Statewide Transportation Analysis & Research

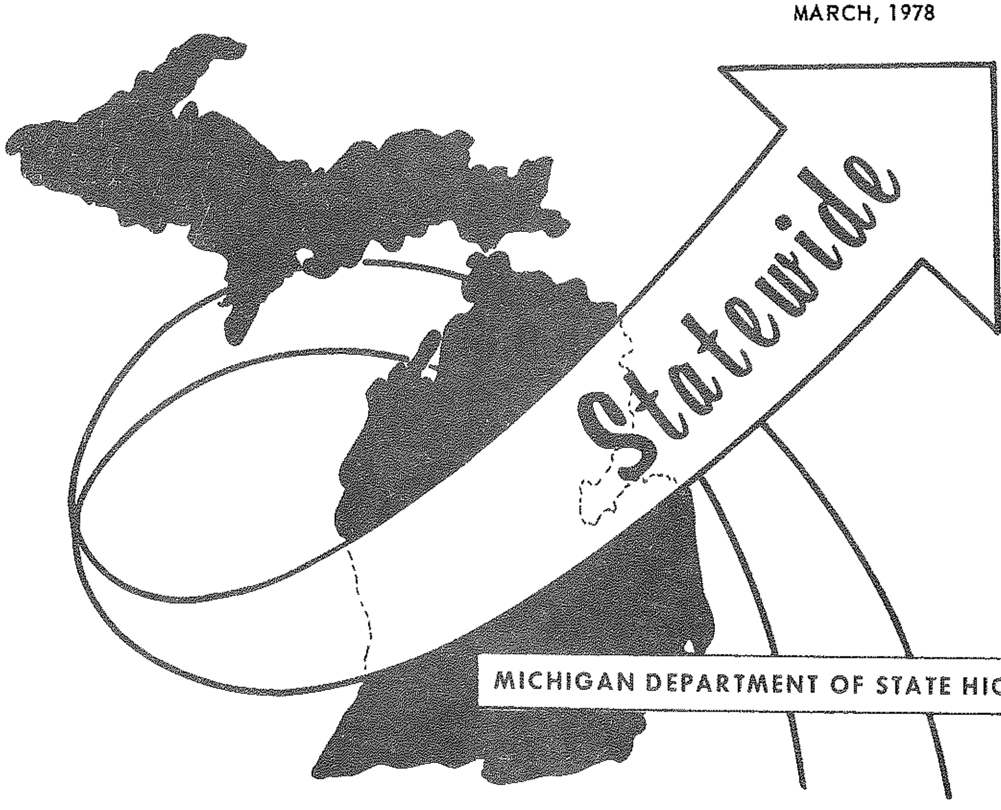
MICHIGAN STATEWIDE
TRANSPORTATION MODELING SYSTEM

VOLUME XIII-D

**IMPACT OF POPULATION AND ENERGY
ON TRANSPORTATION NEEDS
A MULTI MODAL APPROACH**

STATEWIDE PROCEDURES SECTION

MARCH, 1978



MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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BUREAU OF TRANSPORTATION PLANNING

MICHIGAN STATEWIDE
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STATEWIDE PROCEDURES SECTION

MARCH, 1978

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

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JOHN P. WOODFORD, DIRECTOR

March 7, 1978

Mr. Sam F. Cryderman
Michigan Department of State
Highways and Transportation
Bureau of Transportation Planning
P.O. Box 30050
Lansing, Michigan 48904

Dear Mr. Cryderman:

Recent emphasis upon changing population growths, mass transit, and the uncertain energy future has generated new problems for transportation planning. The impact of these factors and their interrelationships must now be addressed in any effective transportation plan.

For most states and regions this task is nearly impossible without drastic amounts of manpower and money. This report describes a process which has been developed to explore the potential diversion of auto trips by purpose for various population growth and energy futures and the impact that the diversion would have upon transportation needs and deficiencies. The basic variables used in this process may be easily understood by administrators, planners, and citizens alike, and thus may be quickly adjusted to reevaluate transportation needs, reflecting any desired planning policy.

Once the variables are defined, however, the process is extremely complex, determining transportation needs based upon population estimates, energy availability, accessibility to mass transit, trip length and purpose, and route travel characteristics. The actual application of this process confirms the fact that the transportation profession may not assume that all roads in all areas will be equally affected by population growth or restricted energy policies. The actual travel characteristics on a route determine how a specific policy will affect final system needs. Transportation needs in some corridors will remain constant for any assumed future conditions, while others will change drastically. Furthermore, this multi-modal process is compatible with all of the previously developed statewide modeling systems.

This report was written by Joyce Newell of the Statewide Procedures Section, under the supervision of Richard E. Esch.

Sincerely,

William M. Lepczyk
Assistant Administrator

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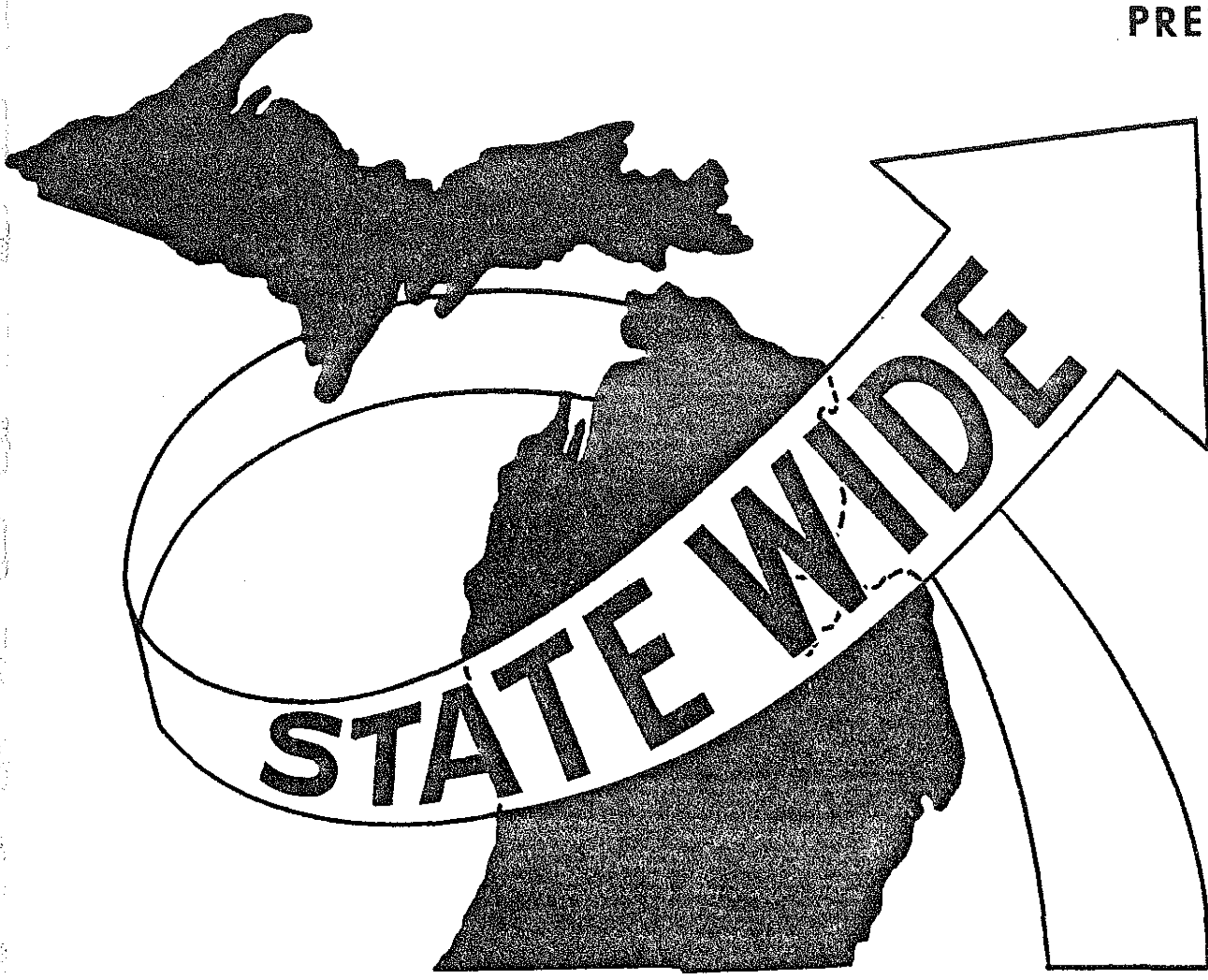
A MULTI MODAL APPROACH

By Joyce Newell

PREFACE



PREFACE

Transportation agencies are constantly being confronted with new challenges and changing demands. Transportation needs and deficiencies must be defined and analyzed carefully to assure that the most critical problems are dealt with quickly and efficiently. However, because of many changing conditions, it often becomes difficult to correctly define future deficiencies. Today's growing and shifting populations, an uncertain energy future, and an increasing emphasis upon travel by modes other then auto add new dimensions of complicity to the task of transportation planning. Moreover, each of these factors not only affect transportation needs, they also affect each other.

These interrelationships between transit availability, population changes, and energy costs help create a massive analysis problem for transportation planners. Methods must be developed which can quickly explore all probable futures and their relationship to transportation and future transportation needs. Any process developed should be designed to operate at a regional or statewide level, since population, energy, and transit changes in any one location may have significant impacts upon travel in many other areas of the state. Because of this and because of the many variables which must be considered, the procedures used cannot realistically be implemented without the extensive use of computer technology. This report describes a computer oriented, multi-modal process which has been developed to help measure the interrelated regional or statewide impacts of energy, population, and an increasing emphasis upon mass transit. The process uses many tools which have been previously developed for the Statewide Transportation Modeling System. This has the primary advantage of gaining multiple benefits from previous system development and has also allowed Michigan's Bureau of Transportation Planning to effectively meet a new challenge in a much shorter time frame.

The major objective of this process is to explore the potential diversion of various auto trip purposes for various futures and the impact those diversions would have upon transportation needs and deficiencies. While the process is extremely complex and technical, the variables most often discussed by administrators, planners, or citizens have been simply defined and thus may be easily changed as policy issues shift to reevaluate future highway needs and potential transit corridors. Finally, the application of this process will reconfirm the fact that state transportation planners cannot assume that population and energy changes will have a uniform effect upon all highways or mass transit corridors. The needs may not change at all or may change drastically depending upon route characteristics. The following page lists the reports which describe previous modeling system developments.

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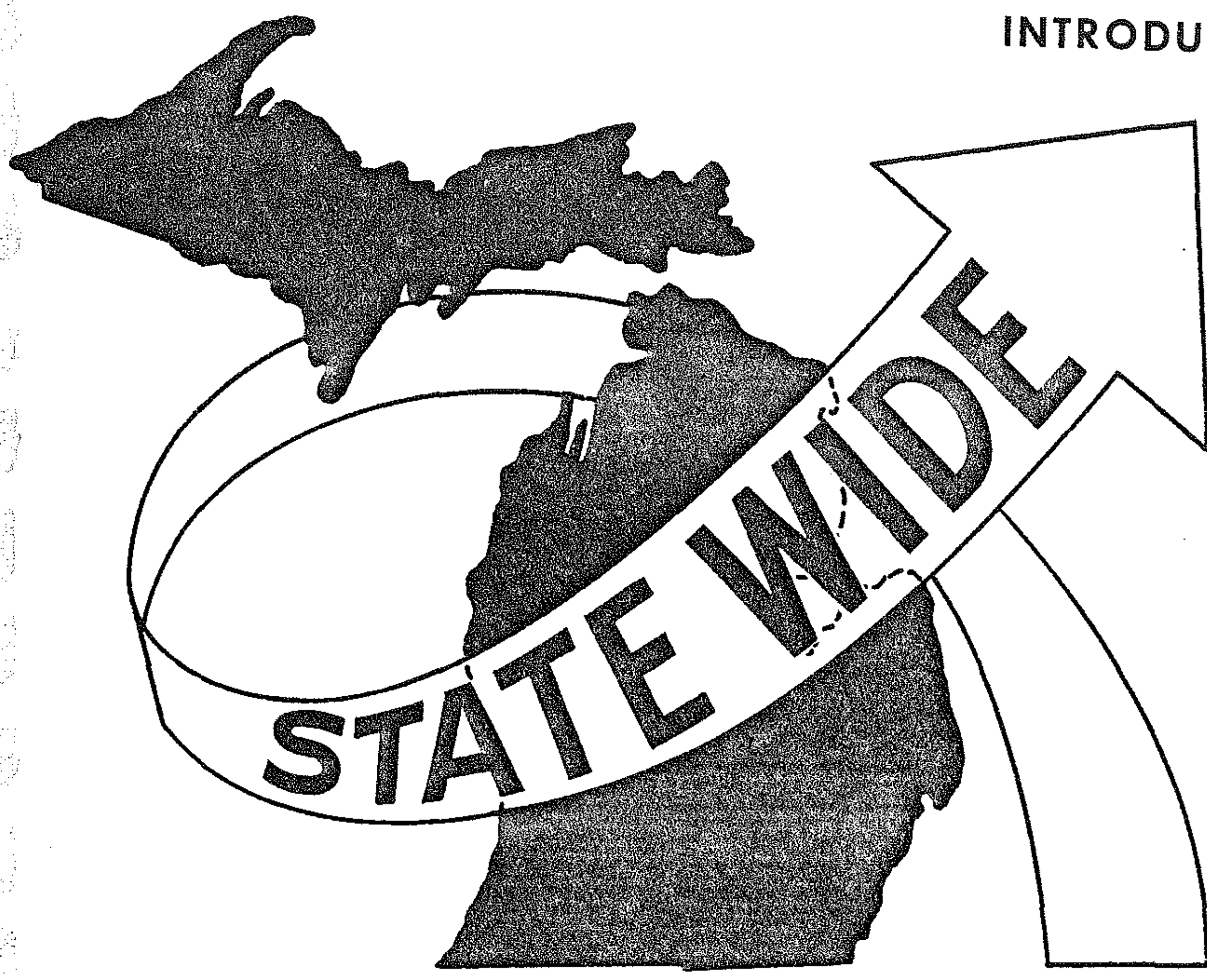
INTRODUCTION



INTRODUCTION

Highway construction programming is a very significant operation of any transportation agency. Determining which construction projects are necessary and establishing priorities requires a great deal of thorough analysis of all possible alternatives particularly in this day and age when funds are not as easily available. Since transportation planners must be constantly planning for future needs, they must be able to accurately predict future travel patterns and the impacts of planned construction and social and economic changes. Critical deficiencies must be identified and assigned high priorities, then other less critical deficiencies may be addressed. The process of identifying deficiencies and their severity is greatly complicated by the Federal requirements that other modes must be considered and that all social and economic impacts must be carefully analyzed.

Recent Federal legislation, increased public involvement, and changing social and economic problems have all contributed to create many new issues which must be confronted by any successful, competent transportation agency. The Federal-Aid Highway Program Manual, Transmittal 107, December 30, 1975, restates the familiar requisition: "It is the FHWA's policy that:. . . appropriate consideration be given to reasonable alternatives, including the alternative of not building the project and alternative modes." It continues stating that an action plan should identify procedures to be followed to ensure that ". . . alternatives containing new transportation modes or improvements to existing modes are adequately considered, where appropriate."

Until recently, alternative modes of transportation have had seemingly little impact upon highway travel. Many people now feel this will soon change. The present emphasis upon energy conservation, together with increased energy and transportation costs may affect travel in many significant ways. People may begin to travel less frequently, make better use of transportation by utilizing mass transit systems or car pooling, reduce required travel by relocating closer to their place of work or shopping, or begin combining and reducing trips. In the past, many transportation modes have also suffered because of "population dispersion". It is practically impossible for any mass transportation system to operate efficiently in any area where demand is widely scattered. Therefore, a transportation planner must be able to estimate population growth rates and major areas of growth when predicting future transportation needs. Thus it has become imperative for transportation agencies to consider the effects of at least three major influences upon travel characteristics: 1) energy availability and cost, 2) alternative modes and an increasing emphasis upon them, and 3) a growing, shifting population with ever changing travel demands.

The problem of defining future transportation needs and identifying possible deficiencies is further complicated by considering the interaction between energy costs, population shifts and growth, and the availability and efficiency of alternative modes. Until recently, it has been practically impossible to effectively address all of these issues and their interaction. Now, by combining information and tools from the three major sources about to be described, a process has been developed which can measure these impacts and hence aid in a number of different planning activities as depicted in Figure 1.

The process described in this report depends heavily upon three previously developed components of Michigan's Statewide Transportation Modeling System as shown in

FIGURE 1

TYPICAL PLANNING ACTIVITY RELATIONSHIPS

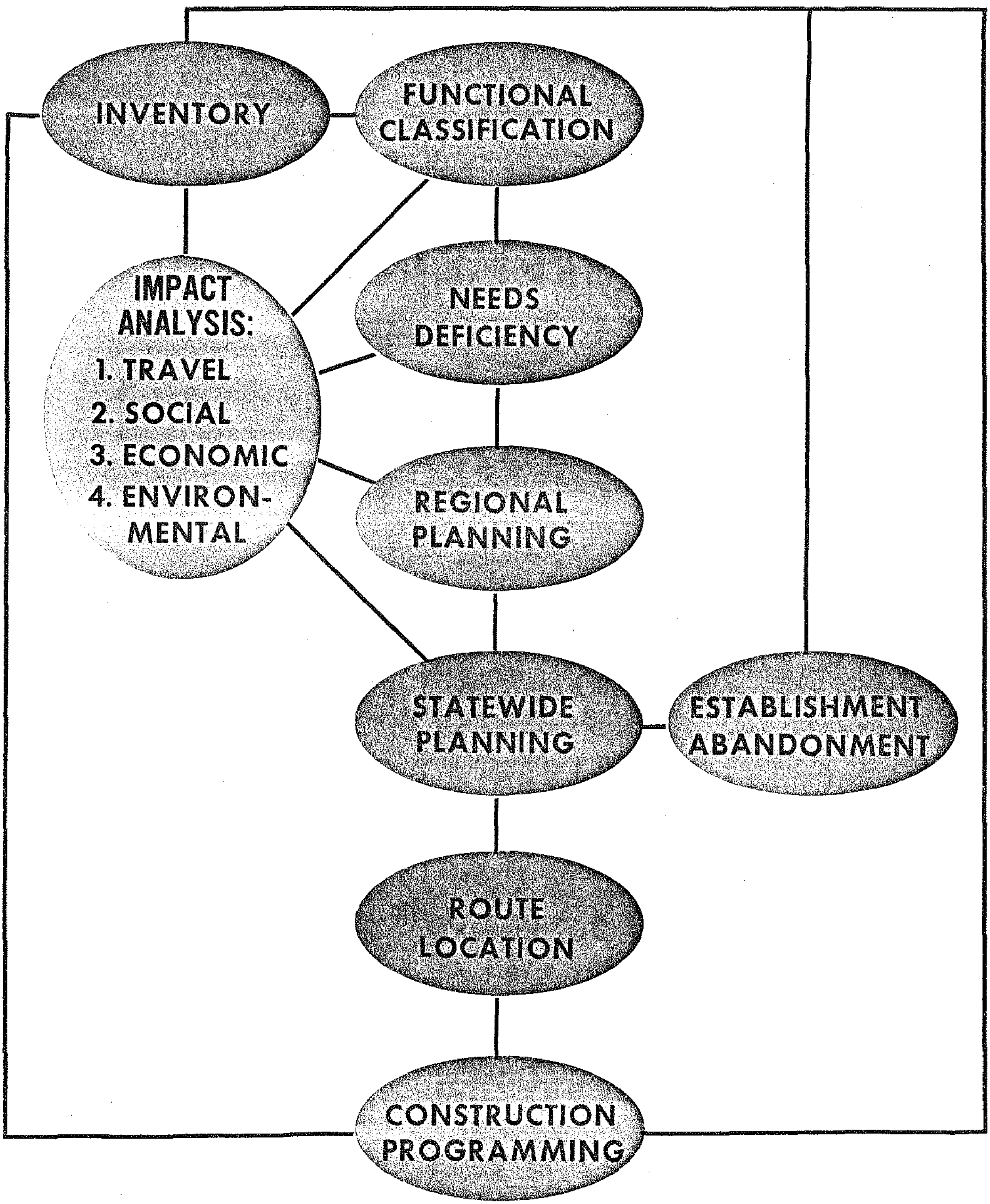


Figure 2. The first major component is the trip generation distribution model. This model consists of a series of computer programs which Michigan has used extensively in statewide traffic forecasting. Using zonal population data, zone-to-zone driving times, and the statewide highway network, the number of trips between each zone pair is calculated and the trips are then assigned to the shortest path between each zone pair.

The second component used extensively in this multi-modal process is a multi-modal network which has recently been developed. Use of this network allows one to begin considering and locating travel corridors by other modes, namely bus, rail, and air. This network is also essential in defining modal availability. Only one more problem remains: How may trips by other modes be accurately estimated and their impact upon highway deficiencies be depicted? Using the tools described, one has the ability, at this point, to generate and distribute highway trips using the trip generation - distribution model and the ability to assign trips onto other modes only if given a method of estimating the number of trips for each zone pair. If one is willing to accept the assumption that highway trips presently comprise the major portion of all travel between most zone pairs at the statewide and regional level, estimates of future travel by rail, air, and bus for various population and energy futures may be obtained using information gleaned from single station origin and destination data.

The origin and destination (O&D) data available in Michigan for use is listed in Figures 3 and 4. This data is the third major component of the multi-modal process. The O&D data contains actual information about trip purposes which enables the department to then intelligently split the highway trip tables by

MICHIGAN'S STATEWIDE TRANSPORTATION MODELING SYSTEM

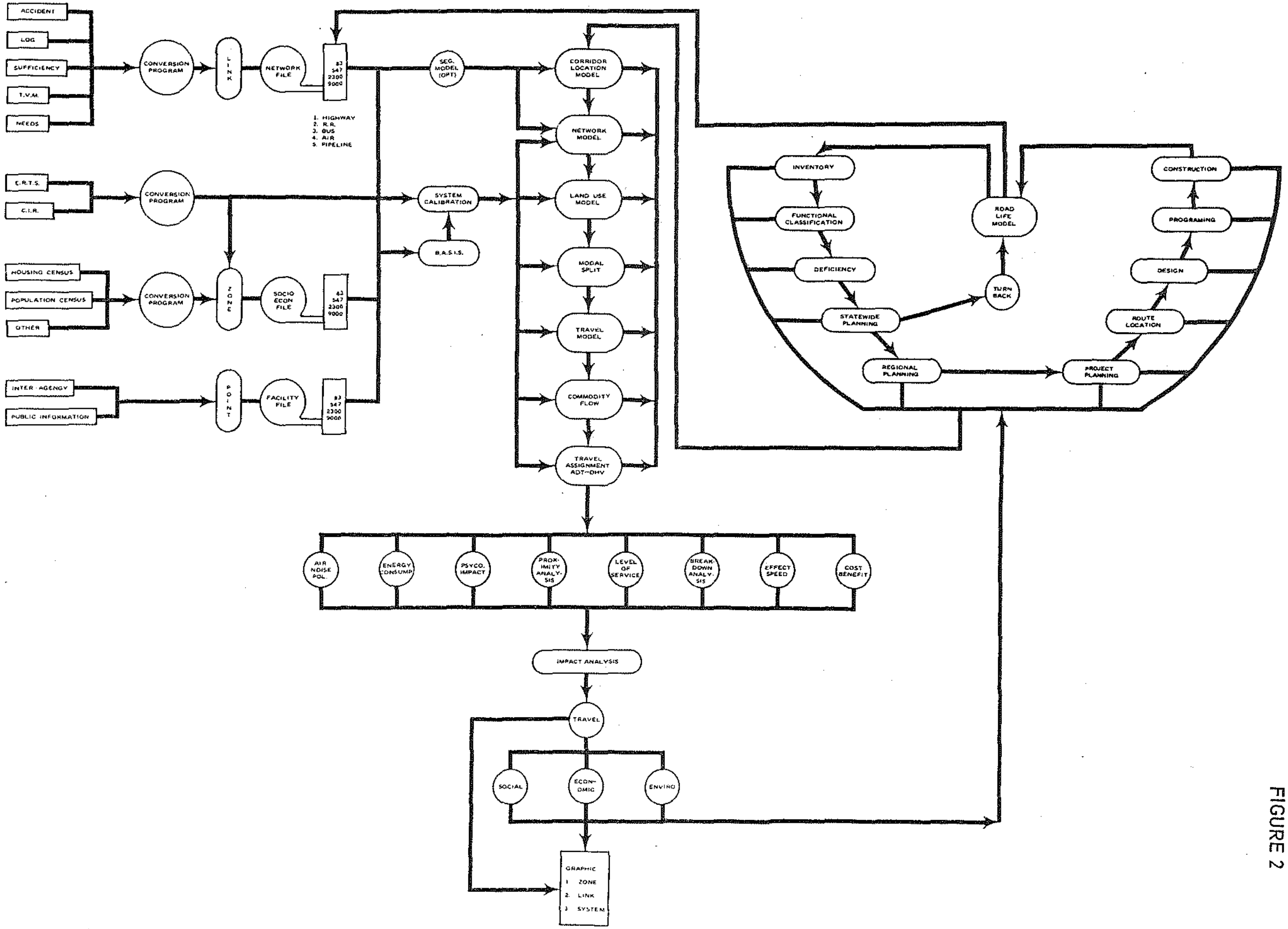


FIGURE 2

FIGURE 3

MINOR ORIGIN & DESTINATION STUDIES

CITY	YEAR
ALBION	1974
ALCONA COUNTY*	1975
ALMA - ST. LOUIS	1974
CHARLEVOIX	1974
CHEBOYGAN	1972
EAST JORDAN	1973
ESCAGLAD	1974
FRANKENMUTH	1975
FRANKFORT	1973
GAYLORD	1972
GLADWIN	1973
GRAYLING	1972
GREENVILLE	1974
HASTINGS	1971
HILLSDALE	1974
HOWELL	1975
IONIA	1975
IRON RIVER	1975
ISABELLA*	1975
IRONWOOD	1975
JACKSON*	1975
KALKASKA	1973
LUDINGTON	1972
MANISTEE	1972
MANISTIQUE	1971
MARSHALL	1975
MUNISING	1971
OWOSSO	1973
PAW PAW	1975
ROGERS CITY	1972
SANILAC*	1975
STANDISH	1973
ST. IGNACE	1974
TAWAS	1972
THREE RIVERS	1971
WEST BRANCH	1974

*RURAL AREA

FIGURE 4

MAJOR ORIGIN & DESTINATION STUDIES

CITY	YEAR
ADRIAN	1967
ALLEGAN	1961
ANN ARBOR	1960
BATTLE CREEK	1961
BAY CITY	1962
BENTON HARBOR	1960
BIG RAPIDS	1968
CADILLAC	1961
FLINT	1966
FREMONT	1969
GRAND RAPIDS	1965
HOLLAND	1967
IRON MOUNTAIN	1968
JACKSON	1967
KALAMAZOO	1966
MARQUETTE	1968
MIDLAND	1969
MONROE	1962
MUSKEGON	1964
NILES	1963
PETOSKEY	1967
PORT HURON	1967
SAGINAW	1965
SAULT STE. MARIE	1964
STURGIS	1968
TALUS	1965
TRAVERSE CITY	1966
TRI-COUNTY	1964
YPSILANTI	1960

trip purpose. Figure 5 summaries some of this data. Once these are created, trip purpose, trip length, and modal availability data, together with the estimated number of total trips per zone pair, become available for use in estimating a quite realistic "modal split". The modal split percentages are obtained from statewide and national statistics related to modal usage in various parts of the United States. The next section describes the total process in greater detail. It is followed by a section showing how the process has been used in Michigan's Northwest Planning Region.

MINOR ORIGIN AND DESTINATION STUDIES

MEAN TRIP LENGTHS BY PURPOSE

REGION 1

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	26	41
2	21	11
3	18	19
4	119	1
5	22	17
6	20	12
ALL	23	

REGION 2

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	27	48
2	25	7
3	20	20
4	197	0
5	22	12
6	25	13
ALL	25	

REGION 3

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	25	47
2	20	7
3	18	18
4	149	1
5	24	15
6	25	12
ALL	24	

TRIP PURPOSE

1 WORK
2 PERS. BUSINESS
3 SHOPPING
4 VACATION
5 OTHER SOC. OR REC.
6 ALL OTHER

FIGURE 5b

REGION 4

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	33	35
2	35	10
3	20	24
4	124	2
5	41	17
6	36	13
ALL	34	

REGION 5

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	35	52
2	30	9
3	26	15
4	193	0
5	32	13
6	30	11
ALL	33	

REGION 7

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	33	39
2	31	10
3	26	21
4	115	3
5	38	16
6	33	11
ALL	35	

REGION 8

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	32	39
2	26	8
3	24	22
4	145	3
5	33	17
6	27	10
ALL	32	

FIGURE 5c

REGION 9

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	34	33
2	35	7
3	47	28
4	136	7
5	52	16
6	47	8
ALL	49	

REGION 10

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	31	36
2	29	8
3	23	20
4	92	7
5	31	20
6	26	10
ALL	33	

REGION 11

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	51	19
2	50	4
3	48	12
4	125	36
5	76	19
6	52	10
ALL	82	

REGION 12

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	58	33
2	51	8
3	45	23
4	201	7
5	64	21
6	53	8
ALL	65	

FIGURE 5d

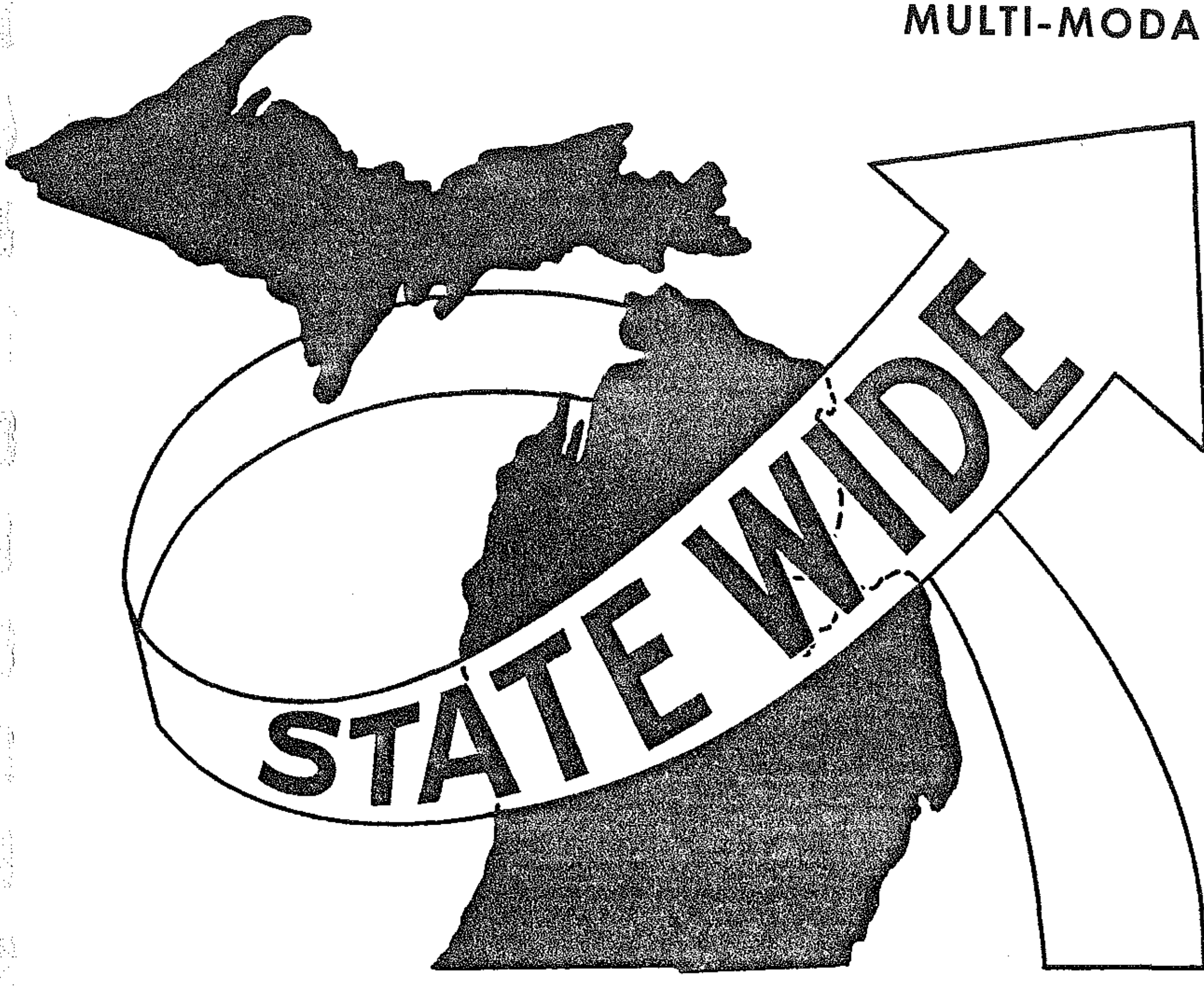
REGION 13

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	42	30
2	35	7
3	24	24
4	179	7
5	40	21
6	37	12
ALL	46	

STATEWIDE AVERAGE

TRIP PURPOSE	MINUTES	PERCENT OF TOTAL TRIPS
1	32	39
2	30	8
3	28	21
4	135	4
5	37	17
6	32	11
ALL	36	

MULTI-MODAL PROCESS



MULTI-MODAL PROCESS

A computer analysis process that simulates an inter-modal traffic assignment has been developed within the Bureau of Transportation Planning by the Northwest Region and Statewide Procedures Section. This system analysis process is intended to serve as a planning tool that supports an alternative energy and "growth futures" concept. It produces potential travel data by selected travel modes that may be used to develop a range of alternative inter-modal transportation networks.

Figure 6 shows the various steps that are performed by this process. It begins with a future highway trip table produced by the existing Statewide Transportation Modeling System for a projected population. The trip table is then divided by purpose using trip length and the purpose data derived from actual O&D studies. The resulting purpose trip tables are then divided by mode using predetermined mode split percentages. These percentages are based upon three different projected future energy conditions -- abundant, conserved, and restricted. The modal split process is selective in that a trip's purpose and length is determined before assigning it to a particular mode. That assignment is then reconsidered on the basis of the availability of the selected mode. Therefore, the resulting link volumes reflect a sensitivity as to how different types of trips might react to an energy-short condition.

Total Trip Table Generation

The State of Michigan and contiguous areas outside the state are divided into 547 zones of which 508 are instate zones, as shown in Figure 7. Zone sizes and boundaries have been determined on the basis of population, land area, political

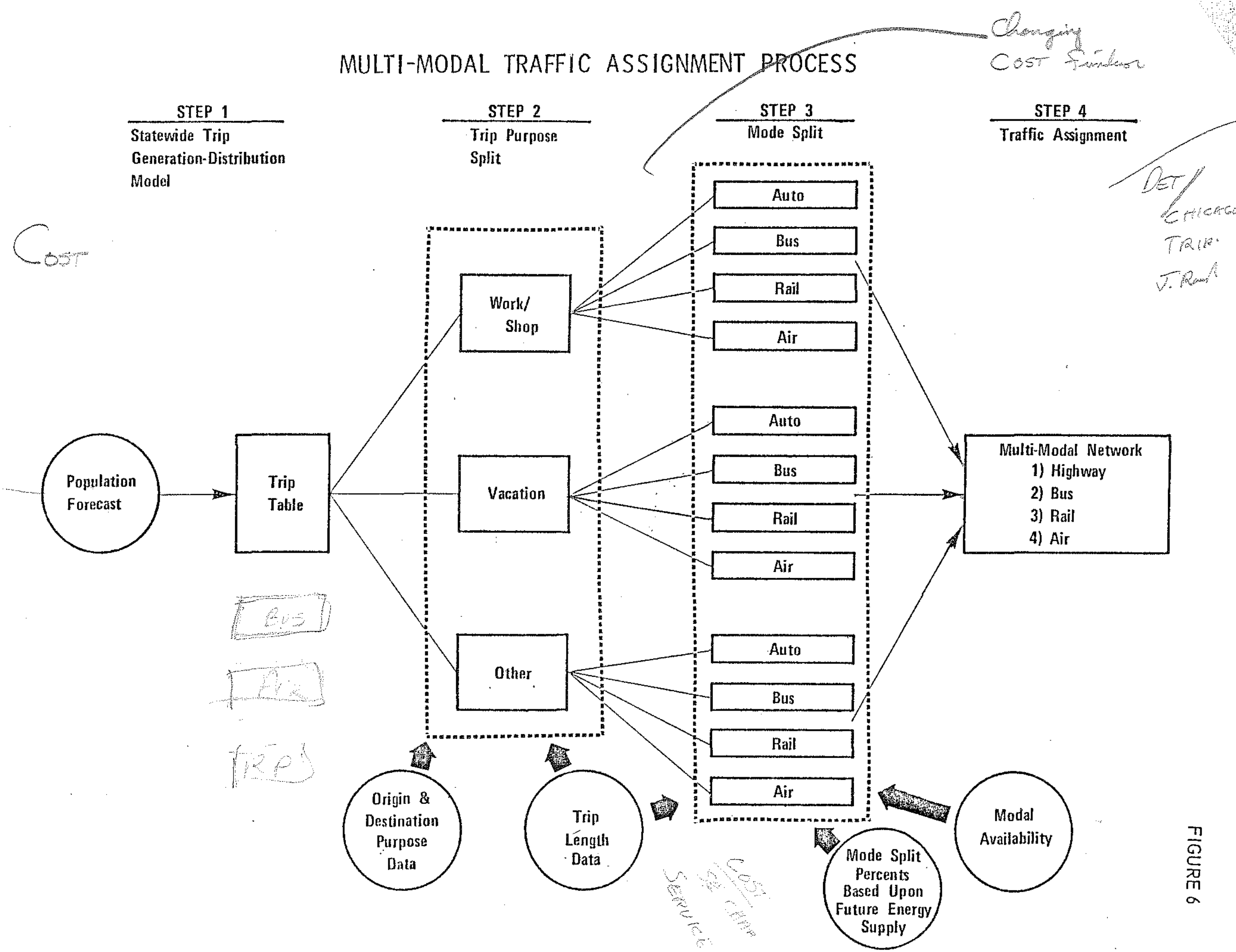
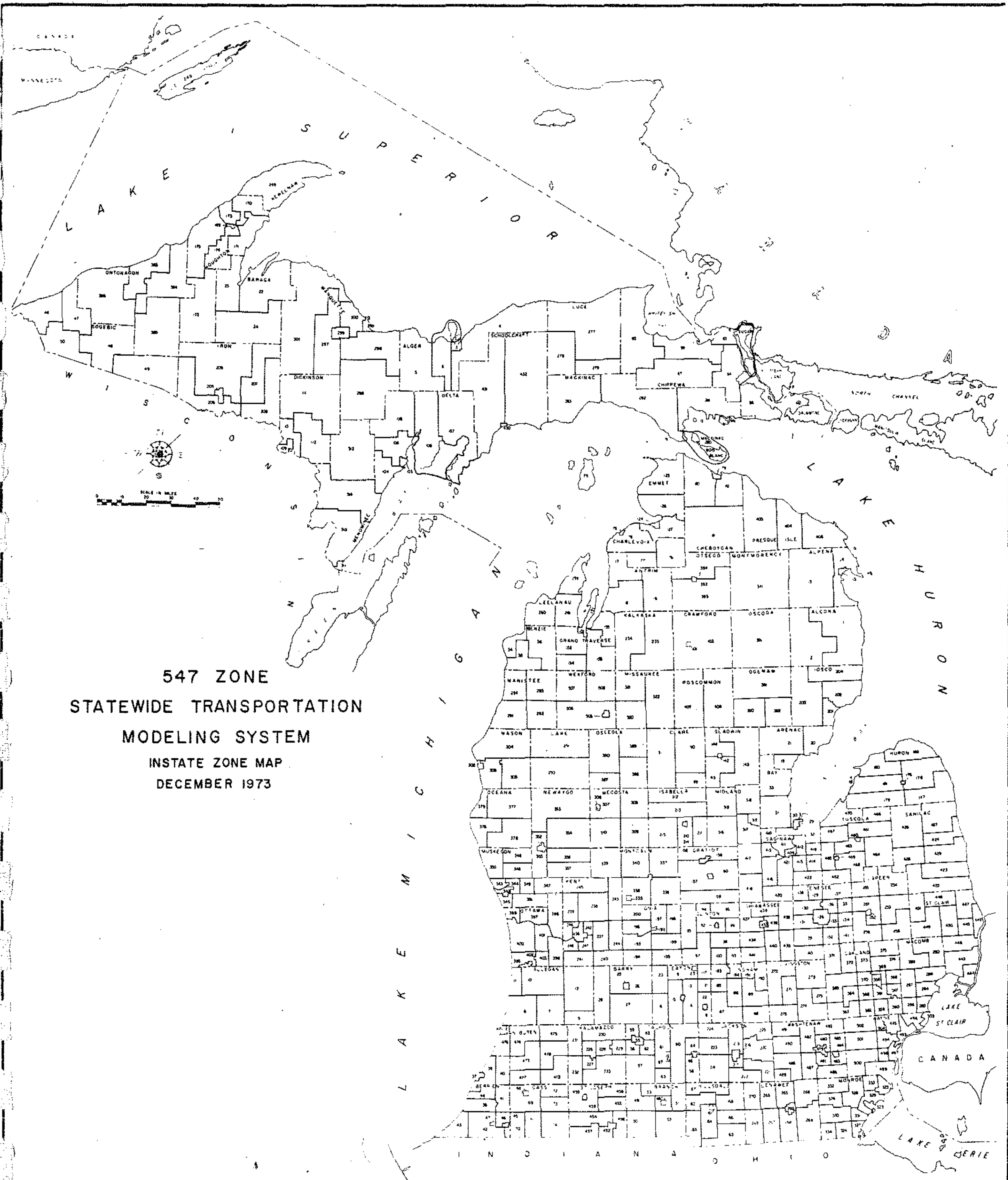

MULTI-MODAL TRAFFIC ASSIGNMENT PROCESS
STEP 1
Statewide Trip Generation-Distribution Model
STEP 2
Trip Purpose Split
STEP 3
Mode Split
STEP 4
Traffic Assignment
Population Forecast
Trip Table
Work/ Shop
Vacation
Other
Auto
Bus
Rail
Air
Auto
Bus
Rail
Air
Auto
Bus
Rail
Air
Multi-Modal Network
1) Highway
2) Bus
3) Rail
4) Air
Origin & Destination Purpose Data
Trip Length Data
Mode Split Percents Based Upon Future Energy Supply
Modal Availability

FIGURE 6

FIGURE 7


547 ZONE
STATEWIDE TRANSPORTATION
MODELING SYSTEM
INSTATE ZONE MAP
DECEMBER 1973
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
WISCONSIN
CANADA
INDIANA
OHIO
LAKE ST CLAIR
LAKE ERIE
NORTH CHANNEL

boundaries, and other relevant factors.

The initial total trip table is generated by the existing Statewide Transportation Model and simulates future travel between these 547 zones. Zonal population forecasts are used to develop this table. In this report, the generated total trip tables represent a year 2000 forecast based on Department of Management and Budget (DMB) population figures. Three different population forecasts are used to simulate travel for "high", "medium", or "low" growth futures. Although these trip tables are derived from highway oriented data, they are assumed to represent all travel generated by all modes because when compared to the highway mode, the current bus, train, and air data reveal that these modes contribute only a small percent of intercity passenger travel in Michigan.

Division of Total Trip Table by Trip Purpose

The objective of this process was to explore the potential diversion of various auto trip purposes for varying futures and the impact the diversion would have upon transportation needs and deficiencies. A common concern expressed is that certain trips, like vacation trips, will not be good candidates for public transportation. However, it is also generally accepted that the work trip, because of its low vehicle occupancy and short travel distance, could become a potential transit trip.

The previously existing Statewide Transportation Modeling System generated only total travel and could not be used directly to assess potential auto diversion by purpose. Therefore, additional information concerning actual trip purpose and length was obtained from various origin-destination surveys. Analysis of the 36 major and 30 minor O&D surveys listed earlier in Figures 3 and 4 was subsequently performed and the results were evaluated by the Northwest Regional Planning team.

The summary appears in Figure 8. Only terminal trips were analyzed as this information would be the final basis for spliting the total trip table by purpose at the zonal level. The Northwest Region Planning team summarized the "trip purpose" to the three typical categories (work, vacation, and other) based on the analysis of actual O&D data. The "trip length" categories were also grouped in a similar manner using driving time as a measure. This was done to reduce the complexity that these features added to later computer runs. An unfortunate result of this action is that the shopping trip was combined with the work trip. These purposes are quite different and it may be beneficial to separate them at a later time.

The vacation trips in Figure 8 represent only 2% of the total travel. Normally this would not warrant a separate trip purpose for analysis. But in Michigan, vacation travel is very significant on many roads and, therefore, it was felt that vacation trips should be considered as a separate purpose. Also, when one considers the trips produced from such zones as those in the Detroit and Chicago areas, one notes that vacation travel may account for 30-40% of the trips generated from those large populated areas. A graph of how the various O&D trip purposes are related to trip length is shown in Figure 9. In this graph vacation trip percentages increase with trip length and the work trip percentage decreases with trip length. This relationship between a trip's purpose and length is an important travel characteristic and was considered when developing the statewide model split percentages used in the analysis process.

The present statewide model uses average daily traffic (ADT) volumes in travel impact analysis. The multi-modal analysis process being developed in Michigan

TRIP PURPOSE BY LENGTH
(Taken from Actual Origin-Destination Survey Data 1/)

TOTAL TRIPS BY PURPOSE AND LENGTH

TRIP PURPOSE 2/	TRIP LENGTH (MINUTES) 3/							TOTAL
	0-30	31-60	61-120	121-180	181-240	241-300	300+	
Work	1,414,056	442,183	99,195	20,187	8,837	3,171	4,575	1,972,204
Vacation	9,892	17,110	12,390	5,620	3,641	2,595	5,264	56,512
All Other	941,255	242,460	57,778	11,911	5,077	2,294	3,164	1,263,939

PERCENT OF TOTAL TRAVEL

TRIP PURPOSE 2/	TRIP LENGTH (MINUTES) 3/							TOTAL
	0-30	31-60	61-120	121-180	181-240	241-300	300+	
Work	60	62	59	53	50	39	35	60
Vacation	0	2	7	15	21	32	41	2
All Other	40	36	34	32	29	29	25	38

1/ Includes both major and minor O-D surveys.
Majors: Ann Arbor, Ypsilanti, Benton Harbor - St. Joseph, Battle Creek, Allegan, Monroe, Bay City, Niles, Tri-County, Sault Ste. Marie, Muskegon, Grand Rapids, Saginaw, Detroit, Flint, Kalamazoo, Adrian, Jackson, Iron Mt., Holland, Port Huron, Midland, Marquette, Dowagiac, Big Rapids, Mt. Pleasant, Sturgis, Eaton Rapids, Grand Ledge, Fremont, Ionia, Caro, Petoskey, Traverse City, Alpena, Cadillac.
Minors: Alcona Co., Cheboygan, Frankfort, Gaylord, Grayling, Ludington, Standish, Frankenmuth, Manistique, Ironwood/Bessmer/Wakefield, Iron River, Hillsdale, St. Ignace, Munising, Hastings, Escanaba-Gladstone, Three Rivers, Paw Paw, Owosoo, Howell, Albion, Ionia, Marshall, Isabella, Gladwin, Alma-St. Louis, Manistee, Rogers City, Tawas, West Branch.

2/ Trip purposes are categorizes as follows:
WORK - Includes all work, shopping and personal business trips.
VACATION - Includes only vacation trips.
ALL OTHER - Includes social, recreation and all other trips.

3/ Based on approximate auto driving times.

FIGURE 8

TRIP PURPOSE VS TRIP LENGTH

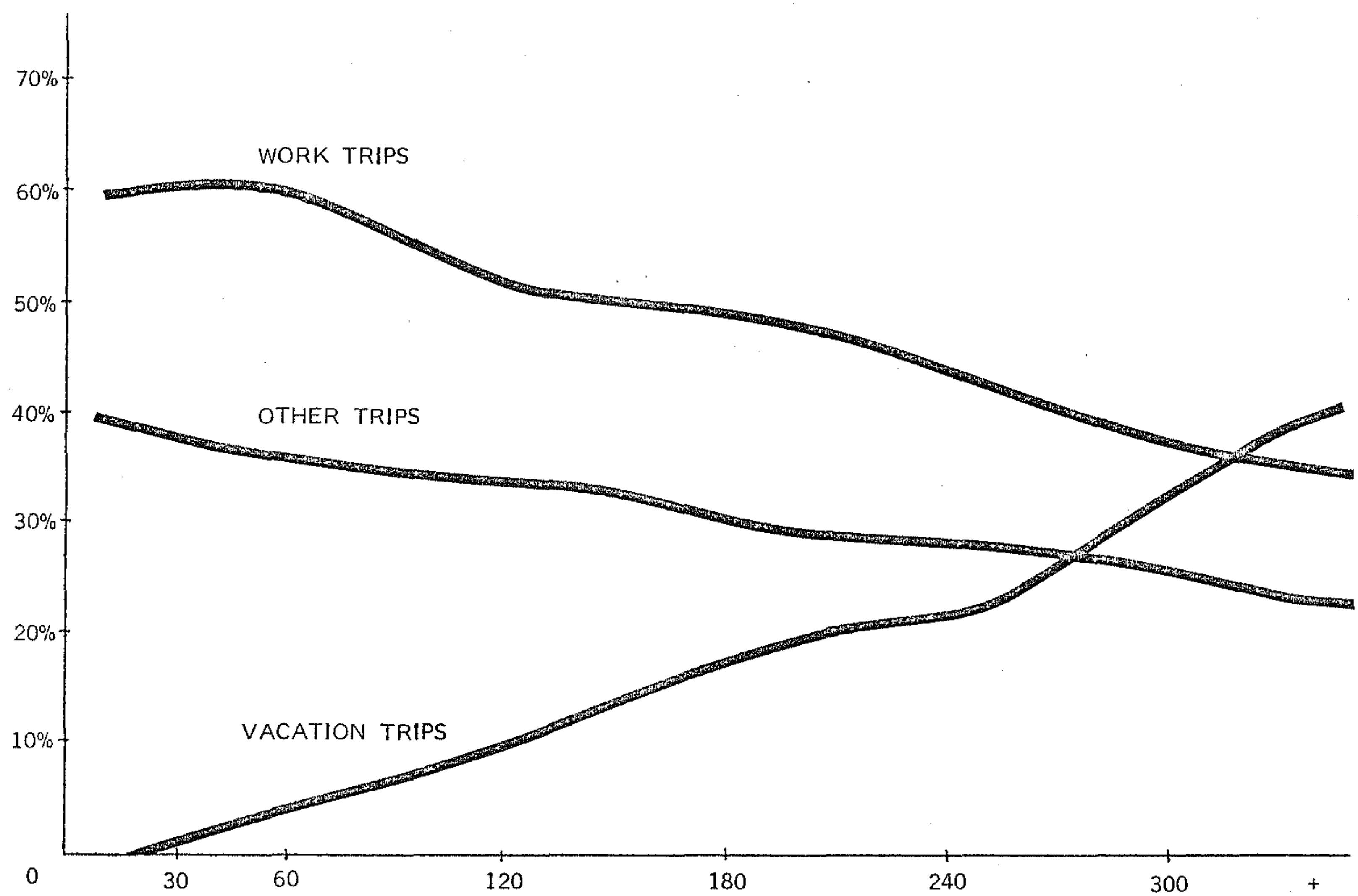


FIGURE 9

requires person trips, therefore, vehicle trips were converted to person trips by utilizing average vehicle occupancy rates for the various trip purposes. Figure 10 shows these vehicle occupancy figures as derived from several minor O&D surveys.

Modal Split of Trip Purpose Trip Tables

As previously indicated, the process being described is intended to show a simulated traffic assignment by mode for selected population and energy futures. Once the total trip table is divided into the various trip purposes, it then becomes necessary to analyze potential modal uses by trip purpose and length. The traffic mode is dependent upon the energy future being considered. Probable modal split percentages were derived for abundant, conserved, and restricted energy futures. The mode split for the abundant energy future favors auto travel, the restricted and conserved energy futures show an increasing use of other transportation modes. Figure 11 shows the mode split percentages by energy future that were used for the northwest regional study. The figures are intended to represent estimates of the possible modal selections and are not based upon extensive research. Although several energy and transportation related studies have been conducted, there is no concensus of opinion about the probable use of alternative transportation modes in an energy deficient future. Trips assigned to alternative modes based upon the mode split percentages were further examined to determine the feasibility. If the access/egress time to the other mode was excessive in comparison to total auto travel time, the trip was returned to the auto trip table. This access/egress time included a 20 minute "wait" period at both the origination and destination airports and at origination and destination rail stations. This helps to discourage short distance trips by assigning a reasonable deterrent caused by time schedules. Thus, a computer process was

TRIP PURPOSE - VEHICLE OCCUPANCY

INDIVIDUAL VEHICLE OCCUPANCY

TRIP PURPOSE	OCCUPANCY
1. WORK	1.28
2. PERSONAL BUSINESS	1.83
3. SHOPPING	2.12
4. VACATION	3.15
5. SOCIAL-RECREATION	2.28
6. ALL OTHER	2.04

COMBINED VEHICLE OCCUPANCY

TRIP PURPOSE	OCCUPANCY
WORK	1.61
VACATION	3.15
ALL OTHER	2.19

FIGURE 10

FIGURE 11

ESTIMATED MODE SPLIT BY TRIP LENGTH
TRIP PURPOSE, AND ENERGY FUTURE

MODE SPLIT PERCENTAGES

ENERGY FUTURE	TRIP PURPOSE	TRAVEL REDUC.	MODE	TRIP LENGTH (MINUTES)[1] 0-30	31-60	61-90	91-120	121-300	300+
ABUNDANT	WORK	0%	AUTO	99.9	99.6	98.6	97.0	94.6	88.8
			BUS	0.1	0.2	0.6	1.0	2.0	2.0
			RAIL	0.0	0.2	0.8	2.0	2.0	2.0
			AIR	0.0	0.0	0.0	0.0	1.4	7.2
	VACATION	0%	AUTO	99.9	99.6	98.6	97.0	96.2	90.1
			BUS	0.1	0.2	0.6	1.0	2.0	2.0
			RAIL	0.0	0.2	0.8	2.0	1.0	1.5
			AIR	00.0	0.0	0.0	0.0	1.0	6.4
	OTHER	0%	AUTO	99.9	99.6	98.6	97.0	94.7	88.7
			BUS	0.1	0.2	0.6	1.0	2.0	2.0
			RAIL	0.0	0.2	0.8	2.0	2.5	2.5
			AIR	0.0	0.0	0.0	0.0	0.8	6.8
CONSERVED	WORK	0%	AUTO	93.0[2]	93.0[3]	97.0	94.0	91.0	84.0
			BUS	5.0	2.0	1.0	2.0	4.0	4.0
			RAIL	0.0	0.0	2.0	4.0	4.0	4.0
			AIR	0.0	0.0	0.0	0.0	1.0	8.0
	VACATION	5%	AUTO	100.0	99.0	97.0	96.0	93.0	87.0
			BUS	0.0	1.0	1.0	2.0	4.0	4.0
			RAIL	0.0	0.0	2.0	2.0	2.0	2.0
			AIR	0.0	0.0	0.0	0.0	1.0	7.0
	OTHER	5%	AUTO	95.0	99.0	97.0	93.0	90.0	84.0
			BUS	5.0	1.0	1.0	3.0	4.0	4.0
			RAIL	0.0	0.0	2.0	4.0	5.0	5.0
			AIR	0.0	0.0	0.0	0.0	1.0	7.0
RESTRICTED	WORK	0%	AUTO	85.0[3]	84.0[4]	97.0	93.0	87.0	81.0
			BUS	10.0	5.0	1.0	3.0	5.0	5.0
			RAIL	0.0	1.0	2.0	4.0	7.0	7.0
			AIR	0.0	0.0	0.0	0.0	1.0	7.0
	VACATION	20%	AUTO	100.0	98.0	97.0	94.0	90.0	84.0
			BUS	0.0	1.0	1.0	3.0	4.0	4.0
			RAIL	0.0	1.0	2.0	3.0	5.0	6.0
			AIR	0.0	0.0	0.0	0.0	1.0	6.0
	OTHER	20%	AUTO	90.0	95.0	97.0	91.0	85.0	78.0
			BUS	10.0	4.0	1.0	4.0	6.0	6.0
			RAIL	0.0	1.0	2.0	5.0	8.0	10.0
			AIR	0.0	0.0	0.0	0.0	1.0	6.0

WORK TRIPS INCLUDE: WORK, SHOPPING, PERSONAL BUSINESS
VACATION TRIPS INCLUDE: VACATION
OTHER TRIPS INCLUDE: SOCIAL, RECREATIONAL, AND ALL OTHERS

1 BASED ON APPROXIMATE AUTO DRIVING TIME
2 INCLUDES 2% SHIFT TO CAR POOLS
3 INCLUDES 5% SHIFT TO CAR POOLS
4 INCLUDES 10% SHIFT TO CAR POOLS

developed that would be flexible enough to assume any desired modal split assumptions. Experience indicates that using three energy futures, three population growth futures, modal availability measures, and the trip purpose/length and vehicle occupancy data provides the desired flexibility and sensitivity.

1. Abundant Energy Mode Split Percentages

Since this energy future is expected to simulate present travel habits, some mode split data is available. A 1972 "National Travel Survey" for passenger travel over 100 miles in length was used to obtain some of the modal split percentages. Information on trips shorter than 100 miles in length was not readily available so a mode split percentage was selected for these trips which reflects a dominance of auto travel. It was felt that the air and rail modes did not warrant consideration for the shorter trips regardless of purpose, while the percentage of trips to be diverted to bus was based upon present travel patterns.

2. Conserved Energy Mode Split Percentages

The basic strategy used to develop mode split tables for the conserved and restricted energy futures was to focus attention on the short distance work trip. This particular trip was considered to be the most likely candidate for transit usage in an energy short future. For the conserved future, 5% of the auto trips were diverted to bus. This 5% applies only to the 0-30 minute work trip. Because car pooling is likely to increase as energy costs rise, the short work trips for the conserved and restricted energy futures decrease by two to five percent. The respective mode split percentages are fairly consistant with the abundant energy table for the other trip length categories.

Because of its high vehicle occupancy, it was assumed that the vacation trip would not become a potential transit trip. Therefore, the auto mode continues to dominate this trip purpose for the conserved energy future. The "other" trip purpose category has features common to the work and vacation trips so some diversion to alternative modes was indicated. Within this trip category is the recreation and social trip purposes. Some long distance weekend trips are already occurring on charter buses. In an energy short future, one would expect an even greater percentage of this kind of trip to use alternative modes, despite a possible reduction in actual trips. These possibilities are reflected in the mode split percentages. The short distance social trips may also shift to other modes especially in the urban areas where improved transit services would already be available. The air and rail modes are again a relatively small percentage of total travel for this future. It should also be noted that for the vacation and "other" trip purposes, trips were reduced by 5% to reflect an increasing tendency to consolidate and eliminate some of these trips.

3. Restricted Energy Mode Split Percentages

For the restricted energy future, the mode split percentages show a 10% auto diversion for the short distance work trip as well as a 5% shift to car or van pools for the short work trips and a 10% shift for the 31-60 minute work trips. Bus and rail traffic increases, while air travel begins to decrease slightly. This prediction is debatable since little data is available to support any assumptions about air travel. For the restricted energy future, a 20% travel reduction factor was applied to the vacation and "other" trip categories indicating a greater reluctance to travel with growing costs.

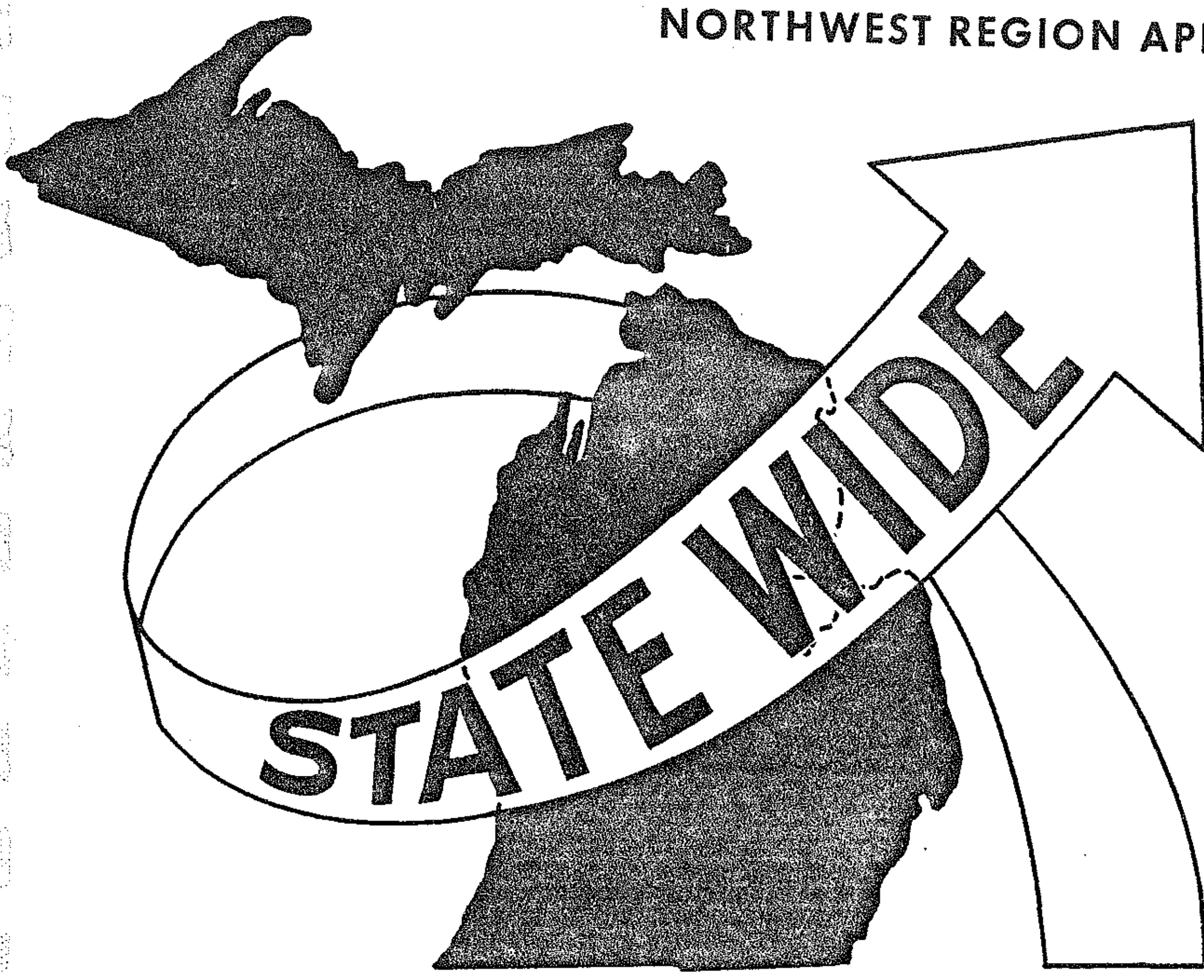
Traffic Assignment by Mode

The traffic assignment portion of this process uses essentially the same techniques as incorporated into the existing statewide highway model. The air and rail network plots have been reviewed by their respective modal planning sections; and with this addition to the existing highway network, intermodal assignments can now be generated.

The basic traffic assignments follow the minimum time paths for each modal network. The potential bus network is assumed to be equivalent to the highway network since any highway corridor showing great bus passenger potential could easily become a bus route. At this time, private ownership and operation of bus, rail, and air modes were not incorporated into the analysis. It is recognized that these considerations are important for current project level planning activities but there is also an awareness of potential for increased state subsidy of private operations, especially in northern Michigan. Therefore, some systems analysis is appropriate within these constraints and should be beneficial to the project planning phase.

The following section illustrates how this process was used in Michigan's Northwestern Planning Region. The modal assignments are shown for three of the nine possible futures. The examples should help illustrate potential modal shifts in a realistic planning application.

NORTHWEST REGION APPLICATION



NORTHWEST REGION APPLICATION

Michigan's Northwest Regional planners recently made use of the multi-modal process to assist in developing regional systems plans. The application of this process requires one to select and define probable "futures" in respect to population growth and energy availability and cost. Since each future must be evaluated for each of four travel modes, it is very advantageous to select only a few "futures". For the northwest region, nine such futures were selected, based upon three possible population growth trends and three possible energy situations. These futures and some generalized systems plans, derived from the multi-modal process for the Northwest Region of Michigan, are displayed in Figure 12. Computer plots of three of these futures will follow with explanations and observations about them. The purpose and modal split ratios, listed earlier in Figures 8 and 11, were used for this study. The three futures selected for demonstration in this report are indicated in Figure 12 by the large dots. A plot for each travel mode per future is required to adequately display the projected assignments. Each plot shown in this report depicts the area around Cadillac and Traverse City. This area contains roads which are extensively used for long distance vacation trips, such as US-131, county roads used mainly for local travel, and state trunkline, such as M-55, which mainly serve regional travel. These highways are labeled in Figure 15. It is interesting to note that because the splits by trip purpose depend upon trip length, the assignments reflect a sensitivity to these different road characteristics. The next several paragraphs are intended to help demonstrate this sensitivity.

The plots in Figures 15 through 26 contain four numbers on each link. The first number is the number of work trips assigned, the second is the vacation trips,

FUTURE ENERGY SUPPLY

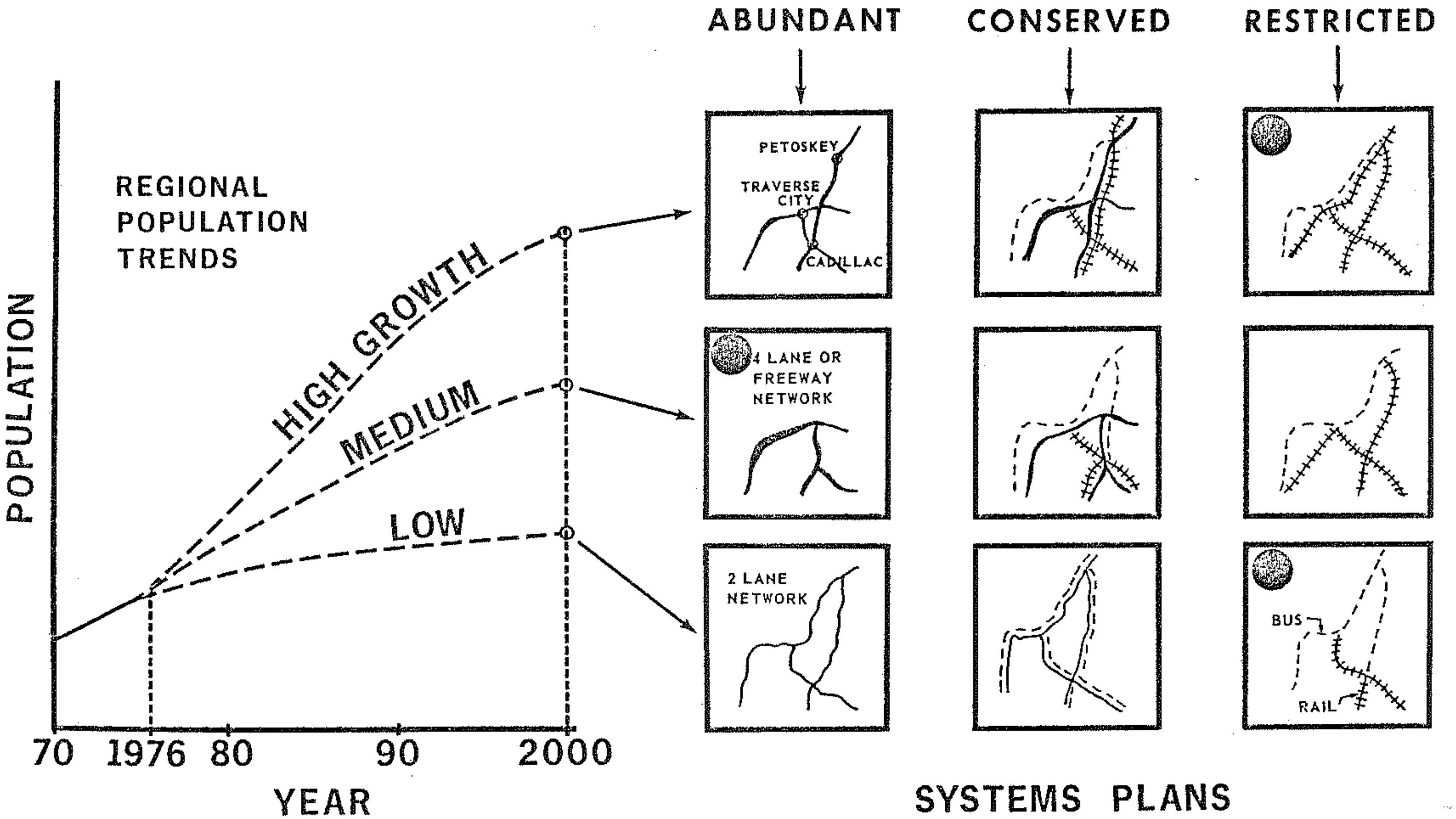


FIGURE 12

the third figure is the "other" purpose trips, while the last number on every link is the total trip assignment. It is important to note here that some caution is necessary when studying the assignments on a link by link basis, especially in urban areas and on local roads, since the 547 zone system is too coarse to adequately predict local traffic. Remembering this, some interesting aspects of this multi-modal method may be displayed by comparing assignments on various types of roads. Examining the assignments for the medium population growth with an abundant energy future, one should find assignments in Figure 13 for the links indicated by the numbered arrows in Figure 15 (see also figures 16 and 17).

These assignments confirm the expectations based upon the known travel characteristics for each of these roads. For instance, it should be no surprise that the travel on US-31 drops rapidly as one travels north from Traverse City. Work/shopping travel on US-31 is 56.7% of its total assignment, compared to 8.6% vacation travel. Comparing these numbers to US-131, where 44.8% of the assigned trips are work/shopping trips and 26.4% are vacation trips, strongly supports actual O&D studies relating to vacation travel on US-131. The logical pattern for vacation trips is also evident on M-55 with 7.8% vacation travel while only 2.2% of the travel on Alden Highway (a county road in southern Antrim County) is vacation travel. The fluctuation in work/shop, vacation, and "other" purpose percents by individual road types may be compared to the statewide percents of 60% work/shop, 2% vacation, and 38% "other" for all three abundant energy futures as shown in Figure 14. The strong vacation attraction of the northwest region is clearly reflected in the assignments which show that even local roads are above average in the ratio of vacation trips to total trips.

HIGHWAY ASSIGNMENTS ON SELECTED LINKS

	PURPOSE	US-31	US-31	US-131	ALDEN HWY	M-55
ABUNDANT -						
MEDIUM POPULATION	WORK/SHOP	4798	2818	3441	2670	1842
	VACATION	728	478	2032	96	256
	OTHER	2938	1672	2214	1552	1174
	TOTAL	8464	4968	7687	4318	3272
RESTRICTED -						
LOW POPULATION	WORK/SHOP	3598	2126	2734	1932	1554
	VACATION	490	320	1386	64	182
	OTHER	1868	1082	1418	1012	824
	TOTAL	5956	3528	5538	3008	2560
RESTRICTED -						
HIGH POPULATION	WORK/SHOP	4940	2852	3562	2538	1660
	VACATION	612	404	1640	86	200
	OTHER	2566	1450	1834	1328	872
	TOTAL	8118	4706	7036	3952	2732

FIGURE 13

STATE TOTAL AUTO TRIPS

POPULATION GROWTH	ENERGY FUTURE	WORK/SHOP TRIPS	WORK/SHOP % TOTAL	VACATION TRIPS	VACATION % TOTAL	OTHER TRIPS	OTHER % TOTAL	TOTAL
LOW	ABUNDANT	5,579,907	59.9	146,367	1.57	3,584,013	38.5	9,310,287
	CONSERVED	5,214,456	60.5	136,261	1.58	3,271,416	37.9	8,622,133
	RESTRICTED	4,788,209	63.6	112,667	1.50	2,625,848	34.9	7,526,724
MEDIUM	ABUNDANT	5,869,675	59.9	158,617	1.62	3,756,616	38.4	9,793,908
	CONSERVED	5,486,016	60.5	147,671	1.63	3,438,320	37.9	9,072,007
	RESTRICTED	5,038,576	63.6	122,104	1.54	2,760,432	34.8	7,921,112
HIGH	ABUNDANT	6,080,147	59.9	168,745	1.66	3,896,532	38.4	10,145,424
	CONSERVED	5,683,460	60.5	157,105	1.67	3,558,894	37.9	9,399,459
	RESTRICTED	5,220,889	63.6	129,907	1.58	2,857,804	34.8	8,208,600

FIGURE 14

Figure 14 also displays the statewide effects of various energy futures. Comparing the conserved energy future with the abundant energy future, one notes that each of the trip purposes are affected about equally; trips by all purposes decrease with the "other" purpose trips decreasing most. Only in the restricted energy futures does trip purpose seem to play a significant role with vacation and "other" trip purposes decreasing considerably faster than work trips. This reflects the assumptions expressed in the mode split percentages, Figure 11, where the five and ten percent travel reduction factors were applied for the conserved and restricted energy futures, respectively, for both vacation and "other" trip purposes. Work/shop trips were also reduced somewhat to include possible shifting to car pools for short distance trips.

Looking once more at Figure 13, we will now quickly compare the abundant energy, medium population growth with the restricted energy, high population growth future. Total auto travel dropped for the restricted future for each of the five links studied. However, work/shopping trips increased on the US-31 and US-131 links, while vacation and "other" purpose trips dropped considerably. Work/shop trips showed the same reluctance to drop on Alden Highway and M-55. Thus one could reasonably infer that roads with a high percentage of work/shop trips will be least affected by rising energy costs, regardless of the rate of population growth. This may be confirmed by also comparing the assignments for the restricted energy, low population growth future with the abundant energy, medium population growth future.

Studying the changes in vehicle trips between population growth futures reveals other interesting comparisons. Figure 14 shows that the low population growth future generates 19% as many trips as the high population growth future. However, when one examines the assignments in Figure 13 for the conserved futures, it is possible to see that this factor is definitely not applied on the link-by-link basis. The other factors of trip purpose, trip length, and modal accessibility cause this ratio to fluctuate as road usage changes. The US-31 and US-131 assignments are well above the average 9% increase between low and high population growths, while the predicted change in travel on M-55 is slightly less than might be expected based upon the statewide average. While more detailed analysis would have to be done to fully explain these fluctuationsin travel growth, a few assumptions might be made. Of the five links listed in Figure 13, M-55 is the only link likely to serve mainly "average" distance trips. Referring back to the mode split ratio, Figure 11, one sees that trips between 30 and 120 minutes in length are considered least apt to select another travel mode. Another special "feature" of the M-55 link is that it is the only link not likely to serve trips between Cadillac, Traverse City, and other major cities. It is also an east-west route while the major traffic movement in this region is north-south. Since most population growth would occur around major cities, particularly southern Michigan cities, it is logical that this growth would affect M-55 the least of any of the five links.

The proceeding paragraphs should help verify that this multi-modal process is sensitive to energy costs, population growth, and road use and trip characteristics. The planning assumptions concerning the various energy futures are reflected by the assignments in varying degrees, dependent upon the road and trip characteristics. These same effects apply to the bus, rail, and air modes, but are somewhat less evident because of the much lower travel volumes for these modes.

Before examining the assignments for the alternative transportation modes, a few explanations are necessary.

The bus mode is the most easily obtained alternative mode. Since bus routes need not be any more limited than the automobile, the potential bus network is assumed to be equivalent to the highway network. Naturally, this will lead to at least a small assignment on each link, thereby subtracting some travel from the auto mode for even very improbable bus "routes". However, this is not a serious problem, for the transportation planner may quickly spot the most promising bus corridors for any given future and the remaining links containing low bus assignments will have very little effect upon auto travel.

The railroad network was used for the rail mode assignments. Initially, for the northwest study, this network contained all tracks presently in service including the Mackinac Straits and Lake Michigan Ferries. Every current freight station was assumed to be a potential passenger station and rail trips were assigned to begin at the station nearest the trip origin and to continue on rail to the station nearest the trip's destination, thus minimizing access/egress times. However, since rail travel is dependent upon existing tracks and train frequencies, two other factors were used. The first factor assigned a 20-minute wait period at both ends of the rail trip. This excluded many short distance trips which were assumed illogical for rail travel. The second factor compared rail access/egress times with total highway times for each trip. If the access/egress time was 30% or more of the highway time, the trip was not assigned to the rail mode, since few people would drive long distances to use rail service. This factor eliminated medium distance trips which did not have good rail service available.

Neither of these two restraints, however, affected the longer distance rail trips, particularly those to and from the Upper Peninsula. Those trips contributed to large volumes on the north-south rail lines in the northwest region which were considered unreasonable, especially since the Mackinac Ferry and other rail lines in the Upper Peninsula are very unlikely to ever provide rail passenger service. This was compensated for by subtracting from all rail links any trips using the Mackinac Ferry, resulting in much more acceptable numbers. It would also have been possible to eliminate other tracks with little or no rail passenger potential and to restrict passenger stations to major towns or cities. Such a modification of the rail network would produce very realistic passenger estimates, but would also reflect a good deal of planning bias by predetermining likely passenger routes. Using a complete rail network, a planner should be able to confirm probable passenger routes by comparing the modal assignments for each rail corridor.

The wait time and access/egress factors used for rail were also used for air travel. The air network consists of all direct flights scheduled during July, 1977. This network in actuality is restricted only by airport locations and hence is subject to frequent minor changes which are somewhat difficult to predict. It is easily possible, however, to make changes to determine the potential effects of such changes by adding or deleting flights. Air travel characteristics are quite different from other travel modes; people will travel greater distances to airports than to other modes and will drive to major airports even though a local airport would provide reasonable connections. Transportation planners cannot agree concerning the effects of high energy costs upon air travel largely because of the distinct characteristics of air travelers. Because the time savings is generally a major factor in decisions to travel by air, schedule and flight connection information is essential to accurately estimate potential travel demand. At present, the multi-modal process cannot adequately utilize such information, hence the air mode assignments are likely to be unrealistic in some cases. Given more data for present air travel, this mode could be greatly improved to better reflect actual demand. Meanwhile, it was felt that the air mode assignments could help determine potential air corridors if used with caution.

The plots for the rail and air modes differ from auto and bus in that they show the "access links", i.e., the highway links used to get to and from the rail stations and airports. Comparing auto travel to the rail and air modes is somewhat difficult since the corridors necessarily differ, and hence the "paths" between any zone pair may logically be quite radically different. For example, if one compares the assignments on the US-131 link north of Cadillac which was numbered 3 in Figure 15, one finds the following assignments for the medium population, abundant energy future in Figures 15, 18, and 21:

AUTO	7687	VEHICLE TRIPS
BUS	470	PASSENGER TRIPS
RAIL	764	PASSENGER TRIPS

It would appear very unrealistic for rail trips to so far exceed bus trips. Even the mode split percentages would seem to contradict these figures. Only when one considers the different zone-to-zone "paths" and the greater flexibility of bus routes, do these assignments make sense. In the rail network, trips from southern Michigan traveling north by rail have only two logical "gateways", one at Cadillac and the other at Bay City. Furthermore, the rail lines through Cadillac provide the most reasonable service to the entire northwest region. Therefore, to compare bus assignments with rail assignments, one should consider all of the potential north-south bus routes serving the area.

The multi-modal process also assumes that every rail, bus, and air corridor provide equal service, hence having equal attraction for the traveler. Obviously, this is a faulty assumption, but it should create no real problem if the transportation planner remembers that the process is designed to help locate the most feasible corridors for alternative modes and to measure the probable impact of the alternative modes upon highway needs.

The bus assignments for each of the three selected futures are shown in Figures 18, 19, and 20; the rail assignments are displayed in Figures 21, 22, and 23; and the air assignments are shown in Figures 24, 25, and 26.

FIGURE 15

AUTO MODE

MEDIUM POPULATION GROWTH

ABUNDANT ENERGY FUTURE

*VEHICLE TRIPS

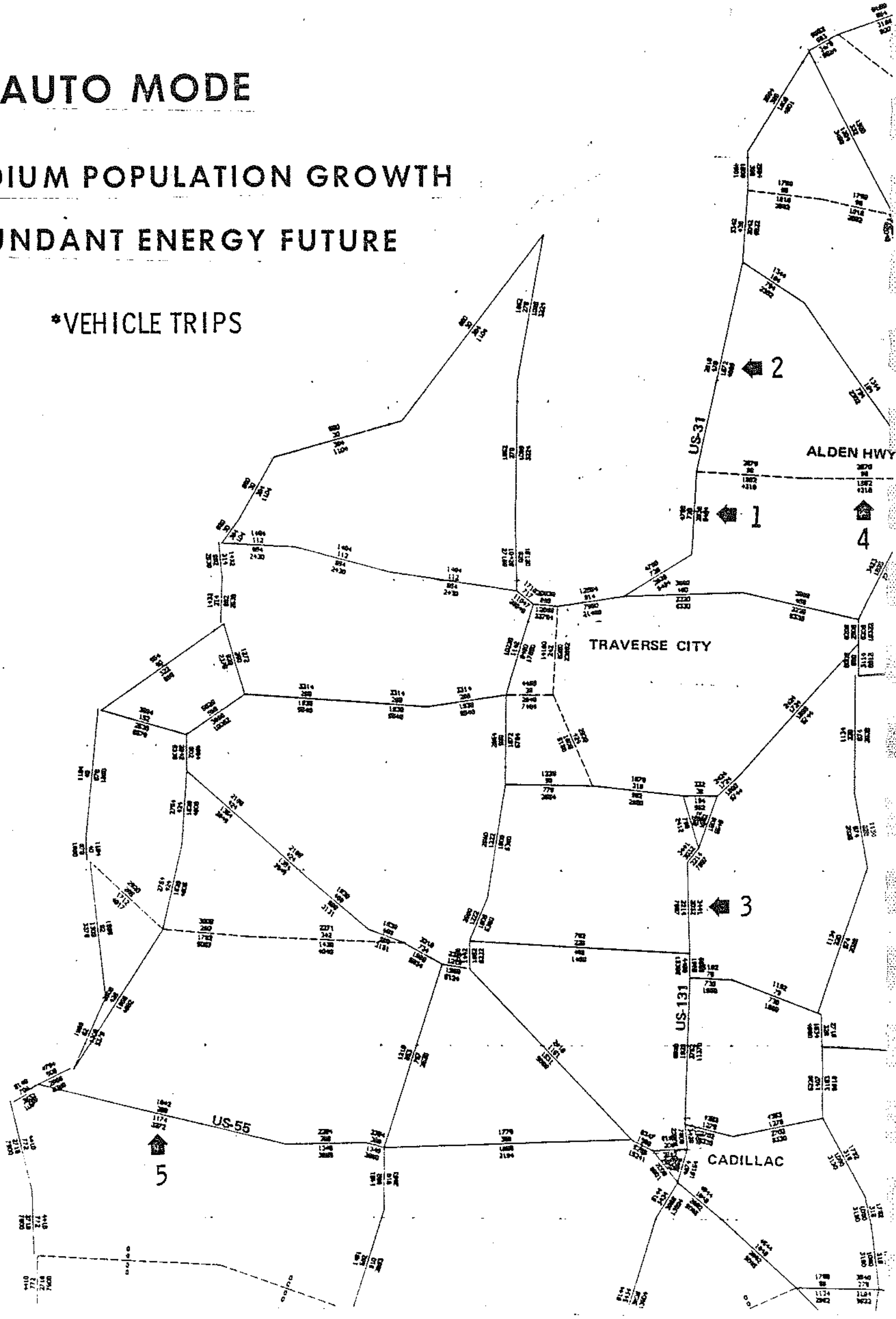


FIGURE 16

AUTO MODE

LOW POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*VEHICLE TRIPS

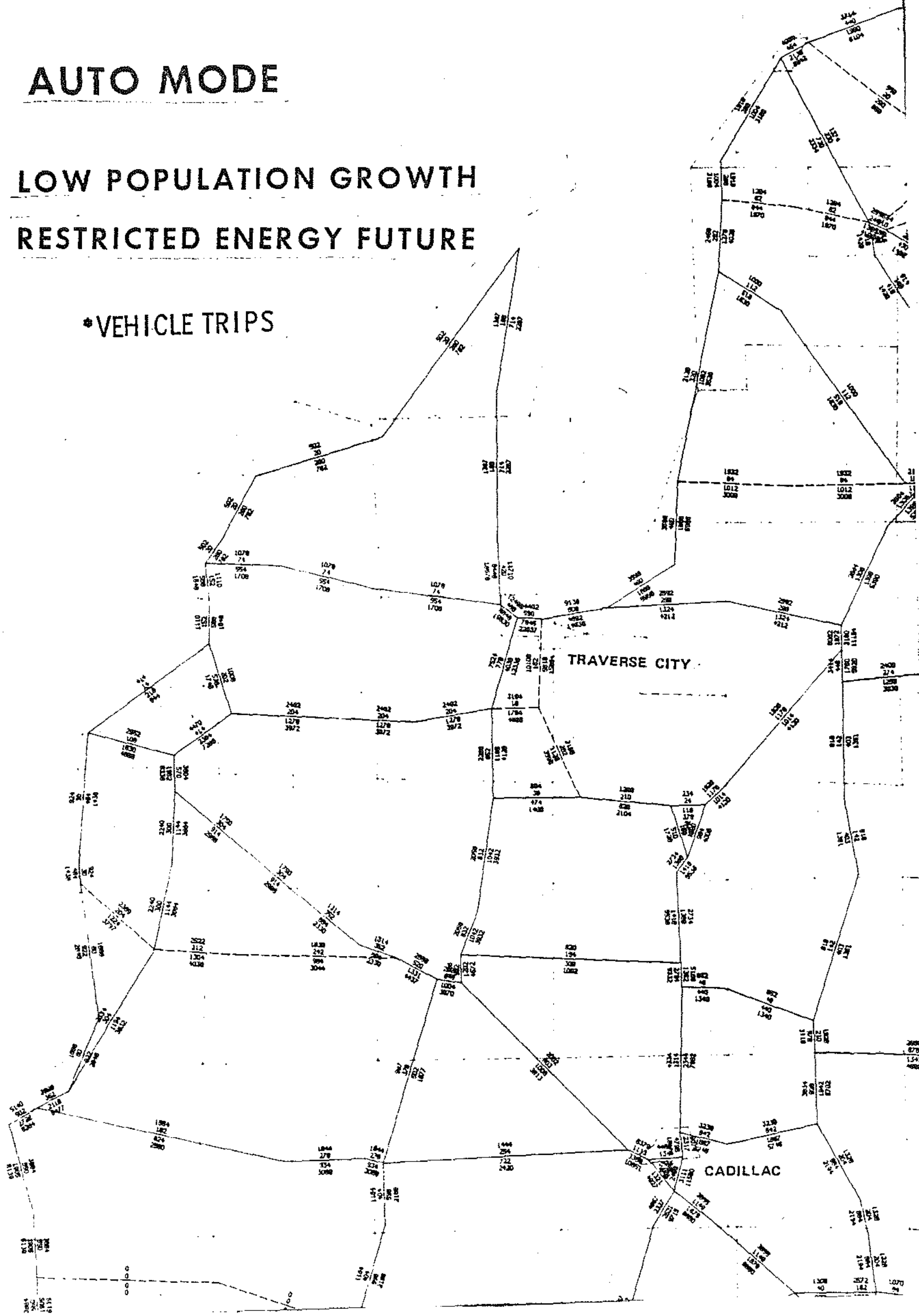


FIGURE 17

AUTO MODE

HIGH POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*VEHICLE TRIPS

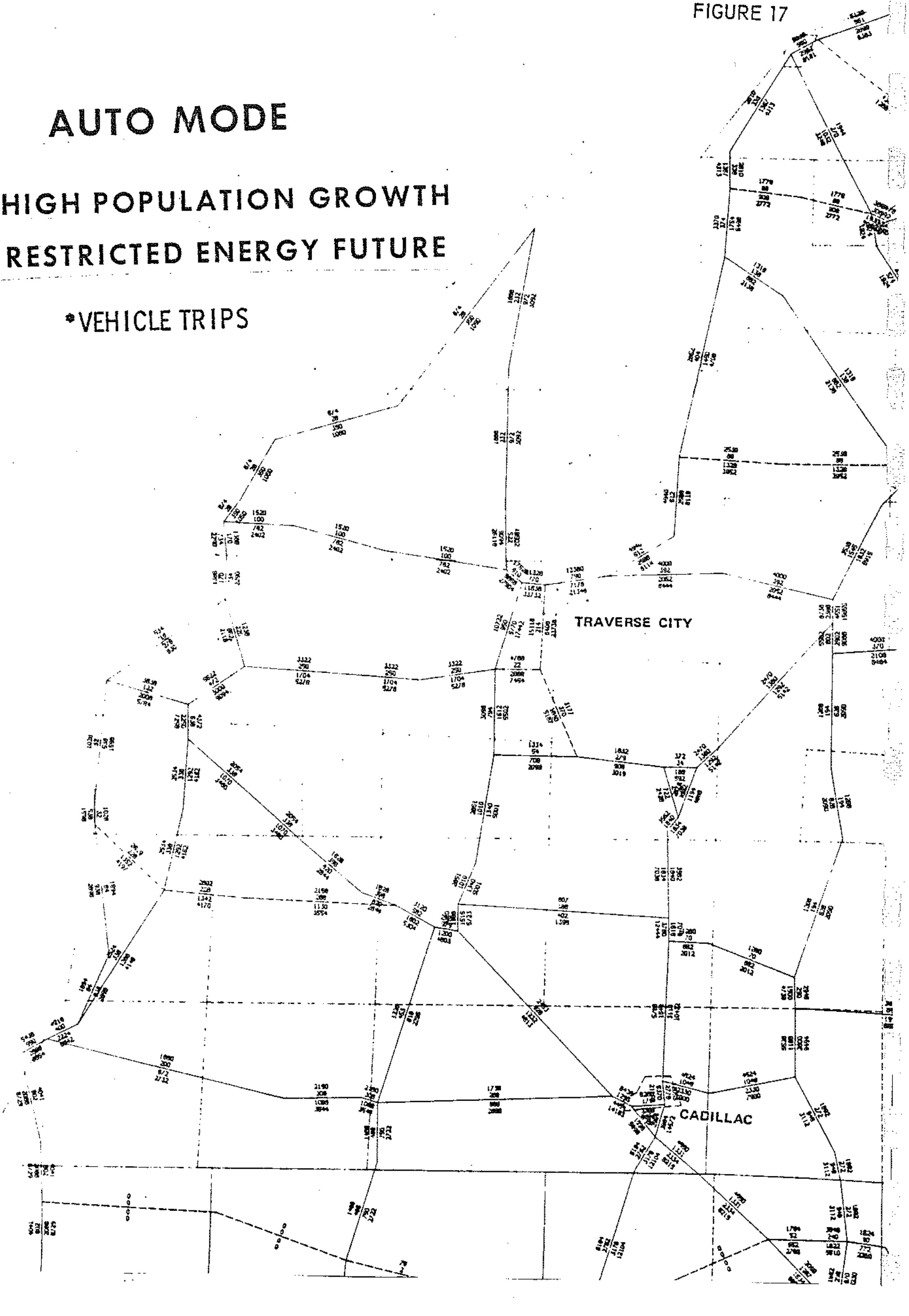


FIGURE 18

BUS MODE

MEDIUM POPULATION GROWTH

ABUNDANT ENERGY FUTURE

*PERSON TRIPS

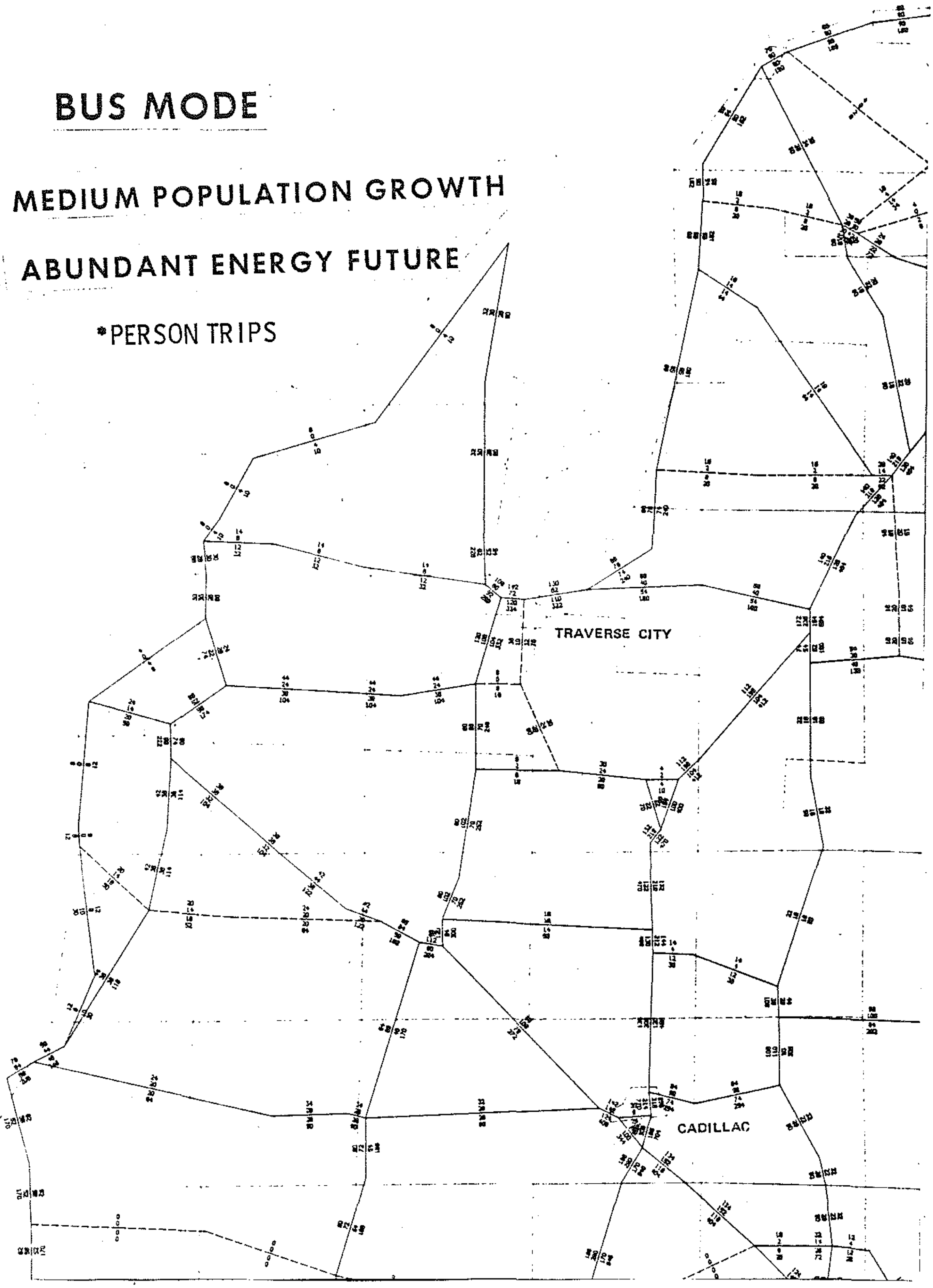


FIGURE 19

BUS MODE

LOW POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS

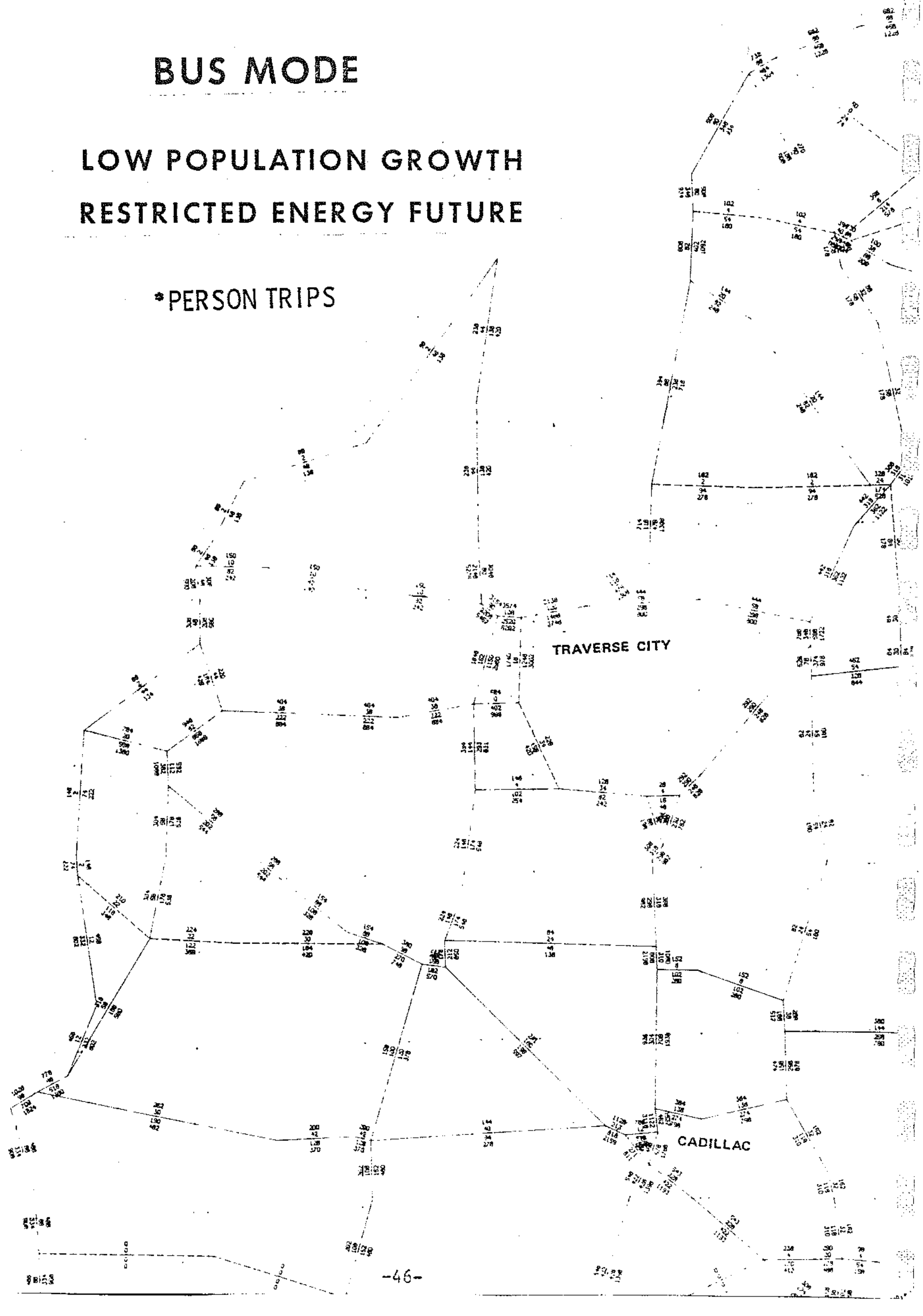


FIGURE 20

BUS MODE

HIGH POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS

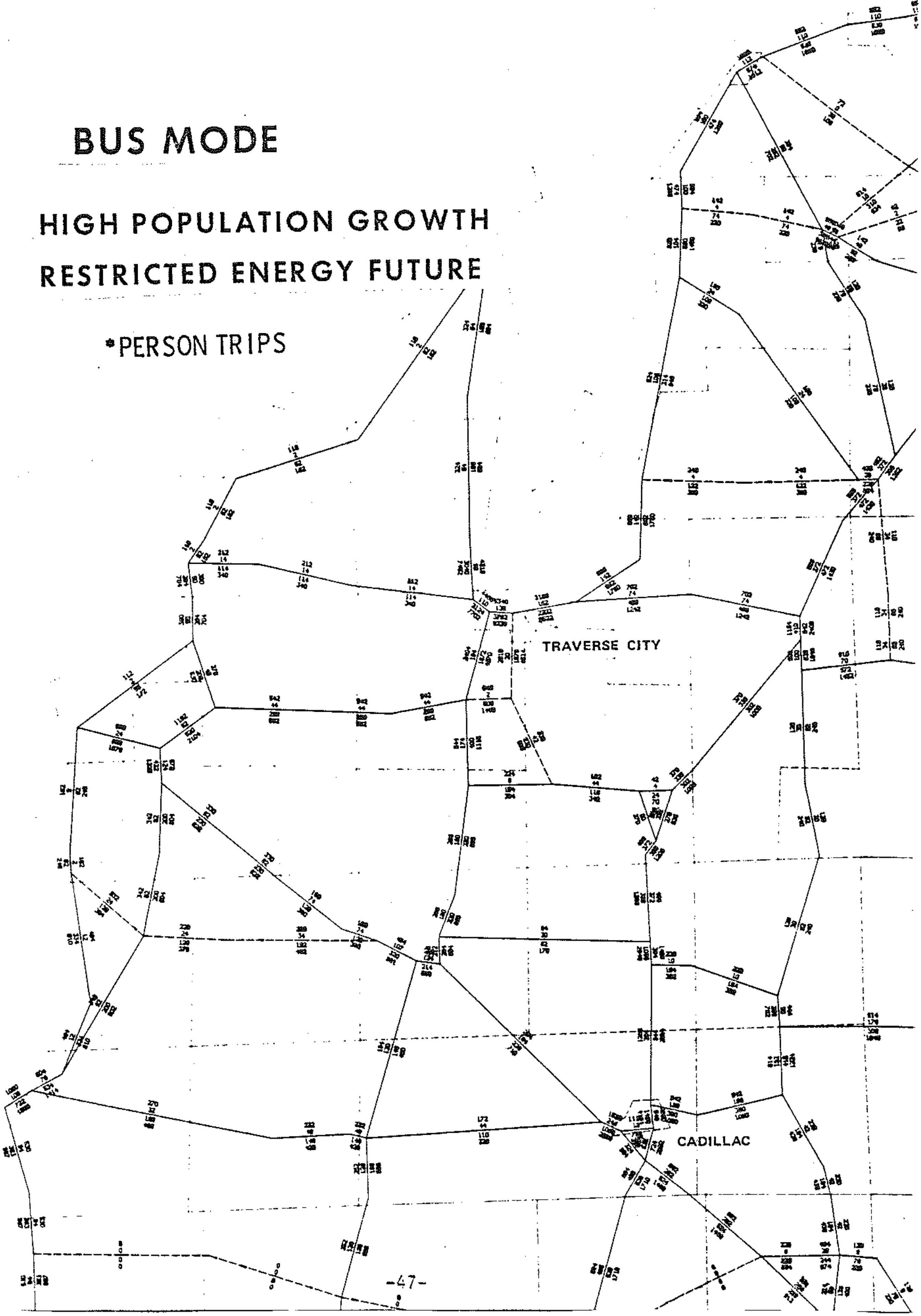


FIGURE 21

RAIL MODE

MEDIUM POPULATION GROWTH
ABUNDANT ENERGY FUTURE

*PERSON TRIPS

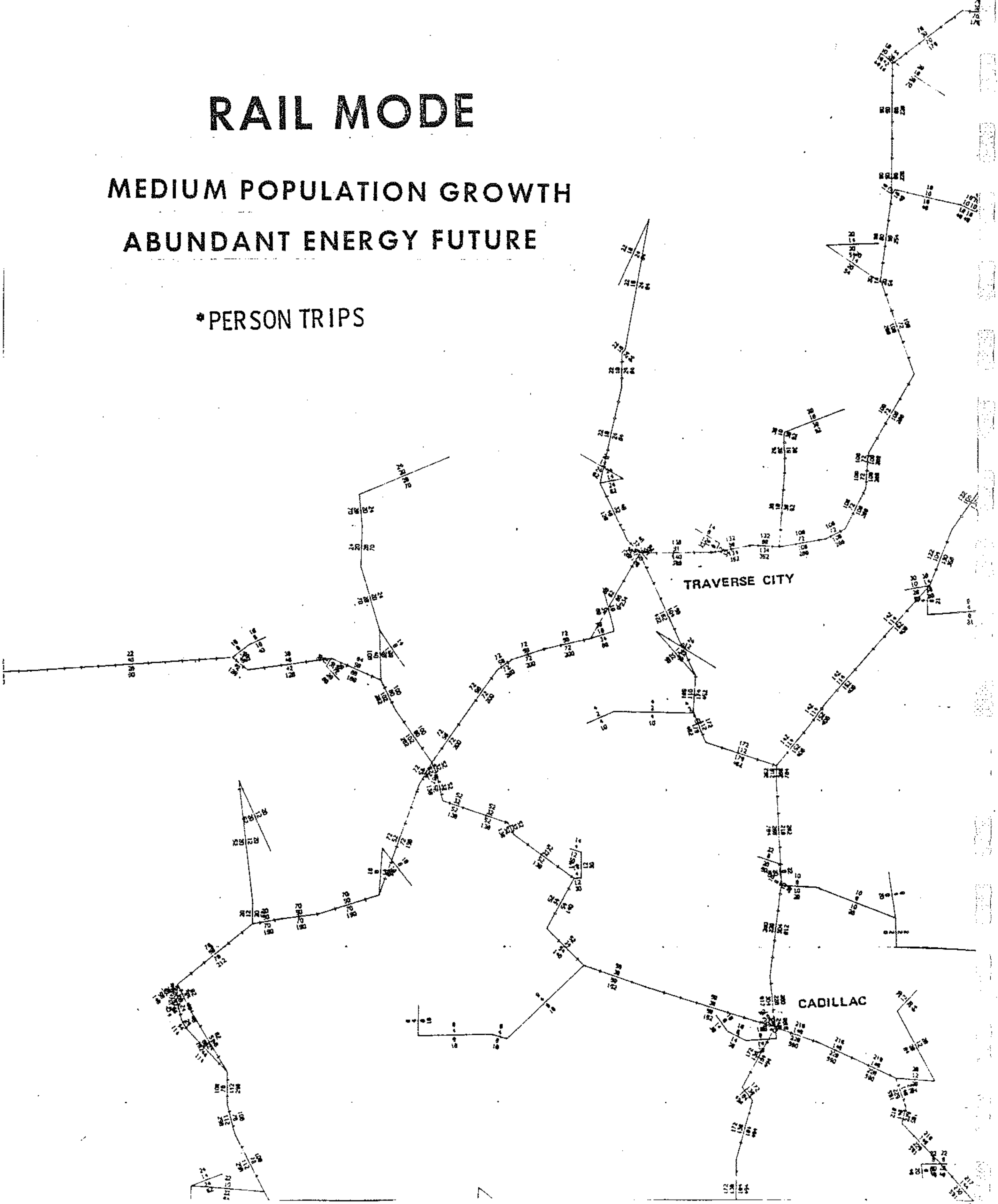


FIGURE 22

RAIL MODE

LOW POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS

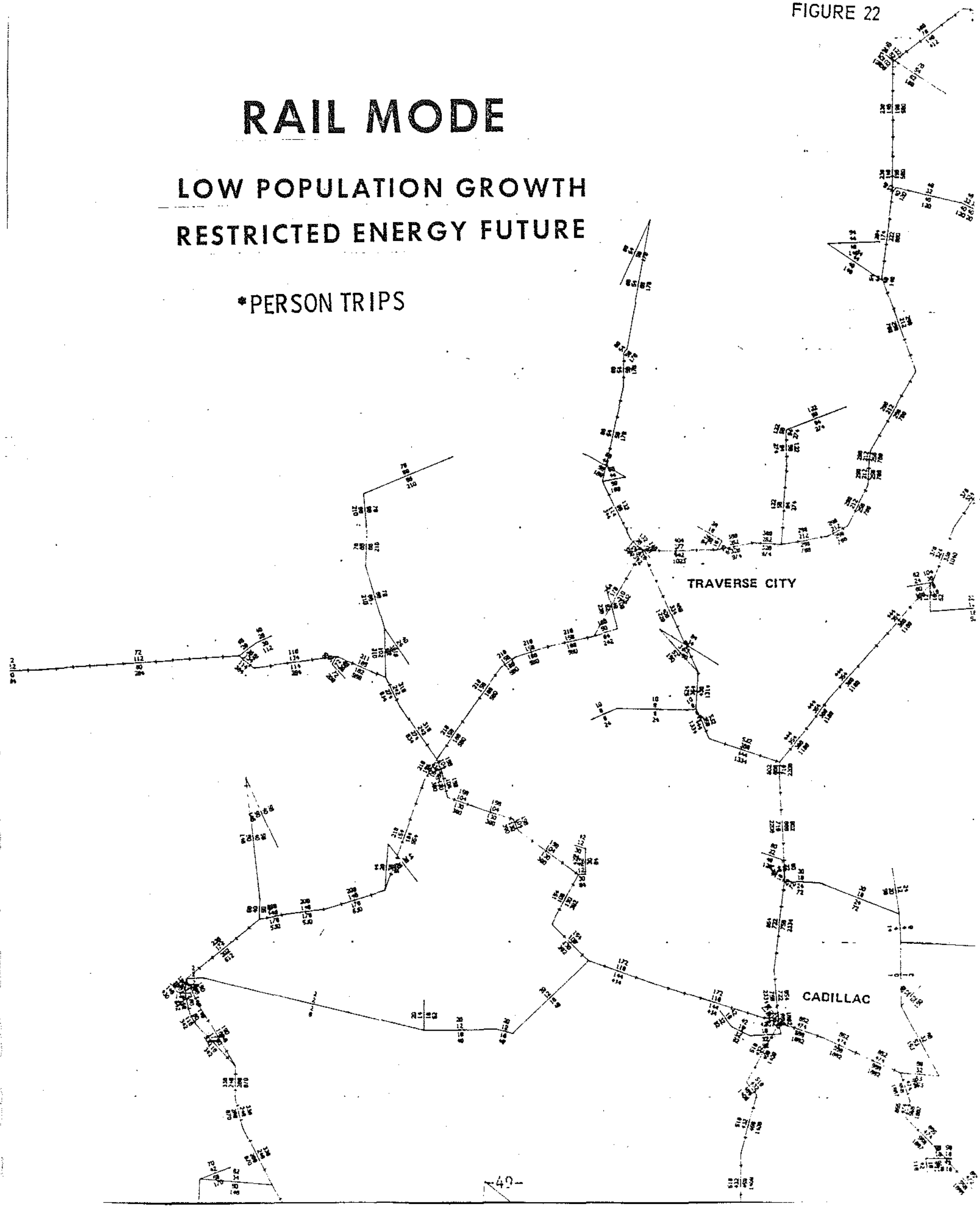


FIGURE 23

RAIL MODE

HIGH POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS

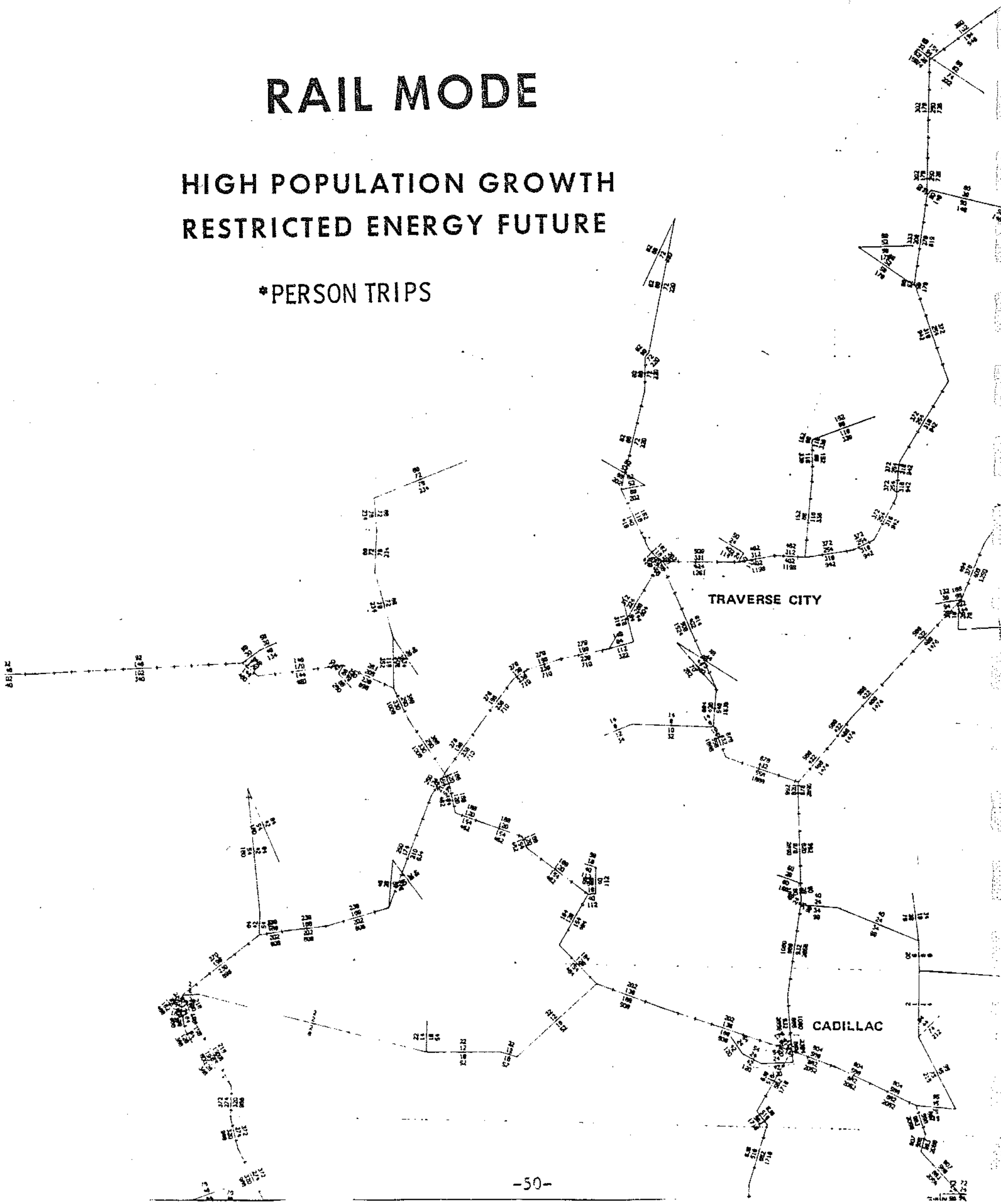


FIGURE 24

AIR MODE

MEDIUM POPULATION GROWTH
ABUNDANT ENERGY FUTURE

*PERSON TRIPS

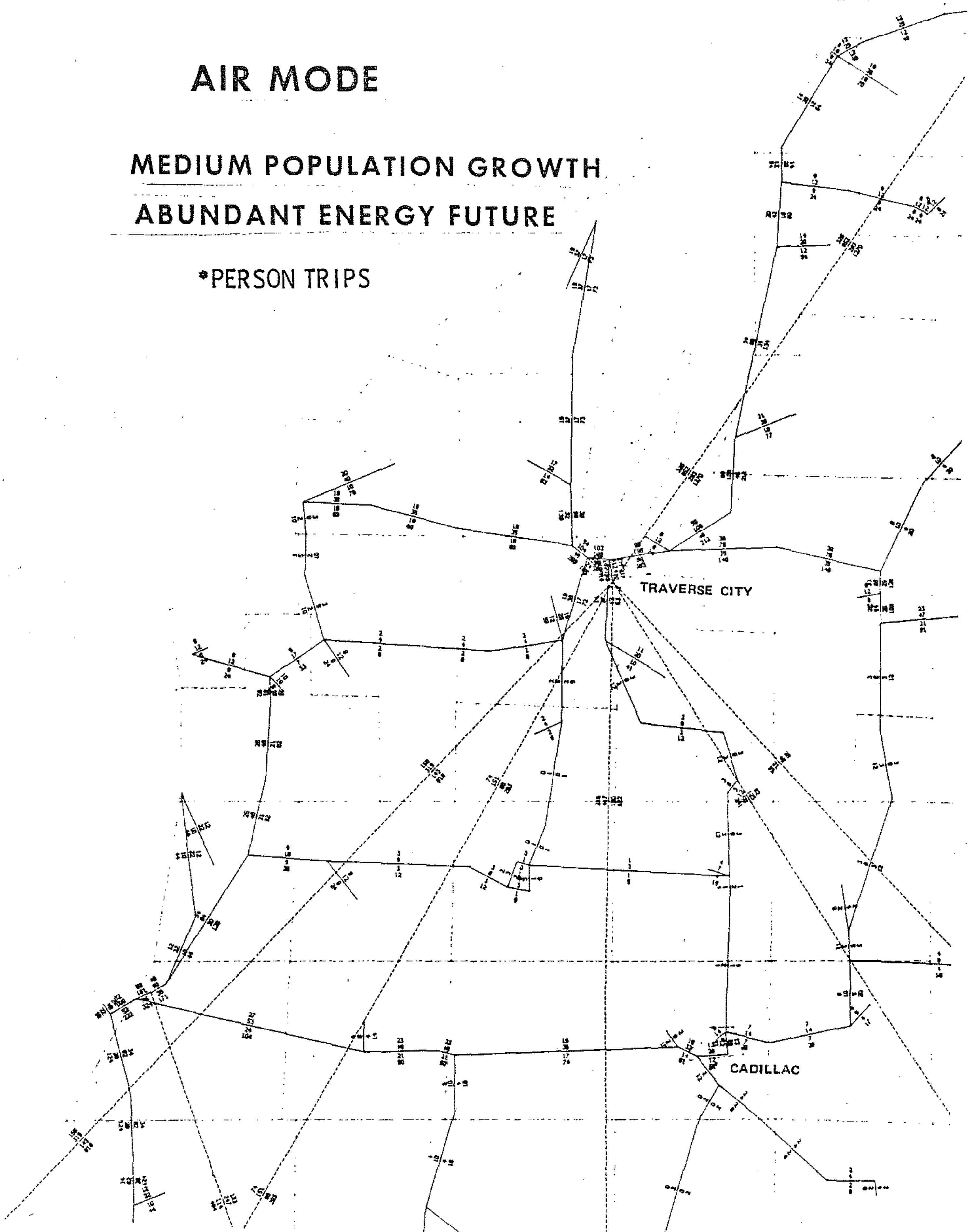


FIGURE 25

AIR MODE

LOW POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS

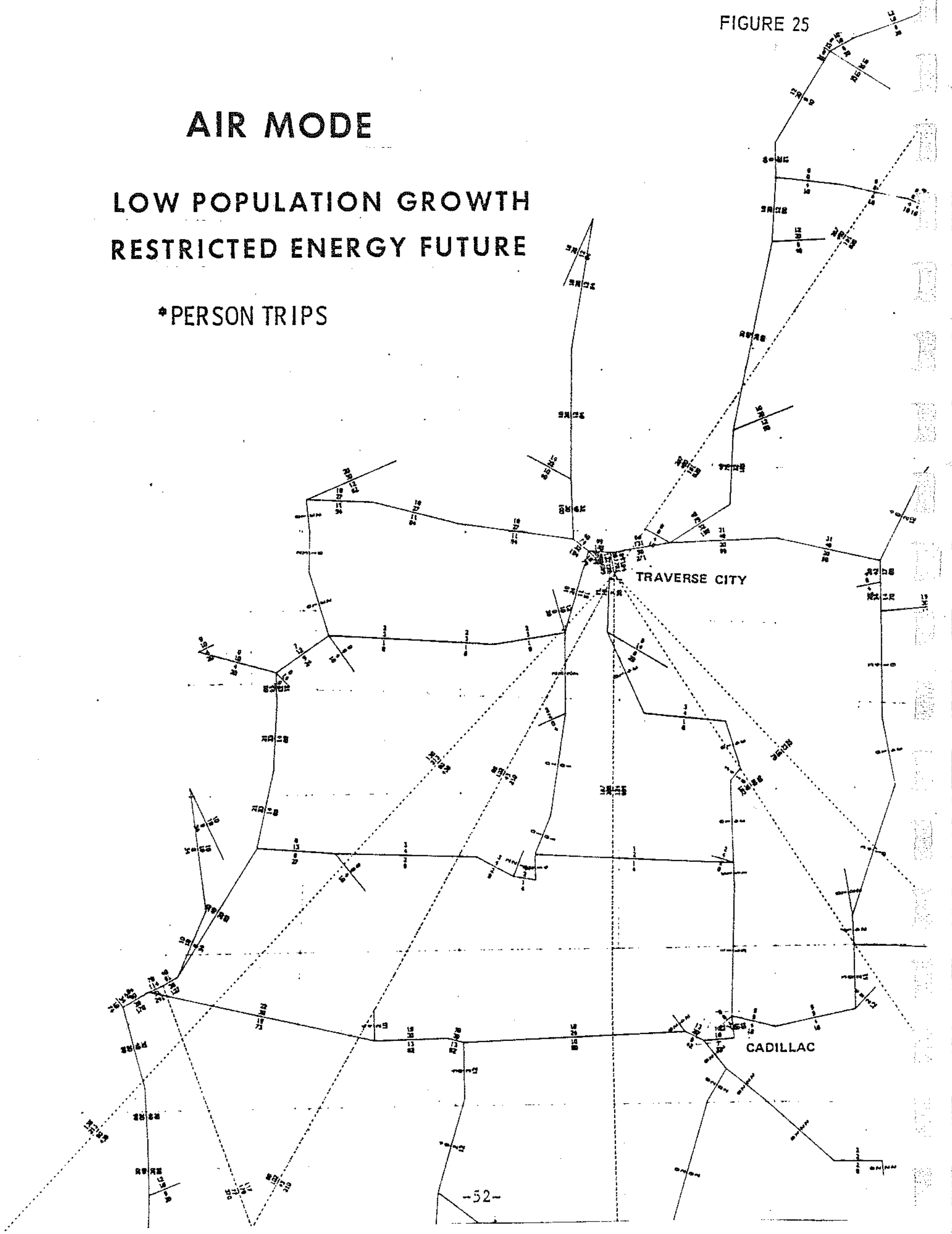
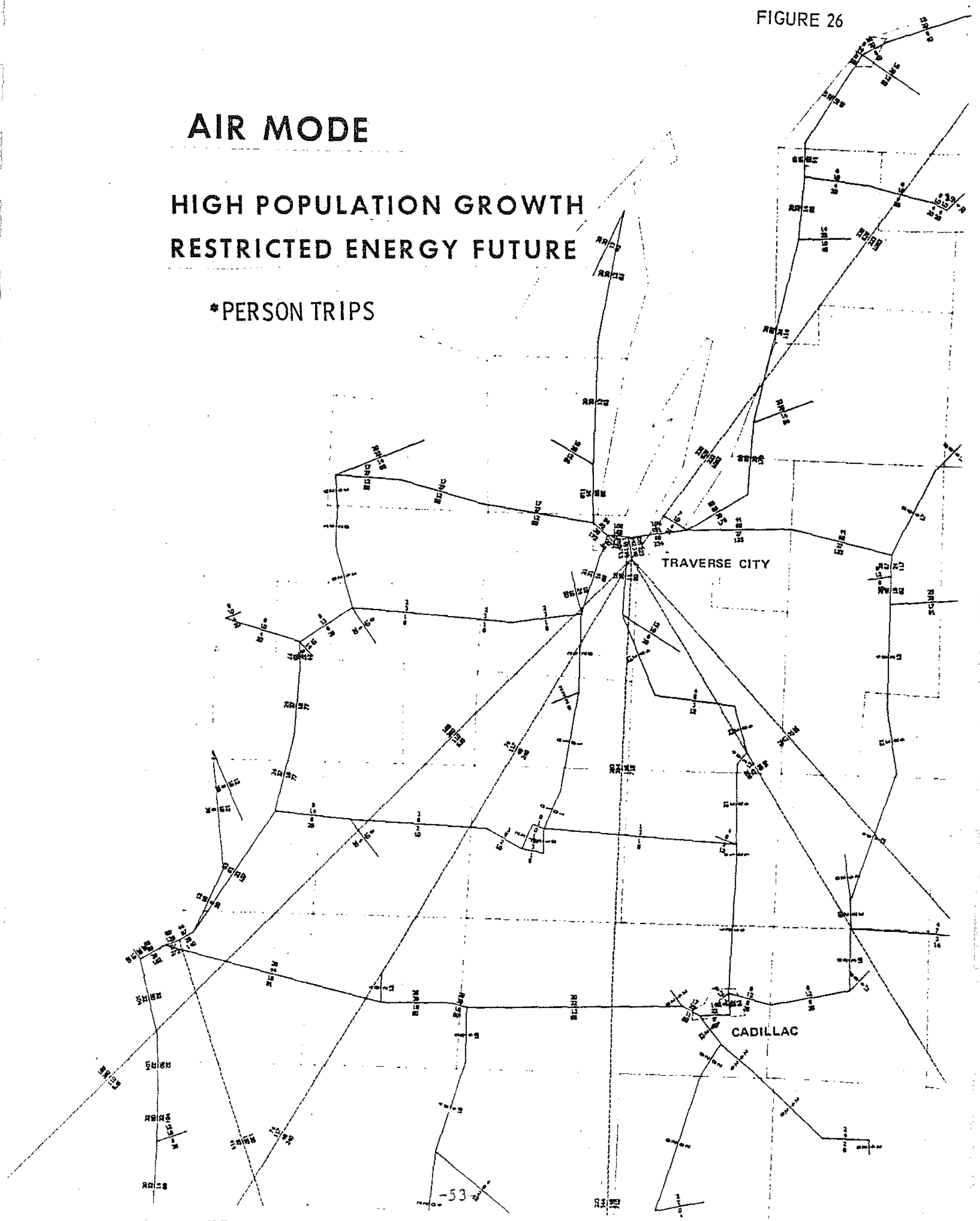


FIGURE 26

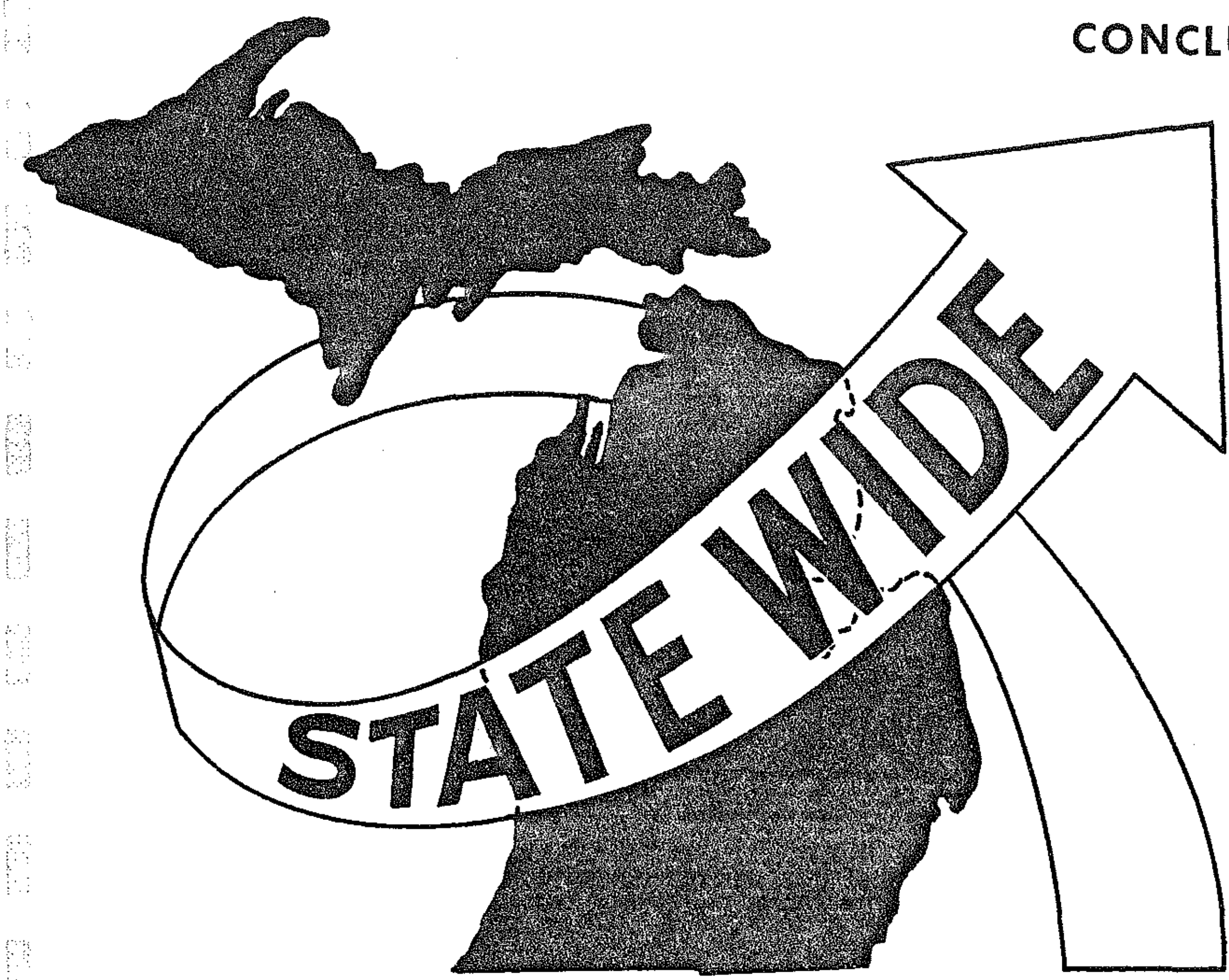
AIR MODE

HIGH POPULATION GROWTH
RESTRICTED ENERGY FUTURE

*PERSON TRIPS



CONCLUSION



CONCLUSION

This report has described a newly developed multi-modal process designed to help measure the interrelated regional or statewide impacts of energy availability, population changes, and an increasing emphasis upon mass transit. It should help locate potential mass transit corridors for rail, bus, and air while also evaluating the effect that such corridors could have upon highway needs. Highway corridors which show grave deficiencies in all probable futures can be located by studying the travel assignments for each of the futures. Such corridors may then be assigned a high priority, while deficiencies showing in only a few of the probable futures may be assigned lower priorities.

The objective of this report was to describe a process which enables one to explore the potential diversion of different auto trip purposes for varying futures and the impact the diversion would have upon transportation needs and deficiencies. The variables most often discussed by administrators , transportation planners, and citizens have been defined simply and are easily explained. This enables one to quickly and easily change desired variables, evaluating transportation needs to accurately reflect current policy issues. The application of the process shows, however, that it is also extremely complex and technical. Changes in population, energy availability, etc., do not cause uniform changes in all travel corridors. Transportation deficiencies and demands vary considerably dependent upon the travel characteristics of any route.

The application of this process in the northwest region was described in detail to help show that the process is in fact sensitive to all of the desired variables. These variables included not only the assumptions about modal selection in "energy short" futures, but also population changes and general road usage characteristics. Furthermore, the multi-modal process utilizes tools previously developed for Michigan's Statewide Modeling System and hence is completely compatible with that system. This compatibility with the existing statewide modeling system will ensure that all pertinent additions, and improvements to that system will be immediately a' ''able for use in the multi-modal process.

Anyone wishing to offer suggestions or comments on this multi-modal process or desiring further information is urged to contact:

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