associated with inmigration by white-collar workers, younger workers, and those with families.

Controlling the effects of both distance and size results in a reduction in the strength of association for all three variables. The extent of the reduction is lower in the case of the communities' age

Table 23. Correlation Coefficients for Housing Age, Housing Cost, Community Size, and Distance to Work with Percentage of Selected Inmigrant Worker Groups

Predictors	Zero Order Correlation Coefficients				
	Newer Housing	Median Value	Median Rent	Community Size	Distance to Work Site
All Workers	0.11*	0.13*	0.13*	0.20	-0.52
Occupational Status					
White-Collar	0.20	0.22	0.22	0.25	-0.36
Blue-Collar	0.08*	0.09*	0.09*	0.17	-0.53
Age of Mover					
Under 35 Years	0.15	0.18	0.17	0.25	-0.44
35 Years and Over	0.10*	0.10*	0.10*	0.15	-0.53
Job Tenure					
Short-Term	0.12*	0.13*	0.13*	0.20	-0.51
Long-Term	0.10*	0.11*	0.10*	0.16	-0.48
Household Composition					
Single or Roommates	0.06*	0.06*	0.07*	0.14	-0.54
Family	0.15	0.17	0.16	0.20	-0.46

*Not statistically significant; all other correlation coefficients are significant at the 0.05 level or less.

Table 24. Associations between Worker Inmigration and Percentage of the Community's Total Housing Units Constructed in the Post-1950 Period, Median Value, and Median Rent by Migrant Characteristics; Controlling for the Effects of Significant Predictors

	Partial Correlation Coefficients								
		First Order, Controlling Distance			Second Order, Controlling Distance and Size			Third Order, Controlling Distance, Size and New Housing	
Percentage of Total Inmigrants	Newer Housing	Median Value	Median Rent	Community Size	Newer Housing	Median Value	Median Rent	Median Value	Median Rent
All Workers	0.17	0.28	0.27	0.52	0.10*	0.08*	-0.03*	0.02*	-0.12*
Occupational Status									
White-Collar	0.25	0.33	0.32	0.48	0.20	0.17	0.07*	0.06	-0.07*
Blue-Collar	0.14	0.24	0.23	0.52	0.07*	0.04*	-0.08*	-0.01*	-0.16
Age of Mover									
Under 35 Years	0.21	0.31	0.29	0.54	0.15	0.11*	-0.01*	0.03*	-0.13*
35 Years and Over	0.16	0.25	0.24	0.49	0.10*	0.06*	-0.05*	0.00*	-0.14
Job Tenure									
Short-Term	0.18	0.28	0.27	0.53	0.12*	0.08*	-0.03*	0.00*	-0.13*
Long-Term	0.15	0.25	0.22	0.47	0.09*	0.07*	-0.05*	0.00*	-0.14
Household Composition									
Single or Roommates	0.12*	0.21	0.20	0.48	0.05*	0.01*	-0.09*	-0.02*	-0.15
Family	0.21	0.31	0.28	0.50	0.15	0.13*	0.00*	0.04*	-0.12*

*Not statistically significant; all others are significant at the 0.05 level or less.

of housing and average value. The relatively weak positive relationship between newer housing and inmigration again holds for white-collar workers, younger workers and those with families. A similar pattern is exhibited in relation to housing value; however, of the housing value relationships, only the relationship with white-collar inmigration remains statistically significant. None of the partial correlation coefficients for median rent are statistically significant when the effects of distance and size are controlled. It is noteworthy, however, that the sign of the relationship reverses in the majority of cases, suggesting that, as hypothesized, inmigration is negatively related to housing costs.

When housing age, community size and distance to the work site are controlled, no statistically significant relationships remain between worker inmigration and median housing value; however, the negative median rent and inmigration relationships, identified when the effects of size and distance were removed, increase slightly in strength. Although the relationship remains relatively weak overall, the negative effect of higher median rent on inmigration becomes statistically significant for several groups of inmigrants including blue-collar workers, workers over 35 years of age, long-term workers, and those unaccompanied by a family. Inmigrating workers in these groups are apparently slightly more sensitive than other inmigrant groups to the rental levels prevalent in the community. These results indicate that the positive correlation found initially between worker inmigration and both median housing value and median rent is an effect of the fact that

the average housing costs in a community are positively related to the proportion of its housing stock constructed since 1950.

As hypothesized, there appears to be a positive relationship between inmigration and newer housing and a negative relationship with median rent. The fact that a slight majority of the inmigrants located in communities with older-than-average housing suggests that the negative effects of higher average housing costs on inmigration are greater than the positive benefits of newer housing for most workers. Blue-collar workers, older workers, those without children, and, surprisingly, long-term workers appear to be less likely to locate in communities with higher average rents. Finally, it appears that the effects of median rent on worker inmigration are different from those of median housing value. While median rent is negatively related to inmigration, median housing value apparently has no independent effect on worker inmigration apart from that caused by the relationship between housing age and inmigration. This may reflect a difference in the residential location behavior of inmigrating workers oriented toward the purchase market rather than the rental housing market. Workers purchasing a home are usually more sensitive than renters to the overall quality of the residences in a community.

VIII. HOUSING DIVERSITY

Although most inmigrants select mobile homes or conventional single family units, they also utilize a variety of other types of housing including apartments, sleeping rooms, boarding rooms, motels, hotels,

and recreation vehicles. From a simple probability point of view, this fact suggests the hypothesis that worker inmigration increases with the diversity of the community's housing stock.

In order to test this hypothesis, a simple diversity index was constructed and the results correlated with the percentage of a project's total inmigrating work force locating in each community. The following index formula was used:

$$\frac{(P_{SF})(P_{MF})(P_{MH})}{(.33)(.33)(.33)} \times 100 = D_i$$

Where:

P_{SF} = proportion of the total housing stock in a community in single family units.

P_{MF} = proportion of the total housing stock in a community in multifamily units.

P_{MH} = proportion of the total housing stock in a community in mobile homes.

D_i = housing diversity index score for a community.

The index scores potentially range from 0, indicating only one type of housing is present in the community, to 100, indicating the housing stock is totally diversified; i.e., equally distributed among the three housing types.

A positive association was expected between the housing diversity index and worker inmigration. The data, however, failed to support this hypothesis. The zero order correlation coefficient ($r = .10$) was positive but not statistically significant. The first order partial,

controlling distance, was slightly larger (r = .18) and statistically significant at the .05 level; however, when both distance to the work site and community size were controlled, no statistically significant association remained between inmigration and housing diversity. The results indicated that housing stock diversity does not exert any significant influence on the inmigrating work force's residential location behavior apart from the effects of community size.

IX. LOCAL PUBLIC SERVICES

The "Tiebout Hypothesis," discussed in the literature review, suggested there is a relationship between selection of a residential location and the availability of local public goods and services. Tiebout (1956) indicated each community offers a package of local public services and taxes. Theoretically, consumers with different preferences for local public services and with different income levels select residential locations from among competing communities on the basis of the tax/service package which best satisfies their public service preferences within their income constraints.

Although there are some limitations to the Tiebout model, it may be particularly relevant to the residential location situation of the inmigrating work force during the construction of a power plant. The inmigrating worker is often faced with a situation in which he has the opportunity to select a residential location from a number of alternative communities. Since communities, particularly in relatively rural areas, may be expected to vary in both the level and quality of local

public services, the local public services/tax package may be one factor in the worker's residential location decision.

Intuitively, one assumes that most people prefer good local services and low taxes. In practice, both rarely occur together. Consequently, potential residents are forced into a tradeoff between service and cost. Tiebout suggests the outcome of the tradeoff is a function of the mover's preferences and income; however, this gives little guidance for determining which factor is most important. In the present study, it is hypothesized that worker inmigration increases with the level of local public services in the community. Furthermore, since residential preferences are often related to the mover's social, economic, and demographic characteristics, it is hypothesized that the effects of local public services on worker inmigration are differentially related to the occupational status, age, job tenure, and household composition of the inmigrating work force.

Since the above hypotheses are limited to services, they obviously only partially encompass the "Tiebout Hypothesis." This is a result of the difficulty in obtaining consistent data concerning relative tax burdens across regions, states, and counties. While measuring local public service output also presents considerable theoretical and empirical problems, service-related data are generally more available in a consistent and complete format from standardized sources. Local public services are represented by a simple index combining water, sewer, fire and police data (see Appendix).

Examination of the bivariate correlation coefficients between the percentage of inmigrating workers locating in a community and the level

of local public services tended to confirm the hypothesis that communities with higher service index scores attract more inmigrating workers. The correlation coefficients were positive for all worker groups but relatively weak. As expected, there was some variation in the strength of the relationship with the social and demographic characteristics of the inmigrants. White-collar workers, younger workers, short-term workers, and those accompanied by their families were more likely to locate in communities with higher levels of local public services. The relationships were statistically significant at the .05 level or better for all worker groups except those without families.

Although the bivariate correlation coefficients appear to support the hypotheses, fire and police protection and water and sewer services are essentially urban services and may be expected to be positively associated with community size. Table 25 indicates the services index scores are strongly positively associated with community size and moderately associated with the distance to the work site. Larger communities tend to have both higher public services index scores and greater distances to the work sites. Since community size has been shown to be relatively strongly related to worker inmigration, the positive bivariate relationship between public services and inmigration may be a reflection of the intercorrelation with community size. This suggests it may be useful to control these interrelationships.

In addition to indicating the bivariate relationships between local public services index scores and worker inmigration, first order

Table 25. Association between Worker Inmigration and Local Public Service Levels; Controlling Distance to Work and Community Size

Selected Worker Groups	Public Service Correlation with Inmigration Control Variables		
	None	Distance to Work	Community Size and Distance
All Workers	0.18	0.48	0.14
Occupational Status			
Blue-Collar	0.16	0.49	0.14
White-Collar	0.21	0.43	0.09*
Age of Migrant			
Under 35 Years	0.21	0.48	0.11*
35 and Over	0.15	0.47	0.16
Job Tenure			
Short-Term	0.18	0.49	0.14
Long-Term	0.15	0.43	0.13*
Household Composition			
Single or Roommates	0.12*	0.44	0.12*
Family	0.19	0.47	0.14

*Not statistically significant; all others significant at the 0.05 level or less.

and second order partial correlation coefficients, controlling for the effects of distance to the work site and community size, are also shown in Table 25. Controlling both distance and size results in a decrease in the strength of the association between public services and inmigration for all worker groups. The extent of the reduction, however, varies with the inmigrant's occupational status, age, job tenure, and household composition. The positive association between inmigration and public services remains statistically significant for only four groups—blue-collar inmigrants, older workers, short-term workers, and those with families. These results show that, when the effects of distance and size are controlled, workers in these groups are slightly more likely to locate in communities with better public services.

Although not a direct test of the "Tiebout Hypothesis," these findings indicate that the level of local public services influences the residential location behavior of the inmigrating workers. As expected, migration into a community tends to increase with the level of local public services; however, compared to the effects of community size and distance to the work site, the effect is very weak.

There also appears to be some support for the hypothesis that the effects of public services on worker inmigration are differentially related to the inmigrant's socio-demographic characteristics. Blue-collar workers, older workers, those employed for a shorter period at a project, and those with families are slightly more likely to locate in communities with higher public service levels. In addition, it appears that the stronger bivariate tendency of white-collar workers and younger

workers to locate in communities with better public services is primarily the result of the weaker effect of distance on these groups and the stronger attraction to larger communities.

X. EDUCATIONAL QUALITY

Since the literature review indicated an almost universal attachment to good schools, it was expected that communities with higher educational expenditures per pupil would tend to attract more inmigrating workers. Educational expenditures per pupil was selected as a proxy for educational quality because, as in the case of all local public services, there are no "objective" criteria upon which to base a measure of educational quality. Since, however, it is the perceived quality and not the objective quality of schools which affects residential location, it was considered possible that inmigrating workers might equate factors such as newer schools, better equipment, and higher teacher salaries which often accompany greater per pupil expenditures with higher educational quality. If this is the case, then worker inmigration may be expected to increase with the level of local school expenditures per pupil.

The bivariate relationships between school expenditures and inmigration were positive as expected for all worker groups, but relatively weak; however, as in the case of most community characteristics, school expenditures were also positively correlated with both community size and distance to work (see Table 26). When the effects of distance to work were removed in a partial correlation analysis, a substantial

Table 26. Association between School Expenditures and Worker Inmigration; Controlling Distance to Work and Community Size

Selected Inmigrant Worker Groups	School Expenditure Correlation with Inmigration Control Variables			
	None	Distance to Work	Community Size	Distance and Size
All Workers	0.15	0.28	0.06*	0.02*
Occupational Status				
Blue-Collar	0.14	0.28	0.06*	0.02*
White-Collar	0.19	0.27	0.07*	0.04*
Job Tenure				
Short-Term	0.16	0.30	0.07*	0.04*
Long-Term	0.11*	0.23	0.03*	-0.01*
Age of Migrant				
Under 35 Years	0.19	0.30	0.08*	0.04*
35 Years and Over	0.12*	0.26	0.06*	0.01*
Household Composition				
No Children	0.13*	0.27	0.07*	0.03*
Children Present	0.16	0.27	0.06*	0.02*

*Not significant; all others are significant at the 0.05 level or less.

increase in the strength of school expenditures' association with inmigration was obtained for all worker groups. When, however, both community size and distance to work were controlled, no statistically significant relationship remained for any worker group.

It is difficult to draw a substantive conclusion from these results. The reduction in the predictive power of school expenditures brought about by controlling the effects of community size suggests that educational quality may have little or no effect upon worker residential location; however, it may also be interpreted as an indication that part of the attraction of larger communities is based upon the fact that they tend to have better school systems. The possibility must also be considered that school expenditures per pupil is a poor proxy for educational quality. An input variable, such as school expenditures, may be an inadequate reflection of the quality of the output.

XI. LAND USE CONTROLS

The presence of effective land use controls may constrain worker migration into a community. Since the construction period is relatively short, housing demand increases and decreases quite rapidly. If the local capacity is limited, expansion of the housing supply may be required. In this situation, the builder's profitability is highly dependent upon timing and level of investment. Since the builder has a relatively short period of time in which to recover any investment, he must limit his investment and enter the market as quickly as possible. Under these conditions, a minimum investment in a mobile home park

becomes quite attractive. Land use controls, however, may make this strategy more difficult either by prohibiting mobile homes outright or by contributing to the costs or time required for development. As a result, developers may be more likely to provide additional housing for the inmigrating workers in those communities with little or no control on development. If developers are more likely to provide additional housing in those communities without land use controls, then a negative relationship should exist between worker inmigration and land use controls.

Examination of the bivariate relationship between worker inmigration and land use controls shows, contrary to expectations, a positive correlation of 0.17, significant at the 0.025 level. Since land use controls are positively correlated with community size and thus with distance to work, the possibility that the unexpected relationship reflects the intervening effects of these variables should also be examined. Controlling distance to work increases the correlation coefficient between inmigration and land use controls substantially to 0.33. When, however, both distance and community size are controlled, the coefficient decreases to 0.07 and is no longer statistically significant.

Although the weak positive relationship remaining when the effects of community size and distance to work were removed was not statistically significant, it may indicate that, rather than acting as a constraint on residential location as expected, effective land use controls may attract inmigrating workers to a community. One possibility is that inmigrants

perceive effective land use controls as an indicator of a positive residential environment or perhaps more likely, communities with higher quality residential environments which tend to attract inmigrants also have more effective land use controls.

XII. PROJECT CHARACTERISTICS

Not only are the relationships between community characteristics and inmigrating worker residential location behavior important to planners and policy makers concerned with forecasting local impacts, it is also of interest to determine what effects, if any, project characteristics may have upon the residential distribution of these workers. The identification of relationships between project characteristics and worker residential location is particularly desirable since utilities potentially exercise greater control over project-related factors. Two project-related variables are examined, the size of the project's inmigrating work force and the stage of project construction.

The probability of a particular household satisfying its residential aspirations depends in part upon the level of the demand for housing as well as the existence and distribution of housing vacancies. Early in project construction, overall employment and inmigration levels are relatively low. Comparatively, competition for available housing is lower during this period, and workers should find it somewhat easier to satisfy their residential preferences in the area immediately surrounding the site. As project employment and the number of inmigrants increase, housing demand may exceed local supplies, forcing later migrants to

search farther afield for acceptable units. It is, therefore, hypothesized that as the size of the project's inmigrating work force increases new migrants will tend to locate farther from the work site and that the mean distance of the journey to work at a project will increase.

Table 27 shows the estimated total number of inmigrants at each survey period and the average distance to the work site for all migrants and new migrants at each survey. The average distance to the work site increases as expected with the size of the inmigrating work force at four of the five projects. At both Sequoyah and Bellefonte, the increase in mean distance is significant for both total inmigrants and new migrants at each survey period. At the Cumberland project, only the differences between mean distances for new migrants are statistically significant. While slightly larger means are associated with larger numbers of inmigrants at Watts Bar, the differences are not statistically significant. Results for the Browns Ferry project indicate that contrary to expectations inmigrating workers tended to locate farther from the work site as the number of migrants decreased.

Although some statistical support is shown for the hypothesis that in general new inmigrants tend to locate farther from the work site as the size of the project's inmigrating work force increases, the strength of the relationship appears relatively weak. The data suggest that in most cases the majority of new inmigrating workers are able to satisfy their residential needs in the area immediately surrounding the site. Pressures on limited local capacities do not appear to have much effect

Table 27. Estimated Size of Inmigrating Work Force and Mean Distance to Work by Project and Survey

Project	Estimated Number of Inmigrants	Mean Work Trip Length in Miles (Significance Level)	
		All Migrants	New Migrants
Bellefonte	279	11.99	11.99
	736	12.85	12.81
	1,167	14.23	14.36
		(.05)	(.05)
Browns Ferry	425	17.56	17.56
	795	17.25	17.26
	410	21.06	23.35
		(.001)	(.001)
Cumberland	435	14.33	14.33
	1,035	16.39	16.54
	340	15.50	13.48
		(NS)	(.05)
Sequoyah	187	12.73	12.73
	513	15.41	15.53
	474	14.68	15.42
	1,142	15.98	16.10
		(.001)	(.001)
Watts Bar	95	18.35	18.35
	420	20.04	20.10
	860	20.62	20.98
		(NS)	(NS)

NS = No statistically significant difference between means.

on inmigrating worker residential location until the size of the inmigrating work force exceeds 1,000 workers. Even then, the increase in the average distance is relatively small. For example, the largest increase occurs at the Sequoyah project and consists of an increase in the average distance of only 3.25 miles or 25.5 percent. At the same time, the inmigrating work force increased by 975 workers or 510 percent.

In addition to the effects of the size of plant employment, stage of project construction may also affect the residential location distribution of inmigrating workers. Studies of the residential selection process suggest that the choice of a residential location is a function of not only the relative number of "opportunities" available in a community, but also of the information concerning those opportunities (Brown and Moore, 1970; Simmons, 1974). Contact on the job with workers who already live in the area surrounding the site provides a potential source of information concerning housing availability. If information on housing availability is obtained through contact on the job, then residential patterns established during the early stages of project construction should influence subsequent development patterns. Consequently, a positive relationship is expected between the residential location patterns established during the early stages of project construction and patterns in later stages.

The relationships between residential distributions at each stage of construction were examined in a correlational analysis by project. The percentage of total inmigrants locating in each community was calculated for each project survey. At each project, surveys were categorized by

their relationship to peak employment; i.e., surveys were identified as either pre-peak, peak, or post-peak employment surveys. Within the data constraints, residential distributions were then compared within and between construction stages at each project.

The results of this analysis are shown in Table 28. Overall, the data indicate that the residential location pattern, once established, remains extremely stable throughout all stages of project construction. As an example, although the size of the inmigrating work force at Sequoyah increased from 187 in the initial pre-peak employment survey to 1,142 at peak, the residential location pattern identified in the initial pre-peak survey accounts for over 85 percent of the variance in the residential location distribution of the inmigrating workers at peak. While the strength of the association is extremely high between the distribution at all stages of construction, the strongest relationships are found among the multiple surveys taken during the pre-peak employment stage of construction. Multiple correlation coefficients during the pre-peak stage range from .964 at Watts Bar to .998 at Bellefonte. The strength of the relationship between residential distributions in the pre-peak and peak employment stages of construction is only slightly lower. Coefficients range from .919 to .993, indicating that the residential location pattern is fundamentally insensitive to stage of project construction.

The extreme stability of the residential location distribution of the inmigrating workers throughout construction raises some puzzling questions. TVA's environmental reports indicate the housing capacity

Table 28. Relationship of the Residential Location Distribution in the Initial Pre-Peak Employment Survey with the Residential Distributions in Subsequent Stages of Construction

Project	Correlation between Residential Location Distributions		
	Initial Pre-Peak Distribution with Other Pre-Peak	Pre-Peak Distribution with Peak	Pre-Peak Distribution with Post-Peak
Bellefonte	.998*	---	---
Browns Ferry	---	.993	.966
Cumberland	---	.987	.989
Sequoyah	.997*	.919*	---
Watts Bar	.964*	---	---

*Multiple correlation coefficient; all others Pearson r.

of the rural communities and small towns immediately surrounding the project sites is generally rather limited. Given the strong negative relationship between distance to the work site and inmigration described previously, one would expect that increasing size of the inmigrating work force would pressure limited local capacities, forcing later migrants to locate farther from the work site. Indications are, however, that, while distance increases slightly in most cases, the size of the effect is practically insignificant until the number of inmigrants becomes quite large, i.e., over 1000 workers. In fact, examination of the relationship between stage of project construction and the residential location pattern reenforces the conclusion that, once established, location patterns are unlikely to change significantly. This leaves the question of how these communities with apparently limited housing capacities maintain their relative competitive "advantage" as residential locations for a significant number of workers. The information hypothesis proposed here, i.e., new inmigrants obtain information on housing availability through contact on the job, is a potential partial explanation for the tendency for the distributional pattern to remain stable; however, it does little to clarify the mechanism by which local housing markets adjust to increased demand.

XIII. SUMMARY AND DISCUSSION

In this section the relationships revealed in the preceding analysis are summarized and their implications discussed. The findings generally

tended to support the overall hypotheses that the inmigrating work force's characteristics, the community characteristics, and the journey to work are important determinants of the inmigrating workers' residential location behavior. At the same time, the data failed to support the hypothesis that the characteristics of the projects themselves are a significant factor in the workers' residential location.

Several specific characteristics of the inmigrating workers were proposed as potential predictors of the inmigrants' residential location behavior: (1) occupational status; (2) job tenure; (3) age of migrant; (4) household composition; (5) stage in the family life-cycle; and (6) household size. In general, the worker characteristics were found to be relatively weak predictors of the differences in the inmigrants' residential location patterns. Only two characteristics, occupational status and household composition, exhibited consistently stronger relationships with the inmigrants' residential location behavior. The occupational status data indicated that inmigrating white-collar workers were more likely than the blue-collar inmigrants to locate in larger communities with newer housing, higher than average housing value, and a greater distance to the work site. These relationships were all as expected. The inmigrants' household composition also emerged as a factor in the worker's residential location behavior but not in the manner expected. It was anticipated that the presence or absence of children in the household would be an important factor in determining the inmigrants' residential locations; however, the data revealed little difference between the location patterns of families

with children and those with no children. Rather, the more salient variable in the worker's household composition appeared to be the presence or absence of the inmigrant's family regardless of its childrearing status. Inmigrating workers accompanied by a family were more likely than those without families to locate in communities with newer housing, higher average value, better local public services, a smaller housing stock, and a greater distance to work.

The differences in the residential location patterns related to other worker characteristics were extremely weak. The relatively small residential location variations associated with the inmigrants' age and family life-cycle characteristics appeared to be primarily related to the differential sensitivity to the journey to work. Both inmigrants over 35 years of age and those in the later stages of the family life-cycle exhibited stronger tendencies to locate close to the work site. In contrast, differences in residential location associated with household size and job tenure were most closely related to community size. Both inmigrants with large households and those employed for a shorter period at a site were more likely to locate in larger communities. Given the characteristics of these groups, this may have been primarily an effect of the positive interrelationship between community size and housing availability.

It was hypothesized that the journey to work is a major constraint on residential location. The data appeared to support this hypothesis. Of the variables examined in this study, journey to work emerged as the single most important factor determining the inmigrating workers'

residential location behavior. The relationship of a community's distance to the work site with worker inmigration was negative. As expected, worker inmigration decreases as the community's distance from the work site increases. Inmigrants in all worker groups exhibit a strong tendency to locate close to the work site. Inmigrating workers apparently consider close proximity to the work site an important criterion for an acceptable residential location.

In addition to the direct effects on residential location of the journey to work, its interaction with the community characteristics also proved to be important. The distance from the community to work exerted a suppressor effect on some community variables. Siting constraints tend to force electrical generating facilities into relatively rural areas. Consequently, community size and distance to work are positively correlated. Since distance to work was negatively related to the worker's tendency to locate in a community, it reduced or suppressed the positive effects of community size. Since several community characteristics included in this study were highly correlated with population, initial analysis of the bivariate relationships between worker residential location and these variables tended to yield conflicting findings with little statistical significance. Statistically significant bivariate relationships were consistently weak and often opposite that expected.

In contrast to the bivariate results, several statistically significant relationships emerged between community characteristics and worker residential location patterns after controlling the effects of distance to work. With distance controlled, inmigration tended to

increase with community size, housing availability (either total units or vacancies), rental tenancy, housing diversity, newer housing, local public service levels, and educational quality. Although the above were all as hypothesized, several unexpected relationships also emerged with controlling distance. Contrary to expectations, worker inmigration tended to increase with residential density, housing cost, multifamily housing, and land-use controls. In part, the unexpected findings may be accounted for by the confounding effects of a positive interrelationship between these variables and community size.

With both size and distance controlled, the relationships of inmigration with residential density, median rent, and multifamily housing were negative, as expected, but no longer statistically significant. In contrast, while also reduced in strength, inmigration's association with median value remained positive, suggesting that housing value affected the workers' residential location behavior differently from rental levels. In fact, associated with a newer housing stock, higher housing values may have attracted inmigrants. Worker inmigration also remained positively related to land-use controls. Although the weak positive relationship was not statistically significant, it may indicate that, rather than acting as a constraint on residential location, effective land-use controls may attract inmigrating workers to a community. Effective land-use controls may be perceived by inmigrants as an indicator of a positive residential environment.

Since the size of a community's population plays such an important role in most impact analyses, its relationship with worker inmigration

was examined in detail. The data indicated the relationship was positive and nonlinear. Log transformation of community population significantly increased the strength of the association with inmigration, suggesting that worker inmigration increases at a decreasing rate with community size as hypothesized. Worker inmigration appeared to increase rapidly with city size to 15,000 population, leveling between 15,000 and 50,000 population, and remaining basically stable over 50,000 population. Communities in the 7,500 to 50,000 population range were particularly attractive to inmigrants. Above 50,000 population, inmigrants appeared to be essentially indifferent to further increases in community size. The relatively large number of communities under 2,500 persons and their close proximity to the projects apparently accounted for worker migration to smaller places.

The relationship of community size to other community characteristics and worker inmigration is complex. Controlling community size generally reduces the predictive power of the remaining community characteristics; however, this should not be interpreted as an indication that community size is the only community characteristic which affects worker residential location. It is more likely that a positive relationship exists between worker inmigration and community size because community size tends to be positively associated with housing availability, public service levels, educational expenditures, land-use controls, and so forth. In particular, the findings suggest that, in the areas surrounding the power plant projects, the attraction of larger communities was primarily an effect of housing availability. This conclusion is supported by the

nearly perfect correlation between community size, total housing units, and vacancies and the fact that the log-linear relationship with inmigration also applies to both total housing and vacancies, as well as community size. The complex interrelationships with community size are also illustrated by community characteristics such as greater residential density and higher average rent which, although positively correlated with community size, tend to discourage worker inmigration. The complexity of these interrelationships underscores the difficulties and potential hazards of applying simple models to a complex behavioral system such as worker residential location. In part, these factors may partially account for some of the problems found in previous attempts to apply gravity-type models to construction worker residential location behavior (see Chalmers, 1977).

In addition to examining the effects of worker characteristics, community characteristics, and the journey to work on the inmigrating workers' residential location behavior, the characteristics of the projects were also examined. The data revealed little support for hypotheses concerning the effects of project characteristics on worker location. Although workers in the later stages of project construction located slightly farther from the work site, the residential location pattern, once established, remained essentially stable throughout project construction.

Of the results obtained thus far, this unexpected finding has perhaps the most interesting implications for impact analysis and mitigation. The extreme stability of the residential location pattern

suggests that an effective mitigation program might be based upon survey results obtained during the early stages of project construction. Early analyses potentially provide accurate forecasts of the distribution of impacts at peak construction and leave two to three years of lead time in which to develop and implement an effective mitigation program. These findings provide considerable support for a strategy of socioeconomic impact monitoring and mitigation such as that implemented by TVA at the Hartsville project.

The primary objective of this chapter was to identify the elements which should be included in models of inmigrating worker residential location behavior at electrical generating facility construction projects. The findings most clearly indicated that distance to work is a key factor in workers' location and that project characteristics have little if any effect. Indications were less clear for the variables related to the workers' and communities characterisitcs. The majority of the worker characteristics were weak predictors of residential location patterns. There were, however, some indications that disaggregation of the inmigrating work force along occupational status and household composition lines may be useful. The findings for the community characteristics gave relatively little guidance for either including or excluding specific variables. The results did suggest, however, that it may be useful to examine both nonlinear forms for the community size and housing availability variables and "interaction" terms for some variables. In particular, the findings suggest that the relationships between community size and distance to work, housing costs

and housing age, and housing tenancy and housing type may not be additively related to inmigrant residential location. The use of interaction terms for these relationships, where the effect of one variable on worker residential location depends upon the other, may prove superior to a simple additive model. These issues will be examined in the following chapter.

CHAPTER VI

REGRESSION MODELS FOR PREDICTING INMIGRATING WORKER RESIDENTIAL LOCATIONS

The initial stages of this research were designed to explore the evidence for association between the predictor variables (worker, community, journey to work, and project characteristics) and inmigrating worker residential location patterns at five electrical generating facility construction projects in the Tennessee Valley. Based upon this exploratory analysis, a pattern of relationships emerged between the location patterns and worker, community, and journey to work variables which has been used as a basis for developing residential location models. Five models were developed in the final stage of this study, including models for the total inmigrating work force and four significant subgroups—white-collar workers, blue-collar workers, workers accompanied by a family, and those unaccompanied by families. Separate models were estimated for these specific subgroups because household composition and occupational status consistently emerged throughout the study as significant factors affecting worker residential location.*

The empirical analysis of inmigrating worker residential location behavior involved the estimation of linear multiple regression equations.

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*In order to determine whether disaggregation of the total inmigrating work force into separate blue-collar/white-collar components and nonfamily/family components was warranted, regression equations including all independent variables were estimated for the total work force and each subgroup and a simple Chow test applied. The null

Table 29 presents a concise list of all the variables used in the analysis. A total of 26 independent variables were examined. Several of these variables were previously described; however, nine "new" variables were also examined. Four of these were logarithmic transformations of previously included variables; LDISWK, LPOP, LDUS, and LVAC. The logarithmic form of community size (POP), total housing units (DUS), and total vacancies (TOTVAC) was examined because the correlational analysis suggested the transformed variable was more strongly associated with worker residential location. The logarithmic form of distance to work (DISTHMWK) was included because past travel studies suggested that friction in space tends to increase in the early stages of a trip, rapidly reaching a point where further increases in trip length have little additional effect.

The correlational analysis also suggested that the effects of interaction between several variables should be explored. The findings

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hypothesis is that the coefficients of the subgroups are not significantly different from coefficients for the total group,

$$H_{0_1}: \beta_i^{wc} = \beta_i^{bc} = \beta^t$$

$$H_{0_2}: \beta_i^{f} = \beta_i^{nf} = \beta^t$$

and the alternative hypothesis is that the null hypothesis is false; that is, at least one of the coefficients is significantly different. A significant F value indicates that the null hypothesis of equality of coefficients should be rejected and that it is appropriate to estimate separate models for each subgroup. The F value (7.367) for white-collar/blue-collar components was significant at the 0.001 level. The F value (7.422) for family/nonfamily groups was also significant at the 0.001 level. The results of these simple Chow tests applied to the above described groups supported disaggregation.

Table 29. List of Variables and Definitions

Variables	Definition
Dependent Variables	
TOTINMIG	Percent of a project's total inmigrating work force locating in each community
BCINMIG	Percent of a project's total inmigrating blue-collar workers locating in each community
WCINMIG	Percent of a project's total inmigrating white-collar workers locating in each community
FAMINMIG	Percent of a project's total inmigrating workers with families locating in each community
NOFAMMIG	Percent of all workers unaccompanied by a family at a project locating in each community
Independent Variables	
DISTHMWK	Distance in road miles from work site to the approximate geographic center of each community
POP	1970 community population
DUS	Total number of dwelling units in a community
DENSITY	Gross residential density
TOTVAC	Total number of vacant units with all plumbing facilities in a community
SINFAM	Percent of total units in single family housing
MULTIFAM	Percent of total units in multifamily housing
MOBHM	Percent of total units in mobile homes
OWNOCC	Percent of total occupied units in owner tenancy
RENTOCC	Percent of total occupied units in renter tenancy
POST50	Percent of total units constructed in 1950 or later
MEDVAL	Median value of a community's owner occupied housing
MEDRENT	Median rent for a community's renter occupied housing

Table 29. (continued)

Variables	Definition
Independent Variables (continued)	
DIVERSITY	Housing stock diversity index score for each community
SERVICES	Local public services index score for each community
SCHEXPND	Expenditures per pupil in 1970 standard dollars
LNDUSIDX	Index score indicating the presence of land-use controls in a community; assigned a value of 0 if no controls, 1 if either zoning or subdivision regulations, 2 if both are present
SCHSER	The standard score for school expenditures added to the community's service index score
LDISWK	Logarithmic transform of DISTHMWK
LPOP	Logarithmic transform of POP
LDUS	Logarithmic transform of TOTVAC
POPDIST	Dummy variable assigned a value of 1 if the community has a population between 7,500 and 50,000 and is located within 30 miles of a project site, and 0 if otherwise
P50VAL	Interaction term consisting of percent of a community's housing stock constructed during or after 1950 multiplied by the community's median housing value
P50RENT	Interaction term consisting of the percent of a community's housing stock constructed during or after 1950 multiplied by the community's median housing rent
RNTSF	Interaction term consisting of the percent of a community's housing stock in rental units multiplied by the percent of total housing units in single family

revealed an interaction between distance and size such that communities with populations in the 7,500 to 50,000 range, when located within 30 miles of a project, were particularly attractive to inmigrating workers. A dummy variable, POPDIST, was constructed to capture the interaction effect and was expected to be positively related to worker inmigration. Worker inmigration was expected to be positively related to the proportion of newer housing and negatively related to higher average housing costs. The preliminary findings, however, indicated that while workers were, as expected, slightly more likely to locate in communities with newer housing and less likely to locate in those with higher average rents, they were relatively unaffected by higher average housing values. Since housing quality may be expected to be highly correlated with price, the interaction between age of housing (proxy for quality) and costs and differences between the rental and purchase markets may account for these results. Two variables, P50VAL and P50RENT, were created in an attempt to reflect the potential interaction between housing costs and the age or "quality" of the community's housing stock. The two cost/quality interaction terms were expected to have opposite signs. P50VAL was expected to be positively related to worker inmigration and P50RENT negative. The argument is that where newer housing is associated with higher rent, the tendency to minimize costs will prevail and the sign of the interaction term will be negative. In contrast, better quality and higher average value may be considered desirable in the purchase market, since the potential purchaser must take into account the eventual resale value of his investment which, in part, depends upon the quality and

price of the units surrounding it. So while the economically rational inmigrant will seek the largest amount and highest quality of housing services at the lowest price possible, he will nonetheless tend to be attracted to communities with higher average values and better average quality.

To create the fourth interaction term (RNTSF), the percentage of rental units were multiplied by the percentage of single family housing in the community. RNTSF was designed to reflect the potential interaction between housing type and tenancy. Previous residential location studies reveal an overwhelming preference for single family residential environments among most Americans. If the inmigrating workers share the general population's preference for single family living also, then they should tend to locate in communities with relatively more single family housing. Single family housing, however, is usually positively associated with owner occupancy and past research suggests that relative unfamiliarity with local housing markets and temporary residency tends to orient new inmigrants toward the rental market. The combination of these factors, recent inmigration and a preference for single family housing, implies that the strength of the inmigrating worker's tendency to locate in single family residential areas depends, in part, upon the amount of rental housing in the community. Since some support for the interaction hypothesis was shown in the partial correlation analysis, the coefficient for the rental tenancy/single family housing interaction term is expected to be positive, indicating that joint increases in rental and single family housing are accompanied by increases in the proportion of inmigrants locating in a community.

The final variable added to the data set (SCHSER) combined the local public services index score with the standardized school expenditures per pupil for each community. The combined variable was created because the exploratory correlational analysis indicated the effects of school expenditures on worker location were not significantly different from those of other local public services. Inmigrating workers were expected to be positively attracted to communities with better educational and other local public services.

Although all of the variables listed in Table 29 (page 170) were examined, the five models presented include only selected subsets of these variables. Variables were excluded on the basis of both theoretical and practical considerations. Variables adding little to the predictive power of the model, and whose theoretical relevance was in doubt, were eliminated. Since impact analysts generally operate under time and cost constraints, eliminating variables with less theoretical and empirical importance was considered desirable because it reduces data requirements for future applications in impact analyses.

In evaluating and selecting the models for presentation, several criteria were applied. The most important factor for forecasting purposes was the predictive accuracy of each model. The assessment of predictability was based upon the amount of variance in the dependent variable accounted for by each model. Models accounting for relatively higher proportions of the variance were selected. In order to determine the overall level of statistical significance, the F test was applied to each model. Conservatively, only models significant at the 0.001 level

or less were selected. The t-statistic was computed to determine the statistical significance of the coefficients for each independent variable. In addition to statistical tests, consistency with past theoretical and empirical findings and interpretability were also factors in determining the final forms of the models and the variables included. Models including variables with less theoretical and empirical importance or coefficients with signs suggesting logically inconsistent relationships were revised. If, however, a variable showed lesser statistical significance but was important theoretically, it was retained in the model. Finally, parsimony was considered. Within the theoretical constraints suggested above, variables with little empirical importance were eliminated.

For each model, the coefficient of determination corrected for degrees of freedom ($\bar{R}^2$), the standard error of the regression, the F statistic, and the number of observations are reported. In addition, the absolute value of the t-statistic and the significance level of the coefficient for each variable are given.

I. PREDICTION MODELS

A Model for Predicting the Residential Location Pattern for All Inmigrants

The following model was developed for predicting or estimating the percentage of a project's total inmigrating work force locating in each community:

TOTINMIG = Constant + POPDIST + LDISWK + LDUS + POST50
+ P50RNT + SCHSER.

The coefficients in the model were estimated using multiple linear regression, and the results are shown in Table 30. All of the coefficients have the theoretically expected signs. At the 5 percent significant level, all coefficients are significantly different from zero, except the interaction term for the relationship between rent and age of housing (P50RNT) and the logarithm of total housing (LDUS).

Examining the variables and coefficients in the model individually, communities in the 7,500 to 50,000 population range within 30 miles of a project are apparently more attractive to inmigrating workers. The coefficient for POPDIST indicates that, ceteris paribus, any one community in this category attracts approximately 14.6 percent of an individual project's inmigrating work force.

Table 30. Regression for Percentage of Total Inmigrating Workers

Variable	Intercept or Coefficient	T for H_0: Parameter = 0	Significance Level	Standardized Coefficients
CONSTANT	15.673	2.87	0.0047	
POPDIST	14.639	5.79	0.0001	0.3678
LDISWK	-7.917	8.30	0.0001	-0.5827
POST50	0.2082	2.46	0.0151	0.2787
P50RNT	-0.0012	1.78	0.0777	-0.2171
SCHSER	0.6852	2.15	0.0335	0.2547
LDUS	0.9164	1.41	0.1613	0.1891

$\bar{R}^2$ = 0.573 F = 31.66 Significance Level 0.0001

Standard Error of Regression = 5.73 Cases = 138

Distance to work is also a significant factor in worker residential location. Workers are more likely to locate in communities closer to

the work site. As expected, the log-distance (LDISWK) is a more effective predictor than the untransformed variable. Examination of the standardized coefficients indicates that of the variables included, distance to work has the greatest influence on worker residential location.

In addition to POPDIST and distance to work, several other variables appear to have an effect upon worker residential location. Inmigrants apparently prefer communities with newer housing (POST50) and better local public services (SCHSER). The results also suggest that interaction between newer housing and rental prices discourages workers from locating in communities where newer housing stocks are also associated with higher rents. The coefficient for the interaction term "P50RNT" is negative, as expected, but significantly at only the 0.10 level.

Of the community size related variables, the logarithm of total dwelling units (LDUS) proves to be the most effective predictor. Although LDUS is not statistically significant even at the 0.10 level, it is retained because of its theoretical importance as a proxy for housing availability and because, while the t-values for the coefficients are a useful indicator of significance, they are not strictly valid. The coefficient for LDUS is positive, suggesting that, as expected, workers tend to locate in communities with more housing; however, the relationship appears to be nonlinear. Worker inmigration into a community tends to increase at a decreasing rate with the size of the housing stock.

In terms of the predictive accuracy of the model, the $\bar{R}^2$ value (0.573) indicates that the variables in the model accounted for 57.3 percent of the variance in the proportion of the total inmigrating work force locating in each community. Although this leaves a substantial amount of the variance unexplained, the F value for the overall model is highly significant. The standard error of the regression for the model is ±5.73 percent.

Overall, the model appears to be satisfactory both in terms of the statistical tests applied and the theoretical expectations, but not very efficient. The results suggest that LDUS does not contribute much and that perhaps the model could have been just as satisfactory without the added complexity of an additional variable.

Residential Location Models for Inmigrating Blue-Collar and White-Collar Worker Groups

The exploratory analysis and the Chow test suggested disaggregation of the total inmigrating work force into blue-collar and white-collar components and the estimation of separate models for each group. The following models were developed for estimating or predicting the percentage of a project's total inmigrating blue-collar and white-collar work forces locating in each community:

BCINMIG = Constant + POPDIST + LDISWK + LDUS + POST50
+ P50RNT + SCHSER;

and,

WCINMIG = Constant + POPDIST + LDISWK + SCHSER + P50VAL
+ RNTSF + VALRENT.

The results of the multiple linear regression analysis for the blue-collar residential location model are shown in Table 31, and for the white-collar model in Table 32. All of the coefficients in both models have the theoretically expected signs. With the exception of total housing units (LDUS), and combined housing costs (VALRENT) in the blue-collar model, and the single family housing/rental tenancy interaction term (RNTSF) in the white-collar model, all coefficients are significantly different from zero at the 5 percent level.

In a manner similar to the model for the total inmigrating work force, blue-collar workers were attracted to communities in the 7,500 to 50,000 population range within 30 miles of a project (POPDIST). A community in this category attracted 14.3 percent of a project's inmigrating blue-collar workers on the average. Also consistent with the TOTINMIG model, communities with newer housing (POST50) and better local public services (SCHSER) exhibited a tendency to attract blue-collar inmigrants. Results for log-total housing (LDUS) were less decisive. The coefficient was positive, as expected, but significant at only the 0.10 level.

While the negative coefficient for the median rent/housing age interaction term exhibited a low level of significance in the model for all workers, it was found to be highly significant in the residential location model for the blue-collar workers (0.012 level). The results indicate that blue-collar workers are less likely to locate in communities where newer housing is accompanied by higher average rent.

Table 31. Regression for Percentage of Total Inmigrating Blue-Collar Workers

Variable	Intercept or Coefficient	T for H_0: Parameter = 0	Significance Level	Standardized Coefficient
CONSTANT	15.82	3.04	0.003	
POPDIST	14.33	5.94	0.001	0.3647
LDISWK	-8.28	9.09	0.001	-0.6176
LDUS	1.0279	1.65	0.100	0.2149
POST50	0.2359	2.92	0.004	0.3198
P50RNT	-0.0017	2.53	0.012	-0.2995
SCHSER	0.6884	2.13	0.035	0.2445

$\overline{R}^2$ = 0.600 F = 35.24 Significance Level 0.0001

Standard Error of Regrestion = 5.47 Cases = 138

Table 32. Regression for Percentage of Total Inmigrating White-Collar Workers

Variable	Intercept or Coefficient	T for H_0: Parameter = 0	Significance Level	Standardized Coefficient
CONSTANT	7.99	1.27	0.206	
POPDIST	18.255	6.09	0.001	0.4110
LDISWK	-5.81	5.30	0.001	-0.3832
SCHSER	0.9197	3.84	0.001	0.3063
P50VAL	0.0126	2.67	0.009	0.3994
RNTSF	0.0023	1.71	0.089	0.1145
VALRENT	-1.0053	1.19	0.235	-0.1952

$\overline{R}^2$ = 0.481 F = 22.15 Significance Level 0.0001

Standard Error of Regression = 7.049 Cases = 138

The coefficient for log distance to work (LDISWK) was negative, as expected, and highly significant. Ceteris paribus, inmigrating blue-collar workers were likely to locate in communities close to the place of work. The standardized coefficients indicated that of the variables included in the model, distance to work played the greatest role in determining the residential location of the inmigrating blue-collar worker.

The residential location model for the inmigrating white-collar work force was somewhat different from the models for both the blue-collar and total work forces. While all three models have the variables POPDIST, LDISWK, and SCHSER in common, the variables, log-total dwelling units (LDUS), newer housing (POST50), and the median rent/newer housing interaction term (P50RNT), were found to have little affect on the white-collar workers' residential location behavior and were eliminated from the model.

In effect, the above variables were replaced by an interaction term between newer housing and median value (P50VAL), a rental tenancy/single family housing interaction term (RNTSF), and a combined median rent and median housing value variable (VALRENT). Examining the effects of the additional variables, the median value/newer housing interaction term was positively related to white-collar inmigration, indicating that they tend to be attracted to communities with higher average housing values when associated with newer housing stocks. This finding does not necessarily imply, however, that white-collar workers prefer to pay higher housing prices. On the contrary, the negative coefficient for the

combined rent and value variable suggests that communities with lower housing costs are preferred when costs are examined independently of housing age or quality. Although at a lower level of statistical significance (0.089), the positive coefficient for the rental tenancy/single family housing interaction term supports the hypothesis that preference for communities with more single family housing depends, in part, upon the amount of rental housing in the communities.

Examining the variables included in all three models, the coefficient for POPDIST indicated that a community in the 7,500 to 50,000 population range within 30 miles of a project attracts approximately 18.3 percent of a project's total inmigrating white-collar work force. In addition, communities with higher levels of school expenditures and other local public services (SCHSER) also attracted white-collar inmigrants. As in the other models, log-distance to work (LDISWK) was negatively related to inmigration.

A simple Chow test indicated that at least one of the coefficients in the residential location models for the blue-collar and white-collar workers was different. In order to determine which individual coefficients differed in the two models, the model for the blue-collar inmigrants was reestimated, restricting each individual coefficient successively to the value found for that variable in the white-collar workers' model. As shown in Table 33, this procedure revealed that the differences between coefficients in the two models were significant at the 5 percent level for only two variables—LDISWK and POST50.

Table 33. Tests to Determine the Equality of Regression Coefficients in Blue-Collar and White-Collar Models

Restricted Variable	Restricted* Value	Original Blue-Collar Estimate	F for H_0: $B_r = B_e$	Significance Level
POPDIST	18.255	14.33	0.75	
LDISWK	-5.81	-8.28	2.10	0.05
LDUS	0	1.0279	0.78	
POST50	0	0.2359	2.44	0.025
P50RNT	0	-0.0017	1.84	
SCHSER	0.9197	0.6884	0	
P50VAL	0.0126	0	0	
RNTSF	0.0023	0	0.26	
VALRENT	-1.0053	0	0.52	

*Value of coefficient in white-collar model.

The residential location behavior of the white-collar inmigrants is apparently less affected by distance to work than that of the blue-collar workers. Restricting LDISWK in the blue-collar model demonstrated that the negative coefficient is significantly larger for blue-collar inmigrants. This indicates that blue-collar workers are in fact more likely to locate closer than the white-collar workers to the work site.

The significantly larger coefficient for POST50 in the blue-collar model was unexpected, since the proportion of a community's housing stock constructed in 1950 or later was proposed as a proxy for housing quality, and white-collar workers were expected to exhibit a stronger housing quality preference. The significant positive coefficient for the newer housing/median value interaction term (P50VAL) found in the model for white-collar workers appeared to support this hypothesis; however, the

coefficient for newer housing (POST50) alone was significant in the model for blue-collar workers only. One interpretation of this result is that blue-collar workers have a stronger preference than white-collar workers for newer housing. This interpretation appears to be inconsistent with evidence that white-collar workers generally live in areas with higher quality housing. An alternative interpretation of POST50's presence in the model for blue-collar workers is that the variable is also a proxy for community growth. Communities with a greater amount of the housing stock constructed in 1950 or later also experienced growth during this period. Rather than indicating a greater preference for newer housing, POST50 may indicate that communities experiencing more recent growth and development are more attractive to blue-collar inmigrants.

Comparison of the $\bar{R}^2$ values for each model reveals that the model for the blue-collar workers is somewhat more effective than the white-collar model in predicting the residential location distribution of inmigrating workers among the communities surrounding the power plant projects. The residential location model for the blue-collar sample accounted for 60 percent of the variance compared to 48.1 percent for the white-collar workers. The standard error was ±5.47 percent for the blue-collar workers and ±7.049 percent for the white-collar workers. Both models were significant at the 0.0001 level.

The substantial proportion of variance unaccounted for by these models suggests that there are probably other significant variables not presently included in the models affecting blue-collar and white-collar

worker residential location behavior. Since the total set of variables examined in this study covers many of the quantitative aspects of a community, the factors may be more qualitative in nature, particularly in the case of the residential location behavior of white-collar inmigrants.

Residential Location Models for Inmigrating Workers with Families and Workers without Families

In addition to supporting disaggregation of the total inmigrating work force into blue-collar and white-collar components, the exploratory analysis and Chow test indicated that disaggregation and estimation of separate models for workers accompanied by a family (family) and those unaccompanied by a family (nonfamily) is appropriate. The following models were developed for estimating or predicting the percentage locating in each community of a project's total inmigrating family workers and nonfamily workers:

$$\text{NOFAMMIG} = \text{Constant} + \text{POPDIST} + \text{LDISWK} + \text{LDUS} + \text{POST50} + \text{P50RNT} + \text{SCHSER};$$

and,

$$\text{FAMINMIG} = \text{Constant} + \text{POPDIST} + \text{LDISWK} + \text{POST50} + \text{SCHSER} + \text{RNTSF}.$$

The results of the multiple linear regression analysis for the nonfamily model are shown in Table 34; for the family model in Table 35. All of the coefficients in both models have the theoretically expected signs. The coefficients are all significantly different from zero at the 5 percent level except log-total dwelling units (LDUS) in the nonfamily

Table 34. Regression for Percentage of Total Inmigrating Workers Unaccompanied by a Family

Variable	Intercept or Coefficient	T for H_0: Parameter = 0	Significance Level	Standardized Coefficient
CONSTANT	19.456	2.94	0.004	
POPDIST	19.156	6.25	0.001	0.3863
LDISWK	-10.216	8.83	0.001	-0.6036
LDUS	1.182	1.50	0.137	0.1957
POST50	0.2956	2.88	0.005	0.3175
P50RNT	-0.0022	2.67	0.009	-0.3160
SCHSER	0.7541	1.95	0.053	0.2250

$\bar{R}^2$ = 0.595 F = 34.58 Significance Level 0.0001

Standard Error of Regression = 6.95 Cases = 138

Table 35. Regression for Percentage of Total Inmigrating Workers Accompanied by a Family

Variable	Intercept or Coefficient	T for H_0: Parameter = 0	Significance Level	Standardized Coefficient
CONSTANT	13.56	2.53	0.013	
POPDIST	14.55	6.00	0.001	0.3766
LDISWK	-6.6848	7.48	0.001	-0.5070
POST50	0.1323	2.95	0.004	0.1824
SCHSER	0.8852	5.06	0.001	0.3390
RNTSF	0.0017	1.63	0.106	0.0995

$\bar{R}^2$ = 0.539 F = 32.98 Significance Level 0.0001

Standard Error of Regression = 5.78 Cases = 138

model and the rental tenancy/single family housing interaction term (RNTSF) in the family model.

Both models include the variable POPDIST. The coefficients for POPDIST in each model are positive, as expected, and indicate that a community with a population of 7,500 to 50,000 persons within 30 miles of a project site attracts approximately 19.2 percent of a project's workers unaccompanied by families and 14.6 percent of those with families. Although the absolute value of the coefficient is greater in the nonfamily model, reestimation of the model for the workers without families, restricting the coefficient to the value in the family model, indicated no statistically significant difference between the coefficients in each model (see Table 36). Examination of the standardized coefficients for each model indicates that POPDIST has approximately the same degree of effect on the residential location behavior of workers with and without families.

Of the variables included in the models, proximity to the project site appears to be the most important factor determining the residential location of both workers with families and those unaccompanied by families. The sign of the coefficient for log-distance to work is negative, and highly significant. As indicated in the previously described results, workers are more likely to locate in communities closer to the project site; however, the strength of this tendency varies somewhat between family and nonfamily worker groups.

Both the standardized and unstandardized coefficients suggest that distance to work has a greater affect on the residential location

behavior of workers unaccompanied by families. Restricting the coefficient for LDISWK in the nonfamily model to the value found for workers with families yielded a significant change in the sum squares of residuals, confirming that the negative coefficient is significantly larger for nonfamily workers.

Table 36. Tests to Determine the Equality of Regression Coefficients in Family and Nonfamily Models

Restricted Variable	Restricted* Value	Original Nonfamily Estimate	F for H_0: $B_r = B_e$	Significance Level
POPDIST	14.55	19.156	0.99	
LDISWK	-6.6848	-10.216	2.67	0.01
LDUS	0	1.182	0.63	
POST50	0.1323	0.2956	0.72	
SCHSER	0.8852	0.7541	0.01	
P50RNT	0	-0.0022	2.01	0.05
RNTSF	0.0017	0	0.03	

*Estimated value of coefficient in family model.

Newer housing (POST50) is also included in both models. The results indicate that both workers with and without families tend to locate in communities with newer housing stocks. The coefficient in the nonfamily model is larger than in the family model; however, restricting the coefficient in the model for workers without families indicated that the difference is not statistically significant. While the magnitude of the unstandardized coefficients is not significantly different, the standardized coefficients indicate that newer housing plays a much more important role in the residential location model for workers unaccompanied by a family.

The combined education and local public services index (SCHSER) is the final variable included in both models. The results indicate that both workers with and without families are attracted to communities with better educational and local public services levels; however, the statistical significance of coefficient is greater in the model for workers with families. The standardized coefficients also indicate that SCHSER contributes more to the residential location model for workers with families.

Of the variables included in the residential location model for workers unaccompanied by families, log-total dwelling units (LDUS) demonstrated the least statistical significance (0.137 level). Although the level of significance was low, the sign of the coefficient was positive, as expected, and the standardized coefficient indicates that housing contributes significantly to the model. Apparently, workers without families are attracted to larger communities with more housing. In contrast, results for workers with families (not shown) indicated that total housing was not significant even at the 0.25 level, and contributed little to explaining their residential location behavior.

The newer housing/median rent interaction term (P50RNT) was significant only in the model for workers without families. The coefficient was negative, as expected, indicating that workers unaccompanied by families are less likely to locate in communities with newer housing where it is associated with higher rental costs. In contrast, workers with families are apparently unaffected by the interaction between newer housing and rental costs.

Past research indicates an overwhelming preference for single family housing units and that the preference is stronger among family households than among nonfamily households. The initial examination of the data in this study indicated that the preference for single family housing among temporary inmigrant workers is affected by housing tenancy type. Communities with higher levels of single family housing appeared to attract more inmigrating workers when rental tenancy levels were also higher. The regression results provide some support for this conclusion. Although not highly statistically significant, the coefficient for the rental tenancy/single family housing interaction term (RNTSF) was positive, as expected, in the family model, indicating that joint increases in the levels of rental and single family housing are accompanied by increases in the proportion of workers with families locating in the community. In contrast, the results for the nonfamily model (not shown) indicated that the rental tenancy/single family housing interaction had little or no affect on their residential location behavior. These findings lend support to the hypothesis that family households are more strongly oriented toward a single family residential environment.

Examining the relative predictive accuracy of the models, the $\bar{R}^2$ values indicate that the residential location model for the nonfamily workers accounted for approximately 59.5 percent of the variance, compared to 53.9 percent for the family worker distribution. The standard error of the regression was ±6.95 percent for the nonfamily model and ±5.78 percent for the family model, indicating that the

average error in the estimates is slightly greater for workers without families. Although a substantial amount of the variance in the residential location patterns of each group remains unexplained, both models are highly statistically significant. In addition, both models appear to be satisfactory in terms of the tests applied and the theoretical expectations, but not highly efficient. The results suggest that the models could be simplified with little information loss by eliminating log-total dwelling units (LDUS) from the nonfamily model and the rental tenancy/single family housing interaction term (RNTSF) from the family model. It was considered desirable, however, to retain them in their respective models because of their theoretical significance.

Cross-Validation: An Application of a Regression Model to A New Sample

While the $\bar{R}^2$ values for each model indicate how well the variables included in each model capture the variance in the distribution of each inmigrating worker group among the communities surrounding the power plant construction projects included in this sample, $\bar{R}^2$ values are only a partial indicator of the ability of these models to forecast or predict the residential location distributions of inmigrating worker groups at future construction sites. Coefficients estimated by ordinary least squares regression provide the "best" linear fit for the data in a given sample; however, a new sample probably will not yield identical estimates for the coefficients. Although the estimated coefficients in a model are generally unique to a sample, they should provide a satisfactory prediction for other samples with little reduction in $\bar{R}^2$

values, if the model has been properly specified (McNeil, Kelly, and McNeil, 1975).

One approach to assessing the forecasting capability of a regression model is cross-validation, applying the estimated coefficients from the original sample to a new sample. In order to cross-validate the residential location models for forecasting adequacy, an additional sample of communities, measured on the same independent and dependent variables, must be obtained. Then the values of estimated coefficients from the original sample must be multiplied by the appropriate independent variables for the new sample to obtain a prediction for each community. The correlation between the observed value of the dependent variable for each community in the new sample and the predicted value provides an indication of the adequacy of the regression model.

The Hartsville Nuclear Plant's construction project provided the sample for the cross-validation analysis. Data were collected on the residential location distribution of the total inmigrating work force among 20 surrounding communities. The analysis was limited to the total inmigrating work force, because residential location distributions were not available by occupational status or household composition for the Hartsville project.

Regression analysis of the residential location distribution of the total inmigrating work force at each project included in the original sample yielded the following results:

TOTINMIG = 15.673 + 14.639 POPDIST - 7.917 LDISWK
+ 0.2082 POST50 - 0.0012 P50RNT + 0.6852 SCHSER
+ 0.9164 LDUS.

This model was used to predict the percentage of the total inmigrating work force locating in each of the 20 communities surrounding the Hartsville site. After obtaining the predicted distribution of the work force among the communities, it was compared to the actual distribution in a correlational analysis. The coefficient of determination ($r^2 = 0.734$) between the predicted and actual distributions indicated that the predicted distribution accounted for approximately 73.4 percent of the variation in the actual distribution. This suggests a high degree of stability in the function (model) as expressed by the variables included in the model and their estimated coefficients.

Direct examination of the actual and predicted percentage of total inmigrants locating in each community also provides some support for the model. Table 37 shows that the predicted values were generally quite close to the values actually observed, particularly for communities receiving larger percentages of inmigrants. Examining the direction of the errors for these communities, it is interesting to note that in 7 of the 10 communities receiving more inmigrants, the errors in predicted inmigration were in the direction of a slight overestimation. In fact, for the five communities at the Hartsville site actually experiencing the greatest amount of project-related inmigration, the residential location model for the total inmigration work force only underestimated the level of inmigration for one community.

Table 37. Actual and Predicted Residential Location Distribution for Communities Surrounding the Hartsville Nuclear Plant Site

Community	Percentage of Total Inmigrating Workers	
	Predicted	Actual
Carthage	8.2	3.9
Cookeville	3.1	1.3
Gallatin	23.0	19.4
Hartsville	11.5	14.5
Hendersonville	0.14	4.7
Lafayette	9.6	7.4
Lebanon	21.4	14.8
Nashville	5.49	5.2
Red Boiling Springs	-1.46	0.7
Westmoreland	-0.60	0.8
Bethpage	-2.16	0.7
Castalian Springs	0.22	4.7
Dixon Springs	13.1	2.3
Goodlettesville	2.46	0.8
Hermitage	3.65	0.6
Madison	3.51	0.7
Mount Julliet	0.00	1.2
Old Hickory	-0.06	1.1
Pleasant Shade	-1.66	0.7
White House	-1.13	0.7

The table included six predictions of negative inmigration. The theoretical meaning of predicted negative inmigration is unclear. One possible interpretation is that a negative prediction indicates a project induces net outmigration from a community. Since, however, the models have been estimated on the basis of inmigration data only, it should be assumed for forecasting purposes that inmigrating workers are unlikely to locate in communities with a predicted negative inmigration. An assumption of zero inmigration for these communities appears to be reasonable, considering the average error in the estimates. The negative values are all within the standard error for the model and are not significantly different from zero.

When a regression model is applied to a new sample of subjects not included in the original estimation of the model, the predictions are usually less accurate for the new sample; that is, generally some loss in R^2 value is experienced. Surprisingly, the residential location model for the total inmigrating work force yielded more accurate predictions for the Hartsville worker residential distribution than for the original sample upon which the model was estimated. In the original sample, the model accounted for only 57.3 percent of the variation in the residential location distributions. By comparison, it accounted for 73.4 percent of the variation in the residential distribution among the communities included in the Hartsville sample. While not impossible, this finding was unexpected.

The results of the cross-validation analysis are encouraging. They indicate that the residential location model for the total inmigrating

work force is relatively stable and reliable. The predictions were generally quite accurate, particularly for the communities where accuracy is most important; that is, the communities actually receiving the most inmigration. Examining the impact assessment and mitigation implications of the errors in the forecast, the model exhibited a slight tendency to overestimate inmigration to impact communities, which is generally a less critical forecasting error than underestimations. If subsequent impact monitoring indicates a lower than projected level of impact in a community, then existing community impact mitigation programs may be reduced or eliminated. If, however, impact assistance has been based upon underestimated inmigration levels, it may be more difficult to implement additional mitigation programs in a timely fashion.

Interpretations and Evaluation

In summary, the regression results indicate that the factors affecting the residential location patterns of the blue-collar and nonfamily workers differ somewhat from those affecting the white-collar and family workers. While all models share some variables in common, the variables found only in the blue-collar and nonfamily models reveal that these groups are more greatly affected by cost and housing availability considerations and less affected by residential environmental factors. The blue-collar and nonfamily inmigrants tend to select communities capable of meeting their basic need for shelter while also reducing their transportation and housing costs. In contrast, the residential location behavior of the white-collar and family workers appears to be more strongly affected by the type and quality of the

residential environment found in a community. In order to locate in communities with higher quality, single family residential environments, they are apparently willing to obtain housing in communities with greater commuting distances to the work site and higher average housing prices. Notwithstanding the geographical differences between the relatively rural power plant setting and urban areas, the findings are generally consistent with those of previous urban research, indicating that blue-collar and single person households usually locate in areas of less expensive housing closer to the place of work, while white-collar households and families tend to be found more often in the higher quality single family suburban locations farther from the work place.

The regression results generally supported the disaggregation of the total inmigrating work force into separate components along occupational status and household composition lines. However, the blue-collar and nonfamily models remained relatively similar to the total inmigrant model, both in terms of the variables included and the sign and magnitude of the estimated coefficients. While remaining relatively similar to the overall model, estimation of separate blue-collar and nonfamily models generally resulted in an increase in the size of the t-values for each individual coefficient and in their statistical significance.

The results for the blue-collar residential location models are not particularly surprising, since blue-collar inmigrants account for over 80 percent of the total combined work forces. Nonfamily workers

are, however, in the minority. They account for only 33 percent of the total sample. The explanation may partially lie in the fact blue-collar workers are less likely than white-collar workers to be accompanied by a family. Of the inmigrating blue-collar work force, 36.4 percent were unaccompanied by a family, compared to 21.7 percent of the white-collar workers. This suggests that future research into the residential location behavior of inmigrating workers might usefully examine possible interaction between occupational status and household composition.

The finding that workers in all inmigrant groups exhibit a preference for residential locations in communities with populations of 7,500 to 50,000 persons within 30 miles of a project site appears to be consistent with nonmetropolitan growth hypotheses that, when the effects of employment opportunity are controlled, smaller communities are intrinsically attractive as residential locations. There also appears to be a minimum community size threshold below which inmigrants are less likely to locate. The lower threshold may reflect an inability of smaller communities to deliver adequate services. The fact that workers in all inmigrant groups also exhibit a tendency to locate in communities with better local public services suggests support for this hypothesis.

In selecting variables for inclusion in the models, most were interaction terms or logarithmic transformations, suggesting complexity of the factors affecting worker residential location. Of the 17 individual untransformed variables, only one (POST50) remained significant when interaction terms or log transformations were included in the models. Only five variables—density, total vacancies, multi-family

housing, mobile homes, and land-use controls—were not included in any form in any model. The absence of significant results for these variables may be due to colinearity with other variables in the models, particularly community size related variables such as total housing and local public services. These findings suggest the hypothesis that simple additive models are unlikely to be successful in explaining complex behavioral systems such as residential location.

Finally, although the Chow tests indicated the appropriateness of disaggregating the total work force, the application of the residential location model for the total inmigrating work force to a new sample suggested the potential usefulness of these models as forecasting tools for impact assessment. While the cross-validation results suggest that the functional form is relatively stable and reliable, it should be noted that a relatively substantial amount of the variance remains unexplained by these models. The unexplained variance may be due to a failure to include all relevant variables, changes in the communities since 1970, or random events. Regardless of the source of the error, no model is likely to adequately substitute for an intimate knowledge of the area surrounding a project and informed judgment. Models should augment rather than replace judgment in impact analysis.

CHAPTER VII

SUMMARY, DISCUSSION, AND RECOMMENDATIONS

This study consisted of an exploratory analysis of the major factors affecting the spatial distribution of the migrant labor force associated with the construction of five electrical generating facilities in the Tennessee Valley. Essentially, the issue under consideration may be characterized as a special case of a residential location or community choice problem, work place constrained migration. Since the rural work site is fixed prior to inmigration, the worker is usually faced with a decision of locating close to the project in a smaller rural community or in a larger community farther from the work site. It was proposed that four factors potentially influence the inmigrating worker's residential location decision: (1) community characteristics; (2) socio-economic and demographic characteristics of the inmigrants; (3) the journey to work; and (4) project characteristics. In order to determine the relative effects of each factor, a research design including the following three stages of statistical analysis was implemented: (1) a bivariate analysis; (2) a partial correlation analysis; and (3) a multiple regression analysis. The primary objective of the study was to improve the empirical basis for forecasting potential impacts on communities surrounding the site of large-scale energy facility construction projects caused by worker inmigration.

The first two stages of the statistical analysis were designed to explore the evidence for association between the predictor variables

(worker, community, journey to work, and project characteristics) and inmigrating worker residential location patterns. In the initial stage, the analysis was based upon bivariate statistical procedures. The inmigrant population was subdivided into distinctive socioeconomic and demographic groups based upon their occupational status, job tenure, age, family life-cycle, household size and composition characteristics. The distributions of these groups were then cross-tabulated with various community characteristics. This step was essentially descriptive. Analytical inferences were limited primarily to the differences between means of the various community characteristics computed for each inmigrant subgroup. Relationships between each individual predictor and the overall residential location pattern were examined in a bivariate correlation analysis. The dependent variables were the percentages locating in a given community of a project's total work force and significant subgroups. The second stage determined the amount of variation each predictor variable explained, controlling for the effects of other predictor variables. The basic bivariate relationships were identified and other "test" predictors were successively entered, using a partial correlation analysis to determine their effects on the basic relationship.

The findings for the initial stages of analysis generally supported the overall hypotheses that worker characteristics, the community characteristics, and journey to work are important determinants of inmigrant residential location behavior. Results for the journey to work and project factors are most definitive, indicating that distance to

work is a significant constraint on worker location and that project characteristics, in contrast, have little if any effect. Indications are less clear for variables related to worker and community characteristics. Worker characteristics generally appear to be weak predictors of residential location patterns; however, some support was shown for disaggregating the inmigrant work force along occupational status and household composition lines. While the relationships between residential location and blue-collar and white-collar status are generally as expected, household composition findings are somewhat surprising. It was anticipated the presence or absence of children in the household would be an important factor in determining inmigrant residential location; however, the data revealed little difference between the location patterns of families with children and those with no children. Rather, the more salient variable in the worker's household composition appeared to be the presence or absence of the inmigrant's family regardless of its childrearing status.

In the initial stage of the analysis, results for community characteristics were disappointing. Bivariate relationships were consistently weak and often opposite that expected. This was primarily the result of a suppressor relationship between distance to work and some community variables. The construction projects were located in relatively rural areas; therefore, community size was positively correlated with distance to work. Since distance to work was negatively related to the tendency to locate in a community, it reduced or suppressed the positive effects of variables positively correlated with community size.

In contrast, a partial correlation analysis controlling distance to work revealed several significant relationships between community characteristics and worker residential location. As hypothesized, inmigration increased with community size, housing availability, rental tenancy, housing diversity, newer housing, local public service levels, and educational quality. Unexpectedly, inmigration also appeared to increase with median rent, median value, residential density, multifamily housing, and land-use controls. When, however, both distance and size effects were controlled, a positive relationship remained for median value and land-use controls only. The results suggested the effects of housing value on residential location differ from those of rent. Higher values when associated with newer housing apparently attract some inmigrants. The positive relationship for land-use controls may indicate that rather than acting as a constraint on residential location effective land-use controls may be perceived as an indicator of a positive residential environment.

Because community population size plays an important role in impact analysis, it was examined in some detail. The analysis suggested a positive log relationship with worker inmigration increasing at a decreasing rate with community size, as hypothesized. Inmigration increased rapidly with city size to 15,000 population, leveling between 15,000 and 50,000, and remaining basically stable over 50,000 population. The 7,500 to 50,000 population range was particularly attractive to inmigrants. Above 50,000 population, inmigrants appeared to be essentially indifferent to further increases in population. The relatively large proportion of inmigrants found in communities under 2,500

population appeared to be primarily a function of their greater numbers and proximity to the projects.

Controlling community size effects generally reduced other community variables' predictive power. This, however, is not necessarily an indication that community size is the only variable affecting worker location. It is more likely that a positive relationship exists between worker inmigration and community size because housing, public services, educational expenditures, land-use controls, and so forth, are positively associated with population. In this study, the nearly perfect community size, total housing, and vacancy correlations and the fact that a log linear relationship with inmigration applied equally well to total housing and vacancy, suggests that the attraction of large communities was primarily an effect of housing availability.

Overall, the results of the initial stages of analysis revealed the relative complexity of the interrelationships between the factors affecting worker residential location. While distance to work was clearly an important location factor, interaction effects tended to reduce the predictive power of individual community variables. This suggested that relationships between community size and distance to work, housing costs and housing age, and housing tenancy and type were not additively related to inmigrant residential location. Similarly, results indicated that nonlinear forms of community size and housing availability measures are better predictors than their untransformed counterparts. The complexity of these interrelationships suggests that conclusions based upon descriptive bivariate studies concerning residential location related impacts should be questioned.

In the final stage of the analysis, multiple regression techniques were used to estimate residential location models for blue-collar, white-collar, family, nonfamily, and total combined inmigrating work forces. In the blue-collar, nonfamily, and total models, the variables and estimated coefficients were quite similar. While the statistical significance of the individual coefficients was lower in the total model, all three models indicate communities located closer to the project site, in the 7,500 to 50,000 population range, with newer, larger housing stocks, lower rental costs, and better services, tend to attract workers. White-collar and family inmigrants exhibited similar preferences for better local public services and community size. They, however, commuted greater distances locating in communities with higher average housing prices, better housing quality, and single-family residential environments. In contrast to the blue-collar, nonfamily, and total work forces, size of housing stock and average rental costs apparently had little effect on their behavior.

I. RELATIONSHIP OF THE FINDINGS TO THE THEORETICAL AND EMPIRICAL LITERATURE

In the early stages of this research, the residential location and related migration literature was reviewed. Three potential frameworks were identified for analysing the residential location behavior of inmigrating workers at power plant construction projects; market forces models, gravity models, and disaggregated residential location models. In this section, each of these approaches has been examined briefly in relationship to the findings.

Market Forces

The findings of this study offer relatively little support for a market forces explanation of inmigrating worker residential location behavior. Market forces models attempt to explain the variations in the residential location patterns of different socioeconomic groups by differences in their incomes. They argue the concentration of lower socioeconomic groups in low rent areas closer to the work place is an effect of an income-induced constraint on their ability to pay higher combined housing and transportation costs. The incomes, however, of blue-collar construction workers at TVA power plant projects often equal or exceed those of white-collar workers. This suggests the persistent tendency of blue-collar workers to locate in communities minimizing housing and commuting costs results from residential values or preferences which differ from those of white-collar workers. The regression results indicate the residential location behavior of white-collar inmigrants is more greatly affected by the status or prestige associated with locations in higher value, higher quality, single family residential areas. This conclusion is also consistent with Duncan and Duncan's (1955) findings that lower income white-collar clerical workers are less likely than higher income blue-collar workers to be found in the lower rent residential areas of a city. The differences in the residential location patterns of the inmigrating blue-collar and white-collar workers are apparently less an effect of market than of social forces.

Gravity Models

In reviewing migration literature, two alternative perspectives were identified; gravity model and city size preference hypotheses. The gravity model approach assumes the spatial distribution of worker residences is a function of community size, size of the work force, and distance to work. It assumes that the greater the "mass of a unit," usually measured in terms of a community's population, housing or employment, the greater the attraction exerted by the community at a given distance. City size preference hypotheses, in contrast, question the assumption that migrants find larger places inherently more attractive residential locations. They argue potential migrants have differing city size preferences which must be taken into account in an explanation of migration flows. They point to recent trends in nonmetropolitan growth as an indication that contrary to gravity assumptions, many people may prefer small town or rural residential locations. The findings of this study indicate less support for gravity models than for city size preference hypotheses. Both the bivariate and regression analyses supported the hypothesis that distance to work poses a significant constraint on worker residential location. There was, however, little indication that worker inmigration is directly proportional to size of project employment or to city size. Inmigrants exhibited a marked tendency to locate in communities in the 7,500 to 50,000 population range. The tendency to locate in smaller communities appears to be more consistent with the city size preference hypotheses and nonmetropolitan growth literature.

Although small communities are apparently attractive residential locations, there also appears to be a lower population threshold below which inmigrants are less likely to locate. The lower threshold may reflect a relationship between community size and local public services. Workers in all socioeconomic groups exhibited a tendency to locate in communities with better local public services. The lower threshold may indicate that inmigrating workers perceive the level of local public services to be inadequate in smaller communities. Leholm, Leistritz, and Wieland's (1976) finding that inmigrating workers were much more likely to express dissatisfaction with community services in places below 1,000 population than in places of 10,000 to 30,000 population would appear to support this hypothesis.

Disaggregated Residential Location Models

Contrary to the highly aggregative nature of gravity and market forces models which tend to assume residential location behavior occurs in a homogeneous context of houses, people, and travel patterns, a number of studies recognize the diversity of residential location patterns, attempting to capture the effects of highly differentiated residential areas, consumer groups, and transportation patterns in what might be termed disaggregated residential location models. Although a variety of variables are examined in studies using this approach, they are generally classifiable within the larger framework proposed by Lee (1966) for analyzing migration. Lee suggested the spatial distribution of migrants is a function of four major factors: (1) origin characteristics; (2) destination characteristics; (3) migrant

characteristics; and (4) impedance effects of the distance between the origin and destination.

Since the work place was determined prior to worker migration, inmigrating worker residential location behavior may be considered an example of work place constrained migration. The universe of potential residential locations was defined by the feasible commuting distance; therefore, in the context of Lee's model, the project site was considered the "point of origin" in this analysis. Residential location patterns were expected to vary with two project characteristics—stage of construction and size of a project's inmigrating work force. The findings, however, gave little indication that either project stage or size had any appreciable effect on worker residential location. Although slight increases in average commuting distance were noted with increasing size at some projects, they were not significant. The findings clearly demonstrated that, once established, the residential location patterns remained remarkably stable throughout construction. As a result, project characteristics were excluded from further analysis.

The model proposed by Lee suggests that the characteristics of the migrant and his household are relevant variables in a residential location analysis. Among the variables examined, worker age, family life-cycle stage, and household size exerted little significant influence on residential behavior compared to occupational status and household composition effects. These results appear to be consistent with past urban studies, indicating that while residential location patterns are differentiated along socioeconomic status dimensions, demographic

variables tend to affect propensity to move and type of unit selected more so than location. The household composition effects identified in this study, particularly for family and nonfamily status, appear to be an exception among demographic variables.

The migration and urban residential location literature suggests that characteristics of a community play an important role in determining residential location. Consistent with this expectation, the analysis demonstrated that community size, services, and growth, housing type, tenancy, quality, and costs were significant factors. Although the urban residential literature placed considerable emphasis on the importance of housing availability, the relationships between worker residential location patterns and housing availability measures were extremely weak. Two factors may account for this result. First, the workers' greater reliance upon mobile homes may have freed them somewhat from conventional housing availability constraints. Secondly, the finding may have been the result of inadequate housing availability data. This study depended upon the 1970 Census for vacancy data and changes since that time may well have rendered that data unreliable. An analysis based upon more recent data may show that housing availability is a much more important factor than indicated in this study.

Residential location behavior is a relatively recent area of research. Consequently, most studies are based upon descriptive, bivariate statistical procedures. The results of this analysis suggest that examination of bivariate relationships, particularly between community variables and location, may be misleading. The analysis

reveals a complex pattern of interrelationships in which often the effects of one community variable were dependent upon the level of another, requiring nonadditive interaction terms to capture the complex effects. This is particularly true for relationships between community size and distance, housing type and tenancy variables, and housing quality and cost.

One community variable which warrants some additional consideration because of its theoretical importance is local public services. The findings indicate that all inmigrants exhibit a similar tendency to locate in communities with better local public services. This finding appears to be inconsistent with Tiebout's hypothesis that fully mobile consumers select their residential locations from among a set of communities, each offering a different bundle of local public services and prices (taxes), in accordance with their income and preferences for outputs of local public services. This hypothesis suggests that communities with differing services/tax packages will tend to attract workers in different socioeconomic groups. The regression results, however, indicate little or no differentiation in the attraction of better community services along occupational status or household composition lines. One possible explanation for this result is that inmigrating workers are temporary residents and are, therefore, less sensitive to local service costs than to service levels. Given their briefer residency, inmigrating workers pay a relatively lower share than the long-term resident of the total cost of better services. In addition, local public service costs are often supported by local

property taxes. Since inmigrating workers are more likely to be renters, they should be less sensitive to the costs of local public services because property taxes tend to be hidden in the rent and spread over the entire year. This is one area which might be examined in more detail in the future.

Contrary to indications in the literature that location and employment accessibility are much less important factors than residential environment and housing characteristics (Rossi, 1955; Lansing, Mueller, and Barth, 1964; Butler et al., 1969; and Ermuth, 1973), proximity to the work place was apparently the most important variable in determining the residential location of inmigrating workers. Although there were variations related to occupational status and household composition, inmigrants in all groups exhibited a tendency to locate close to the project site. As noted in urban studies of journey to work patterns, the effects of journey to work were nonlinear with a log transformation providing an adequate fit for the distance relationship. The findings of this study provided additional empirical support for the conclusion that journey to work is a more important factor in determining the residential location behavior of inmigrating workers than one would expect from the results of urban residential location studies.

In the final analysis, less support is shown for gravity model and market forces approaches than for disaggregation approaches emphasizing the roles that separate components play in residential location behavior. While project characteristics had little effect, the findings generally support the contention that inmigrating worker residential location

patterns are a function of the characteristics of the household, community, and journey to work. The patterns of residential location behavior found among the inmigrating workers were overall quite similar to those of movers in urban areas. The similarity is surprising, considering the differences between the geographical settings of residential areas surrounding rural power plant construction sites and those found in urban areas. It suggests the residential location preferences of inmigrating construction workers may not be significantly different from those of other movers. The differences may be primarily an effect of the temporary nature of their residency.

II. EVALUATING THE FORECASTING POTENTIAL FOR RESIDENTIAL LOCATION MODELS BASED UPON REGRESSION TECHNIQUES

In addition to contributing to an understanding of some of the factors affecting worker residential location, the regression models may be used to forecast potential community impacts resulting from the worker inmigration associated with the construction of future power plant projects. Prior to applying a model in a forecasting situation, there are several issues which should be examined, including the adequacy of the tests applied to the model, accuracy of forecasts, applicability in new situations, and limitations of the approach (Sanderson and O'Hare, 1977).

In developing the models included in this study, several tests were applied. First, Chow tests were used to determine whether the total work force should be disaggregated and separate component models estimated. The results supported disaggregation and estimation of

separate models for blue-collar and white-collar components and family and nonfamily components. Second, the coefficient of determination corrected for degrees of freedom, $\bar{R}^2$, was used to determine the relative efficiency of each model. The $\bar{R}^2$ values indicated the models were capable of accounting for substantial amounts of the variance in residential location patterns, ranging from 48 to 60 percent for the various inmigrant groups. Third, the F test was applied to each model to determine overall statistical significance. All models were highly significant, 0.001 level or better. Fourth, t statistics were computed for each individual coefficient. Fifth, variables and their coefficients were examined for their consistency with previous theoretical and empirical analyses. Finally, the total inmigrant model was applied to a new set of data in a cross-validation analysis.

Some assessment of the accuracy of the models' predictions was indicated by the range of $\bar{R}^2$ values reported above; however, the cross-validation analysis performed on the Hartsville Nuclear Plants' data more closely approximated a forecasting situation. Although Chow tests indicated disaggregation should yield more effective estimating equations, data limitations restricted the cross-validation analysis to the total inmigrant model. The application of the model to 20 communities surrounding the Hartsville site proved relatively successful. The simulated forecast was quite accurate, particularly where accuracy is critical (e.g., in communities actually receiving greater inmigration). The model accounted for over 73 percent of the variance in the residential location pattern and the errors were generally in the direction of over

estimating migration into those communities which in fact received greater numbers of inmigrants.

Assessing the applicability of a model to a new situation involved both temporal and spatial dimensions. The cross-validation analysis also provided a basis for assessing the applicability of the models. Data from the census for the Hartsville project communities were nine years old. Community data used in estimating the models ranged from zero to seven years. Considering the varying time periods involved, relative changes could be expected to have some effect on the accuracy of the model predictions; however, the models accounted for substantial amounts of the variance at all projects, including Hartsville. The Hartsville project's geographic setting also differed from previous projects. While the original projects were located in a variety of settings, Hartsville was the only site located in the Nashville basin within 30 miles of two communities in the 7,500 to 50,000 population range. Furthermore, Hartsville was a much larger project and TVA consciously intervened in the transportation system and local housing markets. Given these factors, the predictive power of the model suggested the functional form is relatively stable and reliable both temporally and spatially.

While stability in a model and extensive testing lend some confidence to the forecasting capabilities of the models developed in this study, a few precautionary remarks concerning the limitations of modeling are in order. Linear regression techniques tend to capitalize on chance variations in a data set and are particularly sensitive to outliers. Consequently, chance variations or very high or very low values for one

variable may affect the placement of a community in one category or another. For example, a model may identify a community as a potential no impact or impact area when in fact it is not. Erroneous placement is especially crucial for the identified no impact areas, since it may be quite difficult to meet demands for additional services in a timely manner. Therefore, it is suggested that impact analysts extensively examine the profile of community characteristics prior to planning and implementing a mitigation program.

Statistical techniques and computer applications can facilitate the identification of potential impact communities, but one should not abdicate all decision-making responsibility. After all, one keypunch error can change a community from an impact to a no impact area. More importantly, it is unlikely that all relevant variables have been taken into consideration. The amount of variance remaining unexplained by the present models and failure to find significant housing availability relationships tends to support this conclusion. In addition, there may be qualitative variables, difficult to factor into regression models, affecting worker residential location. Finally, it is unlikely that any modeling approach can adequately accommodate the kind of apparently random land conversion by inexperienced entrepreneurs found in the area surrounding the Sequoyah site by Borcz (1977). While potentially useful forecasting tools, models are poor substitutes for extensive knowledge of the area around a site and sound judgment.

III. IMPACT ANALYSIS AND MITIGATION IMPLICATIONS

Construction of electrical generating facilities in rural areas usually entails inmigration for a significant portion of the work force. The size and spatial distribution of this inmigrating work force are important factors determining the extent and intensity of the socio-economic impacts associated with construction. The ability of a local area to accommodate the construction-related population influx is largely a function of the size of the existing infrastructure relative to the increase in population.

In assessing the potential impacts of worker inmigration, baseline data are collected on housing, schools, public services and facilities, and so forth, in the communities surrounding the project site. The total number of inmigrating workers and related population is forecast and distributed among the surrounding communities, based upon a location model or other ad hoc allocation rule. Once the allocation of the forecasted population influx is accomplished, the demand on local housing, schools, services, facilities, and so forth, is projected and compared to local capacities in order to determine the potential level of impact.

Under the current practices for nuclear power station construction projects, potential socioeconomic impacts are forecast for the environmental report approximately two years prior to the start of construction. The impact analysis and mitigation program are based upon the projected distribution of the inmigrating work force at the peak employment stage, some six years later. During this period, a number of external changes may occur which alter both the distribution and magnitude of the impacts.

Attempts are being made to overcome this problem by implementing monitoring systems designed to provide the necessary data to verify projected impacts or to adjust the mitigation programs for unexpected developments.

The findings of this study suggest that the monitoring/mitigation approach is potentially quite effective. The analysis of the project effects reveals that the basic residential location pattern for the inmigrating work force is established in the early stages of construction and, once established, remains extremely stable throughout project construction. This stability has significant implications for impact analysis and mitigation programs. If residential location distributions are insensitive to the stage of project construction, then impact monitoring data may be useful for testing the accuracy of the forecasted distribution in the very early stages of construction. The findings suggest that projections of the peak residential distribution may be made in the first year of construction with 85 to 95 percent accuracy based upon the data for as few as 100 to 200 inmigrants. Re-examining the forecasts early in the construction of a project leaves a lead time of two to three years during which an effective mitigation program may be developed and implemented. Although this does not eliminate the requirement for preliminary impact forecasts for the environmental report, it indicates that the potential exists for better planned, coordinated, and more effective mitigation efforts.

Aside from stability, there are other aspects of the residential location behavior which potentially reduce the likelihood of significant

adverse impacts, particularly in the area of community services. Analysis of worker residential location patterns suggests that workers consider local services in selecting a residential location. The findings indicate that workers in all inmigrating groups are more likely to locate in communities with more and better local public services. While inmigration may have an impact on communities with better services, the probability of adverse impacts may be less than it would be if residential locations were selected without regard for local services. In addition, local public services and facilities are partially related to community population. A recent TVA study (1976) of communities surrounding two-unit electrical generating facility construction projects finds, for example, that communities over 10,000 population experience little identifiable impact on services. Similarly, although there are some variations, impact levels are generally low to moderate among communities in the 2,500 to 10,000 population range because basic urban services and infrastructure are usually already in place. The study concludes adverse impacts on local public services and facilities are most likely in communities under 2,500 population. Within this context, the tendency exhibited by the inmigrant to locate in communities in the 7,500 to 50,000 population range has positive impact implications. Significant worker migration into a community under 2,500 population appears to occur only when it is very close to the site (within approximately 5 miles) or when there are no communities of 7,500 to 50,000 population within 30 miles of the site. The tendency to locate in the community size ranges associated with greater service capacities

reduces the potential level of impact. Furthermore, the findings indicate that workers locating close to the site in communities under 2,500 population are much less likely to be accompanied by a family. Thus, since the population influx per worker is smaller, the potential total demand on local public services and facilities is lower in those communities where it is most crucial. The combination of these findings suggests that the pattern of worker residential location behavior tends to reduce the overall potential for significant adverse impacts on local public services and facilities.

The combined implications of the residential location patterns are interesting. The stability of the residential location distribution throughout construction suggests that if one can affect the early pattern of residential location, then potentially peak construction impacts may be reduced. This may be partially accomplished in the site selection process by identifying and including as siting criteria residential location factors which are either partially or wholly controllable. Three residential location factors identified in the present study—distance to the work site, community size, and local public service levels—are potential candidates for consideration in the site selection process. The findings suggest that, by selecting sites in closer proximity to communities in the 7,500 to 50,000 population range or those with better services, the residential location pattern may be influenced in such a manner that it tends to reduce service level impacts. If, however, other siting constraints preclude locating in close proximity to these communities, the effective distance

may be reduced by implementing an employee transportation system. Similarly, residential location patterns may be affected by intervention in the local housing markets, either indirectly through the collection and dissemination of housing availability information or directly through construction of additional units.

IV. CONCLUSION

In conclusion, this study has examined some of the major factors affecting the spatial distribution of inmigrating workers associated with the construction of major electrical generating facilities. Multiple regression techniques have been used to develop predictive residential location models for the blue-collar, white-collar, family, nonfamily and total inmigrating work forces. The total inmigrant model was applied to extra sample data and proved a potentially useful forecasting tool. The implications of the findings for impact assessment and mitigation were examined. The study suggested that, regardless of the strategy adopted, examination of worker residential location patterns potentially facilitates the development of more effective impact assessment and mitigation programs.

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APPENDIX

APPENDIX

This appendix describes the construction of measures for the following variables: residential density, local public services index, land use controls, and educational expenditures per pupil.

Residential Density

Using the concept of residential density required the selection of an appropriate measure. The measure selected was gross residential density, consisting of the total number of residential units in a community divided by the community's total acreage. For incorporated places, the total acreage within the corporate boundaries was used. For unincorporated areas, development of a density measure required a decision as to what constitutes a community's boundaries. This decision was based upon interviews with local residents whose occupations tend to be community related, such as local school teachers, postmen, shopkeepers, and ministers. The informants were asked to draw the boundaries of their communities directly upon county road maps. They were instructed to include only those areas where they felt the majority of the community's residents would agree to their inclusion as a part of the community. Most informants were able to comply with these instructions.

In order to calculate gross residential density, each informant's boundaries were transferred to a common map. Although the exact boundaries varied from person to person, there was generally a large area in which all informants were in agreement. Depending upon the

shape the informants' community boundaries tended to take, a circle or irregular polygon was drawn, incorporating the area within the boundaries indicated by most informants. The total area within each circle or polygon was calculated and the number of dwelling units determined. Dividing the number of units by the area in acres yielded an estimate of a community's gross residential density.

Local Public Services Index

In order to test hypotheses concerning the effects of local public services upon residential location, a simple index consisting of water, sewer, fire, and police data was constructed. Availability of sewer services was measured by the percentage of the total housing units with public sewer. Since communities with water systems generally have relatively little variance in the proportion of units with public water supplies, the water availability data was limited to a dummy variable indicating whether or not a public water system existed in the community. Fire protection was represented by the fire insurance rating, ranging from a score of 1, indicating a high level of protection, to 10, indicating little or no fire protection. The number of patrol personnel per 1,000 population was used as the measure of police protection. This variable was selected because it relates directly to the visibility of the police in the community and may be a factor in the residents' perception of police protection.

In order to calculate the index score, the raw value of each variable was converted to a standard score, or a z score, expressing a community's deviation from the mean of each variable's distribution in

standard deviation units. The standard score indicates the relative position or location of a community's score in the distribution. The mean of a distribution of standardized scores is always 0, and the standard deviation is always 1. A community with a value above the mean has a positive standard score for that variable. A standard score below the mean is negative. Since larger values for fire insurance ratings indicate poorer protection, the standard scores are multiplied by -1, so that higher standard scores always indicate higher service levels for all variables. The final index score consists of an unweighted linear summation of each community's standard scores for each local public service variable.

Land Use Controls

Information concerning local land use controls was obtained by telephone interviews with the directors of the regional offices of the Tennessee State Planning Office and the Councils of Governments (COGs) offices in north Alabama. No data were collected for the three towns in Kentucky.

The process included several steps. First, a list was compiled of all project communities by planning region or COG. Second, the informants were asked to identify the project communities with zoning, subdivision, building and occupancy permit regulations. This step revealed that none of the project communities required occupancy permits and that, outside larger urban communities, building permits had few if any regulatory functions. In smaller communities, building permits were primarily adopted for taxing purposes or as a prerequisite for

federal flood insurance certification. Consequently, occupancy and building permits were deleted from further analysis. In the third step, the informants were asked to use their judgment in categorizing the effectiveness of the enforcement of the zoning and subdivision controls in each project community in their planning region. Zoning and subdivision controls were rated separately with effective controls assigned an arbitrary value of 1 each for effective controls, 0 if otherwise. The land use index score consisted of an unweighted summation of the scores for the individual controls. The index ranged from 0 to 2, with 0 indicating no effective land use controls in the community, 1 indicating either an effective zoning ordinance or subdivision regulations, and 2 indicating the presence of both effective zoning and subdivision controls in the community.

Educational Expenditures Per Pupil

Calculation of the standardized educational expenditures per pupil for each community was somewhat complicated. In order to obtain comparable data, it was necessary to adjust the data for differences between school systems in incorporated and unincorporated areas and to correct for temporal and regional differences between projects. Since county school systems usually provide transportation for their pupils while city systems do not, and transportation expenditures do not contribute directly to educational quality, it was considered desirable to deduct transportation expenditures from the total county educational expenditures. The adjusted total was then divided by the average daily

attendance (ADA) to obtain a school expenditures per pupil figure comparable to that calculated for incorporated areas.

In addition to the effects of differences between unincorporated and incorporated areas, expenditures are subject to relatively large temporary variations caused by capital expenditures in one or two years. While capital improvements may contribute to enhanced educational quality, the temporary peak in expenditures is unrepresentative; therefore, the adjusted school expenditures per pupil were averaged over the three year period prior to project construction.

After the school expenditures per pupil were adjusted for transportation and averaged over the three year period prior to construction, the average adjusted school expenditures per pupil for each community were standardized by converting the data to Z scores. It was necessary to convert the data to common units for two reasons. First, school expenditures per pupil increased dramatically with time and inflation, making the data for later projects incomparable with earlier projects. Second, there were both regional and state differences in the levels of expenditures per pupil. The Z score conversion provided a useful indication of the level of educational expenditures per pupil in each community relative to all other communities in a project area in standard units. The standardized average adjusted educational expenditures per pupil was used as the proxy measure for educational quality in this study.

VITA

James Vann Cunningham was born in Winchester, Tennessee. He attended elementary schools in Chattanooga, Tennessee, and graduated from Chattanooga Central High School. While an undergraduate student at the University of Tennessee, Chattanooga, where he received a Bachelor of Arts degree in sociology and anthropology, he was appointed a Political Science Honors Intern in the Mayor's Office of the City of Chattanooga, and elected to the Sigma Pi, National Blue Key, and Raven Honor societies.

After undergraduate school, he was employed by the Chattanooga-Hamilton County Regional Planning Commission as an Associate Planner. He was subsequently promoted to Senior Planner, responsible for long-range planning and budgeting programs, including the comprehensive plan update, capital budget, workable program, and community development fiscal program.

Upon receiving a graduate research assistantship, he entered the Graduate School of Planning at the University of Tennessee, Knoxville. As a graduate student, he was awarded a Chancellor's Citation for Exceptional Academic Achievement and the American Institute of Planners Outstanding Student Award. He was also elected a member of the Honor Society of Phi Kappa Phi. He received the degree of Master of Science in Planning.

While attending graduate school, the Energy Division of Oak Ridge National Laboratory employed him as a Research Specialist in the area of

social indicators research. He was also employed by the Tennessee Valley Authority as a consultant for the Regional Planning Staff in the area of socioeconomic impact analysis and power plant site screening methodology.

He is married to the former Alice Jean McCashin of Chattanooga.