reasoned approach to these problems will be given definiteness of direction and be pressed with vigor. The stakes are high, for the economic and the social welfare of the United States is dependent on an adequate highway transportation system developed on a sound fiscal policy.

PROGRAM AND PROJECT PLANNING

By Roy E. Jorgensen
Director of Highway Planning
Connecticut State Highway Department

Discussion of Program and Project Planning will be limited to some aspects of Connecticut's highway planning which it is believed are somewhat different in character from planning survey activities in most other states.

Program Planning. A $99,000,000 five-year state highway construction program has been planned and there is only $31,000,000 in sight to accomplish it.

The first year of the five-year program ended on June 30, 1946. The second year is the fiscal year ending June 30, 1947. The third, fourth, and fifth years will be the fiscal years of 1948, 1949, and 1950. If the $99,000,000 program is carried out according to plan, it would mean that all projects contemplated would be completed or under way by July 1, 1950.

The biggest "program" job at the moment in Connecticut is to present the five-year program of $99,000,000 and the latter program, involving another $200,000,000, in a manner that will assure that its importance and urgency are recognized by the legislature whose responsibility it is to establish the basis for financing Connecticut's road program. It is important to make clear the character of the major improvements being planned in and adjacent to cities, to indicate the value these improvements will have in the relief of congestion and reduction of hazard, and, above all, to establish a recognition that the program is a fact and not a proposal. Whether construction proceeds rapidly or slowly, whether there are $31,000,000 or $99,000,000 available in five years, the characteristics of the individual projects will be unchanged because they are based on the traffic to be served and not fitted to potential revenue. This must be made clear. *There is no uncertainty about a soundly planned program except the rate at which it will be undertaken.* The Connecticut highway planning unit has just completed and is now distributing a program report. Some of the illustrations from this report will show how the state

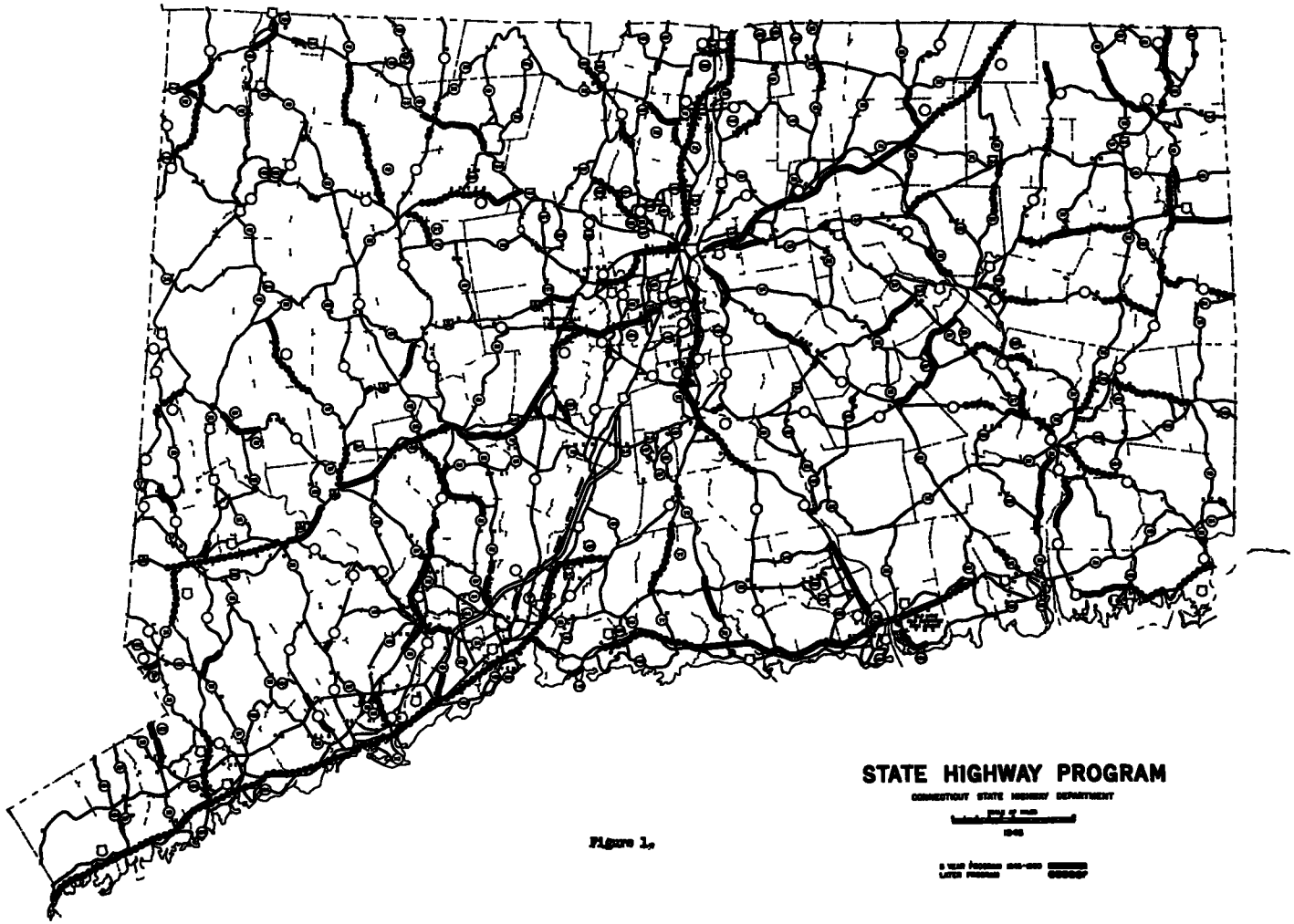
STATE HIGHWAY PROGRAM
CONNECTICUT STATE HIGHWAY DEPARTMENT

Figure 1.

highway program is being presented.

The state highway program has been shown on a state map, Figure 1, to indicate the geographic distribution and approximate location of projects. The solid lines are the projects given top priority - the ones included in the five year program and all that can be financed with $99-million. The remainder of the program is shown with dotted symbolization. The extent and importance of projects in the later program are helpful in demonstrating the urgency of meeting the proposed five-year schedule of improvements. From the map, it will be apparent to the representatives in the legislature and other interested individuals that it has been necessary to defer many important improvements beyond the period of the five-year program. If the five-year program is not financed to permit its realization for eight or ten or 12 years the whole program will be postponed accordingly and the deferred important projects will be even further removed from initiation than they are under the proposed schedule. If no additional funds become available, the 5-yr program will stretch into a 16-yr program and the long-range program, estimated to cost $300,000,000, at present prices, will become a heritage for future generations.

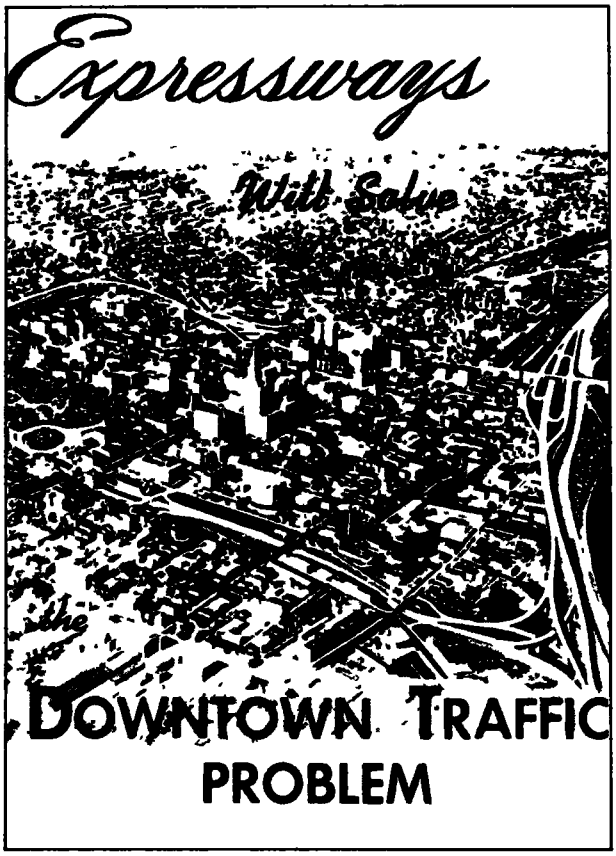

Figure 2

Figure 2 illustrates the manner in which the planned expressways, which account for a large part of the cost of the program, will serve the central area of one of Connecticut's cities. Origin and destination studies have shown conclusively that the central business areas are by far the most important generators of traffic and that relief of congestion can be

accomplished only by serving these areas directly. 1/

There is presented in Figure 3 a comparison between gasoline consumption, elapsed time, and stops on alternate routes between the New York state line and the New Haven city line, based on test runs made this year. The "old route" is U. S. No. 1 which passes through the several cities and unincorporated communities close to Long Island Sound. In large part it is no different in its physical characteristics from any other city street even though it is U. S. No. 1 and an important traffic artery. The "Expressway" is the Merritt Parkway, which is a four-lane, divided, limited access highway with no impedances to prevent high, uniform travel speed except for toll station stops.

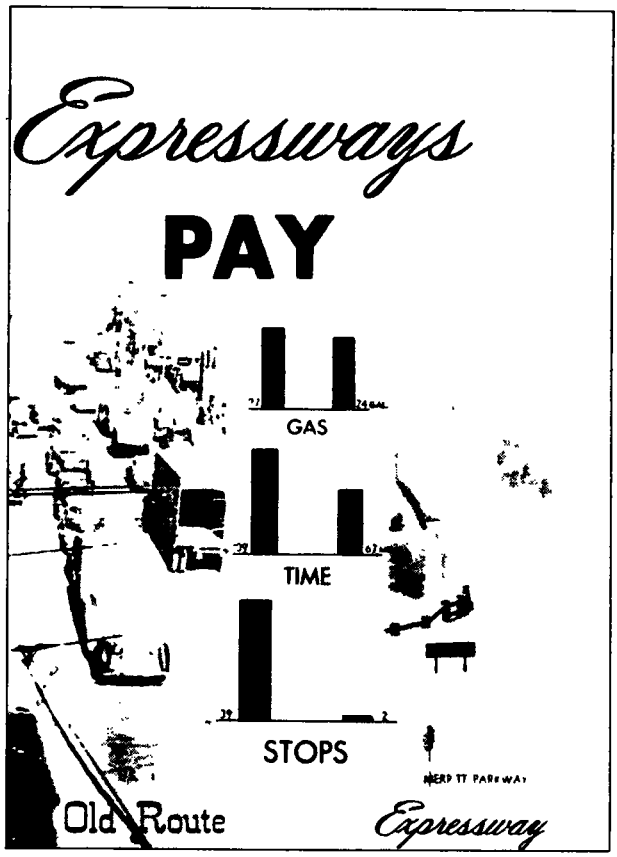

Figure 3. Expressways Provide Both Comfort and Economy

Details of the test runs which were made on the same day for each route are shown in Table 1. It is very evident from this tabulation that the "Expressway" route provides economy of motor vehicle operation and freedom of travel without the attendant irritation of those impedances so abundant on "old routes."

It is important to show what the development of an adequate network of main highways is going to mean in the reduction of hazards. In the program report comparisons have been made between accident rates on expressways and on the road system generally. Tables 2 and 3 give comparative data for

1/ *"Highway Planning Survey and Traffic Engineering in Connecticut, American Association of State Highway Officials' Proceedings, Papers and Discussions, page 119, 1944.*

Table 1

	Expressway (Merritt Parkway)		Old Route (U.S. No. 1 - Boston Post Road)	
	1st Trip	2nd Trip	1st Trip	2nd Trip
Time of Day	8:30-9:30 AM	10-11 AM	2-4 PM	4:30-6:30PM
Time of Trip	1 hr 6 min	1 hr 8 min	1 hr. 41 min	1 hr 57 min
No. of Stops	2	3	37	41
Mileage	48.3	48.3	47.7	47.7
Gas Consump. (gals.)	2.35	2.35	2.60	2.70

accidents and fatalities respectively. These can be translated into potential accident reduction resulting from the transfer of traffic from existing roadways to expressways.

There were 415 people killed in traffic accidents in Connecticut in 1941. What would have been the situation had the expressways program been completed and serving as the main traffic arteries? The 415 deaths represented a rate of 8.0 for every 100,000,000 vehicle-miles of motor travel in the state. Records on existing express highways indicate a reduction to about 3.5 is a reasonable expectation. Using this value and applying it to the estimated traffic that would have been diverted to the express highway system, had it been completed in 1941, it is found that there could have been saved the astounding total of 94 lives. And these figures don't stop with 1941. This year, had the system been completed, 80 to 90 people might have been saved from death in motor vehicle accidents, and next year an additional 90 or more, etc.

Figure 4 compares the fatalities which occurred on paralleling sections of the Merritt Parkway and U.S. No. 1 between 1940 and 1944, during which period the total traffic using each was reasonably comparable. The death rate was 4.5 times greater on U.S. 1 which had 103 traffic deaths as compared with 23 on the Merritt Parkway.

Figure 5 shows the extent to which the long ignored but now fully recognized urban traffic problem has expanded the state highway program. The rate of state highway construction must be expanded greatly if the most urgent of the accumulated improvement needs are to be met. In large part the necessary expansion must be directed at the urban traffic problem - at breaking the bottlenecks in the cities through the provision

Table 2

ACCIDENTS PER 100 MILLION VEHICLE MILES [a]

Description	Present Length Mi	Period	Avg. Daily Traffic	Accident Rate
	Expressways			
Merritt Parkway -- passenger cars	37.5	7-38 to 1-45	8,900	170[b]
Hartford Expressway -- 14 percent trucks and buses	4.2	10-42 to 10-46	6,150	97[b]
	Other Routes			
Conn. State Highway Average	2,880	1940-1944	2,360	303
Route 15, E. Hartford-Glastonbury, Suburban Area, 2 lanes	8.4	" "	6,530	520
Route 15, E. Hartford-Industrial Area 4 lane divided	1.0	" "	20,000	1,150
U.S. 1, New York-New Haven, Urban and Suburban 4 lane undivided	46.0	7-38 to 1-45	10,800	440

[a] Reported to Motor Vehicle Department.

[b] Rates computed on total traffic and accident experience. Length was not complete throughout this period.

of expressways which can move large volumes of traffic with safety and dispatch.

In the five-year program, urban projects will cost $47,000,000 out of the $99,000,000 total, or almost 48 percent of the program. In the over-all program, urban improvements will make up 58 percent of $174,000,000 of the $300,000,000 total. It is noteworthy that the amounts shown for the pre-war period, 1937 to 1941, which total $45,000,000, represent pre-war construction dollars. The five-year program totals

Table 3

FATALITIES PER 100 MILLION VEHICLE MILES

Description	Length Mi	Period	Avg. Daily Traffic	Fatality Rate
		Expressways		
Merritt Parkway -- passenger cars	37.5	7-38 to 1-45	8,900	3.5[a]
Hartford Expressway -- 14 percent trucks	4.2	10-42 to 10-46	6,150	2.7[a]
Arroyo Seco Parkway California	5.8	1941 to 1944	27,200	3.5
		Other Routes		
Conn. State Highway Average	2,880	1940 to 1944	2,360	8.0
U.S.No. 1, New York-New Haven, Urban and Suburban 4 lane undivided	46.0	7-38 to 1-45	10,800	11.2
California State Highway Average (rural)		1941 to 1944		14.0
Figuoro Street Los Angeles	5.35	1941 to 1944	25,100	14.0

a Rates computed on total traffic and accident experience. Length was not complete throughout this period.

$99,000,000 at post-war prices. To make a comparison of accomplishment between the $99,000,000 program and the pre-war program of $45,000,000, the $99,000,000 must be scaled down to about $70,000,000. It is also true that if current price levels do not prevail it will be possible to accelerate the program proportionately.

Figure 6, which is based on a nation-wide analysis by the Public Roads Administration to obtain composite mile index

values, shows the influence of high post-war prices. The post-war construction dollar buys only 82 percent as much as the 1925-1928 dollar. In contrast to this is the period 1932 to 1941 during which the value increased to over 120 percent.

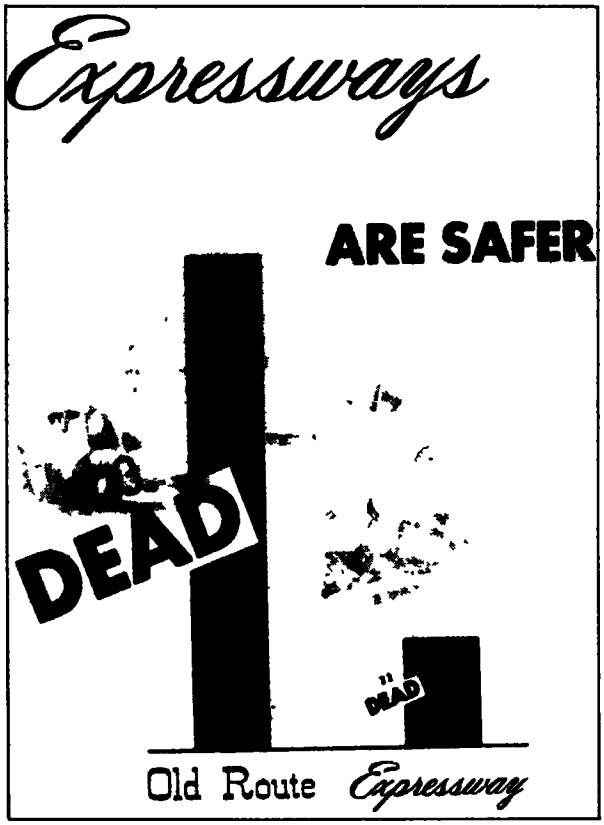

Figure 4

Illustrated by Figure 7 is one of the urban highway improvements being planned for early construction in the city of Middletown, population 26,500, to break a long existing bottleneck. The proposed new expressway along the Connecticut River parallels Main Street, the wide street in the left of the picture. In addition to being the center of business in the community Main Street is a bottleneck into which traffic from all radiating highways is funneled. Conditions on it are particularly bad during the summer months when through traffic to the shore from the Hartford metropolitan area, north of Middletown, is extremely heavy. Traffic on Middletown's Main Street varies from 16,000 to 20,000 vehicles daily. It has been estimated through origin and destination studies that 11,000 vehicles will be diverted to the improvement. Of these 40 percent will be through traffic or traffic which will entirely by-pass the central business area.

The area through which the new road is to go is not well developed because of the danger of such floods as the very exceptional ones of 1936 and 1938. There are a few low standard dwellings which will be demolished as a part of the project. The State is arranging to finance the proposed highway improvement without aid from the City, but has obtained an agreement from the latter which obligates the City to develop the area between the new road and the river as a waterfront park

The improvement shown is planned to permit its extension both north and south as a later part of the long range

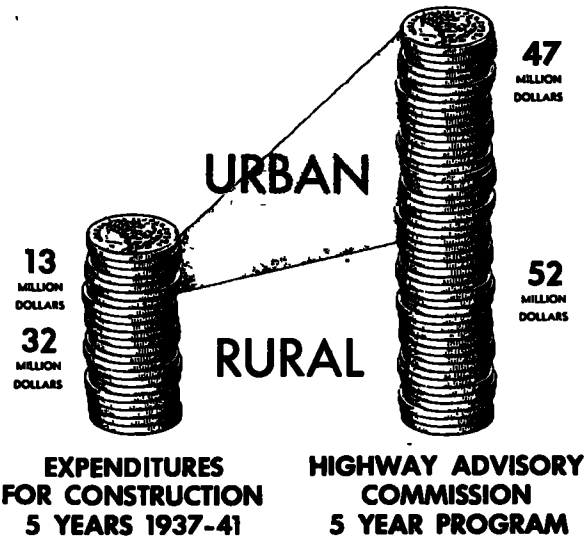

Figure 5. Urban Needs Expand Highway Program

program.

Comparison of the funds estimated to be available for state highway construction and the cost of the five-year program is made in Figure 8. The estimated revenues of the highway department for the five-year period total $117,746,000 of which $15,198,000 represent federal aid allotments. Deducting the $96,052,000 needed for recurring obligations and adding the existing balance at the beginning of the period, there will remain but $31,000,000 for state highway construction.

In Figure 9 there is shown, against the background of traffic growth, the way state highway construction has varied in amount since 1922. The 1946-1950 value indicates what will be available with existing revenue rates. It is obvious that since 1931 the rate of state highway construction has not kept pace with the rate of traffic growth. In large part this is the reason that road needs have accumulated in such great magnitude. It is not intended to imply that highway purpose receipts have not kept pace with the upward trend in traffic. Obviously, receipts from the gasoline tax bear a direct relationship to traffic. However, with specific and increased allocations of funds for expenditure on other than state highways and with greater demands on the highway department in total mileage and in increased cost of maintenance, the proportion of total revenue left for state highway construction has become progressively less. Figure 9 shows, too, the extent to which it has been necessary to resort to bond issue and toll

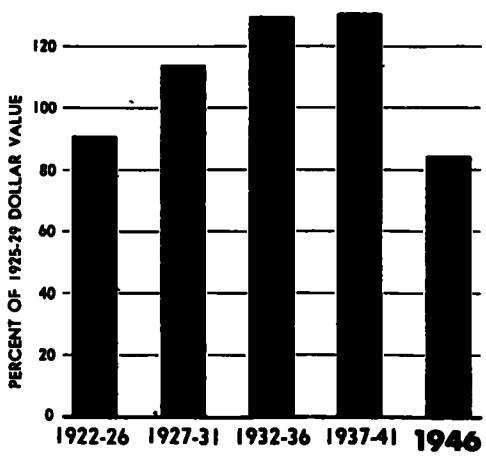

Figure 6. Less Construction per Dollar

Figure 7. The Riverfront Expressway in Middletown

financing to accomplish what has been done since the middle thirties. The bond retirement and interest payments for two of four projects for which bond issues were made are provided for from the regular highway fund. This reduced the amount that might have been spent on normal construction by about $15,000,000 up to the present time.

The foregoing illustrations are all included in the program report. They have been developed, also, as large posters which are to be displayed in the lobby of the State Capitol during the first months of the legislative session in 1947. Brief descriptive captions will be used with the posters.

Two figures, 10 and 11, are not from the program report but they do have a great deal of program significance. Figure 10, and Table 4 from which the figure was developed, compare the cost per mile and cost per vehicle mile for construction projects serving different volumes of traffic. It will be noted that each of the values represents a large mileage of road. The comparison is based on 658 mi of rural state highway construction from 1933 to 1942 and on average daily traffic in 1939. It shows a relation between cost per mile and traffic volume that is generally recognized. The high standard improvements for heavy traffic volumes are the most costly per mile. However, it is not generally recognized that these roads

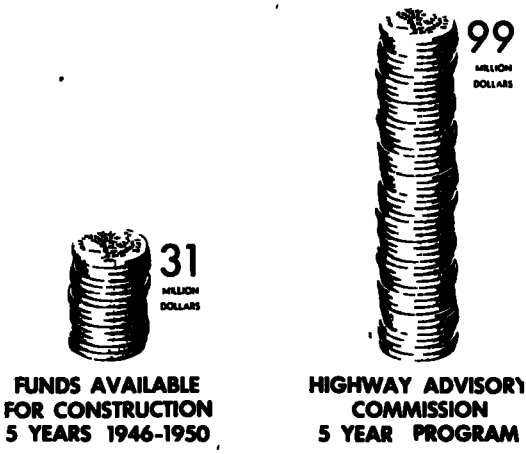

Figure 8. Funds do not meet urgent state highway construction.

are not the most costly in relation to the service provided. It will be seen that the roads with the least traffic - the cheapest in cost per mile - are actually much the more costly per vehicle mile of travel.

It is believed that Figure 10 represents a fair over-all picture, based on a large representative sample, but it will be found that individual improvements may vary greatly from the curves shown. There are locations, for example, where reconstruction on heavily traveled existing roads can be provided by fairly cheap widening within the existing rights-of-way and without great cost for excavation or structures. On the other hand, reconstruction of a road of the same traffic volume may require a complete new road through expensive properties and over difficult terrain.

From Figure 11 it is possible to appraise the rapidity with which the problem of congestion on two-lane, rural state highways will increase with the anticipated increase in motor traffic from 1939 (the year of our comprehensive state-wide traffic survey) to 1955. The line for 1939 shows the miles of two-lane rural state highway with average daily traffic exceeding various volumes. It was plotted directly from the traffic tables developed as a part of the basic state-wide highway planning survey. There were only three miles with 9,000 or more vehicles a day, about 17 mi with 8,000 or more, 30 mi with 7,000, etc. The dashed line for 1955 represents a direct expansion of the 1939 curve

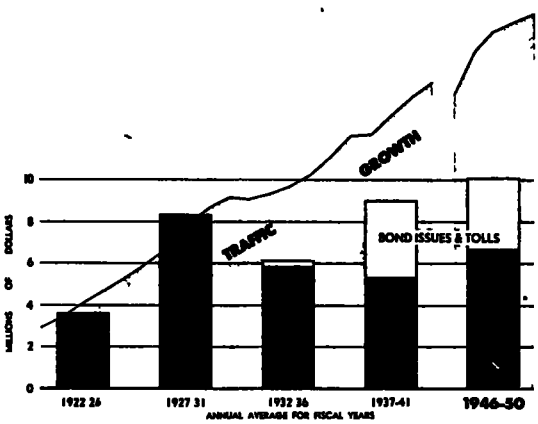

Figure 9. Construction of State Highways

The 1946-50 estimate is based on current revenue rates which do not meet needs of the planned program.

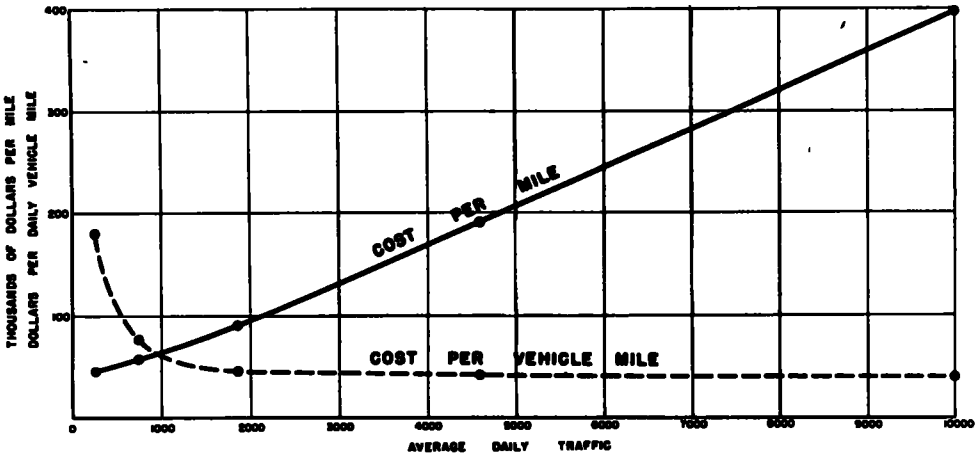

Figure 10. Rural State Highway Construction Cost

to reflect the estimated 53 percent increase in traffic. That such an estimate is conservative is indicated by the 23 percent increase in rural highway traffic actually realized from 1939 to 1941.

The important point that this chart brings out is that a 53 percent increase in traffic means far greater percentage increases in the mileage of two-lane roads needing reconstruction to provide more traffic capacity, and that, if highway traffic congestion is not to become progressively worse, the

Table 4

RURAL STATE HIGHWAY CONSTRUCTION

1933 - 1942 Inclusive

Average Daily Traffic Group	Miles Constructed	Average Traffic	Cost Per Mile $	Cost Per Daily Vehicle Mile $
0 - 500	215	245	44,000	181
501 - 1000	100	750	56,000	75
1001 - 3000	174	1,850	85,000	46
3001 - 6000	69	4,600	190,000	41
6001 and over	100	10,000	395,000	39

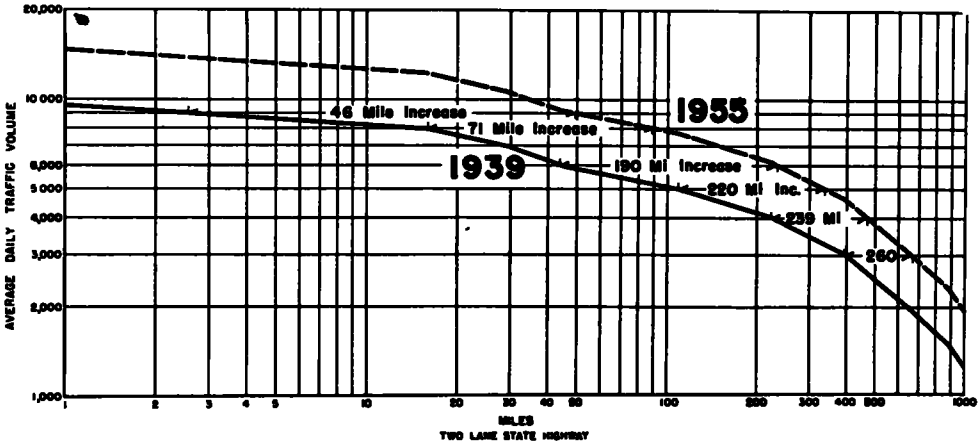

Figure 11. Increase in Miles of Highway Serving Various Traffic Volumes from 1939 to 1955

reconstruction program must be scheduled to keep pace. For example, if the reconstruction program up to 1955 were to be planned to assure that four-lane roads would be provided in cases where 6,000 or more vehicles a day are carried on rural roads, the program would have to include not only the 44 mi in this category now but also the increase of 190 mi which would be added by 1955. If sights should be set on 4,000 vehicles a day - and this is a value adopted by many states for planning purposes - there would be 220 mi as of 1939 and an additional 239 mi added by the 53 percent traffic increase by 1955. The plans for Connecticut's construction program are based, approximately, on meeting the 6,000 vehicles a day value.

Project Planning. It is the conviction of the Connecticut Highway Department that project planning from the traffic standpoint must precede location and design activities and be more comprehensive than it now generally is, if effective planning is to be obtained.

It has been said that highway planning survey data can and should be used to justify programs and project plans. And, in many cases, this is probably all that is being attempted. Locations and designs are being made just as they always have been, with every effort directed toward obtaining good line, and grade, and with thoughtful consideration of the topography, property development, and construction costs. Then, when the project plans have been formulated with definiteness, estimates are made of traffic to be served and, in some cases, comprehensive determinations of road user benefits are calculated. With this done, it is possible to say that the planning survey

data are being used in project planning. It may be possible to show that there will be resultant benefits equivalent to the cost of improvements. Presumably, too, priority will be given to improvements in the order of benefits derived from them.

However, is it not more important to know: (1) that the proposed project will not be found lacking in the years ahead because of the failure to consider the probable future development of adjacent section of the route and connecting routes; and (2) that the location of the project from the standpoint of service and cost is better than other alternative locations? It has been the experience of the Connecticut planning survey organization that these determinations can be made satisfactorily only if they start from a study of traffic origins and destinations, if they consider long range improvements which will be needed on all connecting and supplementary highways, and if each alternative location is analyzed and its benefits related to cost.

Probably it is general practice now for states to make traffic evaluations based on origin and destination studies before deciding whether to by-pass cities and before initiating survey of a line around or through the city. This is advance traffic planning and is an example of the character of traffic planning preceding location and design that the writer advocates. However, in most cases it is believed that this advance traffic planning falls short because it stops with determining whether a by-pass should or should not be built. It would seem to be equally important to be sure that whatever by-pass or city route is built is the best of the various possible alternates. This aspect of traffic planning - the evaluation of alternative improvements - has been found most illuminating in its exposure of preconceived ideas of where and how projects should be laid out.

An example is provided by a study which was made for a project in Connecticut from Glastonbury to East Hartford to establish the character and location of an improvement of the existing two-lane road, which is inadequate for the average daily traffic of 10,500 vehicles (1940).

A preliminary study was made in 1945 without the benefit of traffic origin and destination data and it was concluded that development of a satisfactory improvement along the present location was not desirable, but, because of the lack of detailed traffic data, it was not possible to evaluate the relative merits of several alternative locations.

In October 1945, after the lifting of travel restrictions, origins and destinations of traffic were determined by interviews taken on the existing road near the northern terminus of the project. Several lines were analyzed by working up

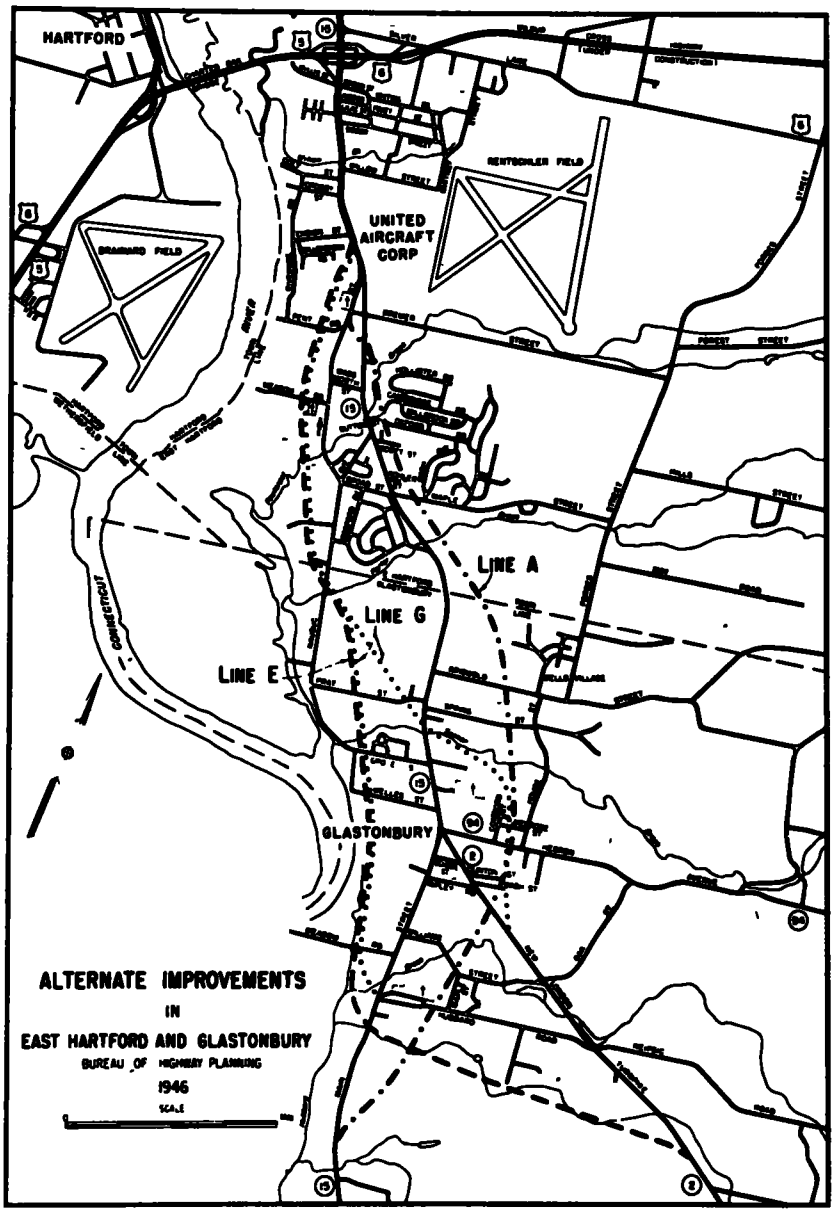

Figure 12

estimates of cost and traffic benefits. The three lines, A, B, and G, as shown in Figure 12, were carried into the final analysis. The other lines possessed no advantages, either in traffic service or economy of construction, that were not possessed by one of the three lines, A, E, and G. A summary of the costs of these alternate lines, A, E, and G, is presented in Table 5. Construction costs for project studies are esti-

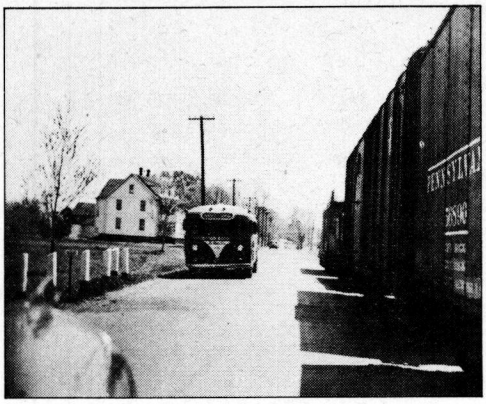

Figure 13

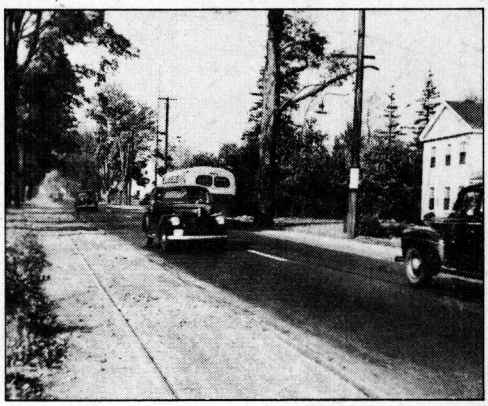

Figure 14

mated by the survey and plans division of the department, based on the character of improvements contemplated and the general locations established by the planning survey organization. Rights-of-way costs are furnished by the bureau of rights-of-

Table 5

SUMMARY OF COST ON ALTERNATE ROUTES

Line	Total Length	Const. Costs	Net Right-of-Way Costs	Total Costs
	mi	$	$	$
A	4.6	1,750,000	420,000	2,170,000
E	5.6	1,790,000	220,000	2,010,000
G	5.7	1,640,000	300,000	1,940,000

Line	Annual Costs (based on 30-yr life)	Annual Maint. Costs	Total Annual Costs
	$	$	$
A	72,300	6,700	78,000
E	67,000	8,000	75,000
G	64,700	7,100	71,800

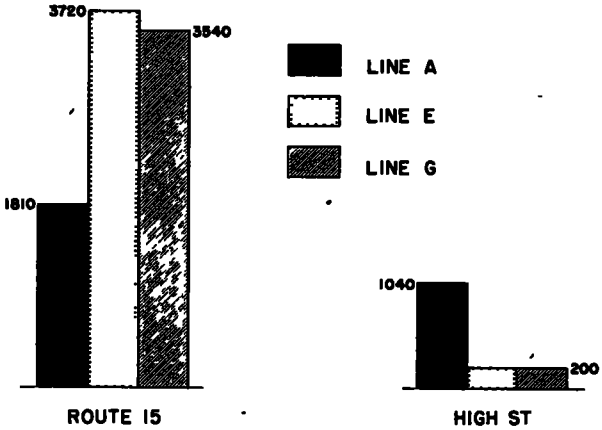

Figure 15. Comparison of Proposed Alternate Routes

way. Maintenance cost estimates are made on the basis of planning survey analyses of current costs for comparable projects. Construction and right-of-way costs are converted into annual values based on the arbitrary and extremely conservative service life value of 30 years. It will be noted that lines A, E, and G have total annual costs of $78,000, $75,000, and $71,800, respectively.

Table 6 presents a summary of the traffic benefits estimated for the three alternate lines and related them to the annual costs. 1/ Annual time savings are about equal on the three lines. All three lines will develop distance losses, although the loss on line A is very small. It will be noted that the benefit-cost ratio for line A is much greater than line E (about 70 percent) and about 15 percent higher than line G.

A further consideration in an evaluation such as this involves an appraisal of what will happen to the existing road, how much traffic will still be using it, and whether it may require further improvements in the future. The situation may be less favorable with one line than with another.

Figures 13 and 14 are pictures of the existing route. They show the narrow pavement and the freight trolley line which monopolizes one shoulder of the road.

Figure 15 shows the volume of traffic in average daily vehicles which would remain on the existing Route 15 at the interview station, as of November 1945, with each alternate location improved. It shows also the volume of traffic remaining on High Street which now provides a parallel alternate means of travel at the location in question. It will be seen that, with line A developed, Route 15 would be brought down to traffic volume much lower than either line E or G could provide. This would be reflected in greater freedom of movement and

1/ The basis for the computation of road user benefits and the development of benefit-cost indices was described in "Origins and Destinations of Highway Traffic -- The Basis for Connecticut Planning," 1943 Highway Research Board Proceedings, page 363.

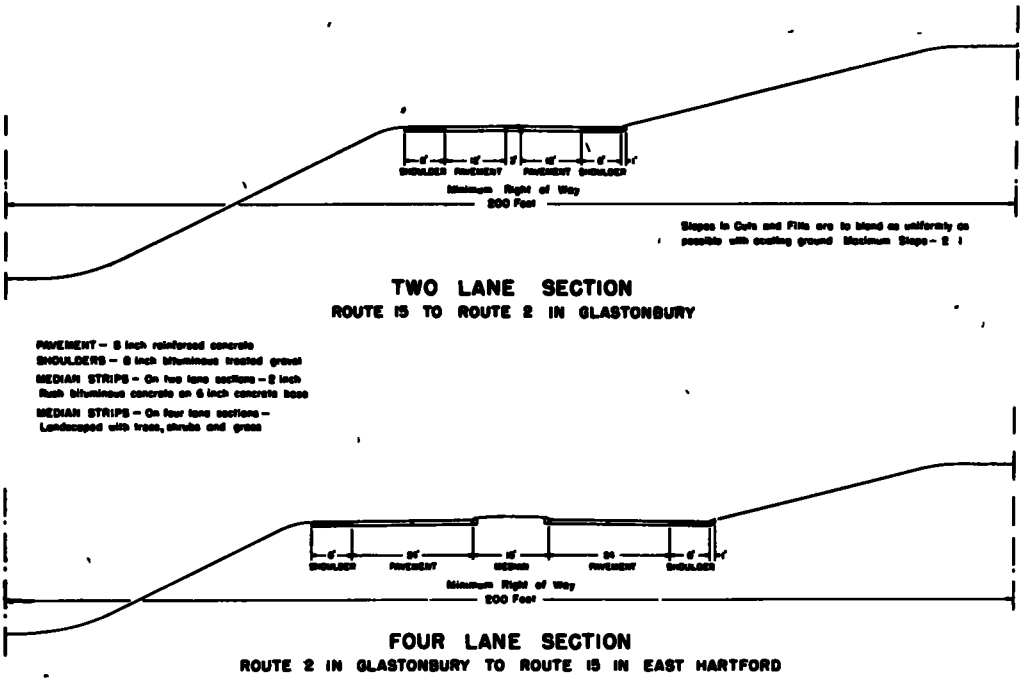

Figure 16. Typical Cross Sections on Recommended Improvement of Route 15

less hazard on the existing road with line A developed than with one of the others. Also, the likelihood of there being need for improvement of the existing road, simply for the local traffic, would be less in the future with A than with one of the other lines developed. As a result of the project analysis a report has been prepared recommending the construction of line A.

Table 6

SUMMARY OF TRAFFIC BENEFITS

Line	Annual Distance Losses	Annual Time Savings	Net Annual Traffic Benefits	Total Annual Costs	Benefit Cost Ratio
	$	$	$	$	
A	600	87,800	87,200	79,000	1.10
E	36,600	87,300	50,700	75,000	0.68
G	18,400	87,100	68,700	71,800	0.95

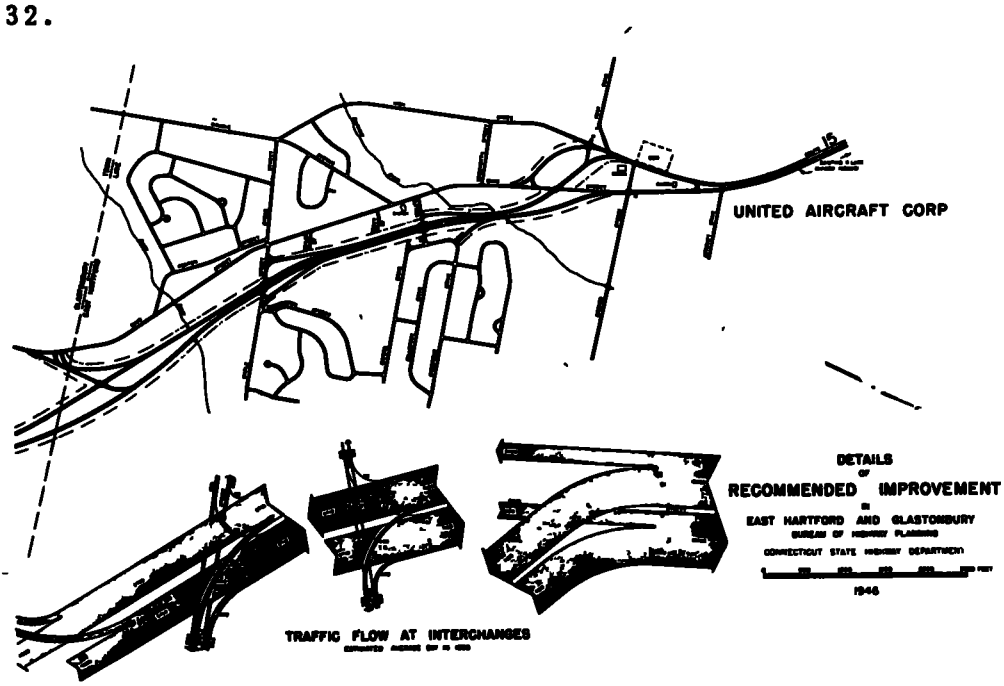

Figure 17

Figures 16 and 17 show the proposed cross-section sheet and a part of the detail layout included in the report. The placing of the flow diagrams for interchanges on the detail plan is an innovation in this report, which it is believed adds a great deal. Heretofore, traffic profiles and flow diagram sheets have been used. The method illustrated in Figure 17, however, puts the traffic diagrams where they become truly significant.

The proof of the need for the kind of project planning here described has been well established. Initial conception of projects and the locations which appear to be "naturals" have frequently been found wanting under the light of intensive traffic evaluations.

In conclusion, it is the writer's opinion that such accomplishments as have been realized, in the application of planning survey data to the administrative and planning problems of the Connecticut State Highway Department, are directly due to:

1. Complete endorsement and active encouragement of the planning survey work by the State Highway Commissioner and the Chief Engineer. It is essential that the Department's administrative heads believe in their planning survey if the latter is to be truly useful.

2. The transfer of experienced and able highway engineers to the planning survey from other Department units.
3. The wholehearted cooperation of the Public Roads Administration in all of the planning activities the State has undertaken.

URBAN PLANNING PROBLEMS

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Planning an adequate highway transportation network for an urban area is now recognized as the basic task in the solution of the larger problem of planning for the many-sided development of the area as a whole. In view of the successful use of data gathered by the highway planning surveys in reaching vital decisions relative to rural highway planning it is reasonable to suggest that the more complex urban conditions can be dealt with by the methods which the surveys have developed.

The present selection of routes for the national system of interstate highways is an outstanding example of using the highway planning survey data for administrative purposes. The relative importance of these intercity routes was determined on the basis of rural and state-wide scope.

It is true that highway planning survey data for comparing the relative importance of routes in the metropolitan areas is sparce. There is not nearly enough information for use in selecting and designating urban circulatory and distributory routes as recommended by the national Interregional Highway Committee. It appears that the final selection and designation of these supplementary routes will have to wait until the additional data for the urban areas now being collected by the metropolitan traffic studies is available.

The states have gained valuable experience in interpreting and using the rural and state-wide data collected by the highway planning survey. This experience can be studied and applied to the urban planning problem with profit and efficiency. The character and principles of state-wide highway planning and urban highway planning are similar but the circumstances of administration and operation are quite different.

The cities are responsible for comprehensive planning, street maintenance, and street operation. In many instances, however, they do not have an adequate understanding of their