Comprehensive Arterial Highway Plan for the Cleveland Metropolitan Area

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●THE Cleveland Metropolitan Area is co-extensive with Cuyahoga County. It contains 58 municipalities, the largest of which is the City of Cleveland (Figure 1).

The county extends along the shore of Lake Erie for about 30 miles. Its width is about 19 miles at its eastern boundary and about 10 miles at its western boundary. Its population in January 1954 was approximately 1,500,000.

Joint Action for a Comprehensive Survey and Plan

Recognizing the need for a comprehensive arterial highway plan based on the prospective development of the county and comprehensive and up-to-date traffic data, a survey program was agreed upon by the U. S. Bureau of Public Roads, the Ohio State Highway Department, the City of Cleveland, and the County of Cuyahoga. The County Engineer, Albert S. Porter, was selected as Survey Director.

With the financial assistance and technical cooperation of the Bureau of Public Roads, the Ohio State Highway Department undertook a comprehensive origin and destination survey of vehicular trips by means of postcard questionnaires, supplemented by roadside interviews. The county was responsible for traffic volume counts and traffic pattern investigations.

Cleveland participated equally with the county in payment for the services of Tippetts-Abbett-McCarthy-Stratton, who were retained as consultants for the preparation of a comprehensive arterial highway plan and report. Their project engineer in direct charge of the consultant's work was Glenn E. Brokke.

Advisory Committee

An advisory committee was appointed by the Survey Director to keep the various public and semi-public agencies of the county informed as to the conduct of the work and the findings of the consultant during the progress of investigations, and to bring to the consultant's attention the advice and counsel of those agencies. The committee was made up of representatives of the participants in the survey program and also those of several civic, public, and semi-public agencies including the Cuyahoga Mayors' Association, the Cleveland Chamber of Commerce, the Downtown Realty and Building Association, the Metropolitan Park Board, the Regional Planning Commission, the Cleveland Automobile Club, and like organizations.

The procedures which were used in each phase of the consultant's study and the tentative findings developed during the course of the work were reviewed periodically with the advisory committee. These periodic reviews and discussions were valuable in developing a highway plan acceptable to the diverse interests concerned with the program.

Land Use

The existing land use pattern of the area (Figure 2) was influenced by many things, including transportation facilities and zoning regulations. In the inner core of the area there remains little undeveloped land, and little future expansion can be expected there. In the outlying areas desirable sites are available for various uses and the future growth of many of these locations is expected to be rapid.

Many and diverse industries have been attracted to the county. Heavy industries, such as primary metal manufactures, have located in the Cuyahoga River Valley where raw materials can be received from lake vessels and where an ample supply of process water is available. Light industries which are not seriously dependent on heavy transportation facilities are located at numerous sites throughout the county.

On the basis of the availability of sites, zoning regulations, industrial trends, and

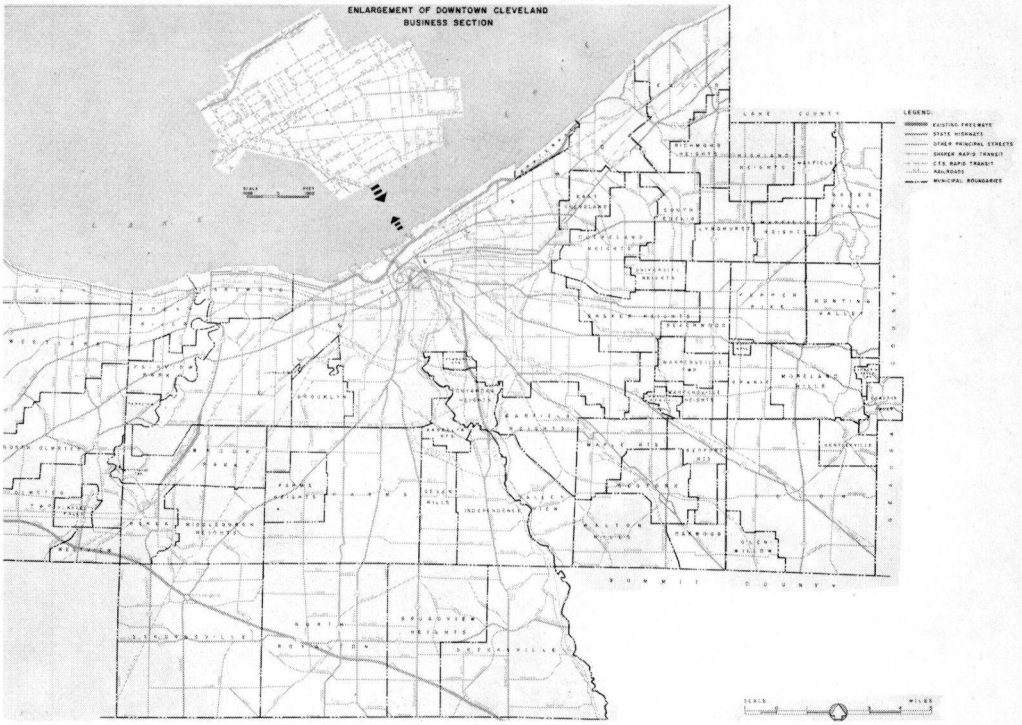

Figure 1. Location map.

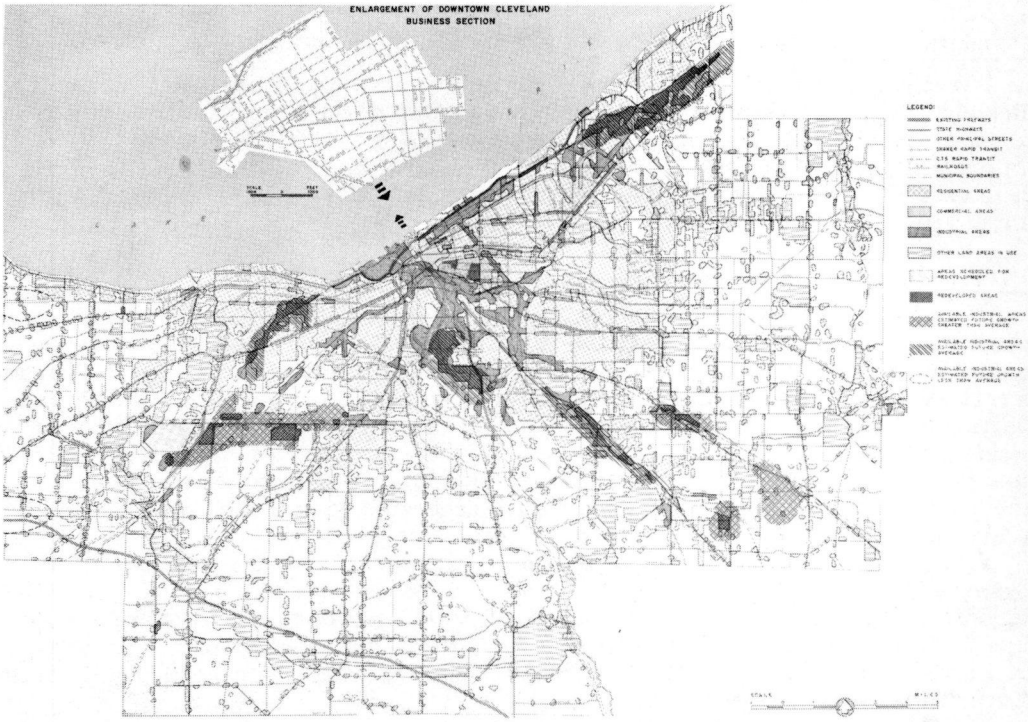

Figure 2. Land use map.

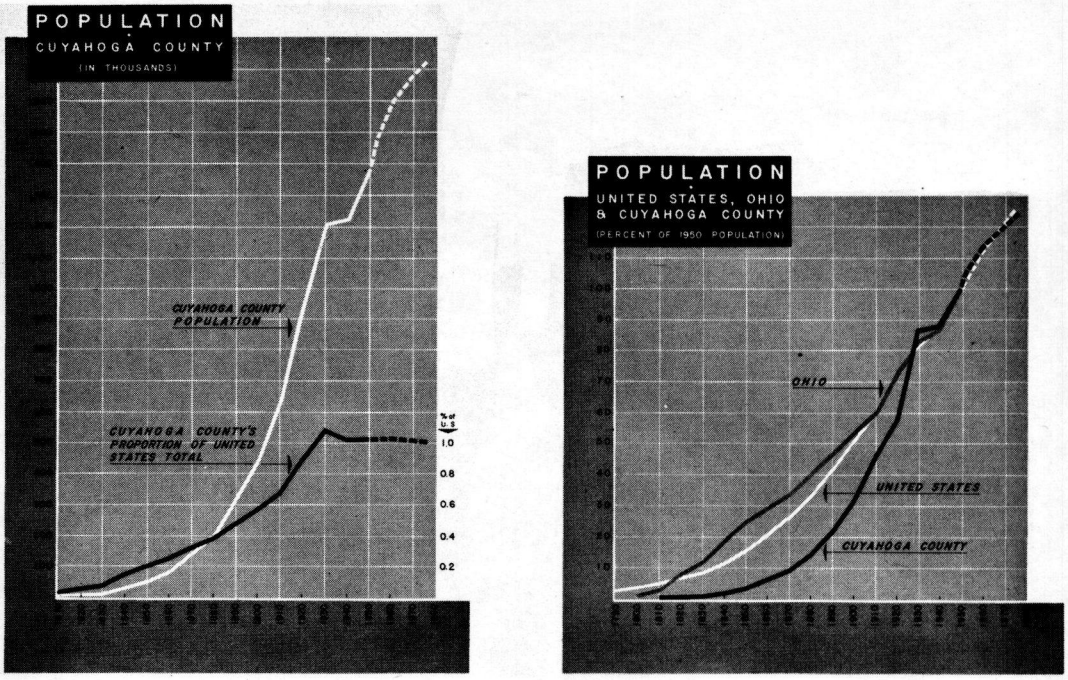

Figure 3. Population trends.

other factors, estimates of the prospective extensions of industrial areas and the probable rates of growth of those extensions were made with the assistance of the Cleveland Planning Commission and the Regional Planning Commission.

Population Growth and Distribution

Forecasts of the future population of the county were based on studies made for the Regional Planning Commission. It is estimated that by 1975 the population will reach about 1,722,000, an increase of about 16 percent over the 1952 population (Figure 3). At present about 64 percent of the county's population is concentrated in Cleveland, but it is expected that this distribution will change in the future as a result of the anticipated rapid growth of outlying areas (Figure 4).

Present Highway and Mass Transportation Systems

The highway network of the county consists of about 3,100 miles of highways, most of which are of the local street type with the undesirable characteristics which accompany unrestricted roadside developments. Two exceptions are the Memorial Shoreway, a freeway which extends along the lake front, and the Willow Freeway, the completed portion of which extends along the eastern edge of the Cuyahoga Valley south of Broadway. By 1954 the Memorial Shoreway was seriously overloaded. In contrast, the Willow Freeway was rendering only limited service largely because it was constructed from the southern portion of the county toward the congested central area without being supplied with adequate access connections to serve that area.

Mass transportation facilities in the county are operated by the Cleveland Transit System, the Shaker Rapid Transit Line, and several interurban bus lines. The Cleveland Transit System's bus and trackless trolley lines cover all of Cleveland and extend into the surrounding areas. In addition, the Cleveland Transit System is completing a rail rapid transit line with east and west branches. Studies are underway by the county for a subway loop to be constructed in the downtown area of Cleveland.

The Shaker Rapid Transit Line operates an interurban type rail rapid transit between downtown Cleveland and Shaker Heights.

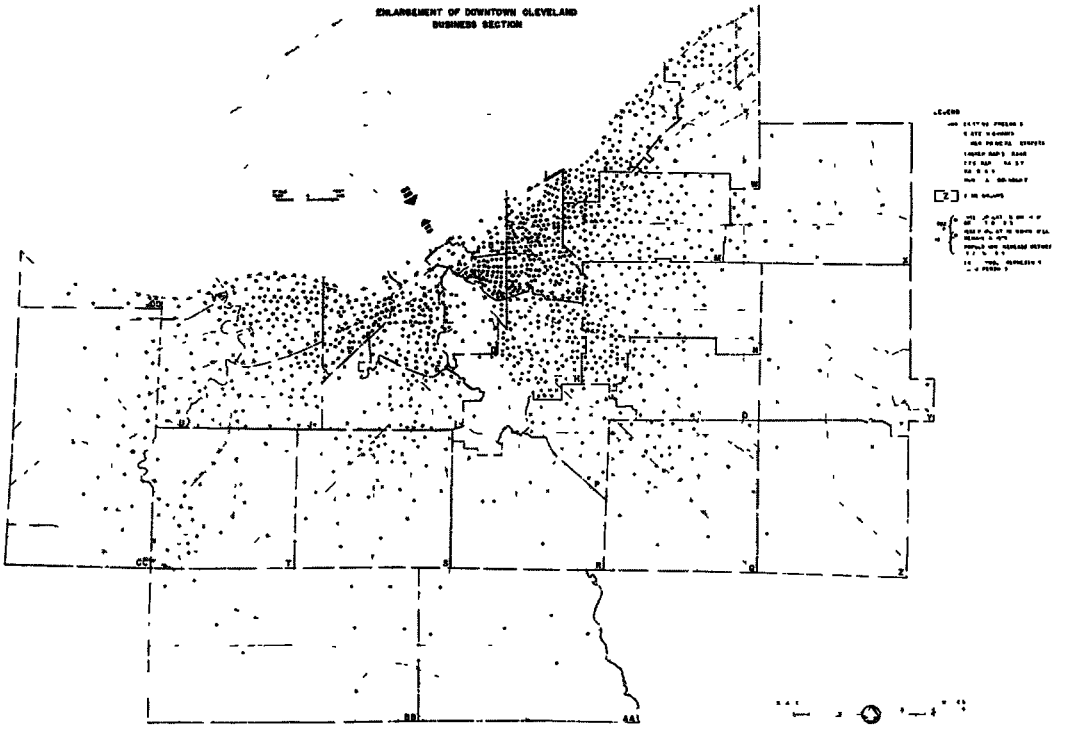

Figure 4. Population distribution, 1952 and 1975.

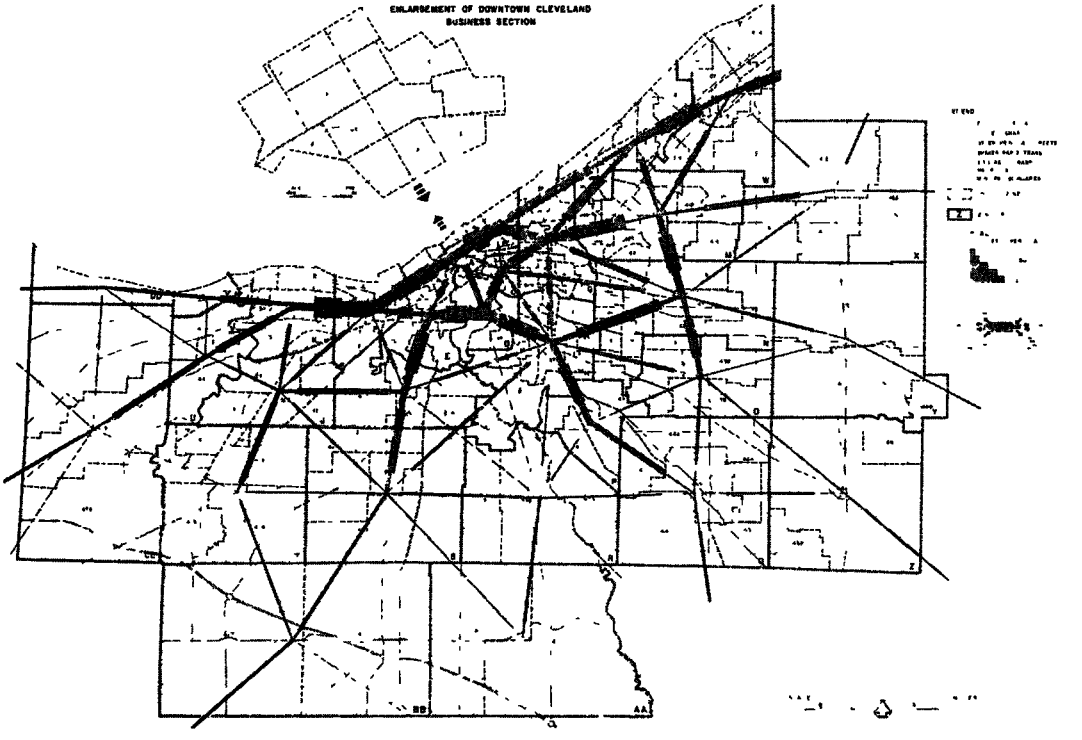

Figure 5. Desire lines, 1952.

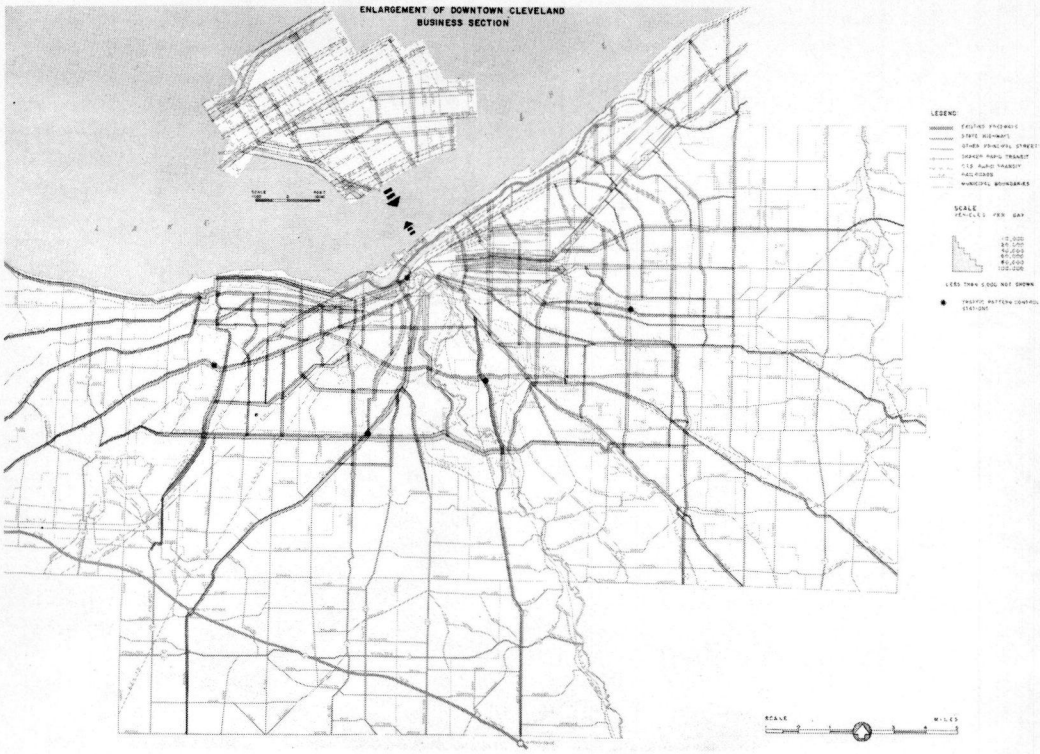

Figure 6. Average daily traffic volumes, 1952.

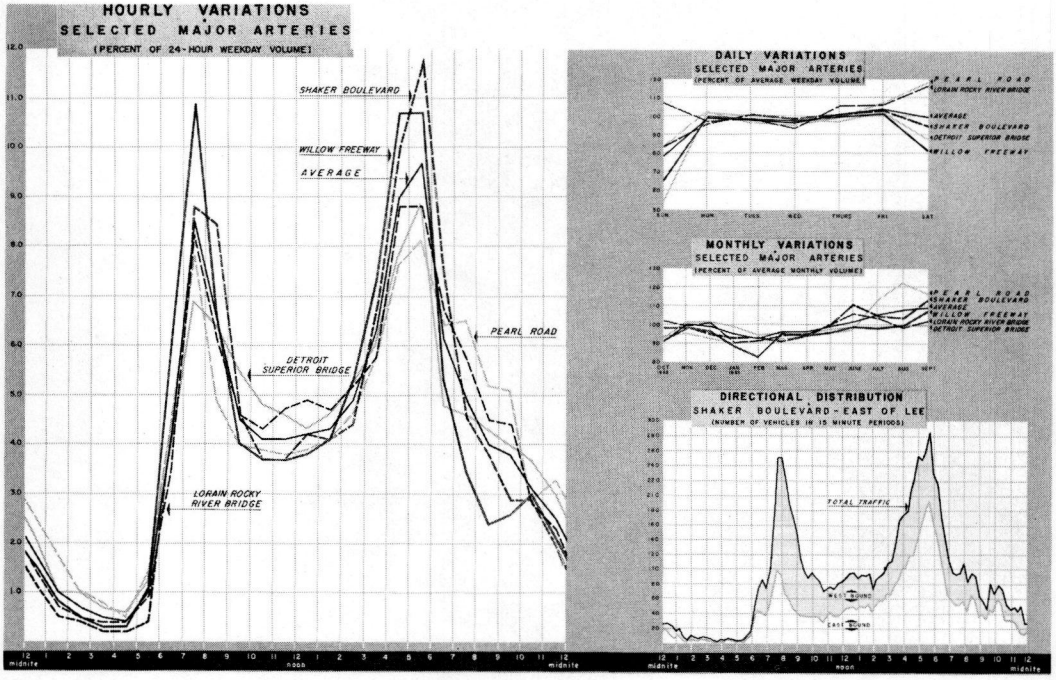

Figure 7. Variations in traffic flow.

Origin and Destination of Traffic

It was found from the comprehensive origin and destination survey conducted by the Planning Survey of the State Highway Department that for the average week day in 1952 about 1,754,000 vehicle trips were made within or through the county. Of these, about 75 percent were passenger vehicle trips, and 25 percent were commercial vehicle trips. About 90.3 percent of the trips had both origins and destinations in the county, 9.3 percent had either an origin or destination but not both within the county, and the balance, 0.4 percent, was through traffic with neither an origin nor a destination in the county. The length of the trips completed within the county varied from a few tenths of a mile to forty miles. The average length was about 5¼ miles.

As a first phase of the investigations, traffic zones were selected by subdividing the county so that traffic movements to and from individual residential communities, shopping and business centers, and industrial districts might be readily determined from survey data. All interested agencies were asked to participate in this work to assure that the origin and destination data so obtained could be used effectively, not only in the present study but in future investigations.

To demonstrate the general desire line pattern of the county without a multiplicity of crossing and overlapping desire lines, the 256 traffic zones used were combined into 45 groups. Each of these groups represents an area of more or less similar characteristics. For clarity, the traffic movements between non-adjoining groups were routed by way of intervening groups (Figure 5). Thus, the traffic which passed through any group without stopping was plotted from the traffic center of that group to the traffic centers of the adjoining groups along the line of travel, and the traffic which originated and terminated in the group was plotted as additional widths.

Daily Traffic Flow and Capacities

The traffic volumes on all of the principal highways in the area were counted by the

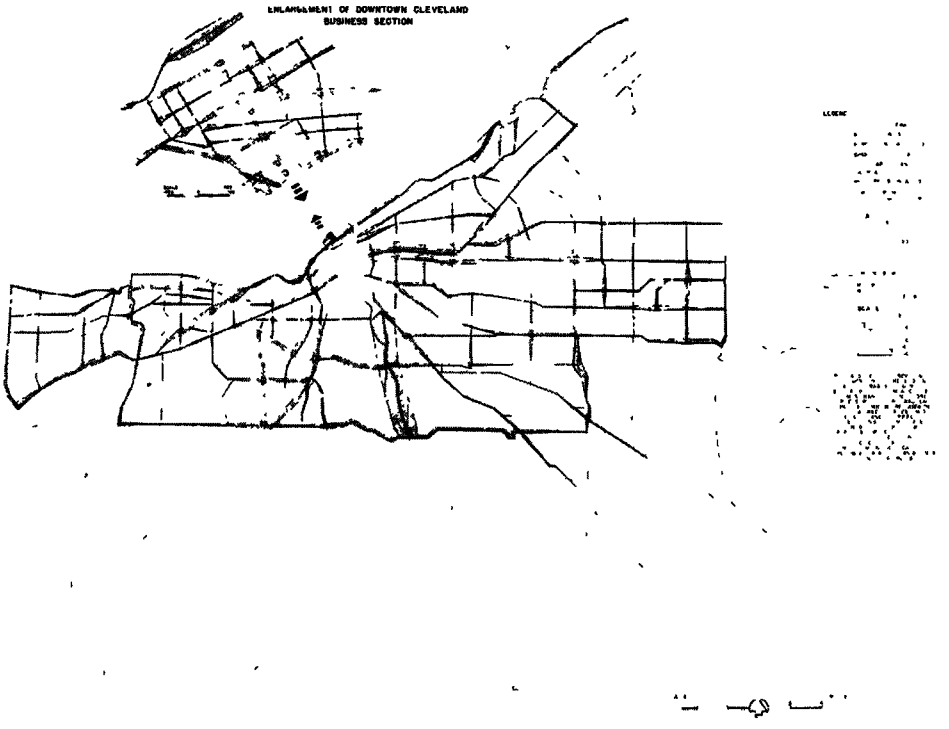

Figure 8. Deficiency and excess of highway capacity, 1952.

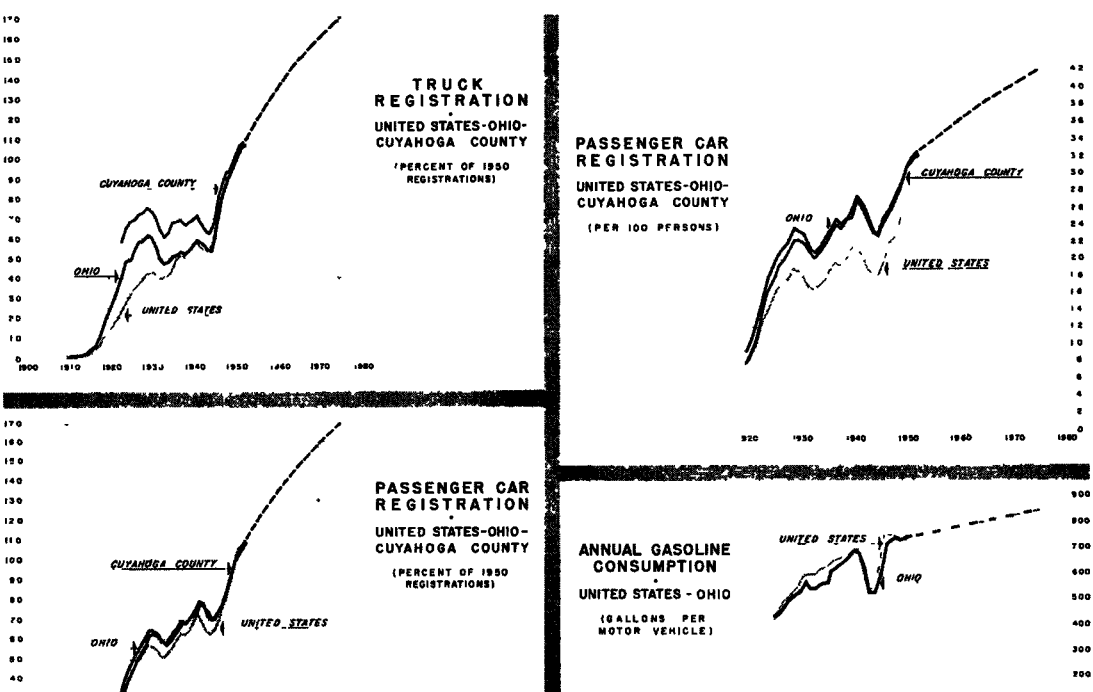

Figure 9. Vehicle registration and gasoline consumption.

county. All of the counts were resolved to a 24-hr week day in October 1952, on the basis of traffic cycle patterns compiled from regular and periodic counts at five traffic pattern observation stations (Figures 6 and 7).

The excess and deficiency of capacity on the existing principal streets in the county for 1952 were computed on the basis of standard procedures. It was found that substantial deficiencies exist throughout the area.

The Willow Freeway leads in availability of capacity. Some other existing facilities, such as the Memorial Shoreway East in the vicinity of East 9th Street and the Bratenahl Freeway east of Eddy Road, had excess capacities due primarily to lack of sufficient terminal capacity (Figure 8).

Traffic Volume Trends

In 1952 there were 32 passenger vehicles for each 100 residents in both Cuyahoga County and the State of Ohio (Figure 9). At the same time, in many regions of the nation where reasonably adequate facilities were available, the ratio was much higher. In California, for example, it was about 40.

The total vehicle registration for the county reached 505,000 in 1952, and it is estimated that by 1975 it will reach approximately 790,000, of which about 725,000 will represent passenger vehicles.

A general indication of the amount which each vehicle is driven annually is given by the records of motor vehicle fuel consumption. The annual gasoline consumption per vehicle increased from 680 gallons in 1940 to about 740 gallons in 1950. It is estimated that the annual consumption per vehicle will reach 850 gallons by 1975, with a commensurate increase in travel.

Future Traffic by Areas

The trips made into and out of any area are related to the type and intensity of land

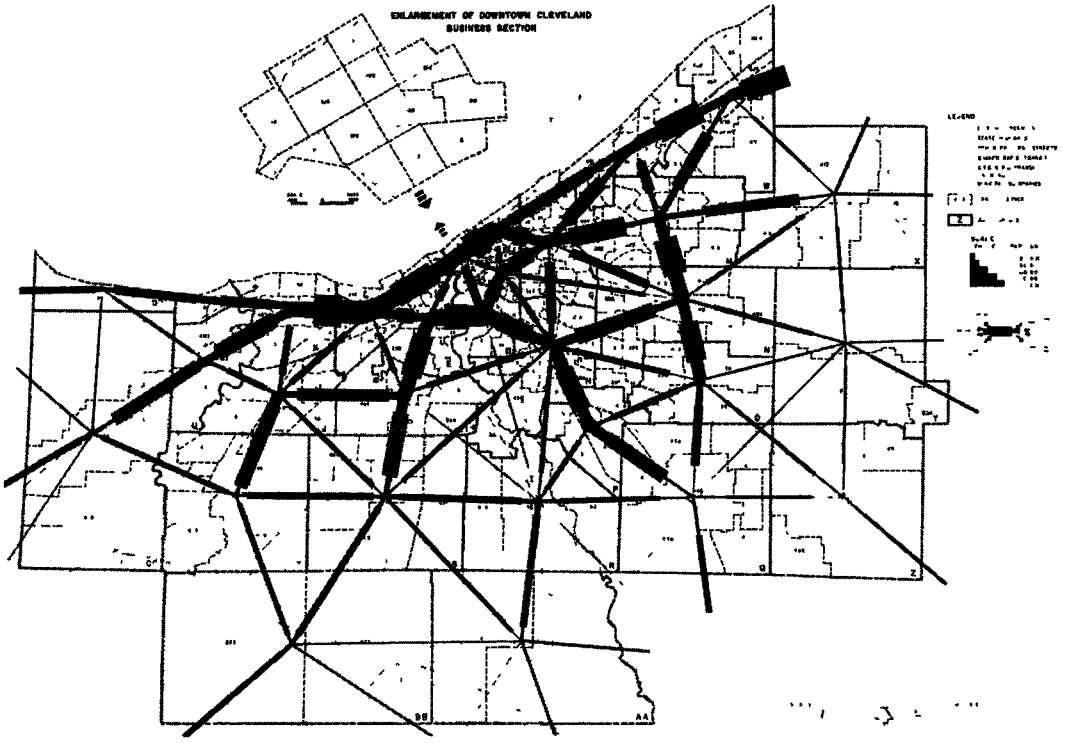

Figure 10. Desire lines, 1975.

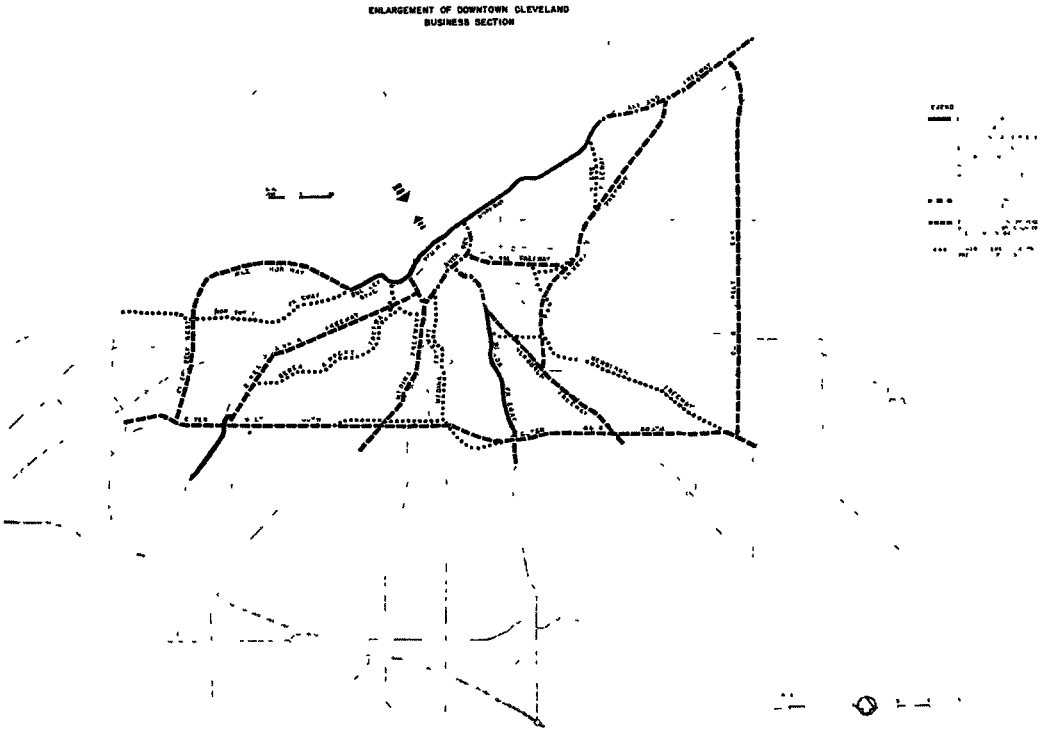

Figure 11. Existing freeways and previously proposed locations.

use of the area. Thus, for a zone which is exclusively residential in character, the total trips into and out of it have a direct relationship to its population. If a zone is entirely industrial in character, the total trips into and out of it are related to the employment in the zone. In the same manner, the total trips which enter and leave a traffic zone of other characteristics can be related to those characteristics.

To determine the future growth of trip generation, the future population of each zone was estimated, industrial and business trends were examined, and the zones were rated according to their probable future development. Careful consideration was given to anticipated changes in the character of each portion of the county. Civic agencies and others concerned with the problem cooperated actively in this work. The total anticipated annual average daily trips in 1975 are estimated at 3,136,000, an increase of 79 percent over the 1952 total.

Estimating Zone-to-Zone Distribution of Future Trips

If the various parts of an area change in a uniform way, the future traffic pattern will be a uniformly expanded copy of the existing pattern. Of course, uniform changes cannot be expected. Portions of the area will remain more or less stable, while other portions will expand or diminish. To estimate for the county studies the logical distribution which is compatible with the anticipated future conditions of development, a new theory of distribution was conceived and a method of successive approximations was developed to perform the distribution. That method was described at the 33rd Annual Meeting of the Highway Research Board. The following is a brief description of the method.

1. For each zone the estimated future traffic volume is distributed to the movements to and from it and within it, in proportion to the relative attractiveness of those movements.

Reasonable indicators of relative attractiveness are existing traffic movements and estimated zonal traffic growth factors.

As a practical matter, the intrazonal movement of the zone may be treated in the same way as an interzonal movement, with due regard to the difference between a trip and a trip end. That was done in the Cuyahoga study.

2. At the end of the first distribution each movement, except intrazonal movements, has two volumes resulting from the zonal distributions at each end of the movement. The pairs of volumes are averaged to obtain a first approximation of zone-to-zone movements and intrazonal movements.

3. The averages for the interzonal pairs of trips radiating from each zone and the first approximation of intrazonal volume are summarized to determine adjustment factors for the zones to be used in the second approximation.

4. For each zone the originally estimated trips are again distributed to interzonal movements and to movements within the zone in proportion to the volumes and adjustment factors obtained by the first approximation. The pairs of tentative volumes obtained for interzonal movements by this distribution are averaged as before, and the process repeated until the desired conformity is obtained.

In the Cuyahoga study experiments were made with variations of the method. It was found that for the procedure outlined above, the convergence was very rapid and otherwise satisfactory. With punched cards and IBM equipment the mechanics of the procedure is relatively simple.

The successive approximations method, with some refinements, was used for the traffic study recently completed for Detroit[1] under Dr. J. D. Carroll's direction.

It is to be hoped that with continued application of the successive approximation technique in other studies the reasonableness of the theory involved will be tested and practicable refinements developed. These refinements should, however, be consistent with the accuracy of the raw materials used, that is, the measured O-D data, and the estimates of future growth.

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[1] Row, Arthur T., "An Approach to O-D Data Analysis," Traffic Quarterly, January, 1955.

Future Distribution of Cuyahoga County Trips

The analysis of the future distribution of Cuyahoga trips indicated that the rapid development of suburban areas will have a major influence on future traffic movements (Figure 10). By 1975 there will be a large demand in the eastern sections of the county for capacity on north-south and northwest-southeast highways, as well as for travel between the northeastern sections and the central portion of Cleveland. In the western section of the county the anticipated growth of Parma and other suburbs will result in large increases in traffic flows to and from those areas. These increases in demand in many cases would seriously overtax the existing highways and will require substantial increases in the capacity of the county's highway network.

Basic Concepts in Highway Planning

For the over-all problem of the county it was necessary to examine the basic concepts of how people can best be transported in going about their ordinary community activities, and how other vital services such as heavy trucking and inter-community transportation can be provided without seriously interferring with the functions of neighborhood streets. It is clear that in addition to any other modes of transportation which exist or may be developed, transportation services must be available on highways designed to accommodate both public and private vehicles.

To be satisfactory, a comprehensive highway plan must be fully integrated with the land use pattern. New highway locations to serve the people of the community should be selected on the basis of the needs for handling traffic, minimum interference with existing structures and natural neighborhoods, and principles of good engineering and economy. The new highways must be located so as to divert through traffic around critical areas of congestion on the older streets and allow those streets to fulfill their essential functions of local service. Highways improperly located will not solve the problems and can create additional conditions of traffic congestion.

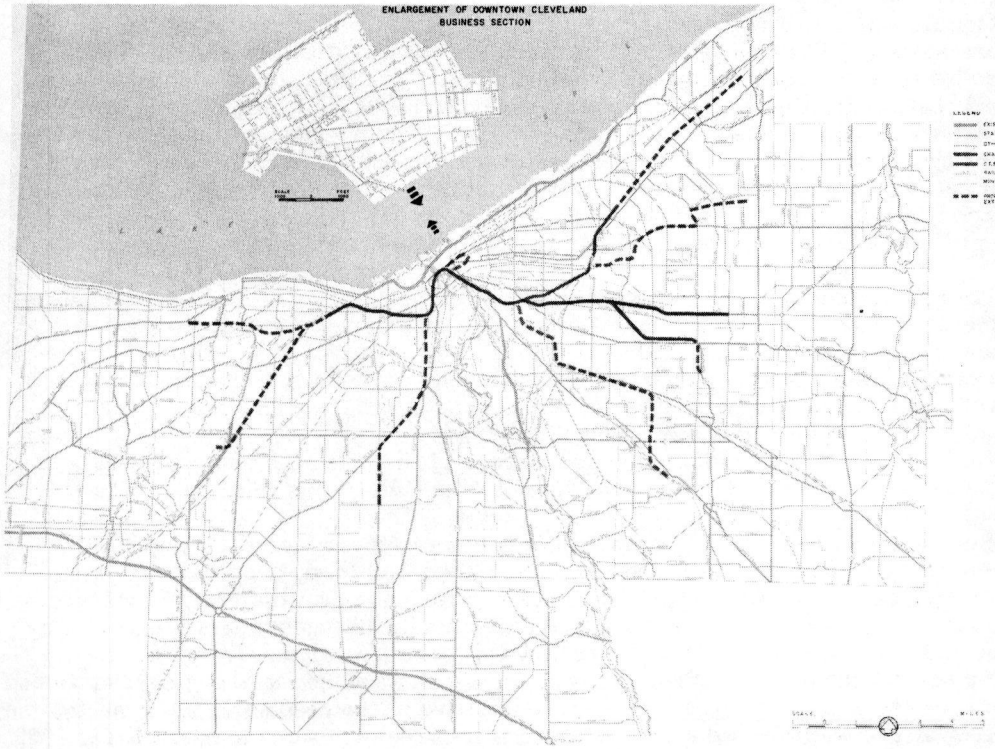

Figure 12. Existing and proposed rapid transit system.

Previously Proposed Freeway Layouts

In 1944 the Regional Association of Cleveland brought together various proposals for freeway layouts and adopted a freeway system to be used as a guide for future planning. In the ensuing years, various other civic agencies prepared layouts which included modifications of that system (Figure 11). Although outstanding talents were brought to bear in the development of the original layouts and modifications, only sketchy traffic data were available and only a few alignments were studied in detail in regard to such matters as services rendered, engineering feasibility, construction costs, and like matters. By 1952 only two freeway sections were constructed.

Existing and Proposed Rail Rapid Transit Lines

For use in this study an analysis of possible extensions of the rail rapid transit system was made jointly by the Regional Planning Commission and the Cleveland Transit System (Figure 12).

The diversion from the highways to the existing and proposed rapid transit lines will be a function of the attractiveness, comfort, speed, and convenience of rapid transit travel in competition with travel by highway buses and private passenger vehicles. The rapid transit system will be most effective in carrying passenger traffic between the downtown area of Cleveland and the intensely developed suburbs.

For this study, a detailed analysis was made of data on origins and destinations of riders of the Shaker Rapid Transit. From this analysis the probable extent of the zones of influence of prospective rapid transit lines was determined and factors were computed for estimating the diversions which would be made from highways to new rapid transit lines. These factors were compared with estimates furnished by the Cleveland Transit System and, as general agreement was found, the Cleveland Transit System estimates were used in this study.

Freeway Study Layouts

The traffic which will use any part of a freeway system is influenced by the extent of the entire system. For this reason, it is necessary to visualize the systems which might be appropriate and to test each by computing the traffic service which would be rendered, estimating the costs and benefits, and evaluating location problems and related matters. Refinements of the layouts include the determination of suitable means for carrying the traffic found to be in excess of the capacity of various sections of the original schemes, and for carrying the traffic initially assigned to freeway sections subsequently found to be unjustified.

The procedure used in the assignment of traffic to alternative freeway layouts was as follows:

1. Travel-time measurements were made on all principal routes within the county. From these, the most favorable time of travel was determined for each zone-to-zone movement via existing streets.
2. Operating speeds were selected for the various sections of each freeway system, and travel time ratios were computed for each zone-to-zone movement for travel via the freeway systems versus travel on city streets.
3. On the basis of data compiled by the Bureau of Public Roads and approved by the American Association of State Highway Officials, the time ratios were related to the trips that would use the freeway systems.
4. For each freeway system, punched cards were prepared for each zone-to-zone movement to show the numbers of passenger car trips and truck trips that would be diverted to the system in 1952. For each zone-to-zone movement the ramp which would be used in entering the freeway system, the freeway interchanges traversed in making the trip, and the ramp used in leaving the freeway were indicated.
5. By sorting the punched cards for each possible movement at each interchange and summarizing the traffic volumes on the cards relative to the respective movements, the basic freeway use which would be experienced if the freeways were in operation in 1952 was established.

6. A traffic expansion factor was determined for each traffic zone for 1975 and, by the method of successive approximations, the interzonal and intrazonal trips to be made in 1975 were estimated. Interchange routing cards, representing the 1975 trips, were prepared and summarized (in the same manner as the cards representing the 1952 trips) to determine the traffic volumes which would use each element of each proposed freeway system in 1975.

7. On the basis of past experience, estimates were made of the generation of new traffic which would result from the construction of each of the proposed freeway systems and the anticipated new traffic volumes were added to the 1952 and 1975 freeway traffic volumes diverted from existing streets.

All previous proposals were studied and modifications were developed where found to be appropriate. All of the system layouts investigated included the 17 miles of freeways now constructed and certain alignments proposed but unbuilt which the Advisory Committee considered to be fixed unless subsequently found to be unsuitable for the needs of the anticipated traffic.

Freeway System A

The system selected for initial study included a layout which is similar to that prepared in 1944 by the Regional Association of Cleveland as a general guide for freeway planning. That system was designated system "A-1" (Figure 12).

If system A-1 had been in operation in 1952, it would have carried approximately 40 percent of the traffic which was actually carried by the existing highway system. The diversion to the freeway system would have amounted to about 4,100,000 vehicle miles per day. By 1975 the anticipated traffic increases would tend to impose on system A-1 traffic loads which would greatly exceed maximum freeway capacities at several locations.

If system A-1 could carry the traffic that would desire to use it in 1975, regardless

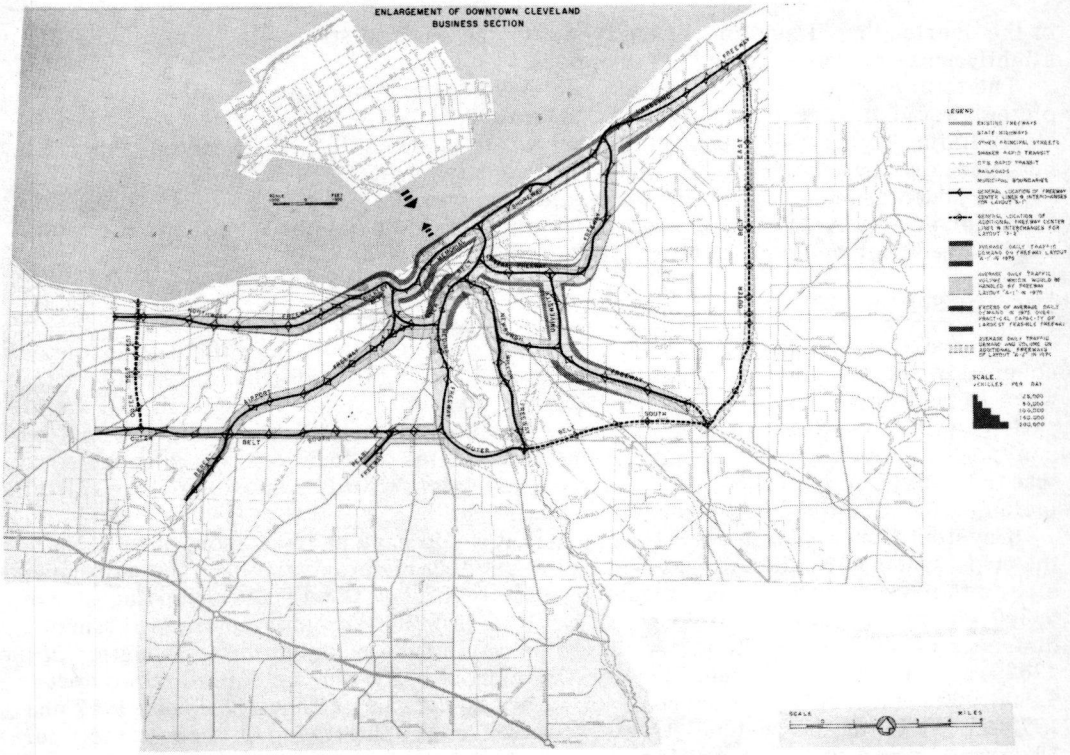

Figure 13. Freeway system A (layouts A-1 and A-2).

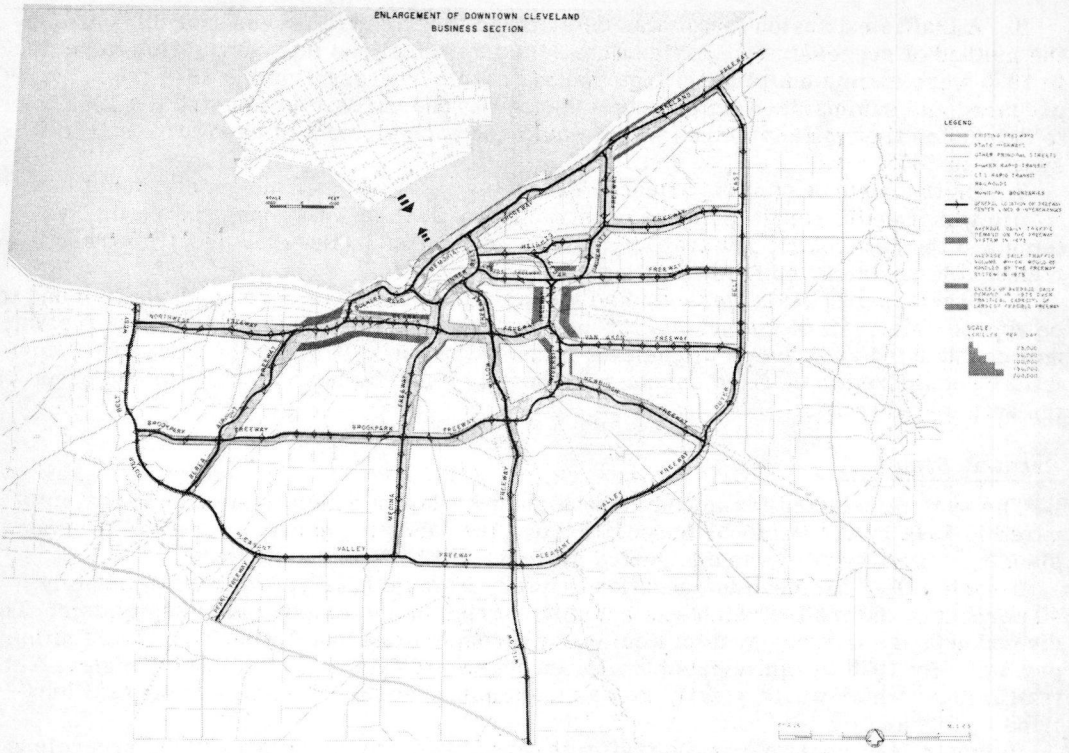

Figure 14. Freeway system B.

of the overloading of sections of the freeway, the surface streets in 1975 would still be slightly more congested than they are today.

The total cost for the system A-1, exclusive of the cost of the 17 miles now completed, would amount to approximately $390,000,000.

A similar layout was prepared to incorporate modifications suggested in general layouts prepared by other agencies and was designated system "A-2."

The added mileage of system A-2 would have no material effect on the overloading found for system A-1. Consequently, system A-2 would also be inadequate for future traffic needs but would cost approximately $444,000,000.

Freeway System "B"

Freeway system "B" was selected with a view toward correcting the deficiencies uncovered by the analyses of systems A-1 and A-2 and determining the suitability of freeways in areas not covered by those layouts (Figure 14). It was recognized that the locations where freeways would not be necessary should be determined, and for that reason freeway alignments were included in system B for all locations where it appeared that they might be justified. The length of the system would be approximately 161 miles, including the 17 miles of freeways now completed.

If system B had been in operation in 1952 it would have carried about 46 percent of the trips which were actually carried by the existing highway system. The daily diversion to the system would have amounted to about 805,000 trips, corresponding to about 5,300,000 vehicle miles. Although many vehicles would encounter increased travel distances by using the system, the diversion would have resulted in the reduction of the 1952 traffic on existing county highways from about 9,200,000 vehicle miles to about 4,800,000 vehicle miles, a decrease of about 47 percent. Although between 1952 and 1975 the traffic on the surface streets would increase, the traffic on those streets in 1975 would be about 14 percent less than the traffic which existed in 1952.

Although the traffic demands on some sections of system B in 1975 would seriously overload those sections, the overloading would be much less severe than for systems A-1 or A-2.

The total construction cost for system B, exclusive of the cost of the 17 miles now completed, would amount to approximately $618,000,000.

Recommended Freeway System

The studies of systems A and B and variations of those systems revealed the areas where freeways are most urgently needed and also the areas where surface arterial highways could accommodate the anticipated demands. Extensive field reconnaissance was made for the selection of tentative alignments which could handle the anticipated traffic volumes safely and efficiently and be appropriate for the existing and anticipated land use and in conformity with the topographic conditions. Consideration was given to the desirability of making maximum practicable use of low value property and avoiding physical barriers, expensive existing structures, cemeteries, schools, churches, parks, playgrounds, and similar areas.

Consideration was also given to the surface arterial highways which are now adequate or which could be made adequate with reasonable improvements. The capacities of these surface arterial highways were reviewed and determinations were made of the extent to which they could carry anticipated future traffic loads and thereby diminish the need for freeway type improvements. In addition, recognition was given to the various localized improvements of surface arterial streets which are programed or proposed.

The recommended layout (Figure 15), incorporates several alignments found to be satisfactory in the previous studies and others which were made satisfactory by readjustments of other segments of the freeway network.

The recommended system, together with principal arterial surface streets, would

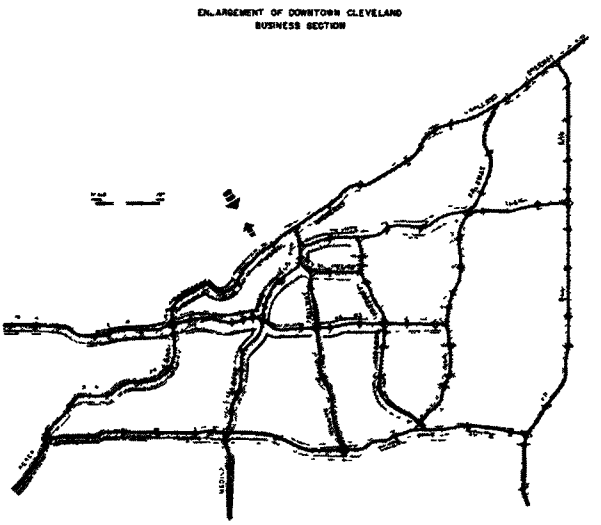

Figure 15. Freeway system C.

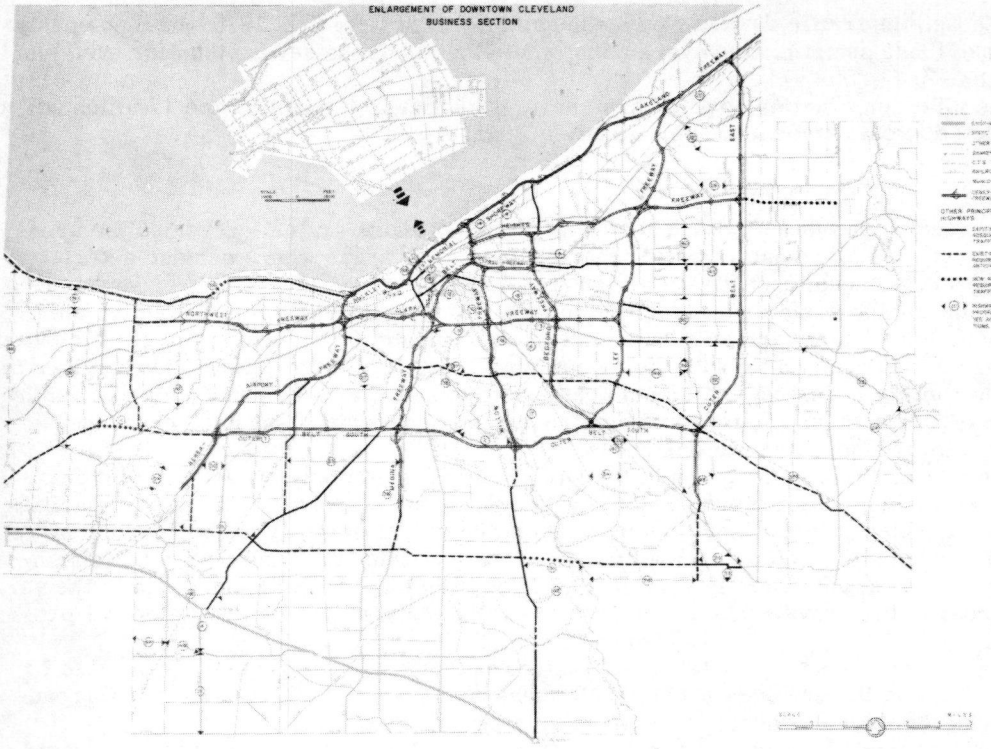

Figure 16. Comprehensive highway plan (with schematic layout of recommended freeway system).

provide a good geographical distribution of arterial highways. The length of the freeway system would be about 119 miles.

The freeway system and the principal arterial streets would adequately accommodate the traffic in 1952 and, with an appropriate allowance for anticipated diversions to the proposed rail rapid transit system, the highways would also be able to accommodate satisfactorily the anticipated 1975 traffic volumes.

On an average weekday in 1952, 1,754,000 vehicle trips were made in the county. It is estimated that if the freeway system "C," together with the proposed rail rapid transit system, were completed and in operation in 1952, 730,000 of those trips would have been made via the freeway system, 980,000 would have been made entirely on surface streets, and the passengers who were transported in the remaining 44,000 vehicle trips would have traveled by rapid transit rather than by automobile. It is anticipated that by 1975 the automobile trip potential will increase to about 3,140,000 trips per day. With the freeway system and the rapid transit system in operation, in that year the distribution of that potential would be 1,185,000 trips on the freeway system, 1,880,000 trips on surface streets, and 75,000 trips converted to rides on the rapid transit.

With both the freeway system and the proposed rapid transit system in operation in 1952, almost 6,000,000 vehicle miles would have been traveled daily on the freeway system. The diversions to the freeway system and to the rapid transit system would have reduced the travel on the surface streets by approximately 45 percent.

By 1975 there would be about 9,000,000 vehicle miles traveled daily on the freeway system. Although at that time the mileage traveled on the surface streets would be slightly greater than the mileage traveled on those streets in 1952, the increased travel would be made in outlying areas where additional surface street capacity would be available. The surface streets in the north central area of the county would be required to carry approximately 15 percent less traffic than they carried in 1952.

The total cost for freeway system C, exclusive of the cost of the 17 miles now completed, would amount to approximately $508,000,000, or about $5,000,000 per mile.

If the freeway system were complete, for the entire period 1952-1975, the average cost of the system per vehicle mile of travel on it would be about 0.8 cents.

The Selection of Priorities

The selection of priorities for the construction of the various portions of the recommended freeway system must be such that the interim stages will provide reasonable solutions for the traffic problems during those stages. As far as possible, each segment completed should be a usable entity. The termini of successive improvements should be so located as to avoid the creation of new conditions of congestion. The order of priorities was based on the following:

1. The relief which it would provide for existing conditions of traffic congestion.
2. The service which it would render, as measured by the construction cost per mile of travel.
3. The sequence required for integration of the entire program.

In most instances these criteria lead to clear cut decisions. In a few instances, however, the relative merits of two or more components are about equal and rearrangements of their respective priorities would also be feasible.

Principal Surface Arterial Highways

The construction of highways to freeway standards can be justified only in locations where the traffic volumes are very large. A network of principal arterial streets at grade is needed to supplement the freeways. This network would provide major feeder routes to the freeway system and would accommodate the through traffic in locations where the volume of that traffic does not justify freeway construction. The network of principal surface arterial highways should be adequate to take care of the important through traffic volumes not accommodated by the freeway network, but should not include the streets where the traffic service requirements are essentially of a local character (Figure 16).

Annual Cost of Freeway System

The average annual cost for the entire recommended freeway system, estimated on the basis of right-of-way purchase costs amortized over a period of 20 years, and an interest rate of 3 percent, would be about $28,000,000. Maintenance costs were omitted as corresponding costs would be incurred in repairing the damages to surface streets which would be caused by the excessive traffic loads if the freeways are not built.

Over-All Justification

The average annual cost of vehicle ownership and operation in the county, excluding state and federal gasoline taxes and registration fees, is estimated at about $560,000,000 over the next 20 years. In addition, an average of $47,000,000 will be collected annually in the county for state and federal gasoline taxes and registration fees. The estimated average annual benefits of the program over the next 20 years would amount to $41,000,000 in savings of out-of-pocket expenses and $73,000,000 in the value of time and convenience.

Thus, the annual cost for the construction of the entire freeway system is only 68 percent of the annual savings in out-of-pocket expenses of road users; 60 percent of the annual state and federal gasoline taxes and registration fees; and only 5 percent of the gross annual costs, exclusive of taxes, for vehicle ownership and operation in Cuyahoga County.

The freeway program most certainly appears to be a good investment.