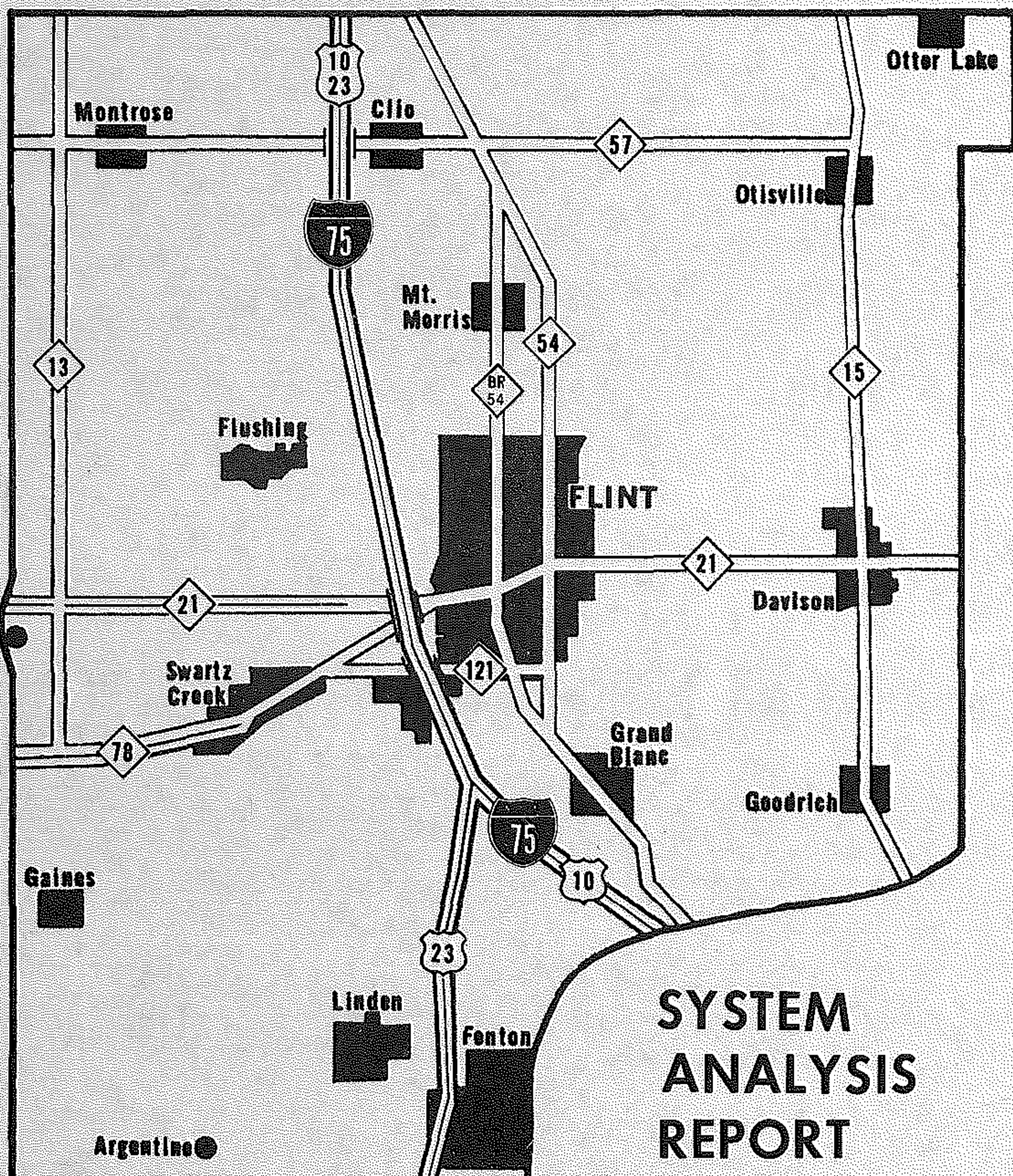
FLINT-GENESEE COUNTY TRANSPORTATION STUDY



SYSTEM ANALYSIS REPORT 1

State of Michigan · Department of State Highways

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

In Cooperation With:

U.S. Department of Transportation

System Analysis Report 1

The I-475 Corridor From Court (Fifth) to Stewart Ave. Flint-Genesee Co.

October, 1972

TRANSPORTATION PLANNING DIVISION

Sam F. Cryderman
Engineer of Transportation Planning

TRANSPORTATION SURVEY & ANALYSIS SECTION

K. E. Bushnell, Engineer

NORTHEAST UNIT

Supervisor Maynard Christensen

Transportation Analyst Michael D. Oberlein

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OFFICE MEMORANDUM

MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

May 2, 1972

To: Keith Bushnell, Engineer of Transportation, Survey and Analysis Section

From: G. Robert Adams
Public Hearings Engineer

Subject:

The Environmental Liaison Unit is currently in the process of preparing the Environmental Impact Statements for the following two projects:

Draft EIS - I-475 (M-78 Interchange at 5th Street to Stewart Avenue, Flint)

Final EIS - I-696 (Lahser Road to I-75, Oakland County).

To comply with requirements of the Environmental Protection Agency for urban freeway Environmental Impact Statements, the following traffic information is necessary for both the above projects:

1. Projected traffic volumes in five-year intervals up to 20 years after construction,
2. Peak hourly volumes, where peaks occur and the duration of the peak,
3. Average speed,
4. Length of average trip on the freeways,
5. Relative number of various types of vehicles.

All projections should take into account the general tendency of local residents to make more trips when good highway facilities are available.

Public Hearings Engineer

GRA:AWJ:fs

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1545
(Rev. 3/68)

REQUEST FOR TRAFFIC INFORMATION

Date 2-24-72

To: K. E. Bushnell, Engineer
Transportation Survey and Analysis Section
Transportation Planning Division

Control Section No. (s) 25051

Project No. 03104 C

Please furnish the following traffic data at the following location,

Route M54 BR, County Genessee, Description from Junction with M54 (Dort Hwy.) 2.8 miles to M78

	PRESENT YEAR	FUTURE YEAR DIRECTIONAL	FUTURE YEAR TOTAL
A.D.T.	After	I-475 is	open.
30th H.V.	3500	← "	
Per Cent Comm. of A.D.T.	8%	"	
of D.H.V.			

☐ Vehicle Turning Movement
☐ Classified Turning Movement
☐ Other ____ SPECIFY

This data is intended for use in:

20740

☐ Preliminary Location Study
☐ Program Estimating
☐ Future Lane Requirements

Design
☐ Road Capacity
☐ Bridge Capacity
☐ Ramp Capacity

☐ Road Closures
☒ Proposed Trunkline Abandonment
☐ Bituminous Project
☐ Other ____ SPECIFY

AVAILABLE DATA

☐ Land Use Map ☐ Population Trend ☐ Origin & Destination Study

☐ Other (Specify) ____

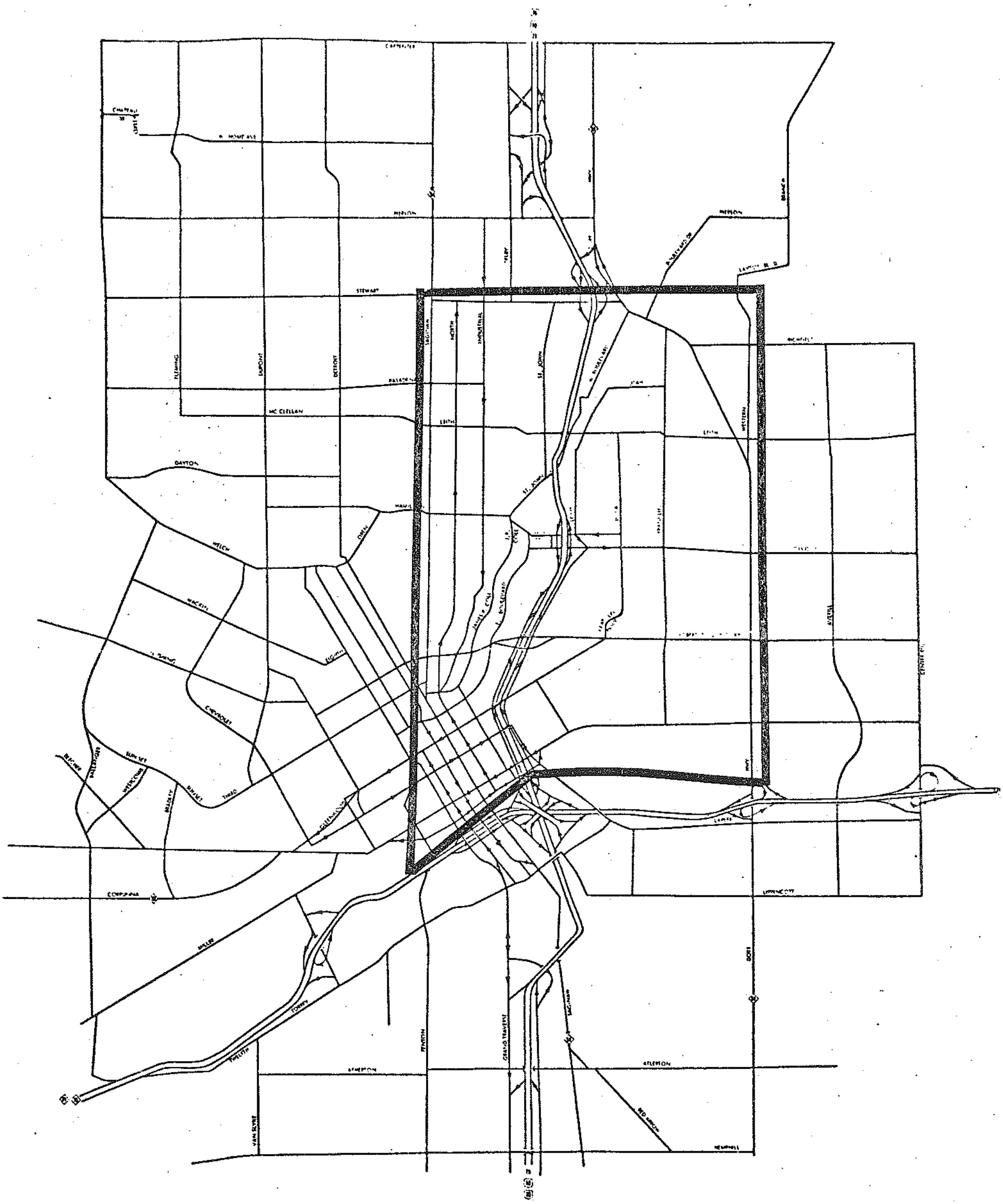
Remarks: ____

Requested by Ransom Abel
Squad Leader
Road Design
DIVISION

DATE NEEDED March 2, 1972

Entered 7-25-72

ATTACHED ARE 2 PRINTS SHOWING PROJECT LOCATION



City of Flint ▬▬▬ Study Area

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INTRODUCTION

The Northeast Area Transportation Analysis Unit of the Transportation Survey and Analysis Section has recently completed the development of travel forecast models for the Flint-Genesee County Comprehensive Land-Use Transportation Planning Study. Using these models and projections of socio-economic data based upon the 1990 Land-Use Plan published by the Genesee County Metropolitan Planning Commission, we have produced forecasts of 1995 trips. We have assigned these trips to a street network which includes existing routes and routes which to date, have been committed to be constructed. This network includes the entire I-475 freeway. Analysis of deficiencies in the committed network has begun and solutions to expected deficiencies will be tested utilizing the traffic assignment process. The ultimate goal of this analysis and testing will be a 1995 Transportation Plan for Flint and Genesee County which best satisfies the stated goals of the participating agencies which a future transportation system must achieve.

Environmental Impact will be one of the criteria against which proposals for the future plan will be tested. The specific measures of environmental impact will be formulated by the participating local governmental agencies in cooperation with the MDSH. Minimum levels of environmental quality will no doubt be established.

In view of the analyses related to environmental impact to be undertaken in the next twelve months, considerable thought and effort has been devoted to developing methodologies which will enable us to determine the system-wide environmental ramifications of various alternate proposals for transportation system improvements. These methodologies address themselves to the specific traffic data needs spelled out in the draft PPM 90-2 and the letter of response to the Draft Environmental Impact Statement for I-696, Lasher to I-75 (from the Region 5 office of the Environmental Protection Agency to G. Robert Adams, Public Hearings Engineer, MDSH received 4-20-72).

The latter document was transmitted to Keith Bushnell in an office memorandum dated May 17, 1972. The memo states that "this letter specifically outlines the various types of traffic information that will be needed by our Testing and Research Division as a basis for noise and air pollution studies now being conducted." Our interpretation of the data necessary to comply with the guidelines governing draft and final environmental impact statements is presented in the paragraphs which follow.

DATA NEEDS BASED UPON PPM 90-2

PPM 90-2 lists 3 traffic items which "shall be used" in predicting noise levels (Attachment 1, Section 3, Paragraph (a), Items 1, 2 and 3).

1. Automobile Volume - DHV or level of service C capacity, whichever is less.

2. Speed - running speed which corresponds with (1) above, and truck traffic (3) below.

3. Truck Traffic - DHV truck volume (truck being defined in appendix A as "a motor vehicle having a gross vehi cle weight greater than 10,000 lbs., and buses having a capacity exceeding 15 passengers").

Paragraph (a) also states, "The prediction method and the noise level predictions should account for variations in traffic characteristics (volumes, speed and truck traffic), topography (vegetation, barriers, height and distance), and roadway characteristics (configuration, pavement types and grades)".

For a given highway section the three characteristics of traffic listed above should be known at each portion of the highway section where the traffic characteristics themselves vary, where the topography varies, and where the characteristics of the roadway vary. When variations have been identified and traffic characteristics for each portion are known, noise levels will be predicted for each portion. It is clear from the PPM that where traffic characteristics vary, traffic characteristics will have to be provided to produce sufficient data for a complete prediction and analysis of noise levels in the I-475 highway section. A glance at the 1995 traffic assignment to the I-475 highway section indicates that ADT varies from link to link on the corridor and consequently "traffic characteristics" should be provided for each link in the highway section.

Inclusion of the ramps, service roads, intersecting and grade separated streets is necessary to obtain an adequate assessment of the characteristics of the traffic overall. For example, where service roads parallel the freeway lanes, the characteristics of the service road traffic should be included when predicting the noise levels generated in the highway section. Similarly the noise levels generated at interchanges would clearly exceed those levels predicted for portions of the highway section which lie between interchanges.

Therefore, to provide satisfactory documentation for the E.I.S. relevant to noise pollution it will be necessary to provide the auto DHV, Running Speed and Truck DHV for each segment of the I-475 highway section; namely, all freeway, ramp, service road and cross street links involved in the project.

DATA NEEDS BASED UPON EPA RESPONSE TO I-696 DRAFT E.I.S.

The EPA letter in response to the I-696 Draft E.I.S. requires further refinement of the items discussed above and several additional data items. The additional items required are:

1. Projections of traffic volumes in 5 year intervals to 20 years [Page 2, Air Pollution, Paragraph 3, item (a)], and projection of traffic 2 years after completion of route (Page 3, Noise Pollution, second paragraph).

2. Average trip length on Freeway (Page 2, Air Pollution, paragraph 3, Item c).

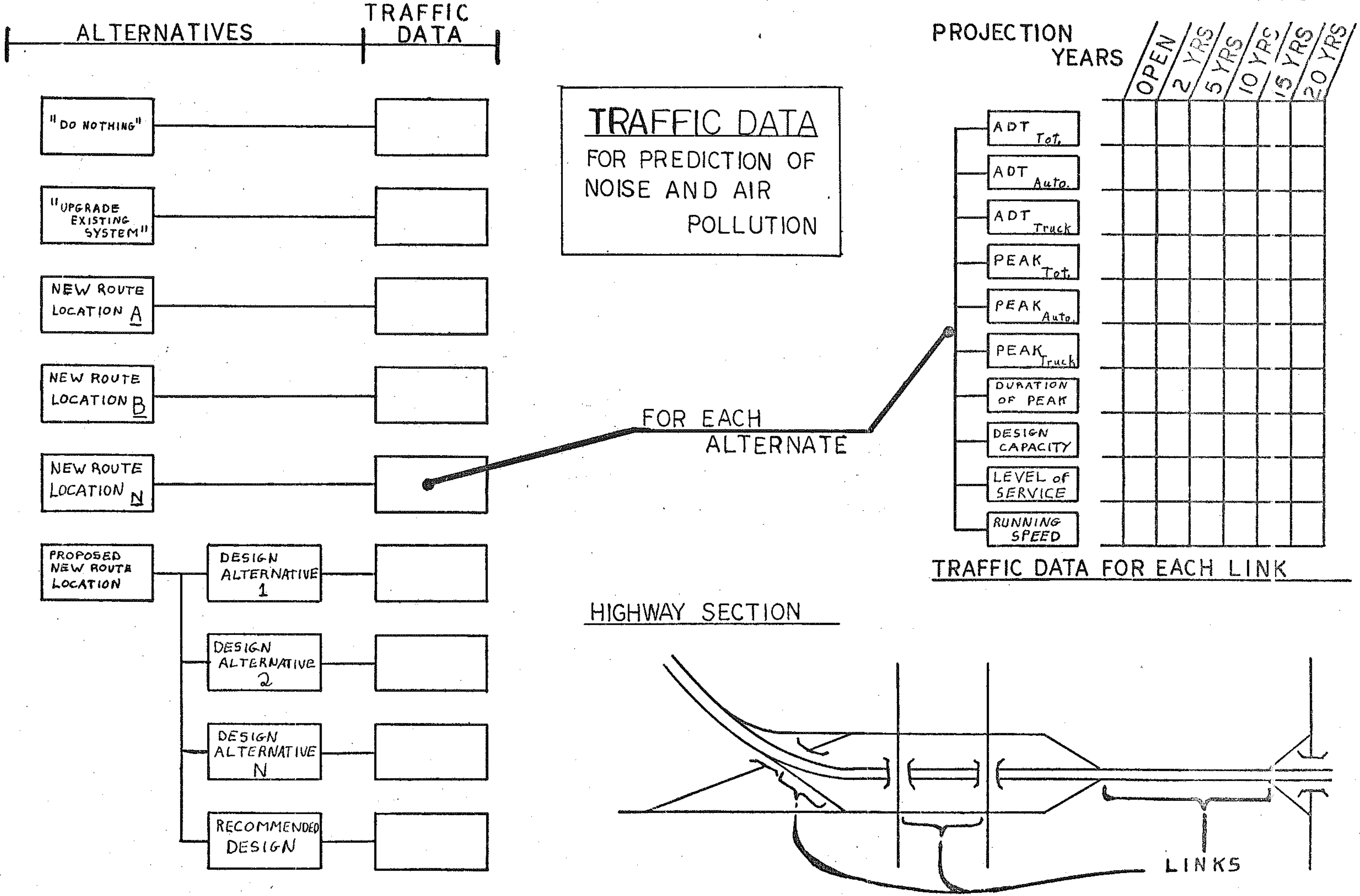
3. Discussion of "alternatives to the proposed action" including the "do nothing alternative" and "consideration given to updating the existing street network in lieu of a freeway project in the study area" (page 1, first paragraph; pages 3 and 4, Alternatives).

Refinements to previously discussed data requirements include:

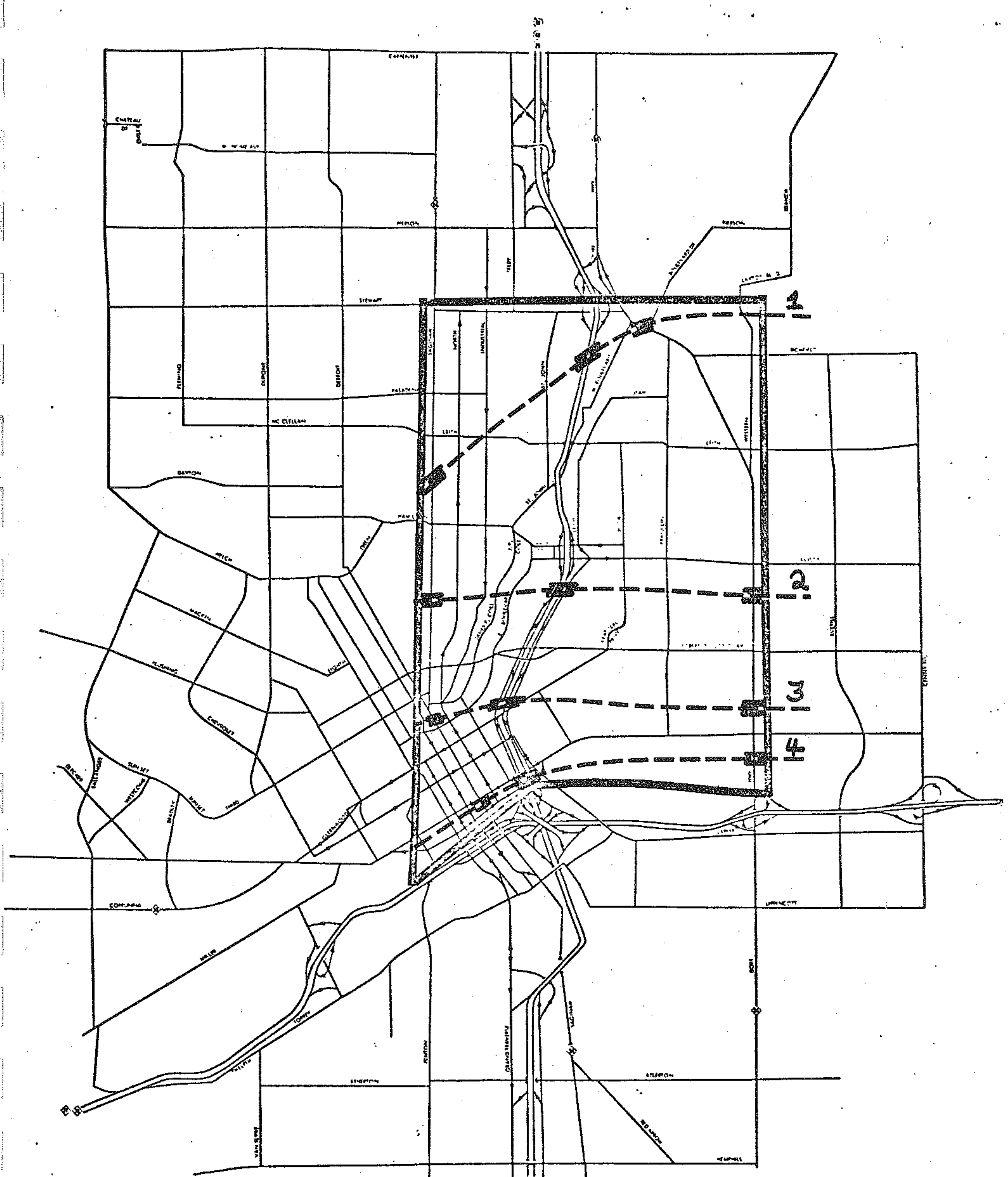
1. The duration of peak volume (Air Pollution, page 2, paragraph 3, item b).

2. Accounting for "the general tendency of local residents to make more trips when good highway facilities are available" and the likelihood that "peak traffic volumes may result in a level of service C or lower and a corresponding reduction in operating efficiency". (Page 2, Air Pollution, Paragraph 3, last sentence; page 4, Alternatives, second paragraph).

When all of the data requirements discussed thus far are combined, the data system shown on the attached chart emerges as the sum total of the traffic data required for acceptable predictions of noise and air pollution on any highway section. The most efficient and reliable method of obtaining these data items is through the use of the forecast models and traffic assignment methodologies which have been developed in the course of the Flint Transportation Study.



ALTERNATIVES
TRAFFIC DATA
"DO NOTHING"
"UPGRADE EXISTING SYSTEM"
NEW ROUTE LOCATION A
NEW ROUTE LOCATION B
NEW ROUTE LOCATION N
PROPOSED NEW ROUTE LOCATION
DESIGN ALTERNATIVE 1
DESIGN ALTERNATIVE 2
DESIGN ALTERNATIVE N
RECOMMENDED DESIGN
TRAFFIC DATA
FOR PREDICTION OF NOISE AND AIR POLLUTION
FOR EACH ALTERNATE
PROJECTION YEARS
OPEN
2 YRS
5 YRS
10 YRS
15 YRS
20 YRS
ADT Tot.
ADT Auto.
ADT Truck
PEAK Tot.
PEAK Auto.
PEAK Truck
DURATION OF PEAK
DESIGN CAPACITY
LEVEL of SERVICE
RUNNING SPEED
TRAFFIC DATA FOR EACH LINK
HIGHWAY SECTION
LINKS



Cutline Location

Study Area

City of Flint

STUDY AREA: THE I-475 CORRIDOR

The Study Area Map indicates that routes other than I-475 are included in this analysis. The three major north-south facilities within the study area, M-54, M-54BR and I-475 (plus the service roads where they occur) were included in the analysis for reasons explained in the following paragraphs.

The very best source of projected traffic volumes in terms of methodological sophistication and accuracy of results are computer traffic assignments of future trips to the Flint-Genesee County street network. It was stated in the introduction that the first of these assignments has been made to the existing plus committed network.

Volumes resulting from this assignment represent the future demand for travel assuming that all facilities can handle the volume of trips desiring to use them. This assumption generally produces volumes on many streets which exceed the possible capacity of the streets. In the course of the analysis of future trips on the existing plus committed system, facility capacities are used to restrain volumes in subsequent traffic assignments in order to redistribute excess trips to routes with capacity in excess of the volume produced in the demand assignment. The result of the capacity restraint process is a set of link volumes which more accurately represents the "on the ground" distribution of trips in the target year. The capacity restraint process is presently underway in the Flint-Genesee County Study.

However, because the process is incomplete, it was necessary to accomplish the redistribution of the trips by another method in order to obtain the data necessary to produce this report.

The method developed is similar to the capacity restraint methodology described above. The most important difference is that it was applied to only a small portion of one travel corridor in the city of Flint while the computer restraint process is applied to the entire Genesee County network.

The demand assignment produced total 1995 volumes approaching 200,000 trips on certain portions of I-475. Volumes of this size are well beyond the possible capacity of the freeway. Consequently a number of these trips will of necessity seek alternate routes. The number of trips diverted to parallel facilities will depend upon the capacity available on these facilities. The viable alternative routes for I-475 are the existing trunklines in the corridor namely M-54 (Dort) and M-54BR (Saginaw). Therefore these two routes were studied along with I-475.

Traffic movement through the corridor was sampled at four locations. On I-475, the locations fall between the interchanges within the study area limits. On the parallel existing routes, M-54 and M-54BR, the locations are roughly in line with those on the freeway. Where variation appears, it represents an attempt to sample the highest volume within that specific section of the roadway. The four locations are shown on the page 6 and will be referred to as "cutlines" throughout the report.

OUTLINE OF METHODOLOGY

In review, the traffic data necessary for proper noise and air pollution prediction are total, truck, and auto average daily traffic; total, truck and auto peak period traffic; and running speed, level of service and duration of peak period. These data are required for each highway section, projected from the year of opening in five year increments to the target year. The "do nothing" alternative must be assessed along with the alternatives or upgrading the existing system and the use of alternate modes of transportation.

The Flint-Genesee County Study has not progressed to the point at which alternate modes can be tested. The "do nothing" alternative and the efficiency of upgrading the existing system are not specifically treated in this document. However, the ineffectiveness of either alternative is clear when the results of the analysis provided in this report are examined.

The methodology outlined below is built upon data available at this point in the Flint-Genesee County Transportation Study. These data are the 1995 demand traffic assignment, the overall growth in trips in Genesee County, and an extensive analysis of capacity on the routes in the corridor. Using these data and the analysis procedure which follows, the projections of specific future traffic volumes were developed.

1. Establish available corridor capacity at levels of service C, D and E.

2. Establish the overall growth in trips from 1966 (the Flint-Genesee County Transportation Study base year) to 1995.
3. Based upon the growth to 1995 (#2) interpolate the growth for 1975, 1980, 1985 and 1990 projection years.
4. Establish 1995 corridor volume at each cutline location based upon the 1995 demand traffic assignment.
5. Determine the corridor volumes at each cutline for the preceding projection years by applying the growth data developed in #3.

To this point, a data base for the corridor has been completed. Corridor and route capacities at each cutline have been determined at three levels of service. Total corridor volume at each cutline has been established for all of the projection years. The next task is to distribute the projected trips to the individual routes based upon the available capacity of the routes.

6. Determine the percentage of the total corridor capacity that each component route comprises at levels of service C, D and E.
7. On a graph showing percentage of total volume on one axis and ascending total corridor volume on the other, locate the volume for the corridor which represents total corridor capacity at levels of service C, D and E. (A separate graph is prepared for each of the four cutlines). Plot the points on

each level of service line that represent the percentage of the total capacity which is provided by each component route in the corridor. Fit a curve through the three points (level C, D and E) for each route. These curves represent the changes in component route percentage of total corridor volume as total volume increases.

8. For each cutline, locate on the total volume axis of the graph, developed in #7, the volume which corresponds to the projected corridor volume at each five year interval (#5). Reading the curves for each component route, determine the percentage of the corridor total that each route comprises at each five year interval.

9. For each projection interval apply the route percentages to the corridor volume total. The resulting figures provide daily traffic projections for each route, for each projection year at each cutline.

The data established to this point, namely, total average daily traffic expected at each cutline location, on each route, for each projection year, serves as the base for the remaining calculations. Daily truck traffic, and high hour total, truck, and auto traffic are determined based upon assumptions utilized in determining capacity. Operating speed requires interpolation of the type used in determining route percent of total volume discussed above.

10. Apply the peak hour percentage assumed in the capacity determination (.093) to each of the average daily

traffic volumes and the high hour volumes (developed in 9 and 10). This produces the number of trucks at the high hour and through 24 hours for each route, location, and projection year.

11. Apply the truck factor (.05) assumed in the determination of capacity to the average daily traffic volumes and the high hour volumes (developed in 9 and 10). This produces the number of trucks at each route, location, and projection year.

12. Prepare a graph for each cutline with increasing total corridor volume on one axis and operating speed (miles per hour) on the other. Locate the total corridor volume associated with levels of service C, D and E. Plot the points on each level of service line which represent the assumed operating speed (as duscussed in the analysis section of this report.) Fit a curve through these points (one for freeway, one for non-freeway). These curves represent the decline in operating speed which occurs as volume increases.

13. Establish the operating speed for each projection year by reading the curves at the appropriate total volume for each projection year.

This completes the derivation of traffic data for use in determining the noise and air pollution levels to be expected with the operation of the I-475 freeway.

Due to the fact that this procedure was developed in lieu of pursuing a more time consuming but much more reliable method utilizing to the fullest extent the technology available in the transportation studies, it is necessarily founded upon a number of untested assumptions. These assumptions are discussed in the analysis section of the report at the point at which they are brought to bear on the data.

ANALYSIS

The discussion of the application of the methodology outlined above and the results of this analysis are presented in the following sections of this report. Each step in the method is discussed and any assumptions made as part of the analysis are also discussed. Where the procedure varies from that which would be used in the normal processing of the Transportation Study, the variation is discussed and the more sophisticated procedure is outlined.

1. CAPACITY ANALYSIS

I. FREE ACCESS ROADWAY CAPACITIES AND SERVICE VOLUMES

The capacity of a roadway at a given level of service is defined as the maximum number of vehicles (in either passenger car equivalents or mixed average traffic) that can pass over the length of roadway considered, within a given time period. It is determined from characteristics of the roadway itself and of the traffic on it, and varies according to four types of factors. These are the geographic variables, the topographic variables, those variables intrinsic to the physical roadway, and the assumed or empirically derived traffic variables.

Independent Variables

A. There are two major geographic variables. The first has to do with the size of the metropolitan population: for a given roadway, as the metropolitan population rises, so does the capacity. This is due to the greater experience of urban drivers in driving under congested conditions, and the consequent lessening of desired headways (the distance between cars). In effect, more cars fit into the same length of roadway, even though speeds remain constant.

The second geographic variable has to do with the location of the roadway section within the urban area. Roadways fulfill two conflicting functions, serving both to more traffic and to provide access to land uses. As the land use function becomes more important, that is, as we move into the CBD from the outer reaches of the metropolitan area, the traffic function of the roadway is impinged upon, lower speed limits are imposed, pedestrian conflicts increase, and capacities are correspondingly reduced.

The number of types of intraregional areas that can be distinguished varies.

B. Topographical variables are of two types also. The first is the steepness of individual grades, when dealing with short stretches of roadway, or the degree of relief in the terrain, when dealing with longer stretches. As the grade becomes steeper, or the terrain rougher, the capacity of the roadway is reduced, due to the decrease in speeds that trucks are capable of maintaining. Grade influence thus depends partly on the percentage of trucks.

While grade factors lower capacities by lowering speeds, shorter sight distances (the distance visible ahead of the driver, as for passing) decrease capacities both by increasing the adverse influence of slower vehicles, and by discouraging high speeds directly.

C. Factors intrinsic to the roadway itself include surface conditions, one-way or two-way operation (one-way streets have different turn factors), the presence of parking, lane width, number of lanes, approach width, lateral clearance, alinement and average highway speed. The lateral clearance factor has to do with the driver's perceptions of the width of the roadway, and is thus related to the actual width factors in effect. Thus, if signs, mailboxes, etc., seem to impinge on the surface area of the road, even though they may in fact be clearly off to the side of the road, drivers will react by decreasing speed, thus reducing capacity. In a sense, the lane width factor is at least partly also psychological. The effect of surface condition apparently is not treated systematically in capacity determination studies.

The addition of extra lanes increases capacity by permitting less restricted passing, and by increasing the surface area of the roadway. The number of lanes is of course related to the width of the approach at intersections, but here a different sort of problem becomes important. The influence of intersections on the capacity of a roadway becomes more important, of course, as the frequency of intersections increases. Thus, in cities the capacity of a roadway is determined by the capacity at its intersections. The approach width is the factor intrinsic to the roadway that has an influence on the intersection capacity of the roadway. As might be expected, the capacity at the intersection increases as the width of the approach increases, due both to the increase in surface area, and more importantly to the lessening of turning conflicts through the provision of separate turning lanes.

The presence of parking reduces capacity by reducing the number of lanes available for traffic, and thus its effect is the reverse of that of adding lanes.

Imposing speed limits reduces the capacity of the roadway at given levels of service by inhibiting the passing of slower vehicles. As the level of service decreases, the effect of a given speed limit is diminished, due to the fact that less opportunities to pass are present a priori; thus, at level of service E (unstable flow), speed limits above 30 mph have no limiting effect.

Alinement and average highway speed are related concepts. Alinement refers to the geometrics (banks, curves, tangents, lengths of straight sections, etc.) of the roadway, and determines the average highway speed, except where speeds are posted. The average highway speed, again except where speeds are posted, is the maximum safe speed possible on short sections, or the average of these speeds for longer sections. As might be expected, alinement and average highway speed have the same effect as speed limits.

D. Traffic variables are much more numerous and complex than the others. They include the peak hour factor, the peak hour percentage, the percentage of commercial vehicles, the percentages of left and right turns, and the ratio of green time to cycle time. The first three deal with the entire length of the roadway, while the latter three deal only with those sections of the roadway where intersections determine roadway capacity.

The peak hour factor is a measure of the peaking characteristics of traffic in the area. It is the ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour to the maximum rate of flow during a given time period within the peak hour; this has been taken to be five minutes for freeway capacities and fifteen minutes for intersections. Another way to look at the PHF is to consider it as being the degree to which actual hourly volume at the peak hour approaches the hourly volume that would result if the flow rate of the peak five minutes (or fifteen minutes) were maintained. Thus, a high peak hour factor means that the roadways in the area are more fully utilized, and their capacities are correspondingly higher.

The peak hour percentage is the ratio of the traffic flow in the peak hour to the total daily traffic; it is again a characteristic of the area as a whole. A high peak hour percentage means that roadways are being under-utilized in the non-peak-hour periods of the day; daily capacities are correspondingly reduced.

Commercial traffic influences capacity on grades, as mentioned above, and at intersections (due to the relative slowness of the commercial vehicle's turning and acceleration). As with the effect of speed limits, the effect of commercial vehicles decreases as the level of service decreases.

The percentage of turns influences capacities at intersections where separate turning lanes are not provided, due to the fact that turning constitutes a slower movement than going straight, and to the fact that traffic conflicts are more likely to occur (especially with left turns). Thus, as the percentage of turns goes down, capacity at the intersection goes up.

The ratio of green time to cycle time, if it reflects actual traffic volumes on the roadways at the intersection, gives a measure of the influence of conflicting traffic on the capacity of the roadway. Thus, if a street intersects on arterial carrying a much larger volume of traffic, the street approach ratio of green time to cycle time will be reduced, and with it, the street's capacity.

There finally remain the dependent variables, which are directly related to the notion of levels of service, and the different approaches thereto. One of these variables is that of the load factor, which reflects the degree to which the available green time at an intersection is being used. This varies with level of service: as the level of service decreases, the load factor increases. Were one to approach the problem of capacities from the other direction, it could equally truly be said that as the load factor increases, the level of service decreases. There are, in short, two ways of approaching these problems. First, given a level of service, and the corresponding load factor, we can determine the maximum volume of traffic possible for the roadway, by taking into account all of the variables mentioned above. Alternatively, given a roadway situation, we can determine the load factor, and thus the level of service at which the intersection is operating. The procedure to be used is determined by the problem.

Similarly, the ratio of service volume to capacity (the v/c ratio), and the operating speed (the average speed of traffic), can be used either to determine the level of service of an operating roadway, or to determine the service volume possible, given the roadway conditions (not traffic conditions) and the desired service level. Operating speed is distinguished from average highway speed in that the former is determined by traffic, while the latter is determined by the roadway.

II. LIMITED ACCESS ROADWAY CAPACITIES AND SERVICE VOLUMES

The freeway constitutes one extreme in the spectrum of roadway types: it is the traffic mover par excellence, serving land uses only indirectly, through its service roads. Consequently, the importance of some of the independent variables mentioned above is eliminated, while other variables are modified in definition and in impact. Nevertheless, they can still be classified into the same four types: geographic, topographic, intrinsic, and traffic-related.

Independent Variables

A. There are as before, two geographic variables. The population variable is important again because of the different driving habits of urban drivers, while the factor of intra-regional location affects capacity on freeways indirectly, both by altering speed limits and by affecting the distance between ramps (thus affecting the number of traffic conflicts). Both of these are the result of increasing land use pressures as the freeway nears the CBD area.

B. Freeways are intended to minimize the effect of terrain on roadway capacities, and to a considerable extent they succeed in accomplishing this goal. Thus the factor of sight distance is no longer important in freeway capacity determination, since all freeways have adequate visibility. The factor of grade is reduced in importance, due to the elimination of steep slopes. It still enters into the

the calculations, however.

C. Most of the factors intrinsic to the roadway are eliminated from consideration in dealing with freeways, due mainly to the fact that freeway characteristics form the standard by which other roadways are judged. Thus surface condition, the presence or absence of parking, the width of lanes, the width of approach, the lateral clearance, and the alinement factors are not pertinent to freeway capacity problems. The remaining intrinisic factors, that is, the number of lanes and the average highway speed, correspondingly increase in importance, and in effect, along with the lengths of roadway between on and off ramps, determine the basic freeway capacity.

D. Traffic variables include the peak hour factor, the peak hour percentage, the percentage of commercial vehicles, the weaving factor, and the "lane-one-volume" factor. The latter two replace the percentage of turn factors and the ratio of green time to cycle time, giving a mesure of the conflict caused by entering and exiting vehicles.

Dependent Variables

The dependent variables include the operating speed, the level of service, service volumes, and the volume to capacity ratio. The load factor ceases to be of importance, since there is no limit to the time available for entering ramp/ freeway "intersections". There are with freeways, as with roadways, two ways of approaching capacity problems: one can determine the level of service of a roadway, given the roadway characteristics, and the demand volumes and operating speed; or one can determine the maximum possible volume, given the roadway characteristics and the ratio of volume to capacity. This latter problem was the one confronted in the determination of service volumes for the Saginaw I-475-Dort Corridor in Flint. The procedure followed is outlined below.

III. DERIVATION OF CAPACITIES FOR THE I-475 CORRIDOR

A. Saginaw and Dort

Since these roadways run through a highly developed urban area, their capacities should be determined by intersection characteristics. To do this with complete accuracy would require detailed information as to the width of each approach at every intersection, the ratio of green time to cycle time at every intersection, the percentage of turns and commercial vehicle at every intersection, and so on. Needless, to say, the data-gathering effort that this would entail is so large as to preclude its serious consideration. Consequently, the figures we have derived for these streets are based on certain assumptions as to the variables involved. These assumptions are as follows:

1. Population was held to be 750,000 (the 1995 projection) throughout the entire capacity determination procedure. We discriminated between two kinds of intraregional area: CBD and Non-CBD. Saginaw and Dort, in the sections reviewed here, are primarily Non-CBD, though Saginaw does have a few CBD links.

2. Since we are dealing with intersections primarily, the impact of grade and sight distance was assumed to be negligible.

3. The intrinsic roadway factors pertinent to intersection capacity determination are the presence of parking (we assumed no parking), and the width of the approach

(we assumed it to equal roadway width, with no ancillary turning lanes). The other roadway factors are of little importance, since the frequency of intersections in this area is such that intersection capacities determine the capacity of the entire roadway.

4. Traffic factors are much more important in intersection problems; hence our assumptions are of more consequence. We assumed five percent commercial vehicles, 10 percent left turns, ten percent right turns, no bus stops, and a ratio of green time to cycle time of .50. With these we found the peak hour percentage (assumed to be .093 throughout the study) to derive the annual average daily traffic figures presented. The source of these assumptions is the Highway Capacity Manual, for the most part, with the peak hour percentage figure derived from several sources, including the Kalamazoo Area Transportation Study.

While the capacities and service volumes derived with these assumptions are not completely accurate for each intersection, the figures reached for the network as a whole should be good approximations of reality. This is due to the fact that the assumptions we have used do not bias the results in either direction. However, these figures do not account for such common improvements as modifying signalization to reflect differences in volumes at intersection approaches, progressive systems of signalization, and so on. Consequently, the figures we derived for the major arterials, where these improvements are most likely to occur, might possibly understate the actual capacities somewhat. On the other hand, the plausible concentration of commercial traffic on arterials might counterbalance the effect of signal improvements, restoring our estimates to reasonableness. The main point to be made here, is that accurate estimates of roadway capacities can be derived with the techniques at hand, provided the necessary detailed, accurate information is substituted for the assumptions we used.

B. I-475

Since the area we are concerned with here is highly developed, the capacity of the freeway is largely determined by the ramps and weaving sections (that is, the ramp/freeway "intersections"). The problem with capacity determination in this case is that there are numerous different capacities possible for a given weaving section, dependent on the demand volumes on the ramp and the freeway links upstream and downstream. Again, we have made several assumptions, which are clarified below.

1. Population, as mentioned above, was held to be 750,000. The influence of the intraregional area, that is, the relative frequency of ramp/freeway intersections, was precisely determined by measuring the length of freeway between ramps. This length factor is very important in the capacity determination process.

2. As stated above, the sight distance factor was assumed to be irrelevant. The grade/commercial traffic factor (with commercial traffic assumed to be five percent of total traffic), was held constant at .93 for all links of all freeways in the Flint area.

3. The only important variables associated with intrinsic characteristics of the freeway were assumed to be the average highway speed (determined by the 60 mph speed limit from Hemphill to Carpenter), and the number of lanes (for which accurate information was available).

4. The traffic variables not clarified in the surface street derivation above include the peak hour factor assumed to be .91, and the weaving and lane-one-volume factors. These latter two are dependent, as mentioned above, on the demand volumes on ramps and freeway links.

   In the absence of any information as to these demand folumes, we were foreced to make certain critical assumptions, outlined as follows:

   a. No entering traffic exits within 1999 feet of its entrance ramp; for every two thousand feet of freeway length, ten percent of the oncoming traffic can exit. (Thus, if the distance between an on-ramp and an off-ramp is 3,000 feet, 15 percent of the entering traffic exits; if the distance is 1750 feet, 0 percent exits.)

b. The ratio of ramp demand volume to freeway demand volume is assumed to be the ratio of the number of lanes on the ramp to the number of lanes on the freeway link immediately upstream of an entrance ramp and immediately downstream of the exit ramp; there are two exceptions to this rule.

   1) When the demand volume so established exceeds the basic limiting value determined by the non-traffic characteristics of the link, it is assumed to equal that value; traffic entering the link is reduced accordingly.

   2) When demand volumes so established result in volumes below the limiting value, they are raised as far as weaving factors, etc., permit.

c. The above assumptions make sense only if we establish a procedure for holding one demand volume in each weaving section constant. The rule for choosing this constant demand volume is that the farthest upstream freeway link in the section be considered given.

Thus, the assignment of capacities proceeds downstream from the initial determination point.

These assumptions make it possible for us to establish certain hypothetical demand volumes, analyze them to determine the level of service which results, and modify them accordingly. After several iterations of this process, the service volumes for each ramp and freeway link can be established. The downstream freeway link is then considered given in the analysis of the next weaving section.

The tables on pages 31 and 32 show the available capacity at each cutline location on each route for levels of service C, D and E, as determined by the procedure described above.

I-475 CORRIDOR - AVAILABLE CAPACITY AT C, D AND E LEVELS OF SERVICE

CORRIDOR CUTLINE 1
BETWEEN STEWART AND BROADWAY

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	30,675	36,196	38,958
I-475 SBd.	23,496	41,770	52,213
I-475 NBd.	24,564	43,670	54,588
M-54	22,475	26,520	28,544
Total	101,210	148,156	174,303

Design Capacity = 138,590

CORRIDOR CUTLINE 2
BETWEEN BROADWAY AND ROBERT T. LONGWAY

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	24,525	28,940	31,146
I-475 SBd.	22,748	40,440	50,550
I-475 NBd.	21,904	38,940	48,675
M-54	20,450	24,131	25,971
Total	89,627	132,451	156,342

Design Capacity = 124,355

CORRIDOR CUTLINE 3
BETWEEN ROBERT T. LONGWAY AND COURT ST. RAMPS

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	24,525	28,940	31,146
I-475 Serv. Rd. SBd.	13,162	15,531	16,716
I-475 SBd.	22,298	39,640	49,550
I-475 NBd.	19,097	33,960	42,438
I-475 Serv. Rd. NBd.	19,775	23,335	25,114
M-54	30,675	36,196	38,958
Total	129,532	177,602	203,922

Design Capacity = 161,737

CORRIDOR CUTLINE 4
BETWEEN COURT ST. AND FIFTH ST.

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	22,900	27,023	29,083
I-475 Serv. Rd. SBd.	19,775	23,335	25,114
I-475 SBd.	16,729	29,740	37,175
I-475 NBd.	14,321	25,460	31,825
I-475 Serv. Rd. NBd.	19,775	23,335	25,114
M-54	30,675	36,196	38,958
Total	124,175	165,089	187,269

Design Capacity = 148,325

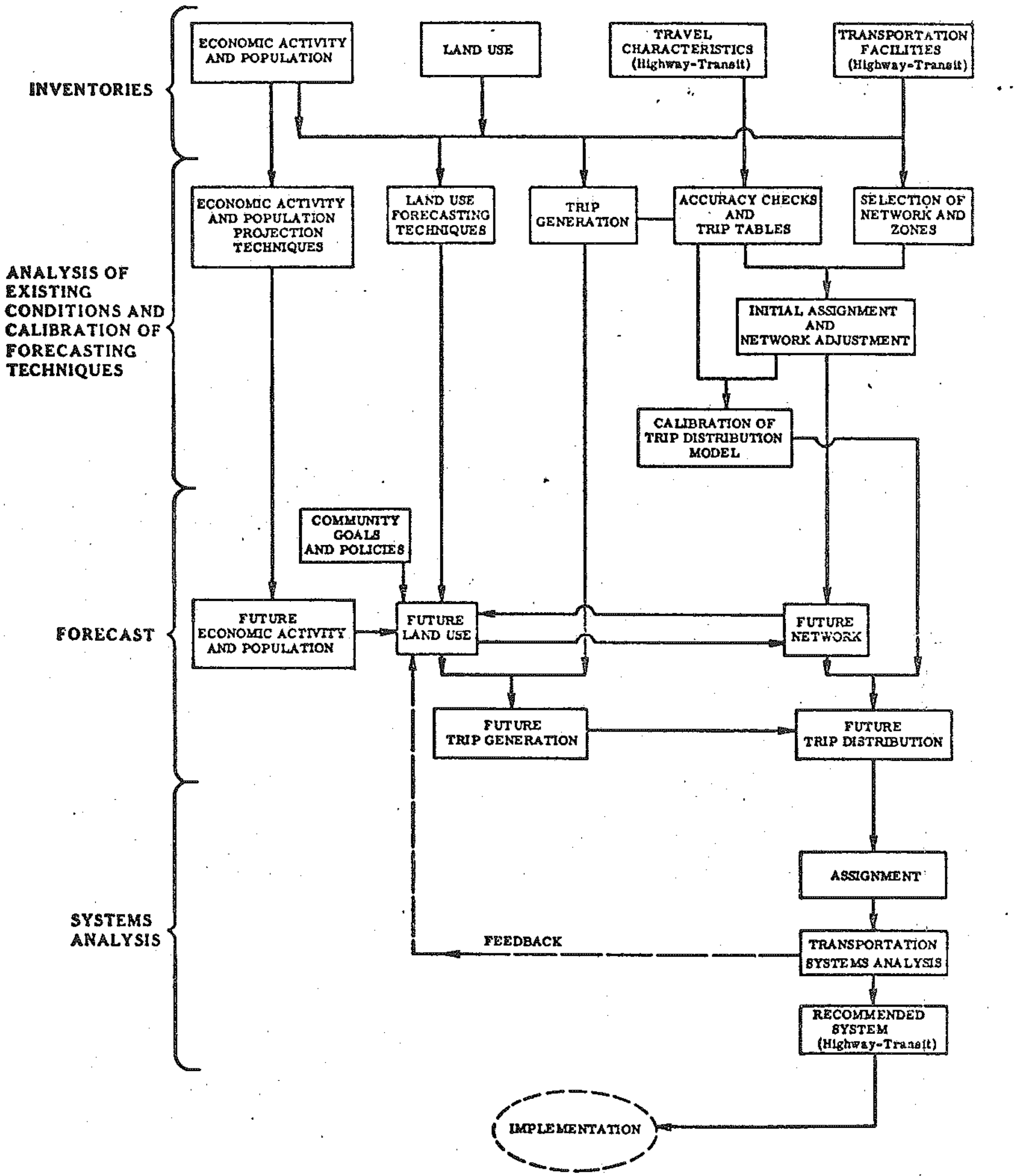
2. GENESEE COUNTY GROWTH IN TRAVEL

The Flint-Genesee County Transportation Study was begun in 1966 when the origin-destination survey was conducted. The processing and analysis of data collected in the survey are shown on the flow chart (page 34). The growth in trips from the base year (1966) to the target year (1995) is determined through the use of the Trip Generation Model. This model consists of a series of equations which relate the number of trips produced and attracted by all of the zones in the study area to various relevant quantifiable socio-economic characteristics of the zones. These equations are "calibrated" to meet certain minimum criteria of a statistical validity and reliability in predicting the existing number of trips produced and attracted by each zone. When the future socio-economic characteristics of zones are determined, trips are determined by replacing the base year characteristics in the equations.

For the Flint-Genesee County Study the Genesee County Metropolitan Planning Commission prepared 1995 zonal socio-economic projections based upon their future land use plan for Genesee County. These projections were inserted into the trip generation equations and the future trips were determined.

The results of this process are shown on the tables and maps on pages 36 to 41 . It can be seen that the overall trip increase from base to future is 1.87. This is rate which was utilized to project the increases in travel

URBAN TRAVEL FORECASTING PROCESS



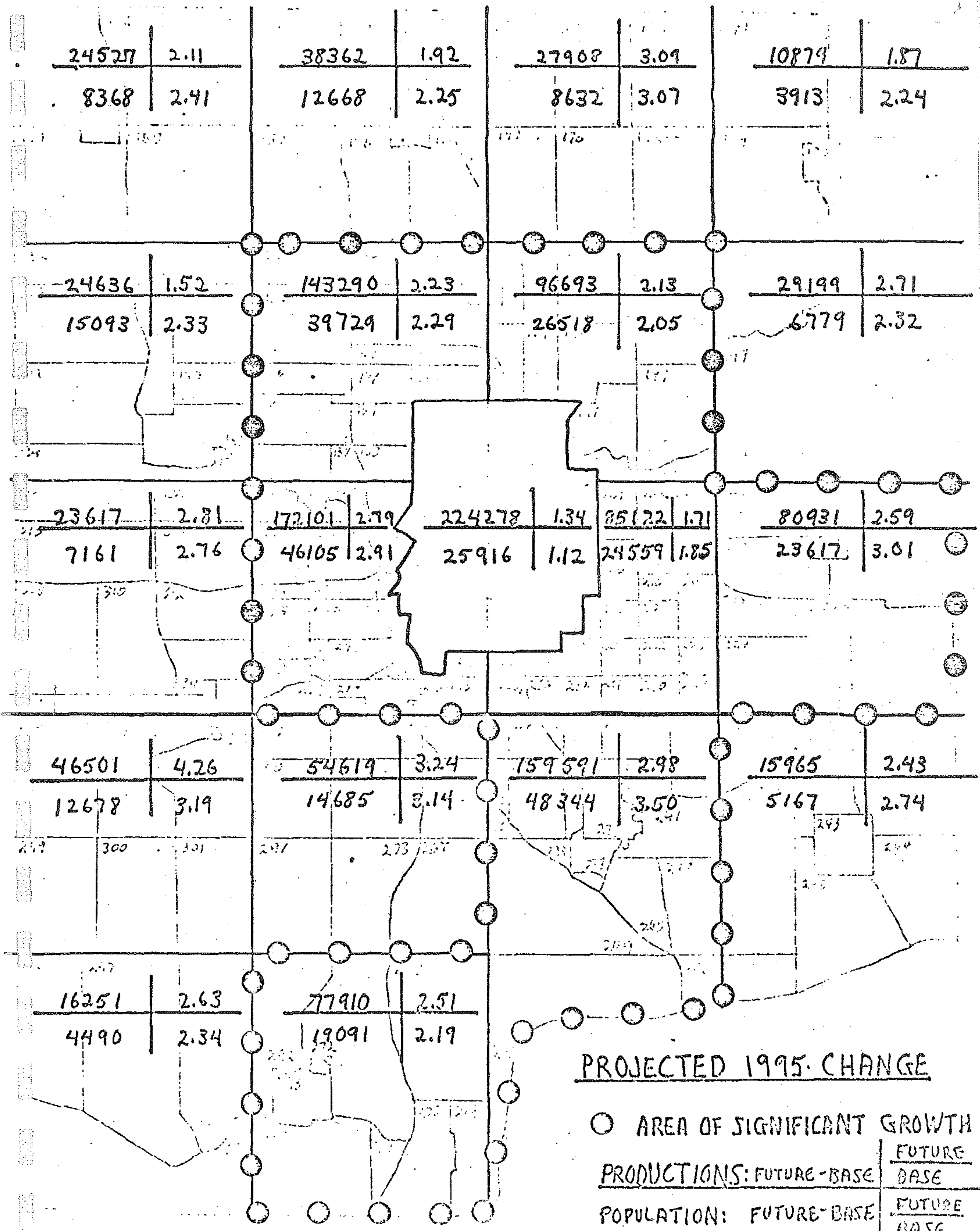
by five year increments in the I-475 corridor. It rests, however, upon the assumption that geographic sub-areas will grow at the same rate and that the impact of the growth measured in volumes assigned to the street system will reflect the same rate of increase. This assumption is clearly erroneous when the township growth figures are examined. Nevertheless, without the benefit of hard data from the transportation study to show the true rate of increase on the ground in the I-475 corridor specifically, the countywide growth rate was used.

1995 GROWTH DATA
POPULATION

TOWNSHIP	BASE	FUTURE	DIFFERENCE	RATIO
Flint City	213275	239191	25916	1.12
Flint	24157	70269	46105	2.91
Flushing	11320	26413	15093	2.33
Mt. Morris	30915	70644	39729	2.29
Vienna	10113	22781	12668	2.25
Montrose	5952	14320	8368	2.41
Thetford	4177	12809	8632	3.07
Forest	3159	7072	3913	2.24
Genesee	25285	51803	26518	2.05
Richfield	5150	11929	6779	2.32
Burton	28769	53328	24559	1.85
Davison	11766	35383	23617	3.01
Atlas & Groveland	2973	8140	5167	2.74
Grand Blanc & Holly	19305	67649	48344	3.50
Mundy	6858	21543	14685	3.14
Fenton	15976	35067	19091	2.19
Argentine	3360	7850	4490	2.34
Gaines	5788	18466	12678	3.19
Clayton	4063	11224	7161	2.76
TOTAL	432946	786189	353243	1.82

1995 GROWTH DATA
TRIP PRODUCTIONS

TOWNSHIP	BASE	FUTURE	DIFFERENCE	RATIO
Flint City	713118	937396	224278	1.34
Flint	96163	268264	172101	2.79
Flushing	47528	72164	24636	1.52
Mt. Morris	116519	259809	143290	2.23
Vienna	41807	80169	38362	1.92
Montrose	22060	46587	24527	2.11
Thetford	13343	41251	27908	3.09
Forest	12523	23402	10879	1.87
Genesee	85445	182138	96693	2.13
Richfield	17099	46298	29199	2.71
Burton	120155	205277	85122	1.72
Davison	50809	131740	80931	2.59
Atlas & Groveland	11141	27106	15965	2.43
Grand Blanc & Holly	80472	240063	159591	2.98
Mundy	24385	79004	54619	3.24
Fenton	51589	129499	77910	2.51
Argentine	9941	26192	16251	2.63
Gaines	14244	60745	46501	4.26
Clayton	13064	36681	23617	2.81
TOTAL	1541081	2898101	1357020	1.88



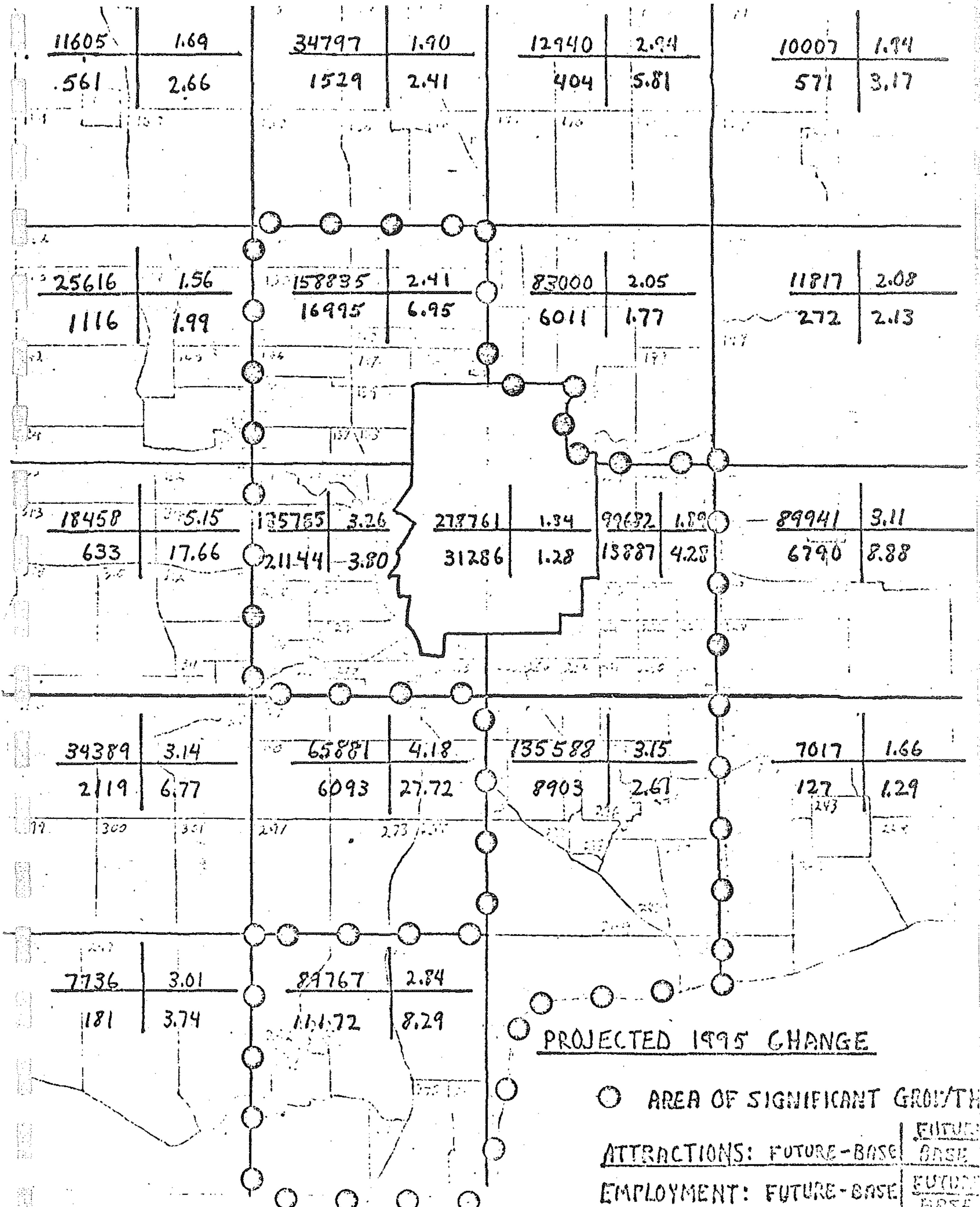
24527 2.11
8368 2.41
38362 1.92
12668 2.25
27908 3.09
8632 3.07
10879 1.87
3913 2.24
24636 1.52
15093 2.33
143290 2.23
39729 2.29
96693 2.13
26518 2.05
29199 2.71
6779 2.32
23617 2.81
7161 2.76
172101 2.79
46105 2.91
224278 1.34
25916 1.12
85122 1.71
24559 1.85
80931 2.59
23617 3.01
46501 4.26
12678 3.19
54619 3.24
14685 3.14
159591 2.98
48344 3.50
15965 2.43
5167 2.74
16251 2.63
4490 2.34
77910 2.51
19091 2.19
PROJECTED 1995 CHANGE
AREA OF SIGNIFICANT GROWTH
PRODUCTIONS: FUTURE-BASE | FUTURE / BASE
POPULATION: FUTURE-BASE | FUTURE / BASE

1995 GROWTH DATA
EMPLOYMENT

TOWNSHIP	BASE	FUTURE	DIFFERENCE	RATIO
Flint City	113426	144412	31286	1.28
Flint	9551	28695	21144	3.80
Flushing	1128	2244	1116	1.99
Mt. Morris	2858	19853	16995	6.95
Vienna	1082	2611	1529	2.41
Montrose	338	899	561	2.66
Thetford	84	488	404	5.81
Forest	263	834	571	3.17
Genesee	7767	13778	6011	1.77
Richfield	241	513	272	2.13
Burton	4229	18116	13887	4.28
Davison	862	7652	6790	8.88
Atlas & Groveland	440	567	127	1.29
Grand Blanc & Holly	5531	14434	8903	2.61
Mundy	226	6265	6093	27.72
Fenton	1533	12705	11172	8.29
Argentine	66	247	181	3.74
Gaines	367	2486	2119	6.77
Clayton	38	671	633	17.66
TOTAL	147685	269911	129794	1.83

1995 GROWTH DATA
TRIP ATTRACTIONS

TOWNSHIP	BASE	FUTURE	DIFFERENCE	RATIO
Flint City	810905	1089666	278761	1.34
Flint	82067	267942	185875	3.26
Flushing	45535	71151	25616	1.56
Mt. Morris	112610	271445	158835	2.41
Vienna	38875	73672	34797	1.90
Montrose	16863	28468	11605	1.69
Thetford	6678	19618	12940	2.94
Forest	10606	20613	10007	1.94
Genesee	79051	162051	83000	2.05
Richfield	10987	22804	11817	2.08
Burton	112151	211833	99682	1.89
Davison	42577	132518	89941	3.11
Atlas & Groveland	10627	17644	7017	1.66
Grand Blanc & Holly	63197	198785	135588	3.15
Mundy	20694	86575	65881	4.18
Fenton	48760	138527	89767	2.84
Argentine	3849	11585	7736	3.01
Gaines	16034	50423	34389	3.14
Clayton	4323	22781	18458	5.15
TOTAL	1551045	2898101	1347056	1.87



11605 | 1.69
561 | 2.66
34797 | 1.90
1529 | 2.41
12940 | 2.94
404 | 5.81
10007 | 1.84
571 | 3.17
25616 | 1.56
1116 | 1.99
158835 | 2.41
16995 | 6.95
83000 | 2.05
6011 | 1.77
11817 | 2.08
272 | 2.13
18458 | 5.15
633 | 17.66
135765 | 3.26
21144 | 3.80
278761 | 1.34
31286 | 1.28
99682 | 1.89
13887 | 4.28
89941 | 3.11
6790 | 8.88
34389 | 3.14
2119 | 6.77
65881 | 4.18
6093 | 27.72
135588 | 3.15
8903 | 2.67
7017 | 1.66
127 | 1.29
7736 | 3.01
181 | 3.74
89767 | 2.84
16172 | 8.29
PROJECTED 1995 CHANGE
AREA OF SIGNIFICANT GROWTH
ATTRACTIONS: FUTURE-BASE | FUTURE / BASE
EMPLOYMENT: FUTURE-BASE | FUTURE / BASE

3. GROWTH OF TRIPS IN FIVE YEAR INCREMENTS

The simplest expression of growth over time is the straight line or linear function. Straight line growth was assumed in determining the increase over the base to be expected in 1975, 1980, 1985, 1990 and 1995. The resultant figures are shown in the table on page 43.

These growth figures represent a very conservative view of future conditions. There is evidence that in reality trips will increase at a rapid rate initially and begin to level off as 1995 is approached. The proof of this evidence can be obtained only after projections of socio-economic data at the traffic analysis zone level are obtained from the Genesee County Metropolitan Planning Commission for each of the intervening projection years. Then, by inserting the data into the trip generation equations, the actual total trips and corresponding growth could be determined. This procedure will be performed in the course of the Transportation study when the five year incremental socio-economic projections become available.

4. 1995 TRAFFIC ASSIGNED TO THE CORRIDOR

In the section entitled Study Area the demand traffic assignment is described. The location of the cutlines and the routes included in the analysis are also described. In order to obtain the 1995 volume expected in the corridor, the volumes produced by the 1995 demand assignment on each route were summed for each cutline. The resulting total

1995 corridor demand volumes are shown in the table on page 43. These totals are used as the basis for the redistribution of corridor traffic to the routes within the corridor (steps 6 through 9) as well as the interpolation of corridor totals for the intervening projection years (step 5).

5. INCREMENTAL GROWTH OF I-475 CORRIDOR VOLUMES

To this point the volume increase over the base year (1966) for each of the five year projection intervals to 1995 has been established, and the 1995 traffic demand assigned to the corridor at each cutline location has been established. Making the assumption that the overall growth in Genesee County and the growth in the I-475 corridor are similar, the corridor volumes at each cutline for each projection year were established by dividing the 1995 total volume by the ratio of the 1995 Genesee County trips to 1966 trips. The resulting 1966 figures were then multiplied by the growth ratios established for the interviewing years. The results of these calculations are shown in the table below.

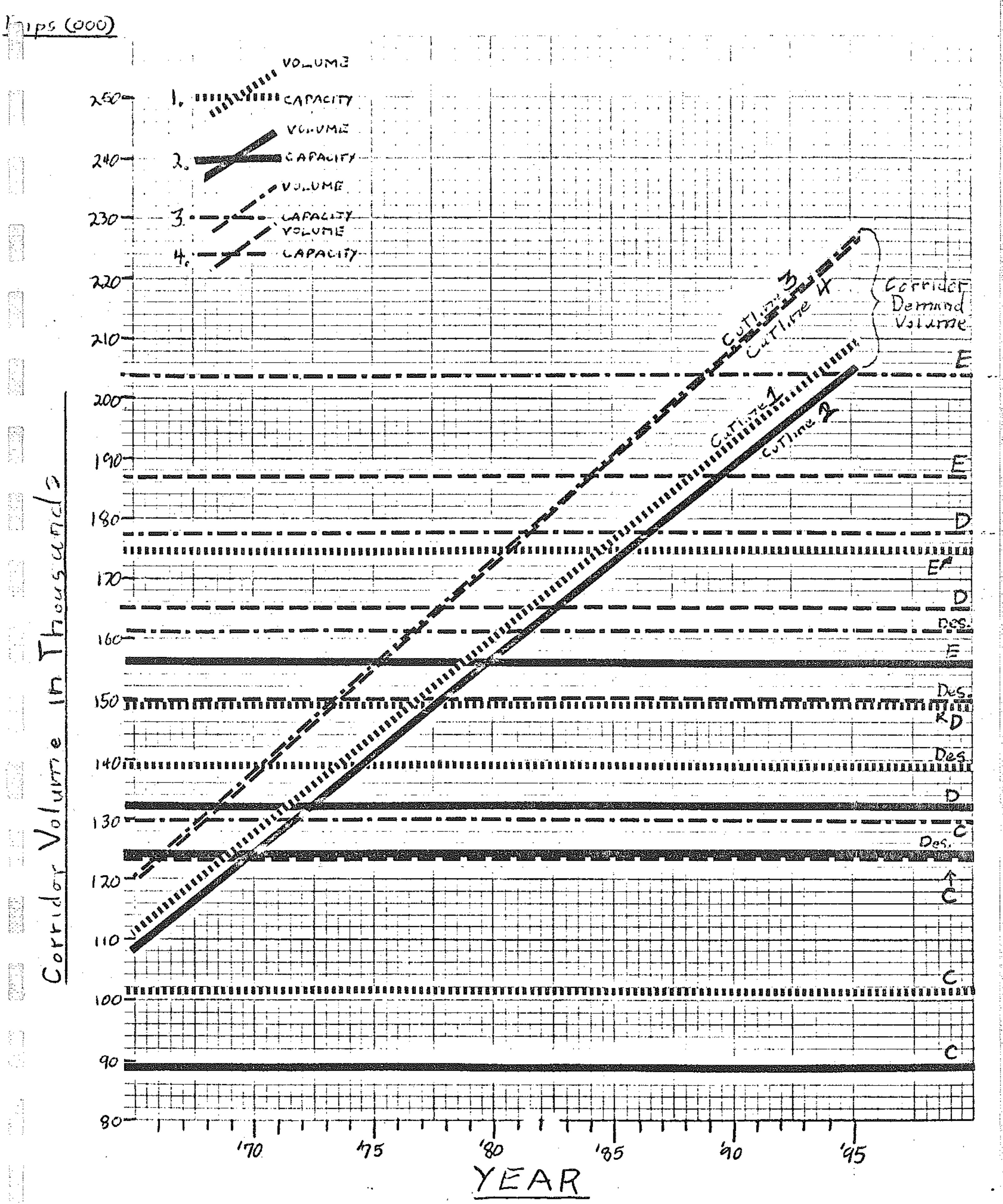
INTERPOLATED TOTAL ADT IN THE I-475 CORRIDOR: 1966-1995

Year	1966	1970	1975	1980	1985	1990	1995
Increase	1.00	1.15	1.29	1.44	1.59	1.73	1.87
Cutline 1	110867	127497	143018	159648	176279	191800	208430
Cutline 2	108775	125091	140320	156636	172952	188181	204497
Cutline 3	120396	138455	155311	173370	191430	208285	226345
Cutline 4	120539	138620	155495	173576	191657	208532	226614

The assumption of similarity of growth between the I-475 corridor and Genesee County in its entirety is erroneous. The tables and maps on pages 36 to 41 indicate that the townships immediately adjacent to the corridor are increasing at rate well over the 1.87 area-wide average. As the fringe of the existing urban area expands, the concentration of trips in the corridor can be expected to increase at an even higher rate than the township growth figures indicate. The Genesee County future land use plan shows extensive new industrial development adjacent to I-475, filling in the spaces between the existing industrial development in the corridor. All of this indicates a tremendous potential demand for travel through the corridor. But again, the only way to ascertain the actual volumes to be expected in the intervening projection years is to assign trips generated for those years to the street network. Since the Transportation Study has not reached the point of having trip projections for these intervening years, the most conservative assumption was employed, namely, that all areas in Genesee County and all routes within these areas will exhibit average growth.

6. ROUTE CONTRIBUTION TO CORRIDOR CAPACITY

The graph on page 45 shows the corridor capacities and the projected corridor volumes at each cutline location as they increase through the projection time period. The task remaining is to distribute total corridor volumes to the individual routes within the corridor.



Corridor Volume Growth vs Capacity And Level of Service

To accomplish this distribution, the tables on pages <u>47</u> and <u>48</u> was developed. This table shows the percentage of total corridor capacity that each route within the corridor comprizes at levels of service C, D, and E, for each cutline location. These percentages were developed based upon the route capacities shown in the tables on pages <u>31</u> and <u>32</u>.

It can be seen that as service volume increases, the freeway percentage of total capacity increases while surface street percentage decreases. The distribution of percentages at three levels of service can be treated as observations of percentage distribution of volumes on routes in the corridor at three points in time in the projection period. The graph mentioned initially shows at what projected year the levels of service plateaus are encountered for each cutline.

7. ESTIMATION OF CHANGE IN PERCENTAGE DISTRIBUTION OF ROUTES WITHIN THE CORRIDOR

Utilizing the service volumes at C, D, and E as longitudinal observation points, the percentage distribution of routes within the corridor was estimated at each five year projection interval. This was accomplished through the use of the graphs on pages <u>49</u> through <u>52</u>. The route percentage curves were developed by locating the points on the volume axis which correspond to the total corridor capacity at levels of service C, D, and E. The percentage of total capacity that each component route comprized was plotted at each service level. This produced three observation points for each component route in the corridor. A line was fit to the

I-475 CORRIDOR - ROUTE PROPORTION CORRIDOR TOTAL AT C, D AND E LEVELS OF SERVICE

CORRIDOR CUTLINE 1
BETWEEN STEWART AND BROADWAY

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	.303	.244	.224
I-475 SBd.	.232	.282	.300
I-475 NBd.	.243	.295	.313
M-54	.222	.179	.165
Total Volume	101,210	148,156	174,303

CORRIDOR CUTLINE 2
BETWEEN BROADWAY AND ROBERT T. LONGWAY

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	.274	.218	.199
I-475 SBd.	.254	.305	.323
I-475 NBd.	.244	.294	.312
M-54	.228	.182	.166
Total Volume	89,627	132,451	156,342

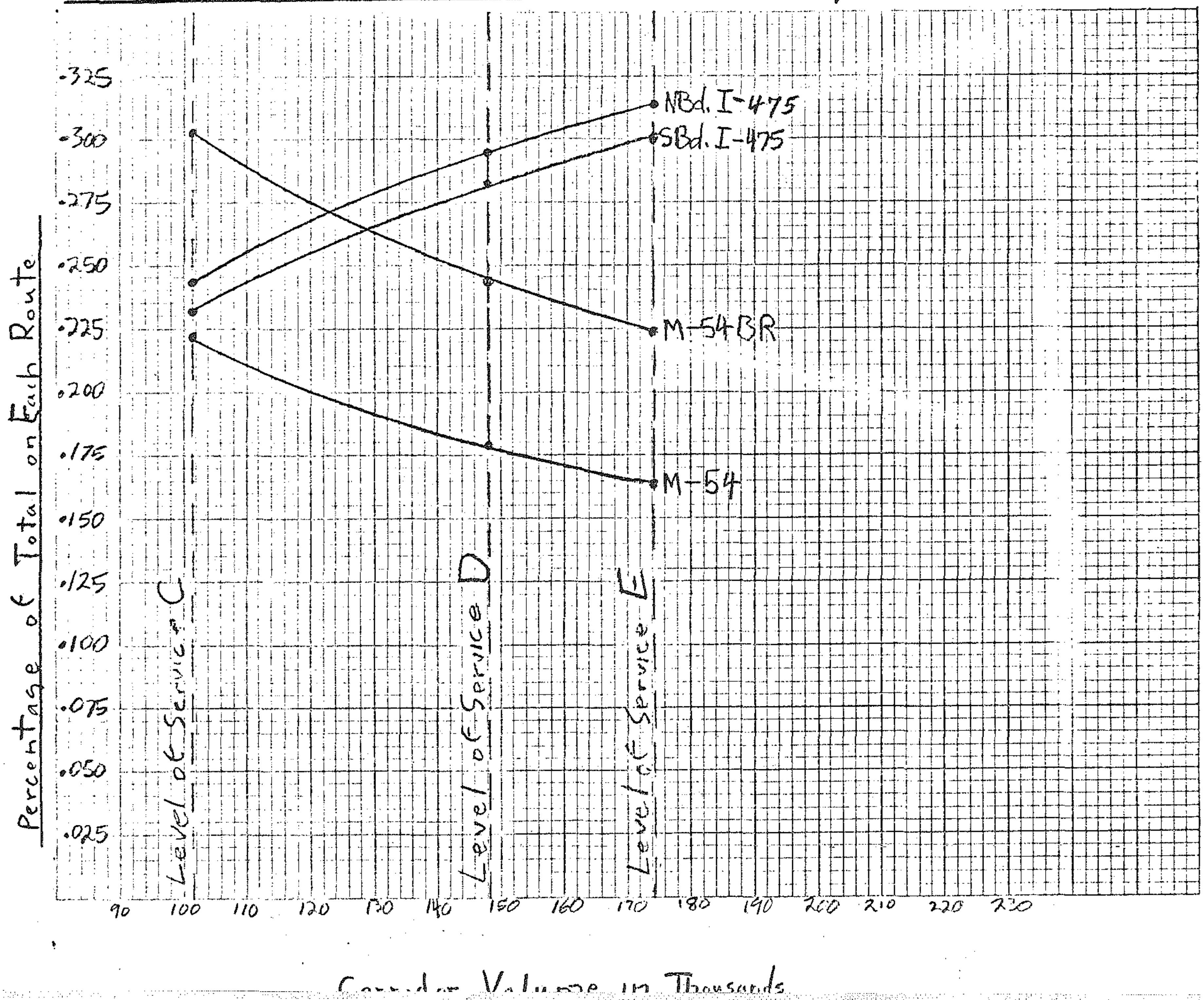
CORRIDOR CUTLINE 3
BETWEEN ROBERT T. LONGWAY AND COURT ST. RAMPS

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	.189	.164	.153
I-475 Serv. Rd. SBd.	.102	.087	.082
I-475 SBd.	.172	.223	.243
I-475 NBd.	.147	.191	.208
I-475 Serv. Rd. NBd.	.153	.131	.123
M-54	.237	.204	.191
Total Volume	129,532	177,602	203,922

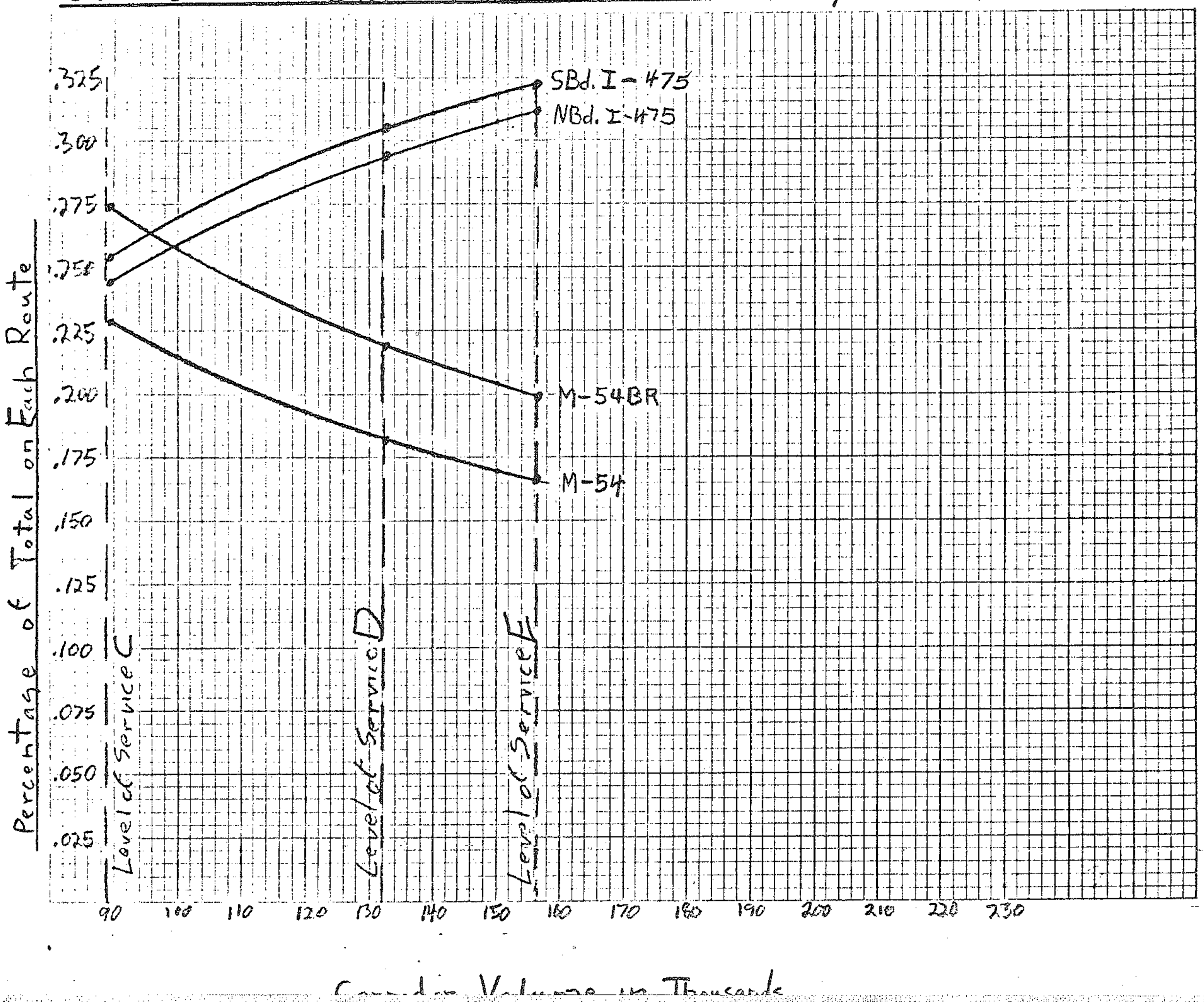
CORRIDOR CUTLINE 4
BETWEEN COURT ST. AND FIFTH ST.

Facility	Capacity at C	Capacity at D	Capacity at E
M-54 BR	.184	.164	.155
I-475 Serv. Rd. SBd.	.159	.141	.134
I-475 SBd.	.135	.181	.199
I-475 NBd.	.116	.154	.170
I-475 Serv. Rd. NBd.	.159	.141	.134
M-54	.247	.219	.208
Total Volume	124,175	165,089	187,269

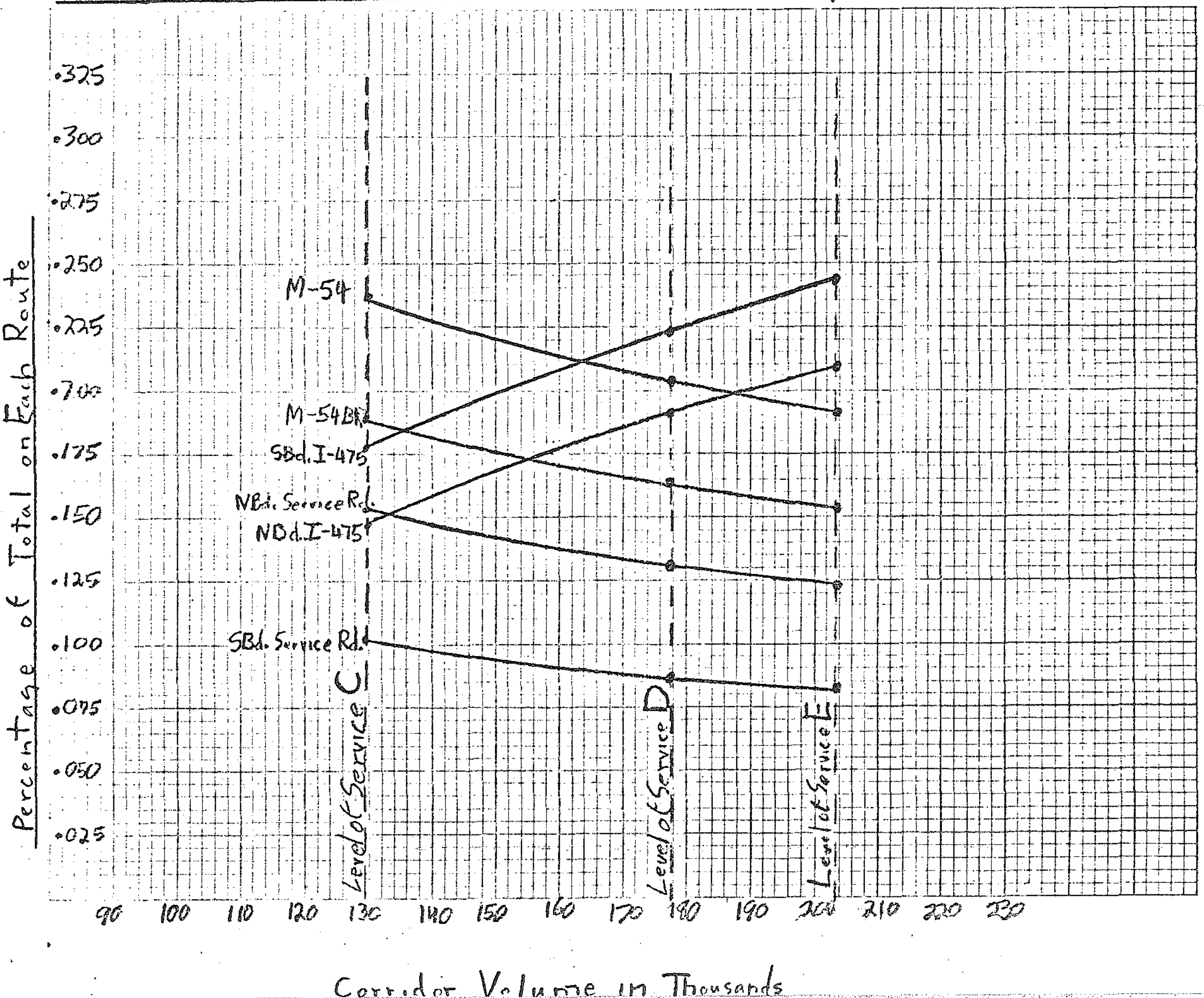
Cutline 1 : Distribution of Corridor Traffic By Total Volume



Cutline 2 : Distribution of Corridor Traffic By Total Volume



Cutline 3 : Distribution of Corridor Traffic By Total Volume



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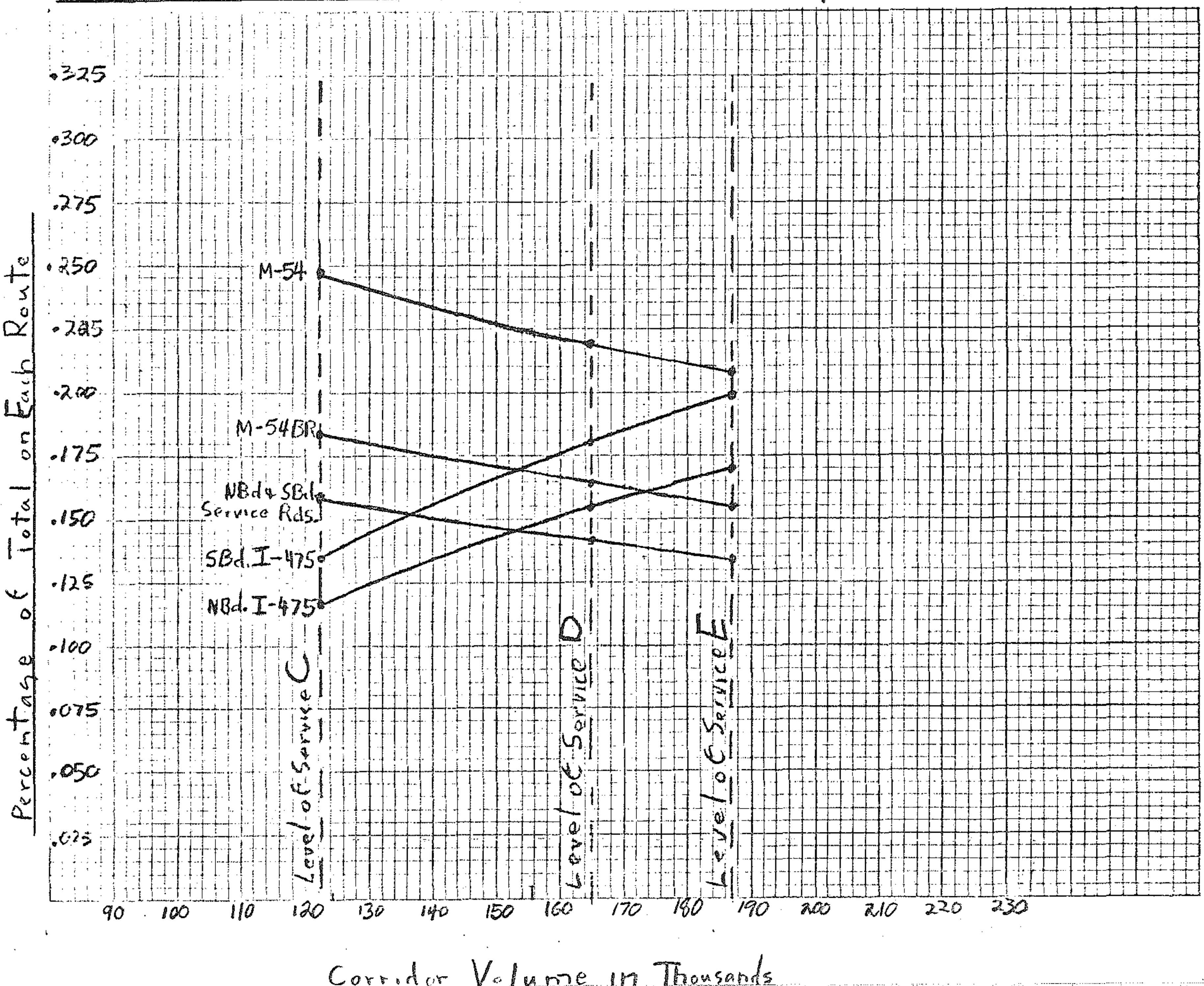
Cutline 4 : Distribution of Corridor Traffic By Total Volume



three observation points for each route. Picking any volume level on the horizontal axis and summing the percentages read from the route curves at that volume level produces a total of 100 percent. These curves, then, represent the change in the percentage distribution of volumes by route as total corridor volume (and by implication, projected year) increases.

8. DETERMINATION OF ROUTE PERCENTAGES AT EACH PROJECTION INTERVAL

Using the graphs developed in the previous step the percentages of projected corridor volume accounted for by each route was determined. This was accomplished by locating the point on the total volume axis that corresponds to the projected corridor volume for a given year, and reading the percentages from the individual route curves. The results of this procedure are shown in the tables on pages 54 and 55.

9. ESTABLISHING ROUTE VOLUME AT EACH PROJECTION INTERVAL

Route volumes were obtained by multiplying the route percentages of each projection year by the corridor total for the year. The tables on pages 56 and 57 contain the 24 hour projected volumes.

The entire procedure discussed in steps 6 through 9 is founded upon the assumption that all component routes will operate at the same level of service at any given point in time through the projection period. This assumption, as

CUTLINE 1: ROUTE PROPORTION OF CORRIDOR TOTAL

ROUTE	C	1975	D	1980	E	1985	1990	1995
M-54 BR	.303	.248	.244	.243	.224	.224	.224	.224
S BD. I-475	.232	.277	.282	.290	.300	.300	.300	.300
N Bd. I-475	.243	.292	.295	.303	.313	.313	.313	.313
M-54	.222	.183	.179	.173	.163	.163	.313	.313
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

CUTLINE 2: ROUTE PROPORTION OF CORRIDOR TOTAL

ROUTE	C	D	1975	E	1980	1985	1990	1995
M-54 BR	.274	.219	.213	.199	.199	.199	.199	.199
S Bd. I-475	.254	.305	.311	.323	.323	.323	.323	.323
N Bd. I-475	.244	.294	.299	.312	.312	.312	.312	.312
M-54	.228	.182	.177	.166	.166	.166	.166	.166
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

CUTLINE 3: ROUTE PROPORTION OF CORRIDOR TOTAL

ROUTE	C	1975	1980	D	1985	E	1990	1995
M-54 Br	.189	.174	.166	.164	.158	.153	.153	.153
S Bd. Serv. Rd.	.102	.093	.087	.087	.084	.082	.082	.082
S Bd. I-475	.172	.203	.219	.223	.234	.243	.243	.243
N Bd. I-475	.147	.173	.188	.191	.201	.208	.208	.208
N Bd. Serv. Dr.	.153	.140	.133	.131	.126	.123	.123	.123
M-54	.237	.217	.207	.204	.197	.191	.191	.191
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

CUTLINE 4: ROUTE PROPORTION OF CORRIDOR TOTAL

ROUTE	C	1975	D	1980	E	1985	1990	1995
M-54 BR	.184	.167	.164	.161	.155	.155	.155	.155
S Bd Serv Rd	.159	.145	.141	.138	.134	.134	.134	.134
S Bd I-475	.135	.172	.181	.188	.199	.199	.199	.199
N Bd I-475	.116	.147	.154	.160	.170	.170	.170	.170
N Bd Serv Rd	.159	.145	.141	.138	.134	.134	.134	.134
M-54	.247	.224	.219	.215	.208	.208	.208	.208
TOTAL	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

CUTLINE 1: PROJECTED ROUTE VOLUMES

ROUTE	C	1975	D	1980	#	1985	1990	1995
M-54 BR	30675	35468	36196	37358	38958	39486	42963	46688
I-475 S.Bd.	23496	39616	41770	46298	52213	52884	57540	62529
I-475 N.Bd.	24564	41761	43670	48373	54588	55175	60033	65239
M-54	22475	26172	26520	27619	28544	28733	31263	33974
TOTAL	101210	143018	148156	159648	174303	176279	191800	208430

CUTLINE 2: PROJECTED ROUTE VOLUMES

ROUTE	C	D	1975	E	1980	1985	1990	1995
M-54 BR	24525	28940	29888	31146	31171	34417	37448	40695
I-475 S Bd.	22748	40440	43640	50550	50593	55863	60782	66053
I-475 N Bd.	21904	38940	41956	48675	48870	53961	58712	63803
M-54	20450	24131	24837	25971	26002	28710	31238	33947
TOTAL	89627	132451	140320	156342	156636	172952	188181	204497

CUTLINE 3: PROJECTED ROUTE VOLUMES

ROUTE	C	1975	1980	D	1985	E	1990	1995
M-54 BR	24525	27024	28779	28940	30246	31146	31905	34631
S Bd Serv Rd	13162	14444	15083	15531	16080	16716	17100	18560
S Bd I-475	22298	31528	37968	39640	44795	49550	50673	55002
N Bd I-475	19097	26869	32594	33960	38477	42438	43375	47080
N Bd Serv Dr	19775	21744	23058	23335	24120	25114	25649	27840
M-54	30675	33702	35888	36196	37712	38958	39830	43232
TOTAL	129532	155311	173370	177602	191430	203922	208532	226345

CUTLINE 4: PROJECTED ROUTE VOLUMES

ROUTE	C	1975	D	1980	E	1985	1990	1995
M-54 BR	22900	25968	27023	27946	29083	30857	32322	35125
S Bd Serv Rd	19775	22547	23335	23953	25114	25682	27943	30366
S Bd I-475	16729	26745	29740	32632	37175	38140	41498	45096
N Bd I-475	14321	22858	25460	27772	31825	32582	35450	38524
N Bd Serv Rd	19775	22547	23335	23953	25114	25682	27943	30366
M-54	30675	34831	36196	37319	38958	39865	43375	47136
TOTAL	124175	155495	165089	173576	187269	191657	208552	226614

has been the case with the other assumptions cited throughout the report, produces a conservative estimation of freeway volumes to be expected in the projection period. It is probable that the service level will decline more rapidly on the freeway than on the surface streets. The freeway will remain the attractive alternate even if it is operating at level of service E while the surface streets are performing at a higher level of service. The reason for this is the fact that travel time on the freeway will appear to be shorter and may in actuality be shorter than on the surface streets simply because of the high functional level of the facility. There are traffic signals, lower posted speeds, and many more conflicting traffic movements to be encountered on the surface alternative streets.

The thrust of these considerations is that the freeway volumes will in all probability increase at a higher rate than the surface street volumes until the point of virtual failure of the freeway (theoretical capacity) at which time the surface streets will fill with the excess corridor traffic.

In any case it was necessary to assume equal level of service on component corridor routes because of the lack of hard data to the contrary. This data will be developed through the assignment of trips generated for the intervening years based upon zone socio-economic projections to be prepared by the Genesee County Metropolitan Planning Commission.

10. PROJECTED HIGH HOUR VOLUMES

In the capacity determination portion of the analysis a peak hour percentage of 9.3 was assumed. It was this factor which was used to determine all of the high hours shown in the tables on pages 67 through 72.

Through the development of peak hour traffic assignments of the trips projected for the intervening years in the course of the Transportation Study, the true peak hour percentage could be determined for each link of each route. In the absence of this data, the 9.3 percent was used.

11. PROJECTED COMMERCIAL VEHICLES

The determination of capacities required that commercial vehicles be considered since the presence of these vehicles in the traffic stream has an effect upon the capacity of a roadway. In the absence of specific data pertaining to commercial vehicles the assumption of five percent at the high hour was made. This factor was also used to determine the 24 hour commercial vehicle volume. It is almost certain, however, that the commercial percentage of 24 hour volume will be substantially higher than the five percent used for the high hour. For the determination of peak hour noise and exhaust emission levels, however, the five percent factor is reasonable.

The technology available to the Transportation Study is capable of producing systemwide commercial vehicle volumes through the traffic assignment process. It was impossible to use this procedure for this report because of the time constraints on the project. Therefore, the conservative estimate (five percent) was used across the board to determine the commercial vehicle volumes. The data resulting from this factoring are shown in the tables on pages 67 through 72.

12. FREEWAY AND SURFACE STREET OPERATING SPEEDS

According to the Highway Capacity Manual, certain operating speeds are associated with each level of service depending on the average highway (design and/or posted) speed. For urban freeway with an average highway speed of 60 mph, the operating speed is 50 mph at level of service C, 40 mph at D, and 30 mph at E. For surface streets, operating speeds are roughly half the freeway operating speeds at each level of service. Based upon this information it was possible to estimate the operating speeds at each projection interval in manner similar to the estimation of percentage of corridor volume for the component routes described in step 7.

A graph was developed for each cutline such that total corridor volume appeared on the horizontal axis and operating speed comprised the vertical axis. On these graphs lines were drawn at the volume which represented the total corridor capacity at levels of service C, D and E. Two points were located on each line, the first indicating freeway operating speed and the second indicating surface street operating speed.

Curves were fitted to the appropriate points for freeway and surface streets. These curves represent the change in operating speed as volume increases. The results of this process are shown on pages 62 through 65.

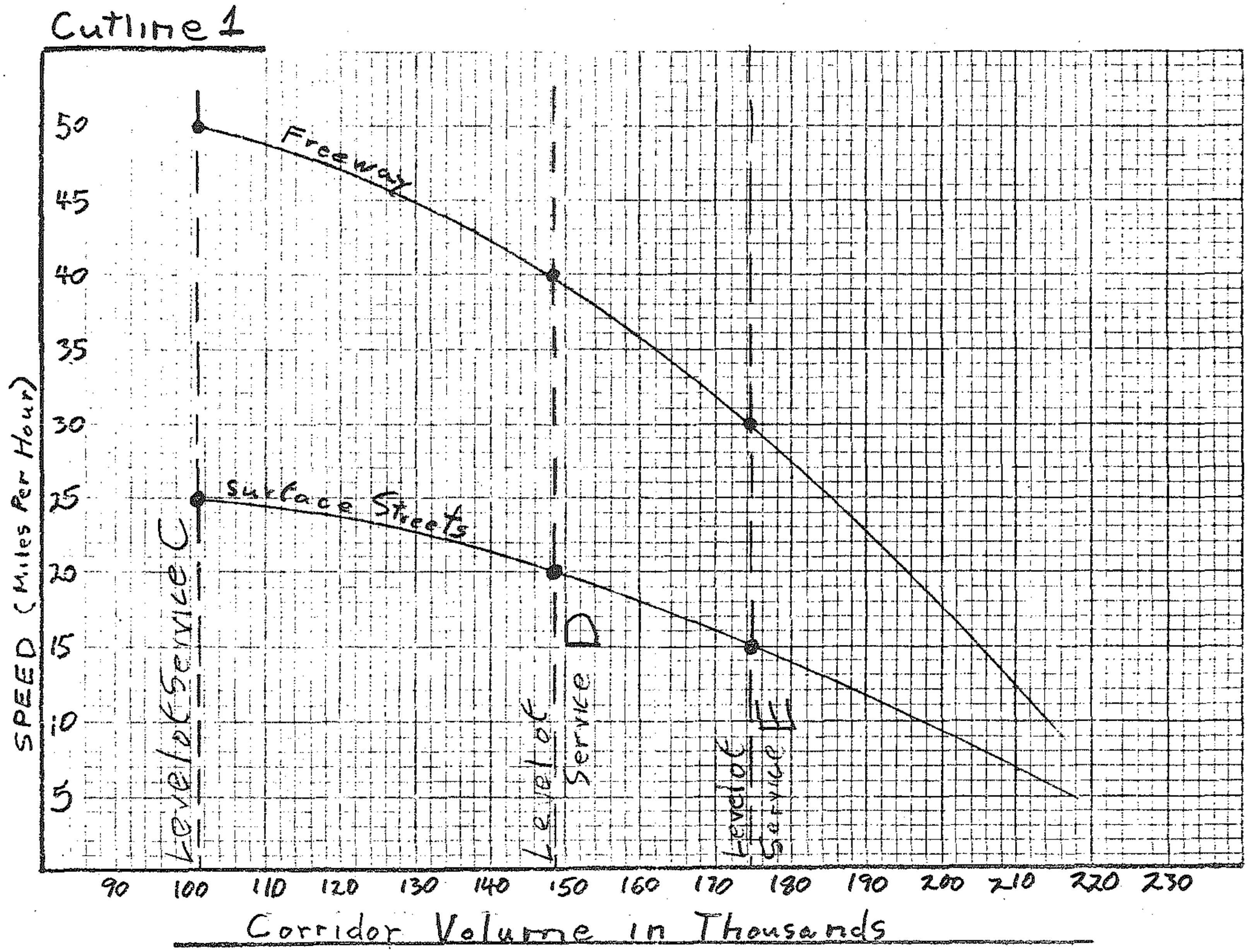
13. PROJECTED OPERATING (RUNNING) SPEEDS ON ROUTES WITHIN THE CORRIDOR

The operating speed for each route, at each cutline location for each projection year was determined by looking up the projected corridor volume on the operating speed graphs developed in the preceding step and reading the speeds from the appropriate curve for each of the component routes. The data derived in this manner is shown in the tables on pages 67 through 72.

It should be stated that accuracy of the curves beyond level of service E is questionable. Theoretically, level of service E represents the condition under which the values of operating speed and density produce the optimum high hour service volume (the maximum possible high hour service volume).

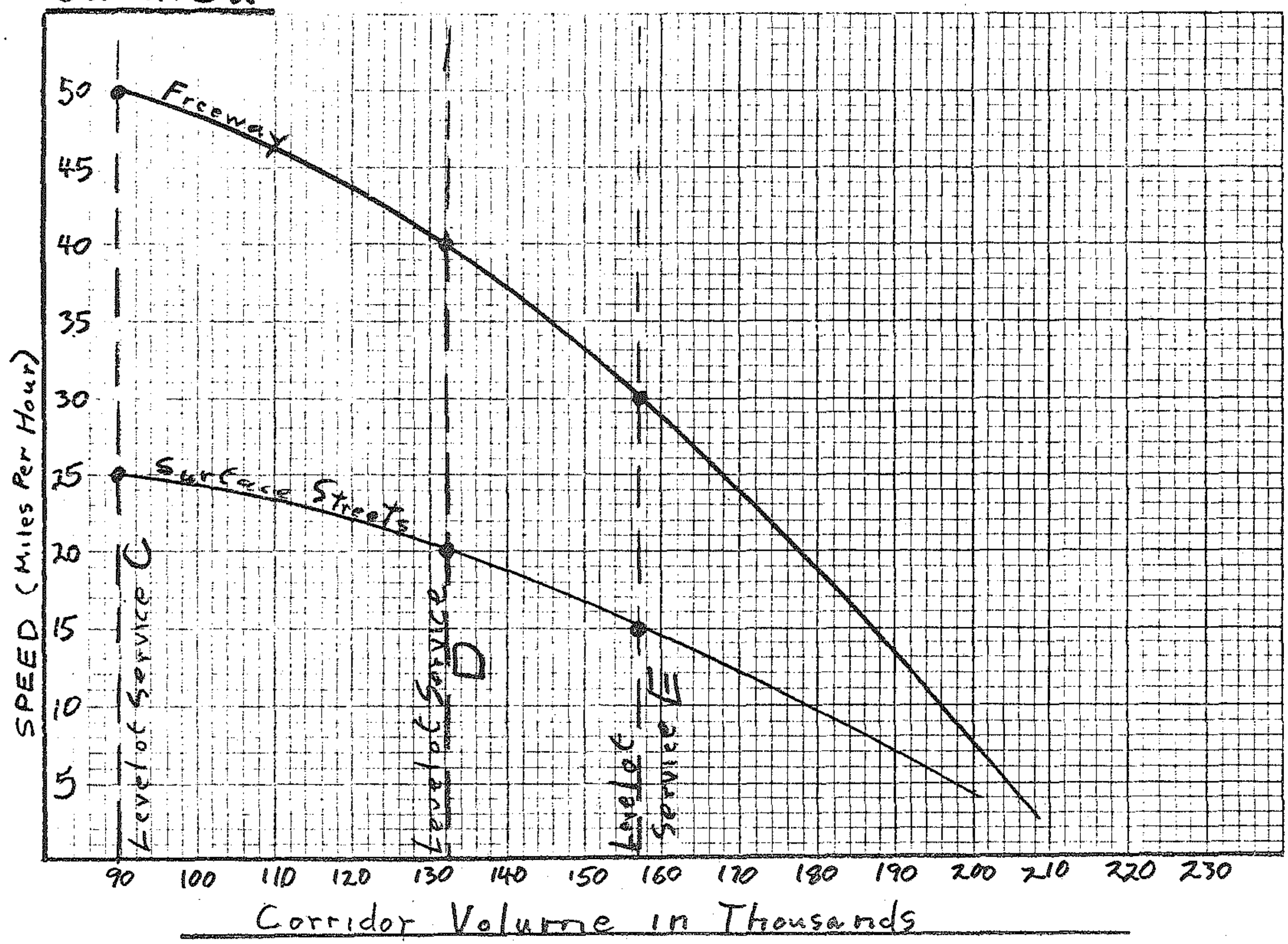
As operating speed decreases beyond the level associated with E, the high hour service volume also decreases. If it is evident, as it is in the I-475 corridor, that traffic demand will continue to increase beyond the corridor capacity at E, then it is reasonable to assume that speed will decrease beyond the E level. When this happens it must be assumed that the peak period will necessarily increase beyond the one hour base used for capacity analysis in this report. The relationship between decreasing speed, decreasing service volume and the resultant extended duration of the peak is

Operating Speed VS Corridor Volume



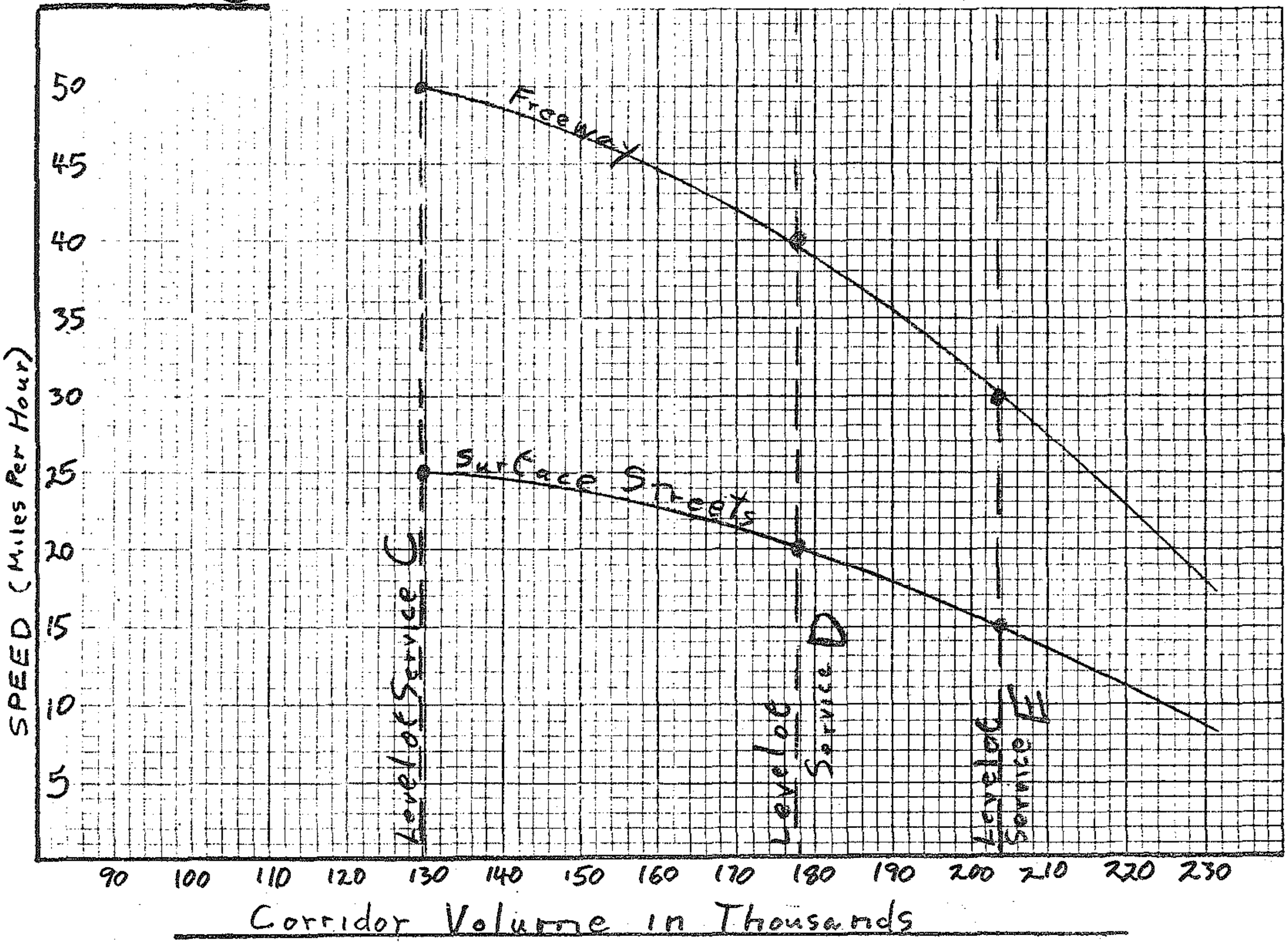
Operating Speed VS Corridor Volume

Cutline 2

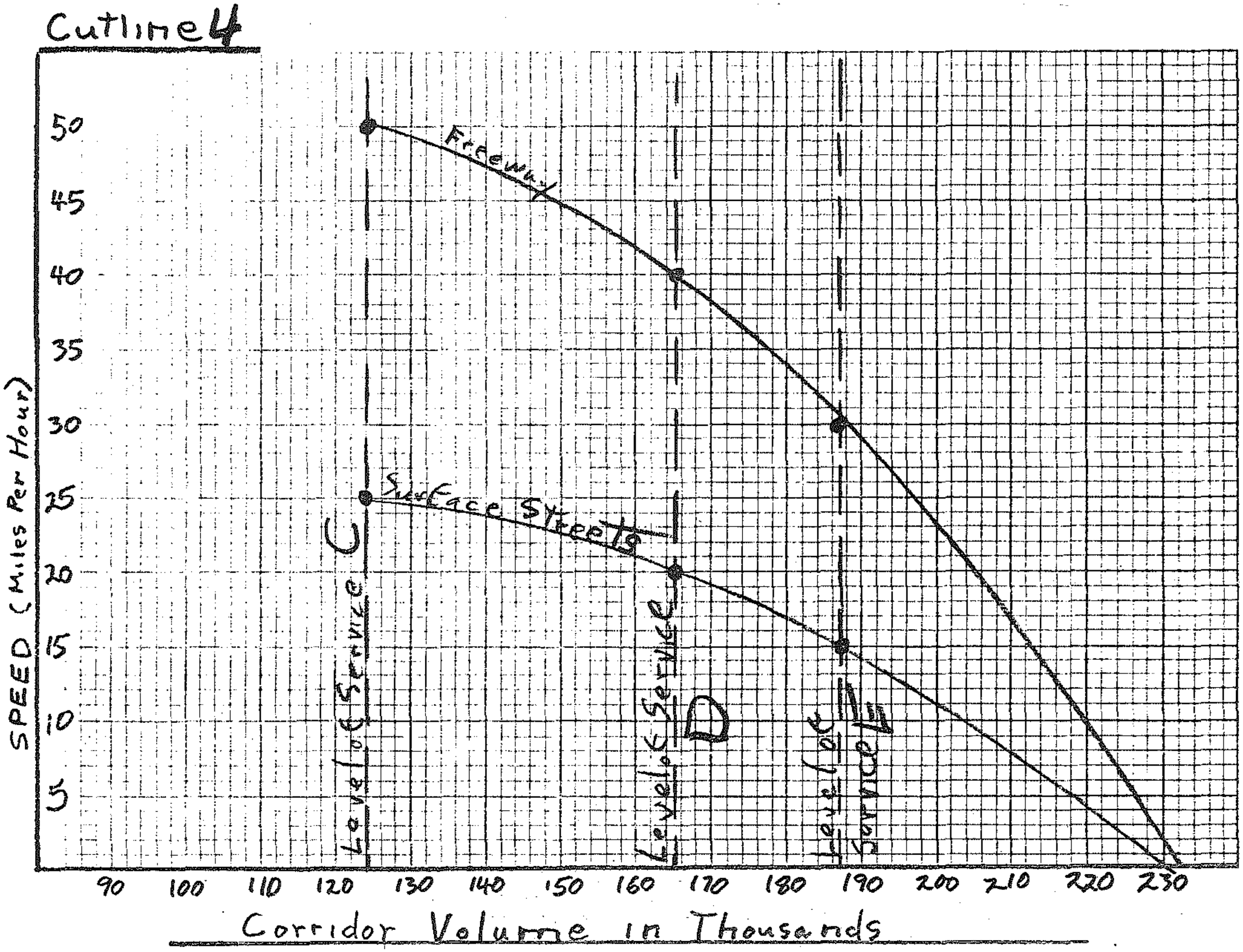


Operating Speed VS Corridor Volume

Cutline 3



Operating Speed VS Corridor Volume



undocumented to the best of the knowledge of the analysts preparing this report. Clearly, however, it is improbable that speeds will continue to decline after level E at the rate shown on the graphs. Speeds can only approach zero rather than cross zero and become negative as the curves suggest.

In summary, the operating speeds shown are reasonable up to level of service E. After level E is reached it is probable that speeds continue to decline but at a much lower rate. The slack created by reduced service volumes is manifested in an increasing duration of the peak period. Neither the increase in peak period length nor the operating speeds past level E are quantifiable at this point in time.

CUTLINE 1	LEVEL OF SERVICE C	1975	LEVEL OF SERVICE D	1980	LEVEL OF SERVICE E	1985	1990	1995
M-54BR 24 Hr.	30675	35468	36196	37358	38958	39486	42963	46688
Truck	1534	1773	1810	1868	1948	1974	2148	2334
Auto	29141	33695	34386	35490	37010	37512	40815	44354
High Hr.	2853	3299	3366	3474	3623	3672	3996	4342
Truck	143	165	168	174	181	184	200	217
Auto	2710	3134	3198	3300	3442	3488	3796	4125
Running Speed	25.0	21.0	20.0	18.0	15.0	15.0	12.0	7.0
I-475 Sbd. 24 Hr.	23496	39616	41770	46298	52213	52884	57540	62529
Truck	1175	1981	2089	2315	2611	2644	2877	3126
Auto	22321	37635	39681	43983	49602	50240	54663	59403
High Hr.	2185	3684	3885	4306	4856	3988	5351	5815
Truck	109	184	194	215	243	199	268	291
Auto	2076	3500	3691	4091	4613	3789	5083	5524
Running Speed	50.0	41.5	40.0	36.0	30.0	29.0	22.0	18.0
I-475 Nbd. 24 Hr.	24564	41761	43670	48373	54588	55175	60033	65239
Truck	1228	2088	2184	2419	2729	2795	3002	3262
Auto	23336	39673	41486	45954	51859	52380	57031	61977
High Hr.	2284	3884	4061	4499	5077	5131	5583	6067
Truck	114	194	203	225	254	257	279	303
Auto	2170	3690	3858	4279	4823	4874	5304	5764
Running Speed	50.0	41.5	40.0	36.0	30.0	29.0	22.0	18.0
M-54 24 Hr.	22475	26172	26520	27619	28544	28733	31263	33974
Truck	1124	1309	1326	1381	1427	1437	1563	1699
Auto	21351	24863	25194	26238	27117	27296	29700	32275
High Hr.	2090	2434	2466	2569	2655	2672	2907	3160
Truck	105	122	123	128	133	134	145	158
Auto	1985	2312	2343	2441	2522	2538	2762	3002
Running Speed	25.0	21.0	20.0	18.0	15.0	15.0	12.0	7.0

CUTLINE 2	LEVEL OF SERVICE C	LEVEL OF SERVICE D	1975	LEVEL OF SERVICE E	1980	1985	1990	1995
M-54BR 24 Hr.	24525	28940	29888	31146	31171	34417	37448	40695
Truck	1226	1447	1494	1557	1559	1721	1872	2035
Auto	23299	27493	28394	29589	29612	32696	35576	38660
High Hr.	2281	2691	2780	2897	2899	3202	3483	3785
Truck	114	135	139	145	145	160	174	189
Auto	2167	2556	2641	2752	2754	3042	3309	3596
Running Speed	25.0	20.0	17.5	15.0	15.0	12.5	10.0	8.0
I-475 Sbd. 24 Hr.	22748	40440	43640	50550	50593	55863	60782	66053
Truck	1137	2022	2182	2528	2530	2793	3039	3303
Auto	21611	38418	41458	48022	48063	53070	57743	62750
High Hr.	2116	3761	4059	4701	4705	5195	5653	6143
Truck	106	188	203	235	235	260	283	307
Auto	2010	3573	3856	4466	4470	4935	5370	5836
Running Speed	50.0	40.0	35.0	30.0	30.0	25.0	20.0	15.0
I-475 Nbd. 24 Hr.	21904	38940	41956	48675	48870	53961	58712	63803
Truck	1095	1947	2098	2434	2444	2698	2936	3190
Auto	20809	36993	39858	46241	46426	51263	55776	60613
High Hr.	2037	3621	3902	4527	4545	5018	5460	5934
Truck	102	181	195	226	227	251	273	297
Auto	1935	3440	3707	4301	4318	4767	5187	5637
Running Speed	50.0	40.0	35.0	30.0	30.0	25.0	20.0	15.0
M-54 24 Hr.	20450	24131	24837	25971	26002	28710	31238	33947
Truck	1023	1207	1242	1299	1300	1436	1562	1697
Auto	19427	22924	23595	24672	24702	27274	29676	32250
High Hr.	1902	2244	2310	2415	2418	2670	2905	3157
Truck	95	122	116	121	121	134	145	158
Auto	1807	2132	2194	2294	2297	2536	2760	2999
Running Speed	25.0	20.0	17.5	15.0	15.0	12.5	10.0	8.0

CUTLINE 3	LEVEL OF SERVICE C	1975	1980	LEVEL OF SERVICE D	1985	LEVEL OF SERVICE E	1990	1995
M-54BR 24 Hr.	24525	27024	28779	28940	30246	31146	31905	34631
Truck	1226	1351	1439	1447	1512	1557	1595	1732
Auto	23299	25673	27340	27493	28734	29589	30310	32899
High Hr.	2281	2513	2676	2691	2813	2897	2967	3221
Truck	114	126	134	135	141	145	148	161
Auto	2167	2387	2542	2556	2672	2752	3819	3060
Running Speed	25.0	23.0	21.0	20.0	18.0	15.0	14.0	10.0
Sbd. Serv. Rd.								
24 Hr.	13162	14444	15083	15531	16080	16716	17100	18560
Truck	658	722	754	777	804	836	855	928
Auto	12504	13722	14329	14754	15276	15880	16245	17632
High Hr.	1224	1343	1403	1444	1495	1555	1590	1726
Truck	61	67	70	72	75	78	80	86
Auto	1163	1276	1333	1372	1420	1477	1510	1640
Running Speed	25.0	23.0	21.0	20.0	18.0	15.0	14.0	10.0
Sbd. I-475 24 Hr.	22298	31528	37968	39640	44795	49550	50673	55002
Truck	1115	1576	1898	1982	2240	2478	2534	2750
Auto	21183	29952	36070	37658	42555	47072	48139	52252
High Hr.	2074	2932	3531	3687	4166	4608	4713	5115
Truck	104	147	177	184	208	230	236	256
Auto	1970	2785	3354	2503	3958	4378	4477	4859
Running Speed	50.0	46.0	41.0	40.0	35.0	30.0	28.0	20.0
I-475 Nbd. 24 Hr.	19097	26869	32594	33960	38477	42438	43375	47080
Truck	955	1343	1630	1698	1924	2122	2169	2354
Auto	18142	25526	30964	32262	36553	40316	41206	44726
High Hr.	1776	2499	3065	3158	3578	3947	4034	4378
Truck	89	125	153	158	179	197	202	219
Auto	1687	2374	2912	3000	3399	3750	3832	4159
Running Speed	50.0	46.0	41.0	40.0	35.0	30.0	28.0	20.0

CUTLINE 3	LEVEL OF SERVICE C	1975	1980	LEVEL OF SERVICE D	1985	LEVEL OF SERVICE E	1990	1995
NBd. Serv. Rd.								
24 Hr.	19775	21744	23058	23335	24120	25114	25649	27840
Truck	989	1087	1153	1167	1206	1256	1282	1392
Auto	18786	20657	21905	22168	22914	23858	24367	26448
High Hr.	1839	2022	2144	2170	2243	2336	2385	2589
Truck	92	101	107	109	112	117	119	129
Auto	1747	1921	2037	2061	2131	2219	2266	2460
Running Speed	25.0	23.0	21.0	20.0	18.0	15.0	14.0	10.0
M-54 24 Hr.	30675	33702	35888	36196	37712	38958	39830	43232
Truck	1534	1685	1794	1810	1886	1947	1992	2162
Auto	29141	32017	34092	34386	35826	37011	27838	41070
High Hr.	2853	3134	3338	3366	3507	3623	2867	4021
Truck	143	157	167	168	175	181	193	201
Auto	2710	2977	3171	3198	3332	3442	3674	3820
Running Speed	25.0	23.0	21.0	20.0	18.0	15.0	14.0	10.0

CUTLINE 4	LEVEL OF SERVICE C	1975	LEVEL OF SERVICE D	1980	LEVEL OF SERVICE E	1985	1990	1995
M-54BR 24 Hr.	22900	25968	27023	27946	29083	30857	32322	35125
Truck	1145	1298	1351	1397	1454	1543	1616	1756
Auto	21755	24670	25672	26549	27629	29314	30706	33369
High Hr.	2130	2415	2513	2599	2705	2870	3006	3267
Truck	107	121	126	130	135	144	150	163
Auto	2023	2294	2387	2469	2570	2726	3856	3104
Running Speed	25.0	22.0	20.0	18.0	15.0	14.0	8.0	2.0
SBd. Serv. Rd.								
24 Hr.	19755	22547	23335	23953	25114	25682	27943	30366
Truck	988	1127	1167	1198	1256	1284	1397	1518
Auto	18767	21420	22168	22755	23858	24398	26546	28848
High Hr.	1837	2099	2170	2228	2336	2388	2599	2824
Truck	92	105	109	111	117	119	130	141
Auto	1745	1994	2061	2117	2219	2269	2469	2683
Running Speed	25.0	22.0	20.0	18.0	15.0	14.0	8.0	2.0
SBd. I-475 24 Hr.	16729	26745	29740	32632	37175	38140	41498	45096
Truck	836	1337	1487	1632	1859	1907	2075	2255
Auto	15893	25408	28253	31000	34316	36233	39423	42841
High Hr.	1556	2487	2766	3035	3457	3547	3859	4194
Truck	78	124	138	152	173	177	193	210
Auto	1478	2363	2628	2883	2284	3370	3666	3984
Running Speed	50.0	43.0	40.0	36.0	30.0	28.0	17.0	5.0
NBd. I-475 24 Hr.	14321	22858	25460	27772	31825	32582	35450	38524
Truck	716	1143	1273	1389	1591	1629	1773	1926
Auto	13605	21715	24287	26383	30234	30953	33677	37598
High Hr.	1332	2126	2368	2583	2960	3030	3297	3583
Truck	67	106	118	129	148	152	165	179
Auto	1265	2020	2250	2454	2812	2878	3132	3404
Running Speed	50.0	43.0	40.0	36.0	30.0	28.0	17.0	5.0

CUTLINE 4	LEVEL OF SERVICE C	1975	LEVEL OF SERVICE D	1980	LEVEL OF SERVICE E	1985	1990	1995
NBd. Serv. Rd.								
24 Hr.	19775	22547	23335	23953	25114	25682	27943	30366
Truck	988	1127	1167	1198	1256	1284	1397	1518
Auto	18767	21420	22168	22755	23858	24398	26546	28848
High Hr.	1837	2099	2170	2228	2336	2388	2599	2824
Truck	92	105	109	111	117	119	130	141
Auto	1745	1994	2061	2117	2219	2269	2469	2683
Running Speed	25.0	22.0	20.0	18.0	15.0	14.0	8.0	2.0
M-54 24 Hr.	30675	34831	36196	37319	38958	39865	43375	47136
Truck	1534	1742	1810	1866	1947	1993	2169	2357
Auto	29141	33089	34386	34353	37011	37872	41216	44779
High Hr.	2853	3239	3366	3471	3623	3707	4034	4384
Truck	143	162	168	174	181	185	202	219
Auto	2710	3077	3198	3297	3442	3522	3832	4165
Running Speed	25.0	22.0	20.0	18.0	15.0	14.0	8.0	2.0

THE UNTESTED ALTERNATES

The analysis portion of this report described the development of projections of traffic data to be used in assessing the noise and air pollution level to be expected with the operation of the I-475 freeway.

The projected volumes indicate that the corridor will be inundated with traffic well before the 1995 target year. Level E service volumes are reached as early as 1980 in spite of the numerous conservative assumptions applied throughout the analysis. The freeway fails to relieve the existing deficiency in the corridor. In fact, it contributes to its own demise - the high intensity land use development planned in the corridor might possibly have been located elsewhere had the amenities of a high level transportation facility not been provided. At this point in the development of the I-475 project, it is folly to contemplate the advantages of the "do nothing" alternative. The fact that portions of I-475 are already in operation has influenced land use planning decisions which are for all practical purposes are irrevocable. Nor can the funding agencies justify non-completion of the route after so large an investment has already been made.

Upgrading the existing system is not a viable alternative because portions of the freeway are already a part of the existing system.

The only conclusion to be drawn from the I-475 experience is that comprehensive transportation and land use planning through the established transportation study structure and methodology is absolutely mandatory if the quality of urban environments is to be maintained or improved. Traffic characteristic forecasts must be an integral part of every stage in the development of a facility from the determination of need at the outset, the testing of alternative solutions, the selection of the location and the details of the design of a new facility (should it be required), to testing the merits of each of the alternatives on criteria other than traffic and roadway considerations. The Flint-Genesee County Transportation Study is the ideal vehicle for developing all of the necessary traffic data to satisfy the needs of comprehensive, systematic transportation planning.