Housing and land use analysis methodology : socioeconomic assessment, Exxon Crandon Project. 1982

Austin, Texas: RPC, Inc., 1982

https://digital.library.wisc.edu/1711.dl/6OA6OSSMTFT6E8O

EXXON MINERALS COMPANY

CRANDON PROJECT

SOCIOECONOMIC STUDY

prepared by RPC, Inc.

HOUSING AND LAND USE ANALYSIS METHODOLOGY

SOCIOECONOMIC ASSESSMENT

EXXON CRANDON PROJECT

prepared for
Exxon Minerals Company

by
RPC, Inc.
Austin, Texas

March 1982

We will appreciate any comments you may have on the methods and techniques we describe in this report. You may direct comments and suggestions to any of the following:

Daniel J. Derfus
Manager, Socioeconomic Study
Exxon Minerals Company
P.O. Box 813
Rhinelander, WI 54501
Tel: 715/369-2800

Frank Sonderman
Community Planning Coordinator
Exxon Minerals Company
P. O. Box 813
Rhinelander, WI 54501
Tel: 715/369-2800

Ronald T. Luke, Ph.D.
President
RPC, Inc.
1705 Guadalupe
Austin, TX 78701
Tel: 512/472-7765

Charles Stern
Community Planner
RPC, Inc.
1705 Guadalupe
Austin, TX 78701
Tel: 512/472-7765

HOW TO USE THIS REPORT

This report is part of a comprehensive study commissioned by Exxon Minerals Company to determine the potential socioeconomic effects of a proposed mine/mill complex in northern Wisconsin. The report describes the techniques we plan to use to estimate the potential effects of the project on housing and land use in the local study area.

Part of the intent of Exxon Minerals Company in commissioning this socioeconomic assessment is that everyone with an interest in the proposed project should have access to the reports concerning the socioeconomic effects that might result from project development. However, this intended readership covers a wide spectrum of interests and technical backgrounds. In an effort to provide information for those with nontechnical interests, as well as for readers who want all the statistical and mathematical details, we have designed our reports in two parts. The first part, printed on yellow paper, covers the highlights of the technical work described in the white pages.

We have organized the technical discussion in the white pages as follows:

- Chapter 1: Our overall approach to the analysis
- Chapter 2: Our procedure and the data we have collected to describe existing conditions
- Chapter 3: A description of the housing market model
- Chapter 4: A description of the spatial allocation model
- Chapter 5: A description of the land use model

The yellow-page summary section describes the procedures we discuss in detail in the white pages, without listing specific data requirements, mathematical formulas, or other technical details.

SUMMARY

Exxon Minerals Company (Exxon) is considering establishing a mine/mill complex near Crandon, Wisconsin. The proposed complex would be based on a large ore deposit containing commercial quantities of zinc and copper. Engineering and economic feasibility studies are underway for the project, and environmental studies are in progress to satisfy local, state, and federal regulatory requirements. Exxon estimates that construction and operation phases of the project will each employ about 900 people.

Exxon has retained Research and Planning Consultants, Inc. (RPC) to prepare a comprehensive assessment of potential socioeconomic effects of the Crandon Project. The overall assessment forecasts effects of the project on the local study area's economy, demography, housing and land use, public facilities and services, fiscal capabilities, sociocultural characteristics, and Native American communities. We have conducted statistical surveys in the local study area to supplement available information for these analyses. In addition, we are preparing case studies on communities that share characteristics with the local study area and that have experienced industrial development similar to that expected from the Crandon Project.

In the housing and land use analysis, we estimate potential effects of the proposed Crandon Project on the local study area. The local study area consists of 40 townships, three cities, and an incorporated village, encompassing most of Forest and Langlade counties and about half of Oneida County in northern Wisconsin (Exxon Minerals, 1980). The economic and demographic analyses forecast changes for the local study area as a whole. In the housing and land use analysis, we allocate estimated new households and employment to specific jurisdictions in the local study area.

Where people locate in the local study area and what type of housing they live in are important factors in the overall socioeconomic analysis. The location of new housing and households determine where new demands are placed on public facilities and services. The location of new housing and new commercial and industrial development determine the additions to the tax base in each jurisdiction. The housing market, spatial

allocation, and land use analyses are pivotal to forecasts of the effects of the proposed Crandon Project on specific jurisdictions within the local study area.

The analysis of housing and land use describes current housing and land use characteristics of the local study area and future conditions without the project and with project development. We compare the two types of future forecasts to determine the net effects of project development on housing and land use in the local study area.

To forecast futures for the local study area, we use three computer models. One of the models assesses the housing market in the local study area. The spatial allocation model allocates new housing to jurisdictions in the local study area. The land use model calculates land use conversions and the effect of the changes on the property tax base.

The housing and land use analysis consists of the following steps:

1. Describe current housing and land use conditions
2. Estimate response of housing industry to increased demands
3. Estimate distribution of population, employment, and housing
4. Estimate effects on land use patterns.

The products from the second, third, and fourth steps are generated for the local study area under two different assumptions: first that the Crandon Project is developed (considering three different development scenarios which represent minimum, maximum, and medium effects), then second that the project development does not occur.

DESCRIBE CURRENT CONDITIONS

We have gathered information describing housing supply and demand and land use patterns in the local study area. This description combines an inventory of the existing housing stock with an analysis of past trends and policies.

The baseline description of housing supply considers business development practices of builders and developers, and lending policies of financial institutions. For housing demand, we examine population size and income characteristics. The land use description considers factors such as soil types that limit residential development, as well as zoning and other official land use controls.

ESTIMATE RESPONSE OF HOUSING INDUSTRY TO INCREASED DEMAND

The housing market model generates an annual forecast of additions to the housing stock. These forecasts estimate new housing, by type, for the local study area as a whole to meet increased demand generated by population growth. The forecasts also identify potential housing surpluses or shortages.

Some construction workers will be short-term residents requiring housing for less than three years. Most new households will be long-term residents who plan to remain for more than three years. To forecast future requirements for short-term housing, we:

1. Determine annual demand for short-term housing

2. Match this estimated short-term demand with the existing and planned supply of short-term housing.

To simplify housing allocation, we assume all short-term residents will demand rental housing. The results of this matching process indicate whether current and expected supply will be sufficient to satisfy future demand for short-term housing.

We forecast the amount of housing required to satisfy expected demand by new long-term households with a computer simulation model. The housing market model uses the description of existing conditions and information on characteristics of new households from the demographic forecasts to describe the local study area market for long-term housing. The model also forecasts annual changes in the supply of housing by type.

Since the primary purpose of this analysis is to determine if a project-related housing shortage will occur, minimum housing prices and development costs are used throughout.

ESTIMATE DISTRIBUTION OF POPULATION, EMPLOYMENT, AND HOUSING

The next step is to allocate additional employment, estimated in the economic analysis; population, estimated in the demographic analysis; and the housing they will require within the local study area. We use a spatial allocation model for this part of the analysis. For each year, the spatial allocation model allocates new employment, new households, and their required housing units to jurisdictions on the basis of attractiveness of the jurisdictions as places to live and their proximity to employment sites and retail centers. Population change in existing households is allocated on the basis of jurisdictions' proportional share of total local study area population.

We then consider to what extent local constraints, such as limited land availability or restrictions on mobile homes in each local study area jurisdiction, may conflict with our allocation of households for each jurisdiction. This comparison results in one of three possible courses of action:

1. No conflict; thus, no change in the model's initial allocation

2. The jurisdiction has reached capacity for development (e.g. land availability) of a certain type of housing; allocations for that year and future years will not consider that jurisdiction for that type of housing until capacity is projected to increase

3. The jurisdiction has exceeded a development constraint (e.g. mobile home restrictions); the model redistributes that jurisdiction's housing allocation to other jurisdictions.

In addition to government constraints, the business policies of real estate lenders and developers also constrain the location of new households. People moving to an area must normally buy existing housing. This means their housing location preference is constrained by the location of existing housing. To a large extent they must buy houses where developers have been willing to develop. Developers are constrained to develop where lenders are willing to lend. Thus we consider possible business policy constraints on real estate development as part of the spatial allocation analysis.

ESTIMATE EFFECTS ON LAND USE PATTERNS

The changes in housing supply from the spatial allocation model and forecasts of commercial and industrial development from the economic analysis determine to what extent local study area land use patterns can be expected to change. To calculate the amount of land required for residential development, we multiply the number of new housing units by the average acreage per residential unit. Similarly, for changes in commercial and industrial land use, we multiply acreage per employee by the number of new employees determined in the economic analysis. Changes in land use cause changes in the property tax base of each jurisdiction. The land use model combines the forecast of land use changes with estimates of value per acre for each use to produce annual estimates of each jurisdiction's tax base.

We will also conduct a special analysis of those jurisdictions that contain prime agricultural or commercial forest land and that we estimate will experience pressure for new development. The results of this special analysis will indicate the possibility that these lands may be converted to other uses. The results will also be used in the special studies of agriculture and forestry/forest products, which are part of the special industries studies described in the economic methodology (RPC, 1981).

DETERMINE EFFECTS OF THE PROJECT

The analysis described above is performed on a without-project scenario and on three with-project scenarios. We determine effects of the Crandon Project on housing and land use in the local study area by comparing the without-project and with-project forecasts that are generated. Differences between these represent potential effects of project development on housing and land use in the local study area.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. GENERAL APPROACH

In the housing and land use analysis, we estimate potential effects of the proposed Crandon Project on the local study area. Where people locate and what type of housing they live in are important factors in the overall effects of the project. For example, the location of new housing and households determine where new demands are placed on public facilities and services. Also, the locations of new housing and new commercial and industrial development determine the additions to the tax base in each jurisdiction.

Our overall approach consists of the following steps:

1. Describe existing housing and land use characteristics in the local study area by subcounty jurisdiction

2. For without- and with-project assumptions, forecast future housing supply and demand and land use characteristics without the project and with project development:

   a. Identify effects of population change on the housing stock for the local study area as a whole (using the housing market model)

   b. Allocate new population, employment, and housing to individual cities and townships throughout the local study area (using the spatial allocation model)

3. For without- and with-project assumptions, forecast changes in land use patterns (using the land use model)

4. Compare the forecasts for future conditions without the project and with the project to determine effects of the

project on housing and land use in the local study area and its jurisdictions.

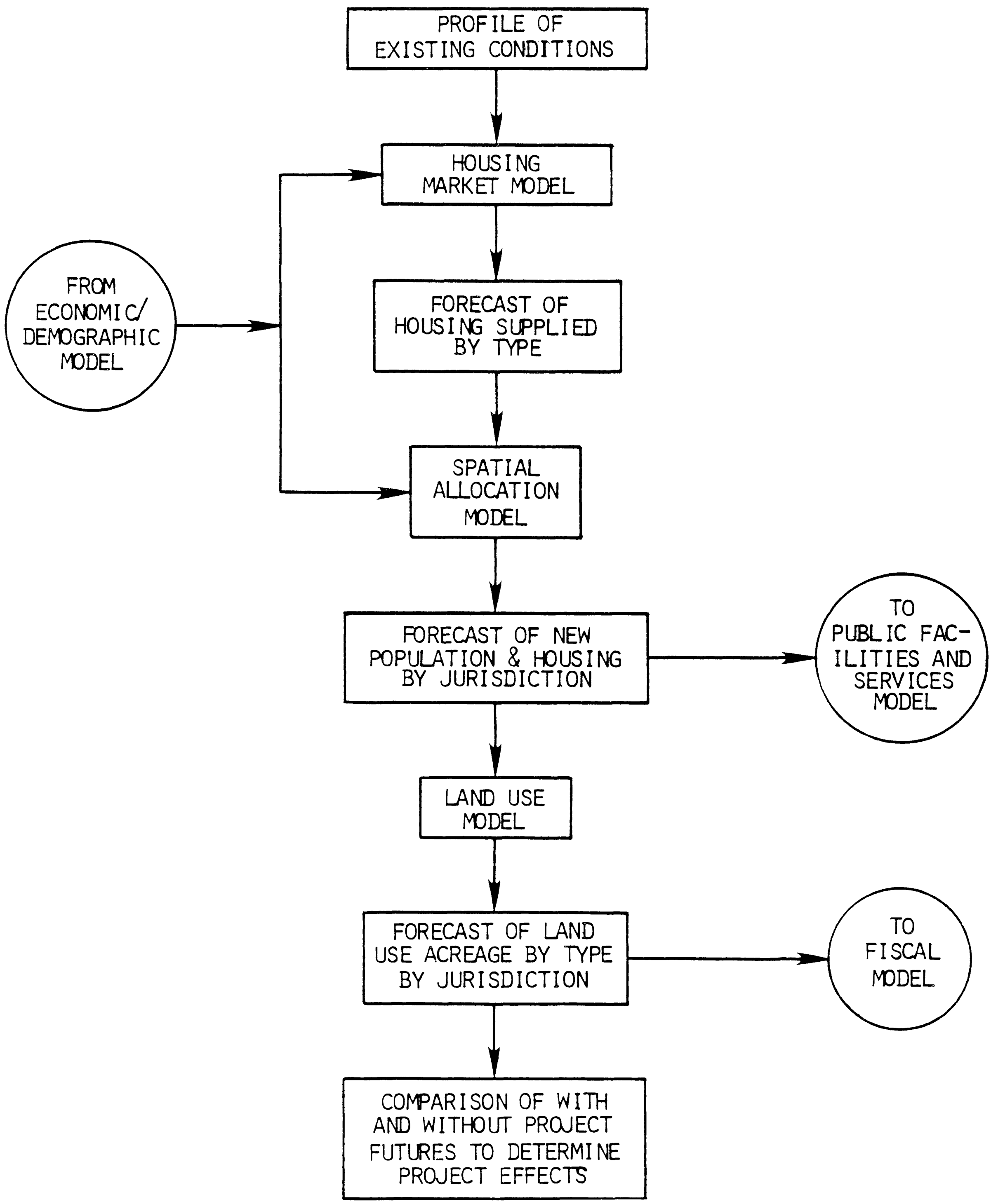
We use three computer models for our analysis of potential effects of the Crandon Project on housing and land use in the local study area. The housing market model assesses the housing market in the local study area as a whole. It does not describe housing in individual jurisdictions within the local study area. The spatial allocation model allocates required new housing to individual jurisdictions. The land use model calculates new land use patterns based upon the distribution of housing units to individual jurisdictions.

The raw outputs of the computer models are not necessarily identical with our professional judgment to the forecast of any variable. The computer models are powerful tools, but they do not and cannot reflect all factors influencing future events. The outputs are always subject to professional interpretation. The rationale for any difference between the computer model's output and RPC's opinion will be stated. The forecast presented in the Forecast of Future Conditions will be the one RPC believes most accurate and defensible in light of all circumstances.

These models and the steps in the analysis described above are shown in Figure 1 and discussed in detail in the following chapters.

Figure 1

GENERAL APPROACH TO HOUSING AND LAND USE ANALYSIS



SOURCE: Research and Planning Consultants, Inc.

2. PROFILE OF EXISTING CONDITIONS

As the first step in our analysis, we collect information and construct a profile of current conditions and trends in housing and land use in the local study area (Exxon, 1981b). The profile characterizes:

1. Housing stock
2. Housing market characteristics
3. Suitability of land for development
4. Land use controls of local government that affect the housing market
5. Policies of lenders, builders, and developers that affect the housing market.

HOUSING STOCK

The analysis of local study area housing stock catalogues current housing supply by type, and also describes changes during the 1970s. Information in this portion of the profile includes:

1. Total housing stock, by location
2. Primary residences, by location
3. Second homes, by location
4. Vacant housing units, by location
5. Mobile homes, by location
6. Age and condition of housing stock.

HOUSING MARKET CHARACTERISTICS

This section of the housing profile describes local study area housing market characteristics including:

1. Vacancy rates
2. Time on market
3. Housing sales and rental prices
4. Home building capacity
5. Speculative construction of homes
6. Availability, cost, and structure of home financing.

SUITABILITY OF LAND FOR DEVELOPMENT

The analysis of local study area land use characteristics focuses on two factors:

1. Identification of land uses that preclude development

2. Identification of locations within the local study area that can be developed.

The concern with these land use aspects arises from the need to identify the amount and location of available, developable land within the local study area for use in the spatial allocation model.

A number of land uses preclude private residential development in certain portions of the local study area. To identify the amount and location of local study area land that can be developed, we identify and map each land use that precludes or constrains development. The land uses identified in the housing profile that preclude or constrain residential development are:

1. Water bodies and wetlands
2. Commercial forest land
3. Prime agricultural land
4. Land with soils unsuitable for septic tank use
5. Publicly owned and Native American lands
6. Previously developed land.

Total acreage available for development is limited by the land uses precluding development as listed above. Subtracting land occupied by these uses produces an estimate of available local study area developable land.

LAND USE CONTROLS

The amount and type of residential development that can occur in areas identified as available for development is directly influenced by zoning and other land use controls in effect. The types of land use controls discussed in the housing profile that may limit the amount and type of residential development occurring in certain jurisdictions of the local study area are:

1. Minimum residential lot size requirements
2. Mobile home restrictions
3. Land preservation policies.

POLICIES OF LENDERS, BUILDERS, AND DEVELOPERS

In addition to government constraints, the business policies of real estate lenders and developers also constrain the location of new households. People moving to an area must normally buy already existing housing. This means their housing location preference is constrained by the location of existing housing. To a large extent they must buy houses where developers are willing to develop. Developers are constrained to develop where lenders are willing to lend. We consider possible business policy constraints on real estate development as part of the spatial allocation analysis.

DATA SOURCES

We obtain the majority of our data from the following sources:

1. County planning and zoning files
2. Wisconsin Department of Development Housing Information System and the Wisconsin Department of Administration
3. North Central Wisconsin Regional Planning Commission (NCWRPC) housing and land use maps and U.S. Geological Survey (USGS) land use maps
4. Interviews with local study area brokers, developers, and officials of lending institutions.

Prior to 1970, reliable housing information is very sketchy. Therefore, we describe the housing trends for the years 1970 through 1979. There is little recorded information on seasonal homes. Consequently, we estimate the number of seasonal homes within the local study area using techniques developed by the Wisconsin Department of Development (DOD).

Most of the available data sources report housing information for the county and incorporated areas. Total housing units for townships in Forest and Langlade counties are estimated through a two-step process. First, a preliminary count of total housing units by township is obtained from North Central Wisconsin Regional Planning Commission land use maps and U.S. Geological Survey land use maps. These counts are updated to 1979 using county building permit data. Because the NCWRPC maps are not available for Oneida County, total housing stock is estimated for this county by updating 1970 census figures with building permit data. Total housing stock estimates for the local study area portions of the three counties are determined by adding housing counts for individual townships within each county.

The housing stock in each local study area township is classified as occupied units, second homes, or vacant units for sale or rent using an estimation process developed by the Wisconsin Department of Development. First, the total number of occupied units per township is assumed to equal the number of households present in each township. The 1979 level of households is estimated by dividing 1979 population by 1979 township average household size. The number of unoccupied units is then divided between second homes and vacant units for sale or rent. The number of second homes in 1979 is determined by applying the 1970 ratio of second homes to unoccupied units to the 1979 total number of unoccupied units. Vacant units for sale or rent in 1979 are then estimated as the difference between 1979 total unoccupied units and 1979 second homes.

Hotel, motel, and resort units may be used as short-term housing during the construction phase of the Crandon Project. We assume that this will occur only if alternative short-term housing is unavailable. The data on hotel, motel, and resort units are available only on the county level.

Data on the age of year-round units are available from the North Central Wisconsin Regional Planning Commission and the 1970 census. Data on the structural condition of occupied dwellings are available from the Wisconsin Department of Development.

Surveys of local study area real estate brokers provide data on housing market characteristics, including vacancy rates, time on market, and sales and rental prices. Interviews with local study area builders are used to determine the housing development capacity in the local study area as well as current and past trends in speculative construction of homes. Lending officers from local study area banks and savings and loan associations were interviewed to supply information on the amounts and types of mortgages written, mortgage terms available to local study area residents, mortgage income qualifications, and participation in federal mortgage assistance programs.

3. HOUSING MARKET MODEL

The housing market model is based on theory developed by Forrester (1968). The model incorporates dynamic relationships that simulate the reaction of the housing market to the demands of new residents. We derive this housing market model from the BOOM series of models. This series was developed between 1976 and 1978 at the Los Alamos Scientific Laboratory to help planners, developers, and policy makers identify in advance the most crucial problems associated with western boomtowns and to provide information to mitigate those problems (Rink and Ford, 1978).

The housing market model forecasts the amount and type of housing demanded by and ultimately supplied to long-term residents of the local study area. We assume that all population increases, except some directly associated with project construction employment and initial project operation employment, will be comprised of long-term residents. The procedure used to analyze the demand and supply of housing for short-term residents of the local study area is discussed below.

The model allows us to make separate forecasts of the demand for and supply of the following:

1. Owner-occupied permanent housing
2. Renter-occupied permanent housing
3. Mobile homes.

Permanent housing refers to housing that is fixed to a permanent foundation and cannot be transported from one location to another. These separate forecasts are made in order to evaluate stock of permanent housing in the local study area available to accommodate new housing demands, the ability of the construction industry in the local study area to meet new housing demands, and the potential long-term mobile home use in the local study area.

The primary purpose of these forecasts is to determine if a project-related housing shortage will occur. Thus, we are forecasting the minimum market price and development costs required for a permanent shelter.

INPUT DATA

The housing market model contains four types of input data: 1) constants, 2) table functions, 3) initial values, and 4) independent variables. The following discussion describes each of these inputs and the information sources used to establish their values.

Constants

The housing market model contains 33 constants for each scenario. The constants describe market relationships which we construct for each forecast. Table 1 lists, describes, and gives the source for each constant. We derive each constant with data

Table 1

ESTIMATES OF THE CONSTANTS IN THE HOUSING MARKET MODEL

Constant	Name	Source
ALTUSEV-$400/acre	Alternate-use value of land	U.W. Extension
ISRATIO-2.5	Income/shelter payments ratio	Area lenders
LCPHO-$10,000	Labor cost component unit of permanent housing	Area developers
MCPHO-$16,500	Cost of materials and fixtures per unit of permanent housing	Area developers
NPHVACR-0.04	Normal permament housing vacancy rate	DOD data
ALPH-50 years	Average life of permanent housing	Assume based on average construction data of occupied dwellings
ADSCPH-0.1401	Annual debt service constant, permanent housing	Area lenders
ADSCTH-0.201	Annual debt service constant, mobile homes	Area lenders
RRTL-0.10	Expected return rate on mobile home lots	Area developers
LCPHS-$4,000/lot	Permanent housing lot services cost, easily serviced land	Area developers
LCTHS-$400/lot	Mobile home housing lot services cost, easily serviced land (low cost)	Area developers
NTHVACR-0.025	Normal mobile home vacancy rate	Realtors, mobile home park managers
CTHOUSE-$11,000	Cost of mobile home	Area mobile home dealers
PHDENS-2 acres/unit	Density of permanent housing	Local officials, area developers
THDENS-2 acres/mobile home	Density of mobile home development	Local officials, area developers
THVA-1.0	Fraction of mobile home value assessed for tax	Assume full equalized valuation across area
LNDRENT-$150	Land rent, annual, alternate use	U.W. Extension
INTR-0.15	Interest rate used to discount in speculation	RPC, Inc.
LTAXR-0.004	Annual property tax rate on unimproved land	Local assessor, developers

(continued)

(Table 1, continued)

Constant	Name	Source
HDAOC-$1,650/lot	Housing developers' administrative overhead costs	Local developers
TDAOC-$100/lot	Mobile home housing developers' administrative overhead costs	RPC, Inc.
SBDDM-2.0 years	Speculator behavioral delay in a declining market	Assume based on local developer
FTFCD-0.0	Fraction of mobile home families considered by permanent housing developers (risk behavior)	Assume based on local developer
FPFCD-1.05	Fraction of new permanent income-qualified households considered by permanent housing developers (risk behavior)	Assume based on local developer
INFLMAX-0.05	Inflation rate on housing when vacancy rate is zero	RPC, Inc.
PHCD-0.25 years	Permanent housing construction delay	Local developers
PHPAD-0.25 years	Permanent housing planning and approval delay	Local developers
THPCD-0.25 years	Mobile home housing planning and completion delay	Local developers
MRPH-0.13	Mortgage rate on permanent housing	Assume using high and low scenarios
DIFR-0.17	Developers interim financing rate	Assume using high and low scenarios
PHAD-0.5 years	Permanent housing assessment delay (normal)	Local officials
MRTH-0.12	Financing interest rate on mobile homes	Assume using high and low scenarios
THAD-0.5 years	Mobile home housing assessment delay (normal)	Local officials

SOURCE

Research and Planning Consultants, Inc., 1980 specific to the local study area. In most cases, the information needed to verify constants comes from interviews with lenders and developers in the local study area. Values for constants that relate to the existing housing stock, such as the normal permanent housing vacancy rate, come from the Wisconsin Department of Development. We obtain tax data from local assessors and the Wisconsin Department of Revenue. Values for alternate land uses come from the University of the Wisconsin Extension Service and county tax assessors in the local study area.

Table Functions

The housing market model uses three table functions to handle nonlinear relationships between variables:

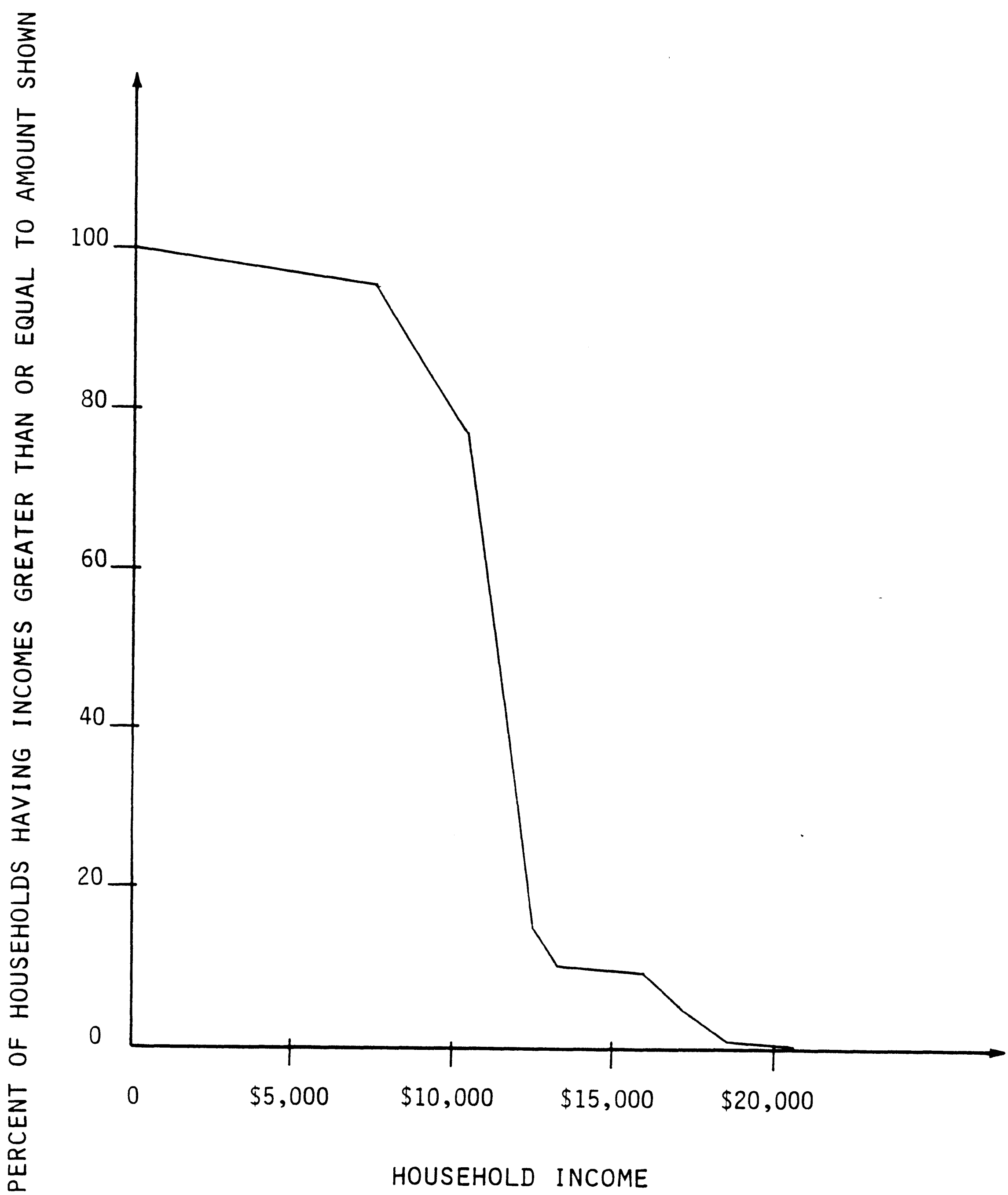
1. Income distribution for new households
2. The rate of new housing starts as a function of the builder's expected profit margin
3. Housing price changes as a function of the vacancy rate for permanent housing and mobile homes.

As an example, the values and relationships used in the without-project scenario are discussed below. The values and relationships used in the with-project analysis are the same except for income distribution.

Figure 2 represents the percent of new households forming in the without-project future that have incomes at or above certain levels. For instance, 95 percent of new households forming in the without-project future have incomes of $7,500 or above, while

Figure 2

INCOME DISTRIBUTION FOR NEW HOUSEHOLDS FORMING WITHOUT-PROJECT FUTURE



SOURCE: Research and Planning Consultants, Inc.

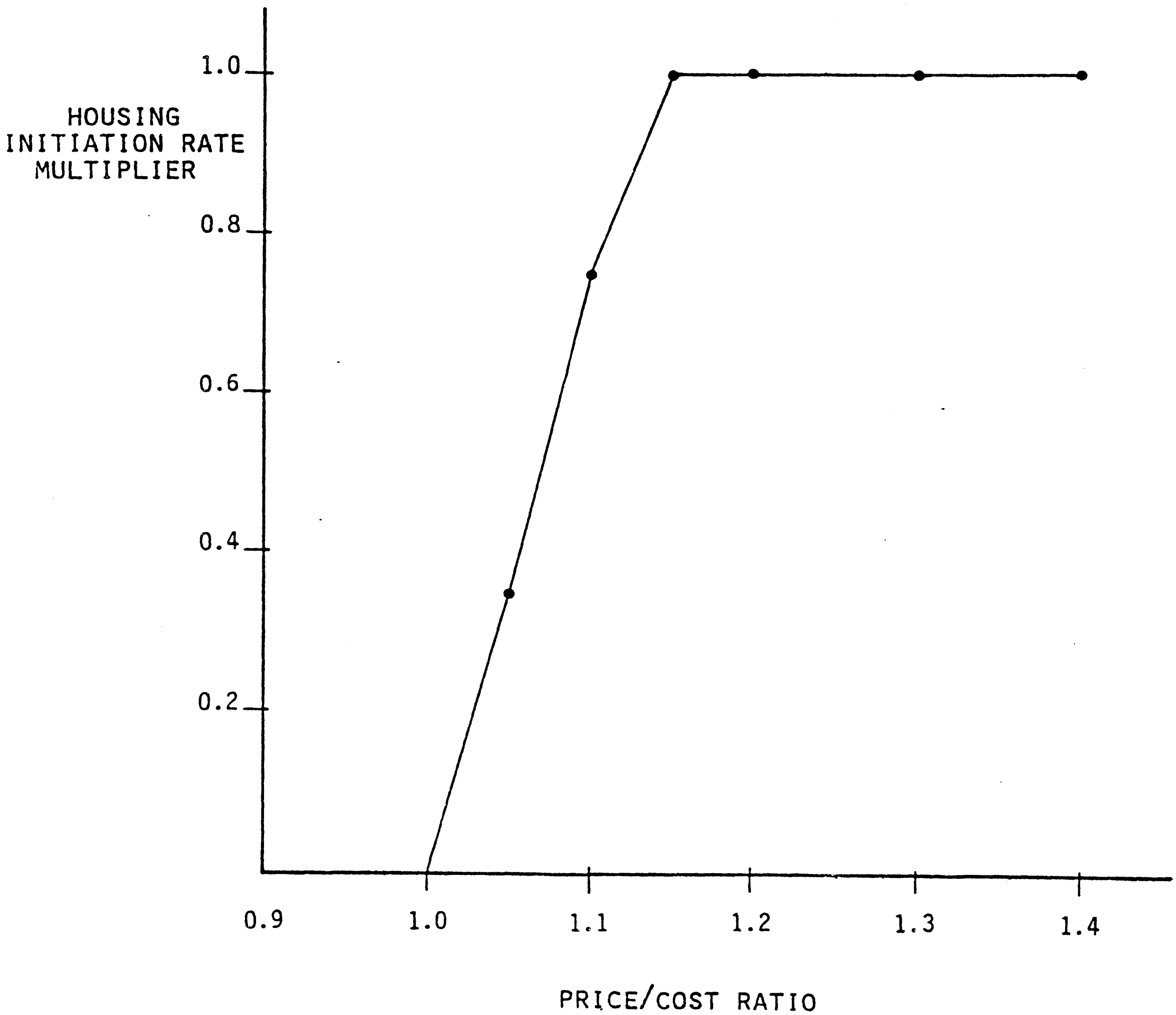
only about 10 percent of new households have incomes of $15,000 or more. We obtain this distribution by first calculating current average annual wage rates by sector for local study area workers based on Department of Industry, Labor, and Human Relations data. Minimum possible household incomes for households with workers in each sector are then determined by multiplying average annual wage rate by sector by the number of workers per household. A conservative assumption of 1.1 workers per household is used in this calculation. Households headed by workers employed in different sectors will have different household incomes. The distribution shown in Figure 2 is then determined by the minimum household income associated with each sector and the percent of total new employment occurring in each sector.

Figure 3 is the percentage of permanent housing that developers would meet at various expected profit margins. We have established the relationship expressed in this figure at 15.0 percent based on interviews with local developers. We believe that the function agrees with the assessment of developer and lender risk behavior (see constants FTFCD and FPFCD). Previous users of the model have established 20 percent ((price-cost)/price) as the expected profit margin at which developers will operate at full capacity.

Figure 4 represents the rate at which housing market price in real dollars is assumed to increase or decrease as a function of the vacancy rate. The function currently sets 4.0 percent as

Figure 3

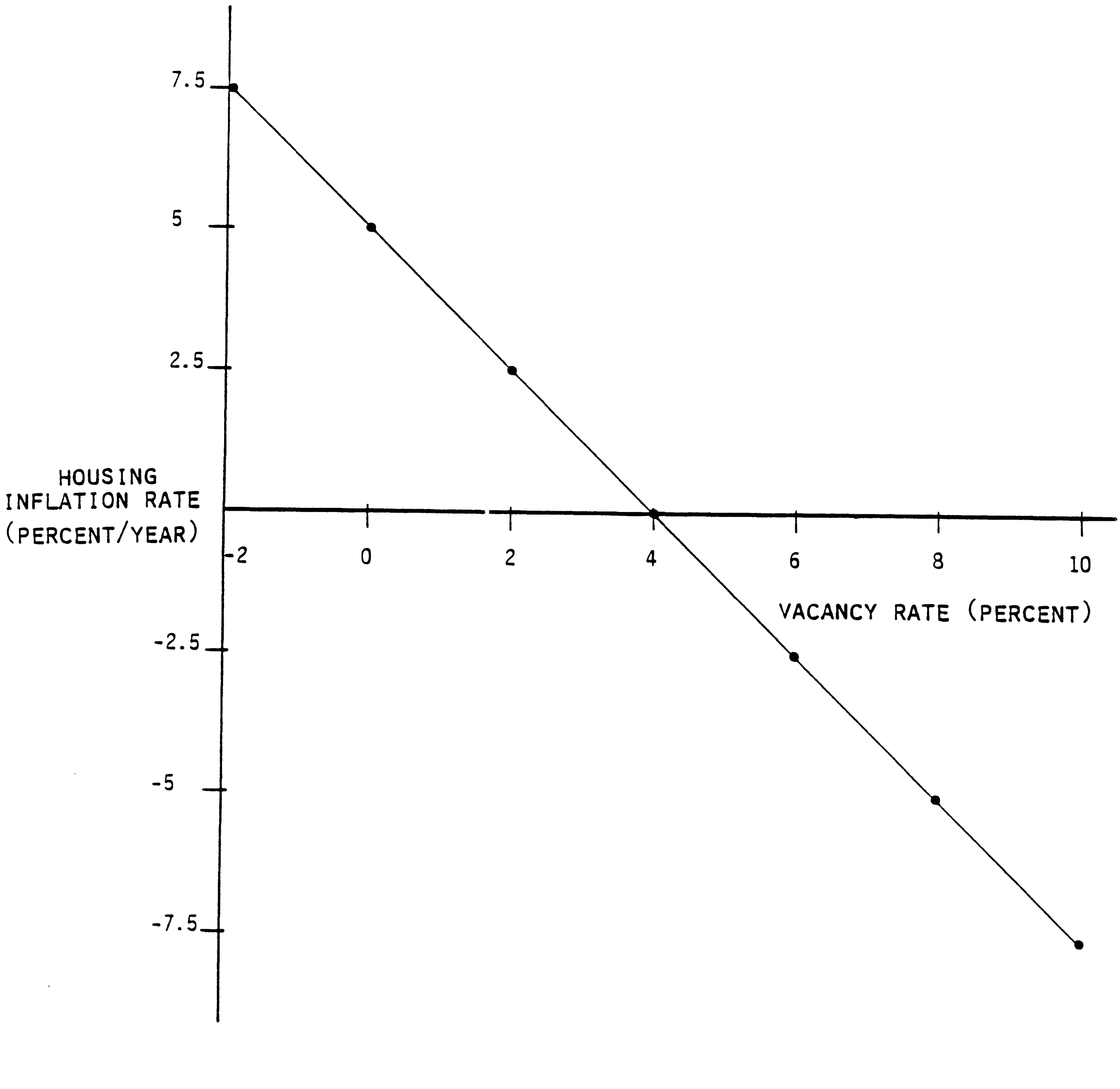
HOUSING INITIATION MULTIPLIER FROM PRICE / COST RATIO



SOURCE: Research and Planning Consultants, Inc.

Figure 4

MARKET PRICE INFLATION RATE FROM VACANCY RATE IN REAL TERMS



Note: Negative vacancy rate is pent-up demand.

SOURCE: Research and Planning Consultants, Inc.

the vacancy rate at which housing prices are stable. The function sets 5.0 percent as the relative price inflation expected for local study area housing stock when the housing vacancy rate is zero percent. This figure shows, in real dollar terms, the relationship of housing price to vacancy rates; long-range price fluctuations, caused by increased building costs and inflation, are held constant. This figure applies to permanent housing and mobile homes, except that mobile home lots have a lower bound on the inflation rate such that rentals will cease below a certain price.

Initial Values

Ten values must be set before using the housing market model:

1. Number of single-family units
2. Number of multi-family units
3. Number of mobile homes
4. Number of substandard housing units
5. Number of short-term housing units
6. Amount of available developable land
7. Market price of single-family units
8. Market price of multi-family units
9. Market price of mobile homes
10. Market price of temporary units.

The data collected for these values are discussed in Chapter 2.

Independent Variables

The housing market model requires data for total population and households by type. The demographic model supplies population data.

CONVERSION OF POPULATION TO HOUSEHOLDS

The housing market model receives the forecast for the local study area population for each year by age, sex, and type from the demographic model. Before allocation can begin, population is converted to households and classified according to the type of workers associated with these households. Inmigrating employment-related population is converted using the same characteristics used in the labor market portion of the demographic model (Exxon, 1981a). A different procedure is applied to form new households from changes in the indigenous population and from non-employment-related migration.

The conversion of indigenous population to new households is based on data produced by the U.S. Bureau of the Census. In addition to reporting population, the census reports the number of heads of households by age and sex. By computing the percentage of each age-sex cohort who are heads of households ("headship rates"), and multiplying these figures by the new indigenous population by age and sex, we forecast the number of new households forming in the baseline population.

Population increase resulting from non-employment-related migration of persons aged 65 years and over is converted to households by applying the same age/sex-specific headship rates used to convert indigenous population over age 65. Adding new baseline households to households resulting from employment and non-employment-related migration produces a forecast of the total new local study area households in each year.

Once total new households forming in a given year are calculated, they are categorized by the employment type of the household head using a three-step process. First, changes in total local study area employment are divided into direct project (employed at the mine/mill complex), nonproject basic (employed in other area industries), and retail and service employment (employed in support of industry or households). Second, information on the number of inmigrating households is obtained from the demographic analysis. The demographic analysis indicates the distribution of employment by type of job. Third, new households forming from the baseline population are categorized by employment type based upon the proportion of total employment change net of direct project jobs taken by inmigrants that occurs in each employment category. For example, if 60 percent of all new employment net of direct project jobs taken by inmigrants occurs in the retail and services sectors, 60 percent of the new households forming from the baseline population would be categorized as retail and services-type households.

This procedure for categorizing households by employment type focuses on the type of job taken by the household head. Multi-worker households may have workers employed in more than one job type. For population distribution purposes, however, the household head's job type and job site are considered to be the relevant factor driving the household's locational decisions.

The procedure just described provides a forecast of the number of new households expected to form in each forecast year, barring economic or income constraints. Research indicates that income levels are key in determining household formation rates and should be taken into account when forecasting the number of new households (Frieden et al., 1977; Williams, 1978). Improvements in economic conditions and income increases have positive effects on household formation. As income levels for a particular age and sex group rise, so does their rate of household formation. This results from an increased ability to bear the costs associated with maintaining a household. Conversely, as economic conditions worsen and income levels decline, household formation rates drop. This results from increased difficulties in meeting household maintenance costs.

To account for the effects of economic conditions on household formation, we do not allow the forecast number of new local study area households age 64 or under to exceed the forecast number of new local study area jobs. For example, assume local study area households are forecast to increase by

500 households and employment is forecast to increase by 600 jobs between 1980 and 1990. In this situation no economic constraints exist that would alter the original forecast number of new households forming. However, if employment for the period 1980 to 1990 is forecast to increase by only 300 instead of 600 jobs, then substantial economic constraints are likely to exist that will affect household formation rates. In this situation we assume that the number of new households forming will equal the number of new jobs created, in this case 300.

Constraining household formation implies that some population increases result in a greater average size for existing households. We allocate this increase in population within existing households among local study area jurisdictions on the basis of each jurisdiction's proportional share of total local study area population.

ANALYSIS OF CONSTRUCTION PHASE HOUSING MARKET

Certain characteristics of housing demand and supply during the construction period of a major project require special consideration. Demand for long-term housing must be adjusted to reflect the short-term residency of part of the construction labor force. Housing supply must also be adjusted early in the forecast period to account for speculative housing development anticipating new housing demand attributable to the project. In the event Exxon Minerals or its general contractor plans to provide housing for the construction labor force directly or indirectly, this must also be reflected in inputs to the housing market model.

Short-Term Housing

Many construction workers may not remain in the local study area permanently. Instead, they may leave the local study area when the proposed Crandon Project begins normal operations. Based on information generated by the demographic model, new population can be divided into two groups:

1. Short-term residents, most of whom are directly associated with project construction, who are expected to remain in the local study area for less than three years and are assumed to seek rental housing

2. Long-term residents, including some construction workers, who are expected to stay in the local study area for more than three years.

Not all construction workers will be short-term residents. Those who were residents of the local study area prior to project startup are likely to stay in the local study area. Some of those originally hired to construct the mine may stay on as miners during the operating phase. To be consistent with the economic and demographic models, we assume that all single workers or workers without families are short-term residents.

After determining short-term demand by housing type for the local study area, we estimate the quantity of each housing type available. Short-term housing can take many forms. As short-term residents will be single or will not move their families to the local study area, hotel, motel, and resort facilities may be used as housing. Some short-term construction workers may bring recreational vehicles to the local study area to use as housing, thus requiring only utility hookups. Others may seek to rent seasonal homes in the local study area which are suitable for year-round occupancy. We match this supply with short-term demand to determine if there will be sufficient housing to satisfy short-term residents' housing requirements. If the supply does not meet short-term housing needs, we estimate potential developer response to the shortage.

The new households classified as short-term residents are subtracted from the total new households demanding housing prior to entering the permanent housing portion of the housing market model. Some portion of the short-term resident demand is added to the demand for mobile homes to more accurately reflect the demand for pads for recreational vehicles and for rental of mobile homes or purchase for quick resale.

Housing Provided by Project Developers

It is not clear at present whether there is any need for Exxon Minerals or its general contractor during the construction phase to take any action to provide housing for the construction labor force. However, if any action is taken it will affect the local study area housing market. Depending on the exact form of action taken, the effect may be to remove certain categories of demand from the market, or to add to the supply of permanent housing.

As part of major projects in other areas of the nation, project sponsors have sometimes provided temporary housing for the construction labor force. This housing may be in mobile home parks near existing urban centers or may be in a self-sufficient "man-camp" adjacent to the construction site. If such action were needed to deal with housing shortages during the construction phase of the proposed Crandon Project, it would have the effect of reducing the demand for short-term housing without adding permanent housing units to the market.

On the other hand, project developers have in certain cases assumed the role of subdivision developers. Subdivisions may be developed with lot sizes and improvements suitable for permanent housing. During the construction period either permanent or mobile housing may be installed and sold or rented to construction workers. Once the construction period ends, the houses become part of the general housing supply for the area. If this occurs, the appropriate adjustment to the housing market model would be the addition of housing units rather than the reduction of demand.

We emphasize that at this time there is no reason to believe any housing action by Exxon Minerals will be necessary. Our assumptions for the project scenarios will be derived from inspection of preliminary model runs and consultation with Exxon Minerals.

ANALYSIS OF LONG-TERM HOUSING MARKET

The long-term housing market is comprised of those households that will reside in the local study area for three years or more and the housing they will occupy. The housing market model tracks three types of long-term housing: owner-occupied permanent housing; renter-occupied permanent housing; and mobile homes. The model examines the behavior of the supply of housing units, prices, vacancy rates, and the distribution of households among housing types based on their ability to pay for various types of housing.

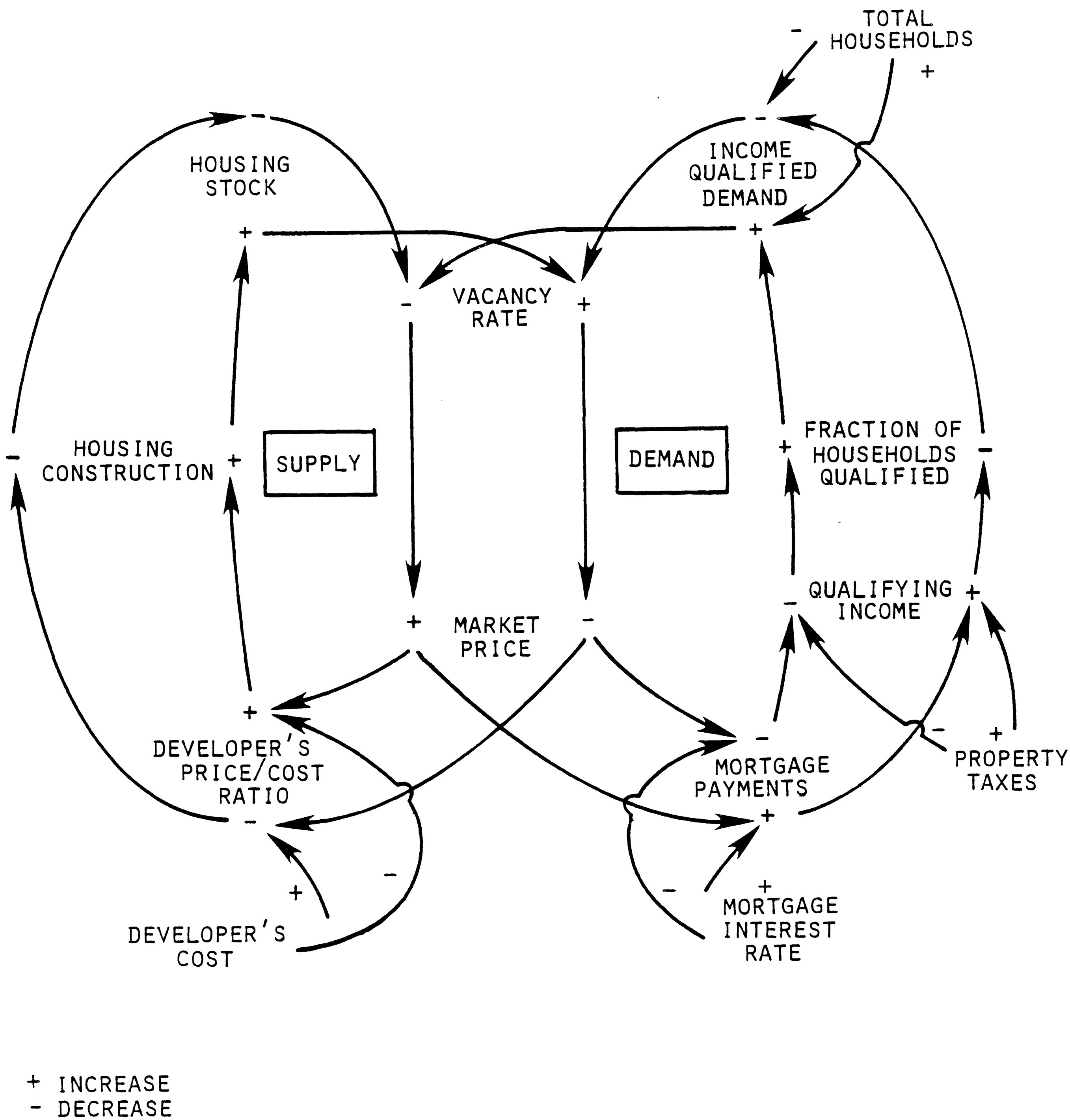
The model assumes that given sufficient income levels, long-term residents will choose to purchase permanent housing. The demand for permanent housing rentals and mobile home purchases is generated by households that cannot afford to purchase permanent housing. Each of these assumptions is described below.

Owner-Occupied Permanent Housing

Figure 5 illustrates our approach to simulating the balance between supply and demand for owner-occupied permanent housing. In modeling the market processes illustrated in Figure 5, we make

Figure 5

LONG-TERM SUPPLY AND DEMAND FOR PERMANENT HOUSING



SOURCE: Research and Planning Consultants, Inc.
(BASED ON RINK AND FORD, 1978)

a number of assumptions regarding developer and consumer behavior:

1. Income necessary to qualify for purchase of permanent housing depends on the market price of permanent housing, local lending policies, mortgage interest rates, and property tax rates. The market price for permanent housing rises or falls in response to variations in the vacancy rates.

2. Builders plan housing starts on the basis of a shortage, or expected shortage, of housing units relative to the number of long-term households.

3. The planned rate of housing starts will be reduced if construction costs approach or exceed the market price of finished housing units. The planned rate of starts will also be reduced if developers' or lenders' perception of risk associated with housing construction exceeds risk/reward ratios associated with alternative investments.

4. The rate of housing starts will be directly affected by lender willingness to extend development and construction loans.

5. Delays between housing initiation and completion include a delay for government approvals and a construction delay.

The four loops in the diagram show how housing supply and demand adjust to shifts in permanent housing vacancy rates and market prices. The supply loops react to housing shortages and decreasing vacancy rates when the market price of housing increases to a level where developers' expected profit margin is sufficiently large to stimulate housing construction. Increased construction in turn leads to increases in total housing stock and increases in vacancy rates. Increased vacancy rates deflate market prices, lowering the developer's expected profit margin. Reductions in the expected profit margin lead to reduced levels of housing construction and slower housing stock growth. This in turn leads to decreased vacancy rates, setting off another round of supply adjustments.

The demand loops in Figure 5 also respond to changes in vacancy rates and market prices. Low vacancy rates brought on by housing shortages lead to increased market prices for housing. This in turn results in increased mortgage payments and raises the income level necessary to qualify for permanent housing purchase. This decreases the fraction of households qualified for permanent housing and the total income-qualified demand for permanent housing, resulting in increased vacancy rates that depress market prices. Lower market prices force mortgage payments to drop, decreasing qualifying income levels and increasing the fraction of families qualified for permanent housing. As income-qualified demand increases, vacancy rates decline, leading to further price changes and demand adjustments. Thus, changes in market prices or vacancy rates set in motion a complex chain of events that works to balance permanent housing supply and demand.

The output of this portion of the housing market model is an annual estimate of the amount of owner-occupied permanent housing supplied to long-term residents of the local study area.

Renter-Occupied Permanent Housing

As stated above, we assume that if a household is unable to qualify for purchase of permanent housing but is able to qualify for purchase of a mobile home, the household either rents permanent housing or purchases a mobile home. The information on relative housing preferences in the local study area, obtained from the survey of permanent residents and construction worker preferences reported by the U.S. Army Corps of Engineers (1981) and others, is used to divide demand between permanent housing rental and mobile home purchase.

Since some lower income new households may be unable to qualify for purchase of either permanent housing or a mobile home, we assume that these households will rent permanent housing.

The final output of this portion of the housing market model is an annual estimate of the number of permanent housing rental units supplied within the local study area. To show the conservative case, the supply of renter-occupied permanent houses is assumed to be newly constructed. Supply of renter-occupied permanent housing is assumed to be no more or less constraining than owner-occupied, depending upon developer capacity and price/cost ratios.

Mobile Homes

We assume that demand for mobile homes is generated by households that cannot afford to purchase permanent housing and do not rent permanent housing. By this definition, long-term demand for mobile homes represents a shortage of permanent housing at a market price consistent with demand.

Demand for and supply of mobile homes and mobile home lots is balanced similarly to demand and supply for permanent housing. In the case of mobile homes, however, we assume that the sales price remains fixed and that supply can expand to meet all demand since they can be manufactured outside the local study area and transported in. The price and supply of mobile home lots are not fixed, and the supply of mobile home lots is not as flexible as the supply of mobile homes themselves. Figure 6 shows how the supply of mobile home lots and the demand for mobile homes and lots adjust to changes in the vacancy rate or market rent for mobile home lots.

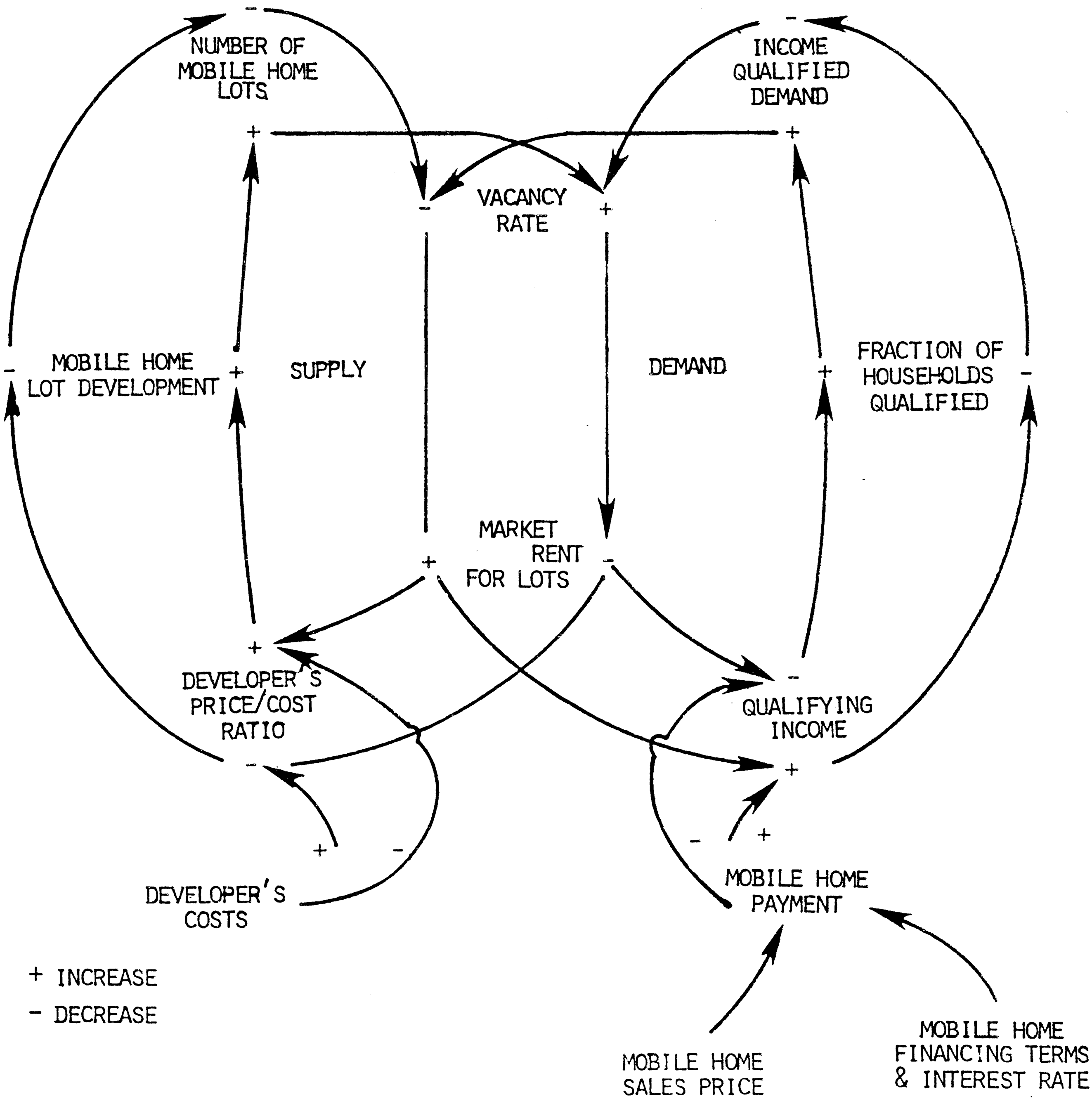
In modeling the relationships shown in Figure 6, we make a number of assumptions regarding consumer and developer behavior:

1. The income necessary to qualify for purchase of a mobile home depends on the sales price, the financing terms and interest rate, property tax payments, and the market rent for a mobile home lot.

2. Mobile home lot developers plan projects on the basis of a shortage, or expected shortage, of mobile home lots relative to the number of households without permanent housing.

Figure 6

LONG-TERM SUPPLY AND DEMAND FOR MOBILE HOMES AND MOBILE HOME LOTS



SOURCE: Research and Planning Consultants, Inc.
(BASED ON RINK AND FORD, 1978)

3. The planned rate of lot development will be reduced if lot development costs approach or exceed the value for which current market prices represent an acceptable rate of return. The planned rate of lot development will also be reduced if developers' or lenders' perception of risk associated with lot development exceeds risk/reward ratios associated with alternative investments.

4. Delay between initiation and completion of a project depends on regulatory policy and lot development time.

As vacancy rates for mobile home lots decrease due to increased mobile home use, the market price for those lots will rise. Rising market prices boost lot developers' expected profit margins, resulting in mobile home lot development. This development increases the number of mobile home lots and works to alleviate the orginal shortage of lots.

On the demand side, as in the supply loop, fewer mobile home lots mean a higher rental price. This increase in the market price for mobile home lots will increase the qualifying income for mobile homes. In turn, this increase in qualifying income will tend to decrease the fraction of households qualified to purchase mobile homes and rent mobile home lots and reduce income qualified demand. This reduced demand will tend to increase the vacancy rate for mobile home lots toward its original level.

Two types of mobile home lots exist in the local study area; fully serviced mobile home lots located in mobile home parks, and rural lots of two acres or more that have mobile homes placed on them. Development costs for fully serviced lots located in mobile home parks are greater than the costs associated with making a rural lot suitable for mobile home use. Accordingly, rents for lots located in mobile home parks are greater than rents for rural lots. Given this relative price difference, many of the new mobile homes may go into rural areas rather than into parks. To avoid scattered mobile home development in rural settings, local study area jurisdictions have the option to expand current regulations on rural mobile home development.

The final output of this portion of the housing market model is an annual estimate of the number of mobile lots supplied to long-term residents of the local study area.

ANALYSIS OF REAL ESTATE SPECULATION

The ability of housing suppliers to anticipate future demand for housing and their willingness to risk capital on their estimates of future demand is important to the smooth functioning of real estate markets. The housing market analysis looks at two types of speculation: land speculation and speculative housing construction. Land speculation influences the price of lots and thus the total cost of housing for a family. Speculative building patterns influence or determine the spatial distribution of the housing and the housing choices available to new households.

Speculative Value of Land

The housing market model also monitors the rate of conversion of land to residential use, and the market and speculative value of land. This portion of the model accounts for the effects of land prices on the price of housing and hence is a constraint on the rate of housing construction. It also provides some indication of the effect of the housing market on land use patterns and conversion rates. This preliminary indication is later refined for each jurisdiction in the land use portion of the spatial allocation model discussed below.

The housing market model makes use of the following assumptions concerning speculation:

1. The value of a lot ready for development as permanent housing is the basis for speculative valuation of land not yet ready for permanent development (e.g., no access to services, not zoned R, or not best location currently available).

2. The speculative value depends on the holding time until conversion.

3. The speculative value further involves discounting of the expected ultimate value according to the estimated holding time, with a discount rate based on the interest rate and return (if any) on interim use of land for other (e.g., agricultural) purposes.

The speculative value of undeveloped land is determined by applying a discount factor to describe the relationship between the price per acre of land currently being developed for residential use and the number of years before speculative land will be ready for conversion. This discount factor, as shown in Figure

7, is internally set in the model based on interest rates and the amount of land annually converted to residential use. The land value for permanent use considered in the model also includes commercial land absorption as a component of the rate of conversion to permanent use.

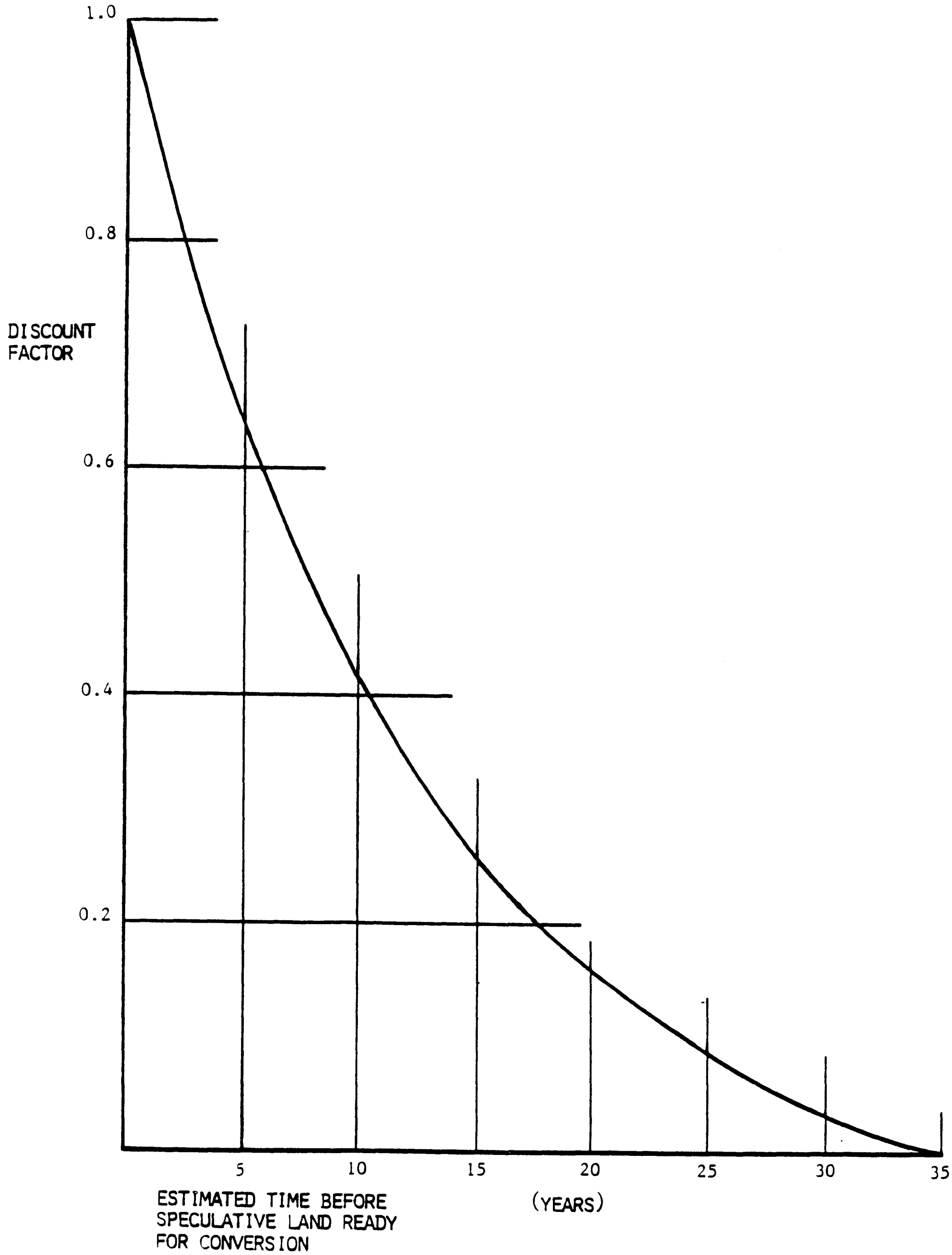
Speculative Building

Builders and developers supply housing and lots in two situations. In contract construction, a builder builds a unit because he has a contract with a specific individual to purchase the house. In speculative construction, the builder builds one or more houses without any commitment from a buyer, based upon his business judgment on the future demand for housing. At present, there is little speculative building in the local study area. The slow growth in demand for housing, high interest rates, and the level of capitalization of most builders in the local study area make it uneconomical for a builder to build more than one or two units without a signed contract from a qualified buyer. This situation may change if the proposed Crandon Project generates greater demand over a sustained period. To make proper assumptions about the behavior of housing suppliers if the project proceeds, we must reflect speculative construction in the housing market model.

There is little information in the housing and industrial impact literature to help us predict speculative development.

Figure 7

DISCOUNT FACTOR USED TO EVALUATE SPECULATIVE VALUE OF UNDEVELOPED LAND



SOURCE: Research and Planning Consultants, Inc.
(BASED ON RINK AND FORD, 1978)

Therefore, we base this analysis primarily on information gathered in surveys of builders, brokers, and developers. This information and RPC's previous experience in housing market analysis are used to adjust the model's behavioral assumptions. The most important assumptions are those concerning the new families considered in deciding how much housing to build. In the without-project future and with-project scenarios, we assume builders consider the addition of families in current and future years to have houses available to sell to new households.

The outputs of the housing market model are inputs to the spatial allocation model. The outputs are eventually used to forecast land use changes and to estimate changes in the tax base of each local study area jurisdiction for the fiscal model.

4. SPATIAL ALLOCATION MODEL

The spatial allocation model used in this study was developed by RPC from the Copper-Nickel Residential Distribution Model (Lea and Bauman, 1978). The model distributes new employment, population, and housing to the jurisdictions in the local study area. Figure 8 illustrates the spatial allocation model and its relationship to the other models in the analysis.

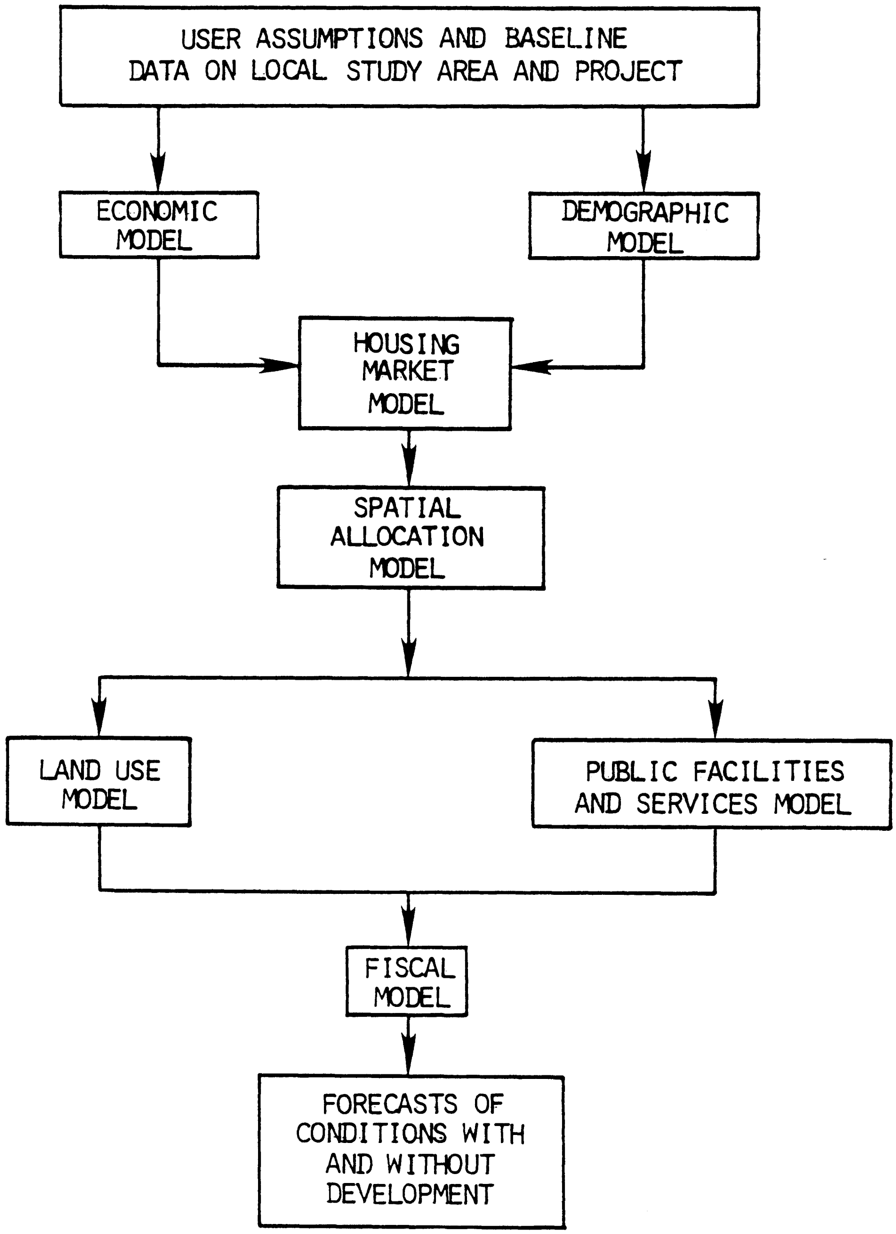
The spatial allocation model receives households for each year by type from the housing market model. It also receives employment by sector from the economic model. The results of the spatial allocation model are used as inputs to the public facilities and services model, land use model, and fiscal model.

UNDERLYING ALLOCATION THEORY

The spatial allocation model is a simplified picture of the real world--a world with a variety of phenomena, only a few of which can be quantified. Distinct but related factors influence the locational decisions of primary employers, retail and service establishments, and households. Within the limits of the available data we have attempted to simulate the various locational decisions distinctly and in the correct relationship

Figure 8

INTEGRATION OF MODELS



SOURCE: Research and Planning Consultants, Inc.

to each other. In doing so we have followed accepted principles of economic geography and regional development theory. (Isard, 1973; Lloyd, et al, 1977)

Similarly, in allocating new commercial activity we have used the location of new primary worker households and of existing commercial activity to simulate the real estate analysis retail and service firms normally follow (Urban Land Institute, 1978).

In the residential allocation procedures, we attempt to simulate the factors that enter into the residential location decisions most households make by selecting quantifiable variables such as the number of existing residential structures in a jurisdiction, the available land, travel time and costs, and the constraints on development (Isard, 1973).

Residential and commercial developers generally try to satisfy consumer preferences when siting new homes or commercial space. However, developers must also respond to the business policies of their lenders and investors. If lenders believe, rightly or wrongly, that houses built in a certain area will not sell, or will have too limited a market, developers and builders may not be able to secure financing. Developers will develop where lenders are willing to lend. We recognize these factors as constraints on consumer preferences in the spatial allocation model and deal with them in the same way we deal with government constraints on development.

The mathematical form used in the spatial allocation model reflects these factors. The equation distributes households to jurisdictions by balancing attractiveness against location relative to work places.

The location formula requires three major inputs:

1. Annual estimates of the amount of new employment, population, and housing added to the local study area, by type

2. An attractiveness indicator for each jurisdiction

3. A location indicator for each jurisdiction.

We derive separate spatial allocation equations for each type of household (construction, operation, etc.) and for commercial employment.

Annual Estimates for Local Study Area

The first major input to the spatial allocation model is the estimate of the amount of each type of new employment, population, and housing added to the local study area for each year of the forecast period. The estimates are the final outputs of the economic, demographic, and housing market models.

Attractiveness Indicators

The next requirement is an attractiveness indicator for each jurisdiction. To gauge the residential or commercial attractiveness of each jurisdiction in the local study area, we develop attractiveness indicators for each location incorporating a number of characteristics. After considering a number of possible variables we identified two local characteristics for incorporation into the attractiveness indicators:

1. Primary residential structures: The number of primary residential structures in a jurisdiction is an index both of population and of the degree of residential development. Primary residential structures are defined here as occupied housing units plus vacant units available for rent or sale. Use of this measure as an attractiveness indicator reflects the fact that many people prefer to settle in relatively close proximity to others. Areas of existing residential development with roads and other public facilities in place offer advantages to developers seeking to minimize costs. We do not include seasonal residences in this attractiveness factor because many of these housing units are not suitable for year-round occupancy and there are no data on which seasonal residences in each jurisdiction are suitable for permanent residences.

2. Commercial activity: We assume that individuals prefer to live in areas close to major concentrations of retail and service establishments. Three indicators of commercial activity for cities and counties in the local study area are available: total retail and service payroll, total retail and service employees, and total number of retail and service establishments. We use the total number of retail and service employees in a

jurisdiction as an indicator of its retail activity. The larger the total number of employees, the greater the selection of retail goods and services is likely to be. The economic analysis provides annual forecasts of retail employment for the local study area.

We use regression and other statistical techniques to determine how well each of these measures explains current residential location patterns. The indicators represent the relative attractiveness of a jurisdiction for a given year based on the standardized values of the variables in the previous year.

Certain factors are likely to have greater effects on location decisions than others. For example, existing residential structures may be more important in attracting new residents than retail activity. To reflect these differences, we weight each variable to reflect its relative importance in attracting new residents. The weights assigned the characteristics used in each equation are derived by regression analysis of the residential locations of respondents to the permanent residents survey.

The following equation shows how the components of the attractiveness indicator for a jurisdiction for a given location decision are weighted.

$$A_i = B_1H_i + B_2R_i$$

Where: A_i = Attractiveness indicator of jurisdiction i

B_1 = Weighting for residential structures

H_i = Number of residential structures for jurisdiction i

B_2 = Weighting for retail trade

R_i = Number of retail and services workers for jurisdiction i

After we determine the overall attractiveness indicator for each jurisdiction in the local study area, we determine the coefficient the indicator receives in the gravity equation, which will be defined later. This is accomplished using regression techniques to obtain a coefficient which best reflects current location patterns. The regression technique is used to determine how the indicators function in determining location attractiveness. Through a series of mathematical tests, a coefficient is determined which describes the "weight" to apply to the indicator in describing existing population distribution patterns. The coefficient is then applied to future distributions. The value of the indicator for each jurisdiction changes in each year of the forecast period. The coefficient remains the same.

As a final step, the attractiveness indicator for each jurisdiction is reviewed and subjectively compared to other indicators. In the final analysis, some indicators are adjusted based on certain qualitative variables such as dominance of retail centers, school and housing quality, and others.

Location Indicator

The spatial allocation model balances the attractiveness of a jurisdiction against its location. Because of the varying quality of the roads in the local study area and the effect of seasonal driving conditions on different roads, we believe that driving time between points is a more realistic measure of accessibility than road distances. To obtain data on driving times, RPC and Exxon Minerals staff established road segments and either drove each segment to measure driving times or estimated driving times based on distance and road types. The results of this exercise were reported in the Definition of the Local Study Area (Exxon, 1980).

Driving times have been established from each jurisdiction to the project site using existing roads. The access road to the project site which will be constructed by Exxon Minerals is incorporated into the travel time estimates for the with-project scenarios.

In the gravity formula, the travel time indicator is raised to the power of a travel time coefficient. As with the attractiveness indicator, we determine this coefficient through regression techniques.

ALLOCATION PROCEDURE

The spatial allocation model distributes employment, population, business activity, and housing to jurisdictions in the local study area through use of the procedures shown in Figure 9. The general procedure for spatial allocation is as follows:

1. Allocate new nonproject basic workers by sector to employment locations following existing distribution of employment by sector.

2. Allocate the new project construction and/or operation households to local jurisdictions.

3. Compare the "unconstrained" allocation to local constraints on residential development.

4. If there is conflict between allocation and local constraints, reallocate households until all have been allocated with no conflict with local constraints on development.

5. Update the index of local characteristics. Repeat steps 2 through 4 for new nonproject basic sector households.

6. Update the index of local characteristics. Allocate new retail and service workers to employment sites on the basis of the location of other new households and previous commercial activity.

7. Repeat steps 2 through 4 for new retail and service worker households.

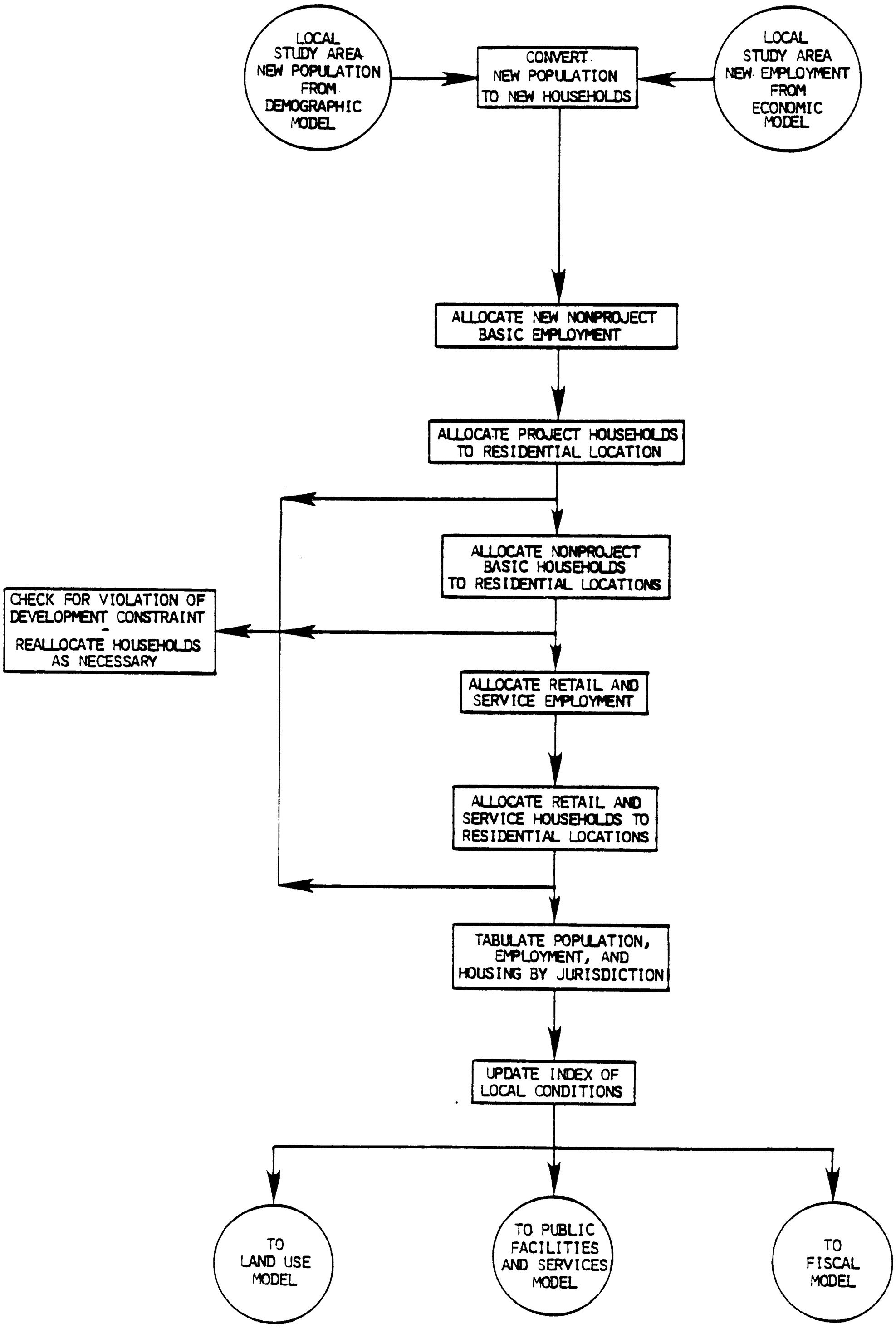
8. Sum the previous allocations to produce a forecast for total new housing for each jurisdiction in the local study area.

9. Use the household characteristics previously developed to convert households by type to population by age, sex, and type for each jurisdiction.

10. Update the index of local characteristics.

Figure 9

SPATIAL ALLOCATION MODEL FOR NEW POPULATION



SOURCE: Research and Planning Consultants, Inc.

While each of the household and employment allocation procedures uses a gravity formula, the attractiveness and location indicators for each are slightly different. In the reallocation procedure for locations with population constraints (step 4), the relative attractiveness of surrounding townships is used to distribute "overflow" population.

Construction and operation labor forces have different location preferences, so we make separate estimates for each group of workers. Generally, local construction and operations workers commute farther to work than nonlocal construction workers because they have a permanent residence (Leholm, et al., 1976; Wieland, et al., 1977). Accordingly, the attractiveness indicator we use in distributing inmigrating construction worker households that will occupy short-term, rental housing is based on the number of vacant permanent housing units available for rent or sale, mobile homes, hotel/motel/resort units, and second homes located in a jurisdiction. We adjust the distance indicator weight accordingly to reflect the relative importance of travel time to these workers.

Inmigrating construction workers with families present, who are categorized as long-term residents (see previous discussion of construction-phase housing market), and local hires who form new households are distributed using the same procedures employed to distribute operation workers. This reflects the nature of these workers as long-term local study area residents.

The attractiveness indicators used for nonproject basic sector employee households are identical to those used for operation employees. The location indicator, similar to that used for operation employees, differs in that the work place component is not the project site but existing employment locations in the local study area.

We determine the number of workers for each of these existing employment locations using a two-step process:

1. Separate nonproject, basic employment increase by sector using information from the economic analysis

2. Allocate nonproject, basic employment workers for each sector to existing work sites within the local study area according to existing local study area employment patterns.

In the allocation of new retail and service employment to jurisdictions, we assume that new commercial activity is attracted to existing commercial areas and areas of increasing population. The indicator used to measure a jurisdiction's commercial attractiveness is the total number of retail and services employees in the jurisdiction.

The location indicator for new retail and service trade employment allocation is the travel time to the existing commercial areas from the household distribution of new project and nonproject basic employees. We assume that these households will demand a number of retail goods and services, influencing retail and service workers to obtain employment according to the retail attractiveness of each jurisdiction to previously allocated households.

Next we allocate the households of new retail and service workers to residential locations. The attractiveness and travel time indicators are the same as those used for operation employees except that travel time is measured from the employment site as determined by the model, not the project site.

The formula used in the gravity model distribution is:

$$Ha_{ij} = Ha_j \times \left(\frac{A_i^{\alpha}/D_{ij}^{\beta}}{\Sigma(A_i^{\alpha}/D_{ij}^{\beta})} \right)$$

Where:

Ha_{ij} = New households of employment type "a" living in jurisdiction i and working at employment location j

Ha_j = Total number of new households of employment type "a" with primary worker working at employment location j

A_i = Attractiveness indicator of jurisdiction i

D_{ij} = Travel time from jurisdiction i to employment location j

α = Attractiveness coefficient

β = Distance coefficient

Σ = Summation

The number of new households by employment type (direct project related, basic employment related, and retail/services related households) comes directly from the previously described procedure for converting population to households.

Attractiveness and distance indicators used are those that have been outlined above.

The body of the formula, that portion enclosed in parentheses, determines the proportion of households working at employment location j who will reside in jurisdiction i. The numerator of this fraction represents the distance-weighted attractiveness of jurisdiction i relative to work place j. The denominator of this fraction represents the total distance-weighted attractiveness of all jurisdictions relative to work place j. Dividing the numerator by the denominator produces an estimate of the distance-weighted attractiveness of jurisdiction i relative to all other jurisdictions. This division produces a fraction that is interpreted as the proportion of households working at employment location j that will reside in jurisdiction i. This fraction, multiplied by the total number of new households of a certain employment type working at location j, gives an estimate of the absolute number of households working at j that will live in i. Carrying out this operation for all employment locations, all new households are distributed from work sites to home sites. For each jurisdiction, the sum of the number of new households locating from each work site yields the total number of new households locating in the jurisdiction.

Allocation of Population Change in Existing Households

Not all population changes result in the formation or dissolution of households. Change in population age 14 and under will not affect the number of local study area households, but will change the average size of existing local study area households. Population growth occurring in years when household formation is constrained because of economic conditions will lead to increases in the average size of existing households, but not in the number of households. As economic conditions improve, persons who earlier postponed establishing independent households will form new households. Formation of these new households will decrease the average household size of existing households. Change in population in existing households is distributed between jurisdictions on the basis of each jurisdiction's proportional share of total local study area population.

Development Constraints

There are two general sets of development constraints which may be present in any jurisdiction. One set consists of development constraints which may be imposed by local officials through zoning, building, or subdivision ordinances. The second set of constraints is less formal. It consists of the constraints on speculative homebuilding and some contract homebuilding which may occur due to the business policies of builders, developers, and lender institutions.

At each step in the household allocation process, we consider the constraints on development specified by each jurisdiction in the local study area. Constraints on residential development that we consider include land availability, mobile home restrictions, and growth controls. If comparing the allocation with the constraints shows that the unconstrained allocation has violated a development constraint (e.g., the amount of available land or restrictions against mobile homes), the model reallocates the constrained housing type. Housing that exceeds local development constraints is distributed to other cities and counties through a second run of the model. This process continues until all housing has been allocated consistent with local constraints on development.

The constrained spatial allocation forecasts are tabulated and processed for each jurisdiction to obtain the total new population, employment, business activity, and housing for each jurisdiction. The completed allocation is recorded and used to update the index of local conditions for forecasts in later years.

Index of Local Characteristics

The data used to calculate each jurisdiction's attractiveness in each year of the forecast are taken from an index of local conditions maintained as part of the spatial allocation model. In each year of the forecast the characteristics of each jurisdiction are updated using the outputs of the housing, spatial distribution, and land use models to reflect changing relationships between jurisdictions. This feature makes the model dynamic as it responds over time to its own forecasts of certain variables.

Jurisdictions can become more or less attractive over time relative to other jurisdictions. Constraints on development which are not binding in early years of the forecast may become so in later years. For example, the land in a jurisdiction available for residential development may be used up at some point in the future, forcing further population attracted to that jurisdiction to be reallocated to others.

The information produced by the spatial allocation model is used as input to the public facilities and services, land use, and fiscal models to determine the effects of the newly allocated population, housing, and employment on each jurisdiction.

5. LAND USE MODEL

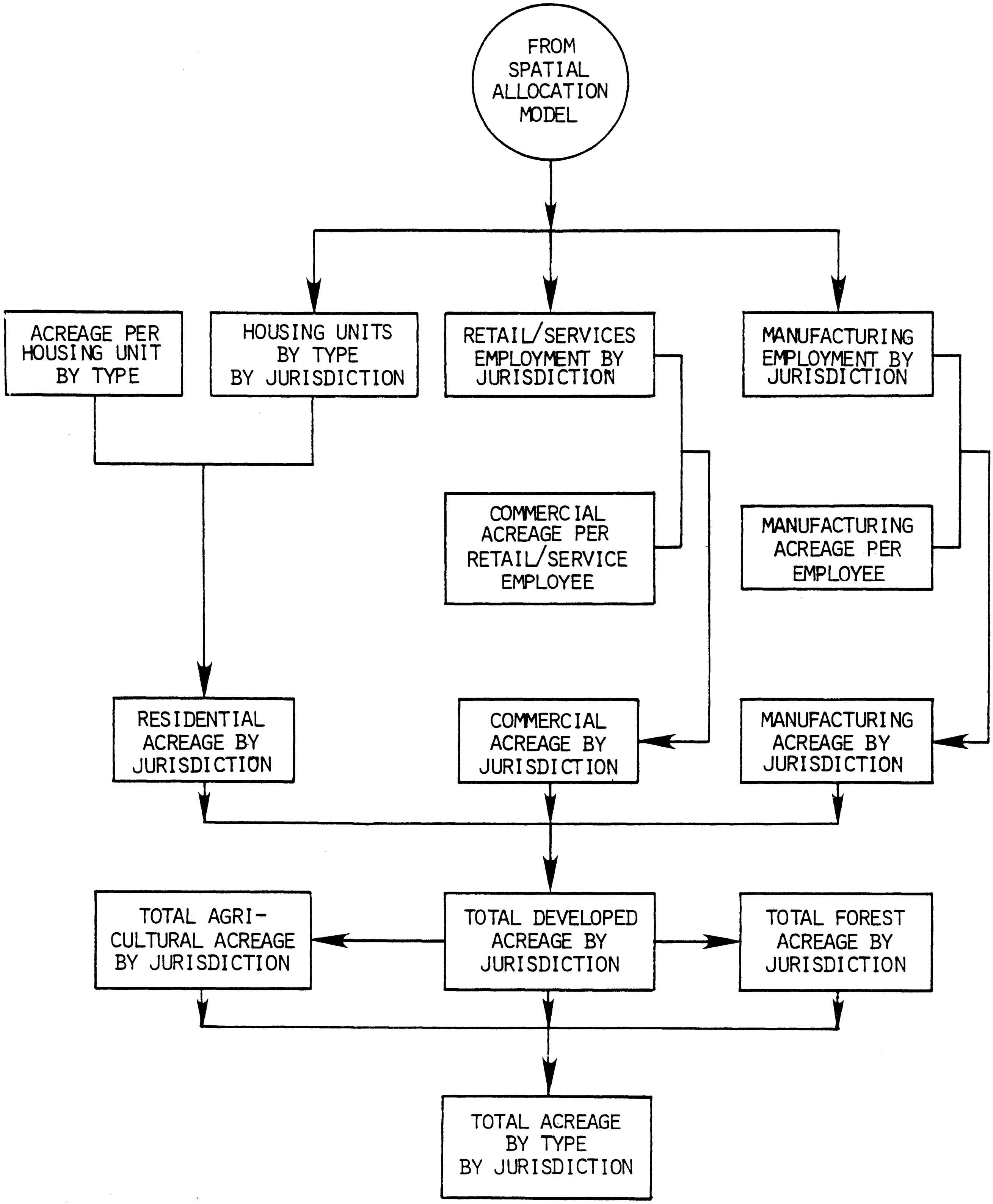
Economic development of the local study area, with or without the proposed Crandon Project, will cause some forest and agricultural land to be converted to residential, commercial, and industrial use. These changing land use patterns in each jurisdiction affect the jurisdiction's property tax base, its agricultural and forestry output, and the undeveloped land available for further development in future years.

To track these changes throughout the forecast period and to allow land use changes to be consistently reflected in other parts of the socioeconomic assessment, we have developed a land use model. The processing steps in the model and its relationship to other portions of the assessment are shown in Figure 10.

The two principal functions of the model are to convert growth into land use changes, and to reflect land use changes as changes to the property tax base of each jurisdiction. This is accomplished using indicators of economic, demographic, and housing changes from other models together with a series of land requirements and land value factors derived from local data where possible and from other sources where necessary.

Figure 10

LAND USE MODEL



SOURCE: Research and Planning Consultants, Inc.

The land use analysis included in the socioeconomic assessment is not limited to a presentation of the outputs of the computer-based model. These outputs allow us to identify any high-growth areas and to perform additional analysis of the effects of land use conversions on prime agricultural and commercial forest lands.

FORECAST LAND USE CHANGES

In all scenarios, with and without the proposed project, increases in population, housing, and economic activity will cause agricultural and forest land to be converted into residential, commercial, and industrial land. All five categories of land are tracked in each local study area jurisdiction for each year of the forecast. Different factors are considered in forecasting each type of conversion.

Information on current acreage and valuation by land use type for local study area jurisdictions was obtained (Wisconsin Department of Revenue, 1979). In cases where acreage information was not reported, the data were obtained from local assessors from the jurisdictions in question. For several jurisdictions local assessors were unable to provide acreage information. In these instances, acreages were estimated based upon valuation information and average per acre values for land in different use categories.

Conversion to Residential Use

The housing market model forecasts annual additions to the local study area housing stock by type. The new stock is distributed to the various towns and incorporated areas by the spatial allocation model. All housing types are distributed to towns and incorporated areas in proportion to number of households. We develop different estimates of the acreage conversions per housing unit for permanent and mobile homes in towns and in incorporated areas. These factors, shown in Table 2, are derived from analysis of current residential development patterns in the local study area and from interviews with developers, brokers, and builders.

Conversion to Commercial Use

Additional land is converted to commercial use to accommodate additional commercial activity. This activity is usually reflected by higher retail sales and service receipts. Besides increased space, increased commercial activity requires additional commercial employees. The economic model forecasts changes in commercial employment and the spatial allocation model distributes this employment to local study area jurisdictions. We use changes in retail and services employment in each jurisdiction as the indicator of the need to convert additional land to commercial use.

Table 2

ACREAGE MULTIPLIERS USED IN LAND USE MODEL

Acreage per Residential Unit

	Permanent Housing	Mobile Homes
Unincorporated areas	2.00	2.000
City of Crandon	0.25	0.125
City of Antigo	0.25	0.125
City of Rhinelander	0.25	0.125

Acreage per retail/service employee = 0.20

Acreage per manufacturing employee = 0.20

New public land = 10 percent of new developed land (residential, retail, and manufacturing)

SOURCE

Research and Planning Consultants, Inc.
Urban Land Institute, 1978, 1977, 1968.

There is a well-developed literature on the normal space requirements necessary to support given levels of various commercial activities (Urban Land Institute, 1977). Data are available on current relationships between commercial land use and commercial activity in the local study area. We have analyzed both national and local sources to derive the land conversion factors shown in Table 2.

Conversion to Industrial Use

The conversion of land for industrial use is calculated in the same fashion as for commercial use. The determining variable is the change in employment by sector allocated to each jurisdiction. The conversion factor shown in Table 2 is derived from a combination of national and local data on industrial land use patterns. Industrial land requirements for each local study area jurisdiction are forecast using this approach. For certain jurisdictions with existing unused industrial space, additional analysis may be required. If substantial increases in industrial land are forecast for such jurisdictions, special analyses of these jurisdictions' industrial space will be conducted.

The conversion factor is not used to calculate direct land conversion for the proposed project. Data obtained from Exxon Minerals are used to determine acreage for the proposed project.

Conversion to Public Use

Conversion of land to residential, commercial, and industrial uses requires conversion of additional land for public uses such as streets and parks. New public use acreage requirements are estimated on the basis of new residential, commercial, and industrial acreage converted from undeveloped use. We derive public facility land use estimates from observation of local land use patterns and from guidelines used by developers nationally (Urban Land Institute, 1968).

Conversion from Undeveloped Use

For purposes of analysis, all jurisdictions are assumed to maintain their current land area throughout the forecast period. This excludes the possibility that one of the incorporated areas will annex land from a town or that a new incorporated area will form. We also assume that land converted to residential, commercial, or industrial use remains in that use.

Given these assumptions, all land development requires a reduction in undeveloped land--in either forest or agricultural land. The initial amount of undeveloped land in each jurisdiction is obtained by adding together the amount of private forest and agricultural land located in the jurisdiction during the forecast period's base year. This information comes from local statistics compiled by the Wisconsin Department of Revenue

(1979). Note that public lands are exluded in these calculations of undeveloped land. As acreage is converted to developed use, it is subtracted from the pool of undeveloped land.

In defining land available for development for use in the spatial allocation analysis, public lands, commercial forests, and prime agricultural land are not considered as land available for development. This constraint eliminates the possibility of converting these lands to other uses.

The output of this portion of the land use model is an annual forecast of land use, in acres, by jurisdiction. These data are used to update the index of local characteristics and as input data to the next portion of the model.

CONVERT LAND USE CHANGES TO PROPERTY TAX ASSESSMENTS

Changes in land use patterns will alter a jurisdiction's total property tax base. The value of land converted annually to residential use is determined by the number of housing units constructed and the average valuation for housing units during the year in question. Average valuation is determined by taking a weighted average of the value of new housing units supplied each year. It is assumed that new units of each housing type will be evenly spread across the study area. Changes to commercial and industrial valuation are determined by multiplying the acreage converted by the jurisdiction's average per acre value for commercial and industrial property. This same approach is used to calculate changes in forest and agricultural value. As land is taken out of each of these uses, forest and agricultural valuations are reduced on the basis of the amount of land converted and the average value per acre for the jurisdiction being analyzed.

The output from this part of the model is a forecast of the equalized valuation by land type for each jurisdiction for each year. These data are used in the fiscal model to forecast property tax rates and revenue for each jurisdiction.

SPECIAL ANALYSIS OF HIGH GROWTH AREAS

The local study area contains valuable commercial forest land and some parcels of prime agricultural land. If jurisdictions where either type of land is located undergo substantial land development, there may be pressure to convert prime agricultural and forest land to other uses. Development patterns in these jurisdictions deserve more analysis of land use trends than can be provided by the computer model.

Along with all public lands, the spatial allocation model considers prime agricultural land and private commercial forest land as unavailable for development. This constraint is based on the assumption that the land's greatest social value is as forest or agricultural land. However, in reality the highest monetary value for the present owners may be realized from development of the land for other uses. If these market pressures are sufficient, they could require adjustment in the development constraints on certain jurisdictions to produce a more realistic forecast.

After the initial runs of the spatial allocation and land use models, we examine development patterns and pressures in each jurisdiction where large percentages of the land available for development have been converted and where commercial forest or prime agricultural land is present. If it appears useful to do so, we vary the land availability constraints to assess how much prime agricultural and forest land may be converted to urban uses. Information generated by this additional analysis will be used in the special studies of agriculture and forestry which are part of the economic analysis (RPC, 1981).

LIST OF REFERENCES

Forrester, J., 1968. Urban Dynamics. Cambridge: MIT Press.

Frieden, Bernard J., and Soloman, Arthur P., 1977. The Nation's Housing Needs 1975-1985. Cambridge: Harvard-MIT Center for Urban Studies.

Isard, Walter, 1973. Methods of Regional Analysis: An Introduction to Regional Science. Cambridge, Mass.: MIT Press.

Lea, A. C., and Bauman, E. H., 1978. Use of Gravity Models for Residential Settlement Projections, Regional Copper-Nickel Study. Prepared for the Minnesota Environmental Board. Twin Cities, Minnesota.

Leholm, A. G., Leistritz, F. L., and Wieland, J. S., 1976. Profile of Electric Power Plant Construction Work Force. Fargo, North Dakota: Department of Agricultural Economics, North Dakota State University.

Lloyd, Peter E., and Dicken, Peter, 1977. Location in Space: A Theoretical Approach to Economic Geography. Second Edition. New York: Harper and Row Publishers, Inc.

North Central Regional Planning Commission. Dates Vary. Existing land use maps by township and city. Wausau, Wisconsin.

Research and Planning Consultants, Inc., 1980. Definition of the Local Study Area, Socioeconomic Assessment, Exxon Crandon Project. Austin, Texas.

________, 1981a. Demographic Analysis Methodology, Socioeconomic Assessment, Exxon Crandon Project. Rhinelander, Wisconsin.

________, 1981b. Economic Analysis Methodology, Socioeconomic Assessment, Exxon Crandon Project. (Draft) Prepared for Exxon Minerals Company. Austin, Texas.

________, 1981c. Report on Current Conditions, Socioeconomic Assessment, Exxon Crandon Project. Austin, Texas.

Rink, R., and Ford, A., 1978. A Simulation Model for Boom Town Housing. Los Alamos, New Mexico: Los Alamos Scientific Laboratory.

Urban Land Institute, 1978. Shopping Center Development Handbook. Washington, D. C.

________, 1977. Industrial Development Handbook. Washington, D. C.

________, 1968. Community Developers Handbook. Washington, D. C.

U. S. Army Corps of Engineers, Institute of Water Resources, 1981. Report of Survey of Corps of Engineers Construction Workforce. by C. Mark Dunning, Research Report 81-R05. Ft. Belvoire, Virginia.

U. S. Geological Survey. (Various dates.) Land use maps. Washington, D. C.

Wieland, James, Leistritz, F. L., and Murdock, Steven, 1977. Characteristics and Settlement Patterns of Energy Related Operating Workers in the Northern Great Plains. Fargo, North Dakota: Department of Agricultural Economics, North Dakota State University.

Williams, Robert C., Jr., 1978. "Household Headship in the U. S." (Ph.D. Thesis). Cambridge: Harvard University.

Wisconsin Department of Revenue. Bureau of Property and Utility Taxation, 1979. Statistical Report of Property Values.