# ORIGINS AND DESTINATIONS OF HIGHWAY TRAFFIC THE BASIS FOR CONNECTICUT PLANNING

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## SYNOPSIS

Connecticut faces a big problem of conversion on its main highway traffic arteries. The main routes pretty generally still follow the historic lines and grades of the first trails Heavy concentrations of traffic have created congestion which can be relieved satisfactorily only by construction of new highways—largely four lane divided express routes. This paper presents an analysis made for one section of the State to determine, on the basis of origins and destinations of existing traffic, which of several alternative major improvements will provide the greatest relief of existing congested conditions and the amount of road user benefits which would result from each alternative. The road user benefits resulting from savings in distance and time on the alternative improvements are finally related to the annual cost of each, to provide an index of economic worth.

For problems of congestion such as exist in Connecticut and other highly developed areas, the benefits from savings in distance are bound to be small They may even be negative The big benefits are savings in time, where time is worth something to the vehicle owner or operator, and those intangibles resulting from the substitution of a more pleasant and safe route of travel. These intangibles are of great importance to those operators of passenger vehicles bound on pleasure trips, shopping and to work—the same ones for whom time, as such, has no positive value In the analysis described, a time savings value is applied to all vehicles, whether on business trips or not, and is justified on the theory that the important congestion relief factor is reflected in and may be measured indirectly by time savings.

We are entering in Connecticut an era in which a great many of our major highway arteries will have to be reconstructed on a new pattern—a pattern determined primarily by the use of motor vehicles and not constricted by the limitations of the existing road network. It will be the era of multilane express highway construction. It will constitute the big step in the development of highway facilities, needed so badly to bring our road plant to a point of efficiency comparable to that built into the motor vehicle. As we commence this new era, our planning is of a most critical nature, because to a large degree initial improvements in various areas of the State will determine what will follow

Many of our main routes are still following the path over which the first settlers trudged. The hilly to mountainous character of our State created the winding and undulating path and this was perpetuated in the line and grade of the road which followed. While adequate for the horse-drawn vehicles and for the use of moderate volumes of slow moving automobile traffic, such roads have reached their elastic limit when they become heavily traveled thoroughfares serving thousands of high speed vehicles a day.

As statistical confirmation of the condition of our major rural traffic arteries, we had from our road inventory and traffic survey of 1938 and 1939, the following:

- 226 miles of two-lane highway carrying traffic of over 4,000 vehicles a day (A 23 per cent increase in traffic from 1939 to 1941 raised the 226 miles to 303).
- An average of five per mile of restrictions on main roads which limited sight to less than 1,000 ft.
- 12 per cent of the mileage of main roads on curvature sharper than 6 degrees.
- 6 per cent of the mileage of main roads on grades of over 5 per cent

The conditions cited deal only with rural highways and ours is in large part an urban state. The need for improvements does not stop at the urban-rural lines and our planning must take cognizance of the great need for adequate urban arteries:

One very satisfying feature of our position as we approach the new era of highway development is that we have not invested heavily in these old roads Almost without exception, they follow the original right of way and are still, as best they can, serving traffic with the two-lane surfaces constructed years ago. We can, therefore, write them off as having given great service to a form of transportation to which they have been adapted but for which they were not created. The new pattern of major arteries can be cut to fit best the needs of traffic without great concern as to what can be salvaged from the existing routes.

#### ANALYSIS OF HIGHWAY TRAFFIC MOVEMENTS

After some interesting experiences with the analysis of traffic movements, by which previously conceived plans for highway facilities were found lacking in their ultimate service to traffic, we have, in Connecticut, become convinced that adequate highway planning requires the fullest possible analysis of traffic movements. Highway traffic and its importance to our way of life are the real justification for the high standard improvements we are planning The motor vehicle owners in our state are paying close to a quarter of a billion dollars a year to own and operate their vehicles That's big business Provision of costly highway facilities is justified as a part of that business, but it is the responsibility of highway administrators to see that the facilities develop their maximum efficiency

In the approach to the problem of planning the major facilities in Connecticut, we have not found it possible to establish a standard procedure; primarily because of the lack of complete traffic data, but also because of the variation in the problems and their complexity However, in the process of working up tentative plans for major express highway improvements between and through several of the major communities in the State we have in every case found the evaluation of existing (pre-war) traffic movements absolutely essential to the logical development of plans for those improvements. Proper location of such facilities can be made only with a knowledge of the individual trip movements making up the traffic flow. Furthermore, the proper location of such facilities and their improvement to limited access, express highway standards will result in concentration of traffic that will require maximum dispersion in the city centers Only through the proper planning based on where traffic is going can this dispersion be efficiently handled at access points and the motor vehicles be expeditiously delivered near their destination.

One of the most clear cut and simple problems we have undertaken to solve will be described in detail. It involves the proposed improvement of a new north-south route through the Ansonia-Derby-Shelton area and is the study on which we have been able to make the most comprehensive analysis. In studying this problem we have attempted to carry our evaluation to the point where the economic worth of alternate improvements could be gauged We have computed such readily calculable road user benefits as would result from alternate improvements and have related these to the cost of such improvements, thereby providing an index of their economic worth.

I wish to make it clear that we recognize the need for greater refinement of procedures and for additional factual information as a basis for unit values. However, it should be equally clear that regardless of the limitations of the study, the end result of such an analysis assures that there will be thorough consideration of the traffic that will use the facility.

#### THE ANSONIA-DERBY-SHELTON STUDY

The Ansonia-Derby-Shelton study was undertaken originally to determine how much traffic would be served by the reconstruction of the main north and south route as a by-pass of the urban area. When preliminary analysis disclosed how little traffic could be diverted to a by-pass, the study was expanded to determine:

1. Which of several alternate improvements would provide the greatest relief of existing congested traffic conditions, and
2. Which alternate route would return to the road users the greatest benefit per dollar of cost for the improvement.

The area covered by the study includes the urban portions of the towns of Ansonia, Derby and Shelton and their immediate environs The total population of Ansonia, Derby and Shelton is 40,000 according to the 1940 census. The area is located at the confluence of the Naugatuck and Housatonic Rivers (See Fig. 1)

The Naugatuck Valley which extends north from the Ansonia-Derby-Shelton area, through Seymour, Naugatuck, Waterbury and Torrington, is particularly noteworthy for the industrial activity in these towns. The main highway serving the Valley is Route 8. This

The portions of Routes 8 and 65 covered by the study constitutes a very vital link in the over-all route from Waterbury to Bridgeport,

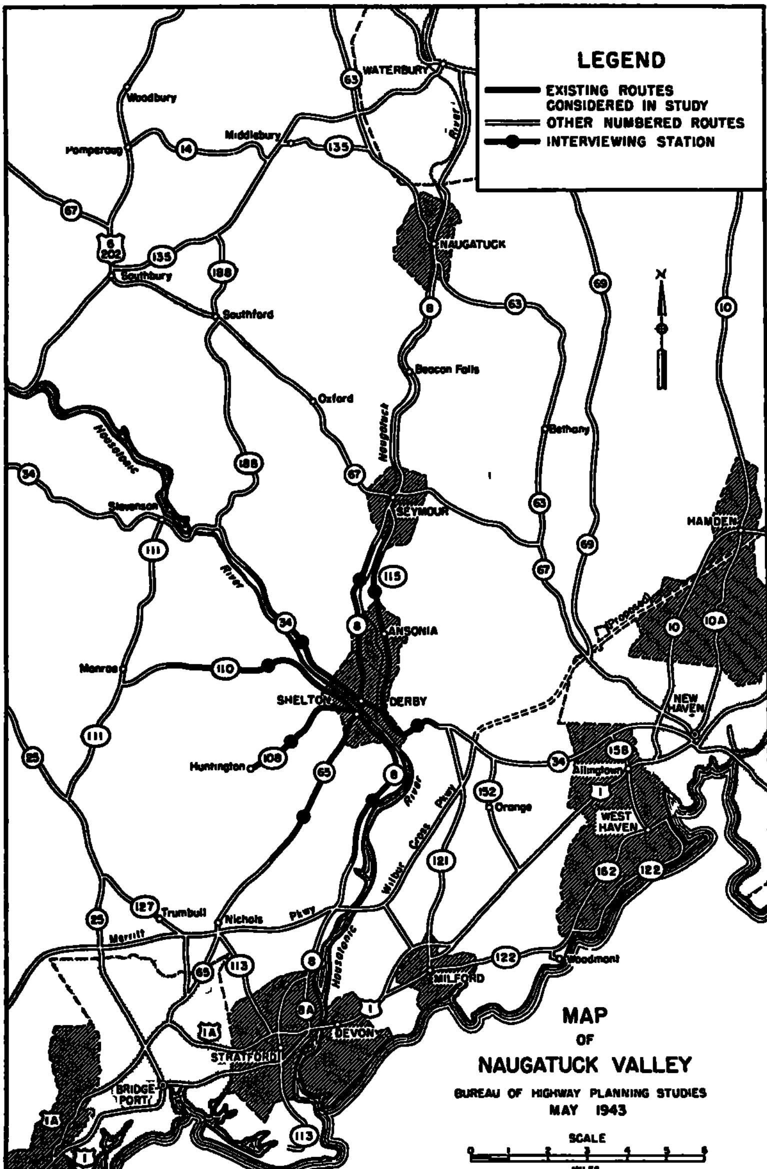


Figure 1

route provides the connecting link between the Valley communities and, via Route 65 from Shelton, makes connection to the Merritt Parkway and provides a direct route to the city of Bridgeport.

all sections of which are either planned for reconstruction or have recently been improved.

This main north-south highway, with a surface constructed from 20 to 30 years ago, on alignment of much greater age, developed at the northern limit of the Ansonia-Derby-Shelton area a 1939 average daily traffic load of approximately 5,300 vehicles on Route 8. Approaching the center of Derby, this load increased to a maximum of 20,000 vehicles per day on the Derby-Shelton Bridge. Continuing south the traffic load decreased from 20,000 to approximately 4,300 vehicles per day at the southern limit of the area on Route 65.

The existing Derby-Shelton Bridge connects the centers of these two towns and is the vital highway link for the closely related communities on either side of the Housatonic River. Since this bridge is the only highway crossing between the Wilbur Cross Parkway Bridge, six miles to the south, and the Stevenson Dam crossing, six miles up the river, it is the converging point for all traffic headed to or from the Naugatuck Valley from points southwest of the river. Like so many other heavily traveled bridges at key locations, a traffic bottleneck is created by the inadequacy of the approaches. In both Derby and Shelton these approaches are narrow streets in the business centers. The almost continuous parking leaves width only for one lane of traffic movement in each direction Double parking and maneuvering of vehicles to and from curb parking positions frequently stall traffic completely.

The heavy through traffic bound into and out of the Naugatuck Valley naturally follows Route 8 and in Shelton Route 65 The city streets on either side of the bridge require left turns in both the north and southbound directions. Traffic signal lights are operated at five intersections on the route.

The need for the relocation of Route 8 away from the traffic lights, pedestrians, parked vehicles and other traffic hindrances associated with city streets, has been recognized for a considerable time. The problem now is to assure that the improvement undertaken will provide relief for the "through" traffic and to the maximum extent possible alleviate the congestion for local traffic In other words, the problem is to make certain that what is done now will fit the ultimate pattern of major traffic arterials, which are required for the expeditious movement of highway transport

Three alternative locations have been considered for the proposed improvement Each of the alternatives begins at a point on Route 65 in Shelton, about two miles south of the Derby-Shelton Bridge, and extends northly for about five miles to a point on Route 8 just north of the Ansonia-Seymour town line. (See Fig. 3.) Further description of the alternatives will be given later.

### THE TRAFFIC SURVEY

The State-wide traffic survey of 1939 and the continuing "maintenance cost study" traffic counts conducted by the Public Roads Administration until April 1941, have provided a foundation for the analysis of traffic movements in the Ansonia-Derby-Shelton

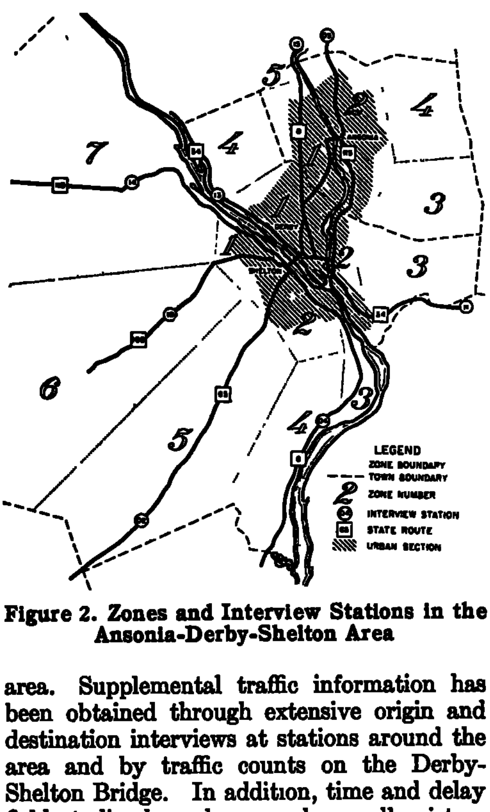


**Figure 2. Zones and Interview Stations in the Ansonia-Derby-Shelton Area**

area. Supplemental traffic information has been obtained through extensive origin and destination interviews at stations around the area and by traffic counts on the Derby-Shelton Bridge. In addition, time and delay field studies have been made on all existing routes through the area which might be affected by the proposed improvement.

*Origin and Destination Survey.* Interviews were obtained from drivers leaving the Ansonia-Derby-Shelton area on each of the state routes. The locations of the interview stations on the various routes are shown in Figure 2, together with the zone breakdowns made in the three towns and their relation to the urban portion of the area. The station numbers, their location, the operating schedule, the average daily traffic, and the number of interviews obtained are shown in Table 1. All interviews were obtained during the months of February, May and June 1940.

TABLE 1

STATION LOCATIONS, HOURS OPERATED, AVERAGE DAILY TRAFFIC, INTERVIEWS

| Station Number | Location: Route Conn. No | Location: Town | Hours operated: Sun | Hours operated: Daily | Hours operated: Sat | Average[a] Daily Traffic | Interviews |
|---|---|---|---|---|---|---|---|
| 02 | 65 | Shelton | 16 | 24 | 16 | 4268 | 2421 |
| 04 | 8 | Shelton | | 16 | | 1806 | 567 |
| 05 | 115 | Ansonia[b] | | | | | |
| 10 | 108 | Shelton | | 16 | | 776 | 359 |
| 11 | 34 | Orange | 8 | 16 | 8 | 6359 | 1762 |
| 13 | 34 | Derby | | 16 | | 2771 | 1182 |
| 14 | 110 | Shelton | | 8 | | 283 | 75 |
| 15 | 8 | Seymour | 8 | 16 | 8 | 5281 | 1858 |
| Total Interviews . | | | | | | | 8224 |

[a] Expanded to 1939 Average Daily Traffic.
[b] Not operated due to construction.

The origin and destination interviews provided a sample of the traffic movements into and out of the area. The sample was expanded to values equal to the 1939 average daily traffic and, with origins and destinations classified by routes of entry and exit, or by zone within the boundaries of Ansonia, Derby and Shelton, it was possible to summarize the traffic movements in tabular form. The summarizations are presented in Tables 2, 3 and 4.

*Time and Delay Field Studies.* On each of the existing routes in the area from which traffic might be diverted to a new facility, test runs were made in an automobile to measure the running time and to determine the stops required on each section of the different routes. The test runs were made to simulate average

TABLE 2

AVERAGE DAILY TRAFFIC IN 1939 THRU ANSONIA, DERBY, AND SHELTON

Including those trips which have both origin and destination beyond the limits of the Ansonia-Derby-Shelton area

| Station of Entry or Exit | Vehicular Types | Station of Exit or Entry: 02 | 04 | 05[a] | 10 | 11 | 13 | 14 | 15 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 02 | Passenger Cars | | | | | | | | | 0 |
| | Light & Medium | | | | | | | | | 0 |
| | Heavy & Semitrailer | | | | | | | | | 0 |
| | Busses | | | | | | | | | 0 |
| 04 | Passenger Cars | 38 | | | | | | | | 38 |
| | Light & Medium | | | | | | | | | 0 |
| | Heavy & Semitrailer | | | | | | | | | 0 |
| | Busses | | | | | | | | | 0 |
| 05[a] | Passenger Cars | 100 | 8 | | | | | | | 108 |
| | Light & Medium | 12 | 2 | | | | | | | 14 |
| | Heavy & Semitrailer | 4 | | | | | | | | 4 |
| | Busses | | | | | | | | | 0 |
| 10 | Passenger Cars | 2 | 2 | 2 | | | | | | 6 |
| | Light & Medium | | | | | | | | | 0 |
| | Heavy & Semitrailer | | | | | | | | | 0 |
| | Busses | | | | | | | | | 0 |
| 11 | Passenger Cars | 264 | 82 | 42 | 12 | | | | | 400 |
| | Light & Medium | 16 | 10 | 20 | 2 | | | | | 48 |
| | Heavy & Semitrailer | 4 | 4 | 4 | | | | | | 12 |
| | Busses | | | 20 | | | | | | 20 |
| 13 | Passenger Cars | 40 | 40 | 2 | | 680 | | | | 762 |
| | Light & Medium | 2 | 6 | | | 52 | | | | 60 |
| | Heavy & Semitrailer | | | | | 38 | | | | 38 |
| | Busses | | | | | | | | | 0 |
| 14 | Passenger Cars | 10 | 8 | | | 16 | 2 | | | 36 |
| | Light & Medium | 2 | | | | 2 | | | | 4 |
| | Heavy & Semitrailer | | | | | | | | | 0 |
| | Busses | | | | | | | | | 0 |
| 15 | Passenger Cars | 1174 | 346 | 10 | 20 | 386 | 18 | 4 | | 1958 |
| | Light & Medium | 132 | 46 | | | 30 | 2 | 2 | | 212 |
| | Heavy & Semitrailer | 82 | 54 | | | 14 | | | | 150 |
| | Busses | 18 | 2 | | 2 | 4 | | | | 26 |
| Total | . | 1900 | 610 | 100 | 36 | 1222 | 22 | 6 | 0 | 3896 |

[a] This station was not operated due to the construction on Conn 115 at the time of the survey. The figures shown were derived from outbound traffic which entered Ansonia through station No 05.

TABLE 3

AVERAGE DAILY TRAFFIC IN 1939 BEGINNING OR ENDING IN ANSONIA, DERBY, OR SHELTON

Including all traffic movements with one terminus in the zoned area and the other terminus outside the area

| Origin or Destination | | Vehicular Types | Station of Exit or Entry | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Town | Zone | | 02 | 04 | 10 | 11 | 13 | 14 | 15 | |
| Ansonia | 1 | Passenger Cars | 301 | 67 | 7 | 518 | 259 | 9 | 765 | 1926 |
| | | Light & Medium | 28 | 7 | 2 | 44 | 9 | | 108 | 198 |
| | | Heavy & Semitrailer | | 1 | | 17 | | | 16 | 34 |
| | | Busses | | | | | | | 4 | 4 |
| | 2 | Passenger Cars | 326 | 83 | 47 | 898 | 251 | 9 | 699 | 2313 |
| | | Light & Medium | 44 | 13 | 2 | 129 | 11 | 3 | 117 | 319 |
| | | Heavy & Semitrailer | 5 | 21 | | 21 | 2 | | 38 | 87 |
| | | Busses | | | | 28 | | | 4 | 32 |
| | 3 | Passenger Cars | 2 | 2 | 1 | 21 | | | 9 | 35 |
| | | Light & Medium | 1 | | | 3 | | | 1 | 5 |
| | | Heavy & Semitrailer | | | | | | | 1 | 1 |
| | | Busses | | | | | | | | 0 |
| | 4 | Passenger Cars | 1 | 1 | 1 | 10 | | | 6 | 19 |
| | | Light & Medium | 1 | | | 1 | | | 1 | 3 |
| | | Heavy & Semitrailer | | | | | | | 1 | 1 |
| | | Busses | | | | | | | | 0 |
| | 5 | Passenger Cars | | | | 1 | | | 16 | 17 |
| | | Light & Medium | | | | | | | 2 | 2 |
| | | Heavy & Semitrailer | | | | | | | 1 | 1 |
| | | Busses | | | | | | | | 0 |
| Derby | 1 | Passenger Cars | 507 | 200 | 58 | 1260 | 759 | 33 | 527 | 3344 |
| | | Light & Medium | 61 | 15 | 18 | 186 | 68 | 9 | 75 | 432 |
| | | Heavy & Semitrailer | 4 | | | 52 | 4 | 3 | 11 | 74 |
| | | Busses | | 7 | | 37 | | | 4 | 48 |
| | 2 | Passenger Cars | 57 | 29 | 11 | 268 | 74 | 4 | 37 | 480 |
| | | Light & Medium | 8 | 2 | 2 | 35 | 5 | | | 52 |
| | | Heavy & Semitrailer | 1 | | | 9 | | | 9 | 19 |
| | | Busses | | 11 | | 19 | 2 | | | 32 |
| | 3 | Passenger Cars | 10 | 10 | | 110 | 9 | | 30 | 169 |
| | | Light & Medium | 6 | | | 22 | 3 | | 8 | 39 |
| | | Heavy & Semitrailer | 1 | | | | | | | 1 |
| | | Busses | | | | 4 | | | | 4 |
| | 4 | Passenger Cars | 2 | 3 | | 28 | 35 | | 7 | 75 |
| | | Light & Medium | 2 | | | 5 | 14 | | 2 | 23 |
| | | Heavy & Semitrailer | | | | | | | | 0 |
| | | Busses | | | | 1 | | | | 1 |
| Shelton | 1 | Passenger Cars | 356 | 198 | 294 | 338 | 130 | 63 | 131 | 1510 |
| | | Light & Medium | 41 | 14 | 46 | 31 | 11 | 21 | 16 | 180 |
| | | Heavy & Semitrailer | 11 | 21 | | 33 | | | 21 | 86 |
| | | Busses | | 2 | | | | | | 2 |
| | 2 | Passenger Cars | 280 | 256 | 161 | 310 | 160 | 49 | 145 | 1361 |
| | | Light & Medium | 33 | 15 | 17 | 30 | 11 | 9 | 17 | 132 |
| | | Heavy & Semitrailer | 2 | 3 | | 4 | 2 | | 4 | 15 |
| | | Busses | | 2 | | | | | | 2 |
| | 3 | Passenger Cars | 80 | 110 | 12 | 33 | 41 | 6 | 22 | 304 |
| | | Light & Medium | 2 | 9 | 5 | 13 | 5 | | 4 | 38 |
| | | Heavy & Semitrailer | | | | | | | | 0 |
| | | Busses | | 16 | 1 | | | | | 17 |
| | 4 | Passenger Cars | 24 | 20 | 6 | 16 | 6 | 3 | 13 | 88 |
| | | Light & Medium | 5 | | 4 | 1 | | 1 | | 11 |
| | | Heavy & Semitrailer | | | | 1 | | | | 1 |
| | | Busses | | | | | | | | 0 |
| | 5 | Passenger Cars | 79 | 6 | 5 | 25 | 10 | 3 | 20 | 148 |
| | | Light & Medium | 18 | | 2 | 2 | | 1 | | 23 |
| | | Heavy & Semitrailer | 1 | | | 1 | | | | 2 |
| | | Busses | | | | | | | | 0 |
| | 6 | Passenger Cars | 24 | 6 | 16 | 13 | 5 | 1 | 10 | 75 |
| | | Light & Medium | 5 | | 9 | 1 | | 1 | | 16 |
| | | Heavy & Semitrailer | | | | 1 | | | | 1 |
| | | Busses | | | | | | | | 0 |
| | 7 | Passenger Cars | 32 | 8 | 5 | 9 | 3 | 7 | 7 | 71 |
| | | Light & Medium | 7 | | 2 | | | 2 | | 11 |
| | | Heavy & Semitrailer | | | | 1 | | | | 1 |
| | | Busses | | | | | | | | 0 |
| Orange (W of Sta. No. 11) Seymour (S. of Sta. No. 15) | | Passenger Cars | | | | 63 | | | 17 | 80 |
| | | Light & Medium | | | | 4 | | | 9 | 13 |
| | | Heavy & Semitrailer | | | | | | | | 0 |
| | | Busses | | | | | | | | 0 |
| Total | | | 2368 | 1158 | 734 | 4657 | 1889 | 237 | 2935 | 13978 |

conditions by "floating" with the traffic movement. On each section numerous runs were made, the minimum on any section being 7 and the maximum 31

The test runs were scheduled, according to the density of traffic at various periods of the day, so as to give weighted average results. That is, more runs were made during the periods of heavy travel so that by taking arithmetic averages of the results, the average was weighted in proportion to the traffic passing at the various periods of the day.

*Alternative Improvements.* Theoretically, a complete analysis of the character attempted in this study would require consideration of every conceivable alternative improvement. Obviously this would be impractical because of the voluminous amount of work involved. Furthermore, it is recognized that regardless of the refinement to which analyses of this character are carried, the limitations on the values used prevent development of precision results. It is a case of taking a number of reasonably representative possible alternative

TABLE 4

AVERAGE DAILY TRAFFIC IN 1939 BETWEEN THE ZONES IN ANSONIA AND DERBY AND THE ZONES IN SHELTON[a]

Including only the zone to zone traffic crossing the Derby-Shelton bridge

| Town | Zone | Vehicular Types | Shelton Zones | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Ansonia | 1 | Passenger Cars | 1062 | 1054 | 173 | 58 | 92 | 47 | 32 | 2518 |
| | | Light & Medium Trucks | 103 | 100 | 28 | 4 | 6 | 3 | 1 | 245 |
| | | Heavy & Semitrailer | 47 | 10 | | 1 | 1 | 1 | 1 | 61 |
| | | Busses | | | | | | | | 0 |
| | 2 | Passenger Cars | 1337 | 1328 | 218 | 73 | 116 | 59 | 40 | 3171 |
| | | Light & Medium Trucks | 154 | 150 | 39 | 6 | 10 | 5 | 3 | 367 |
| | | Heavy & Semitrailer | 97 | 47 | 6 | 3 | 4 | 3 | 2 | 162 |
| | | Busses | | | | | | | | 0 |
| | 3 | Passenger Cars | 14 | 14 | 2 | 1 | 1 | 1 | 1 | 34 |
| | | Light & Medium Trucks | 2 | 2 | 1 | | | | | 5 |
| | | Heavy & Semitrailer | 1 | | | | | | | 1 |
| | | Busses | | | | | | | | 0 |
| | 4 | Passenger Cars | 9 | 9 | 2 | 1 | 1 | | | 22 |
| | | Light & Medium Trucks | 2 | 2 | | | | | | 4 |
| | | Heavy & Semitrailer | | | | | | | | 0 |
| | | Busses | | | | | | | | 0 |
| Derby | 1 | Passenger Cars | 2251 | 2236 | 367 | 124 | 195 | 100 | 68 | 5341 |
| | | Light & Medium Trucks | 255 | 249 | 65 | 9 | 16 | 8 | 4 | 606 |
| | | Heavy & Semitrailer | 110 | 28 | 2 | 2 | 2 | 2 | 2 | 148 |
| | | Busses | 10 | 10 | 2 | 1 | 1 | 1 | | 25 |
| | 2 | Passenger Cars | 296 | 294 | 48 | 18 | 26 | 13 | 9 | 704 |
| | | Light & Medium Trucks | 32 | 31 | 8 | 1 | 2 | 1 | 1 | 76 |
| | | Heavy & Semitrailer | 15 | 4 | | | | | | 19 |
| | | Busses | 16 | 15 | 3 | 1 | 1 | 1 | | 37 |
| | 3 | Passenger Cars | 61 | 61 | 10 | 3 | 5 | 3 | 2 | 145 |
| | | Light & Medium Trucks | 12 | 11 | 3 | 1 | 1 | 1 | | 29 |
| | | Heavy & Semitrailer | 4 | 2 | | | | | | 6 |
| | | Busses | | | | | | | | 0 |
| | 4 | Passenger Cars | 15 | 15 | 2 | 1 | 2 | 1 | | 36 |
| | | Light & Medium Trucks | 4 | 4 | 1 | | | | | 9 |
| | | Heavy & Semitrailer | 1 | | | | | | | 1 |
| | | Busses | | | | | | | | 0 |
| Total | | | 5910 | 5676 | 980 | 308 | 482 | 250 | 166 | 13772 |

[a] The traffic making up this table was not actually sampled by interview but was analyzed by correlation with the zone to zone station interview records. The average daily traffic of 20,000 vehicles over the bridge provided a control value for this correlation For example, in Shelton it was assumed that the percentage from each zone for the inter-zone traffic was the same as for the zone to station travel from Shelton zones through stations on routes leaving Ansonia and Derby That is, we assumed that the inter-zone travel crossing the bridge had the same distribution between Shelton zones as did the Shelton zone to station traffic crossing the bridge Likewise, distribution of zone travel in Ansonia and Derby was based on the distribution of Ansonia and Derby zone to station travel crossing the bridge With the percentage of zone to zone travel established for each zone on both sides of the bridge, it was assumed there would be uniformity in the relative distribution of the trips, i e , a zone on one side with 25% of the inter-zone traffic was assumed to take 25% uniformly from each zone on the other side of the bridge

Actual interviews of this zone to zone travel would have been obtained but it was not felt that the abnormal traffic conditions of this year would provide a reliable measure of normal traffic origins and destinations The need for such interviews was not apparent when all field data were obtained in 1940 as the scope of the final study changed considerably from the original 1940 problem, which was merely to estimate the volume of traffic which would use the proposed by-pass improvements and evaluating their potential traffic service and gauging the comparative road user benefits which would be developed. These evaluations with the comparative costs will give indices rather than precise answers. But, the availability of such indices should assure the creation of improvements planned with full cognizance of their value to the road users.

In the analysis of the problem three locations for the proposed improvement have been considered. Figure 3 shows the full length of the three alternatives in their relation to the existing state routes and the urban area Figure 4 shows the disposition of grades at intersecting roads and the proposed treatment of access points for the center portions of the three lines

*Line A* is definitely a by-pass route It was so located when the problem was first given detailed consideration in 1941 The line runs through strictly rural territory throughout its length, swinging to the west of the urban centers of Shelton and Derby and crossing the Housatonic River approximately one-half mile above the Derby dam. The area traversed is but slightly developed for agricultural purposes.

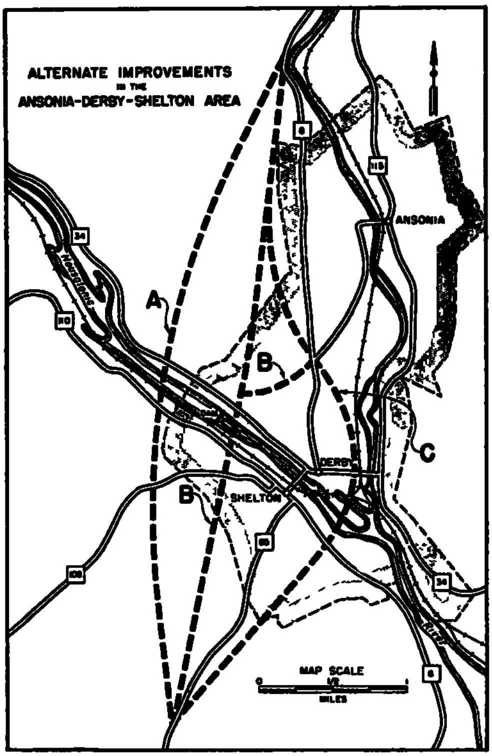


Figure 3


Figure 4

The rugged nature of the country is indicated by the Housatonic River crossing which will require a structure approximately 1,200 ft. long, about 110 ft. above water level, and with approach grades of 4.5 and 5 5 percent, each approximately one-half mile in length. Additional grades of 1,000 ft. or longer include one 7 percent and two 5 percent grades. Alignment throughout the length is good, the sharpest curve on the line as surveyed being 3 degrees The total length of Line A is 5.27 miles.

Assumptions made in analyzing Line A are:

1 Route 110 in Shelton would be separated from the proposed improvement, with access to the north provided only by single one-way connecting ramps

2. Route 34 in Derby would be overpassed

by the Housatonic River Bridge No access is proposed at this route.

3. Access at grade would be provided at Route 108 in Shelton and Hawthorne Avenue in Derby.

4. The crossing of four additional roads of minor importance would be made at grade.

*Line B*, as will be seen from Figure 3, is the most direct of the three alternatives between the established termini. This location was brought in for consideration when it was recognized that Line A would provide little service to local traffic. Line B, located only in a general way, passes through the urban portions of both Shelton and Derby, and crosses the Housatonic River about one-quarter of a mile below the Derby dam. The urban sections traversed by this line are neither extensive nor highly developed. In Shelton the line is west of the center and in urban territory for only approximately one-half mile. Likewise in Derby the line is west of the center and in urban development for only a short distance. It continues north skirting the edge of the developed portion of both Derby and Ansonia

Line B traverses country almost as rugged as does Line A for the portion in Shelton and the river crossing. The remainder of the line is through somewhat easier country. The Housatonic River crossing will require a bridge about 1,350 ft long and approximately 90 ft. above the river Bridge approach grades will be approximately 3 and 5 percent, each for a distance of about 1,500 ft. Additional grades 1,000 feet or more long are limited to about 3 percent The alignment on this route would be excellent.

A "connector" to provide a more direct connection for Ansonia and Derby traffic is proposed from the intersection of Atwater Avenue and Seymour Avenue (Route 8) to the intersection of Smith and Cherry Streets in Derby The existing city streets, namely Cherry Street and Hawthorne Avenue, are proposed to be utilized in their present condition to join the proposed "connector" to Line B proper

Line B as tentatively laid out is 4 99 miles in length The "connector" adds 0 28 miles, making a total improvement of 5 27 miles

In analyzing Line B the following assumptions have been made:

1. Route 110 in Shelton would be separated from the proposed improvement with access to the north provided only by connecting ramps

2 Route 34 in Derby would be overpassed by the Housatonic River Bridge. No direct connection is proposed to Route 34.

3. Hawthorne Avenue in Derby, just beyond the north end of the Housatonic River Bridge, would be underpassed with access provided by a single one-way ramp in the southeast quadrant, by double one-way ramps in the northwest quadrant, and by the extension of the local street in the northeast quadrant.

4 Access at grade would be provided at Route 108 in Shelton

5. Seven additional local roads of minor importance would be crossed at grade.

*Line C* was laid out to approach the centers of all three of the communities in the area as closely as appeared practicable, with the realization that such a location would naturally serve the greatest volume of traffic. Intensive property development seemed to preclude a close approach to the Ansonia center, but it was possible to get a location which tapped the principal connecting street between Ansonia and the other two communities. Line C passes quite close to the centers of Shelton and Derby and much closer to Ansonia center than do either of the other alternative routes. (See Fig. 3)

The line passes east of Shelton center and crosses the Housatonic River about one-quarter mile below the existing Derby-Shelton Bridge. It continues through Derby just west of the railroad station, veers to the west underpassing Seymour Avenue, Route 8, at the intersection of Atwater Avenue, and then runs northwesterly to the high and open ground west of Sherman Avenue After overpassing Division Street, Line C coincides with Line B for 1 2 miles to the northern terminus of the project.

From the standpoint of topography Line C is much more favorable than the other alternates, the terrain east of the existing route being much less rugged than that to the west. While this line, as in the case of Line B, had not been definitely located, it appeared that good alignment would be obtained with the sharpest curve about two degrees. Grades would be moderate with a maximum of 4 percent for lengths of 1,000 feet or more

Line C as tentatively laid out is 5.49 miles in length.

In the evaluation of Line C the following assumptions were made:

1. Access at grade would be provided at Prospect Avenue in Shelton, at which location only right turns would be permitted in each of the four quadrants.

2. Route 8 in Shelton would be separated from the proposed improvement with access provided by single one-way ramps in each of the northeast and northwest quadrants, to and from the river crossing only.

3. Route 34 in Derby would be separated with access provided by single one-way ramps in each of the four quadrants.

4. Access would be provided at the junction of Seymour Avenue (Route 8) and Atwater Avenue in Derby by means of single one-way ramps in the east and south quadrants only.

5. Grade separations without access would be provided at Division and Coram Avenues in Shelton and at Hawkins and Division Streets in Derby.

6. Five additional local roads of minor importance would be crossed at grade

The points of access which have been selected on each of the above lines form the basis of the following development of traffic densities and corresponding benefits.

## BENEFITS

The total benefits derived from any given highway improvement may be grouped basically as (1) direct road user benefits, and (2) general community benefits. The road user benefits in turn include (1) savings in operating costs and (2) relief from congestion as reflected in greater riding comfort, freedom of movement and related values. We have attempted to establish reasonable and practical measures of these road user benefits. General community benefits will be obtained from almost any improvement and it would be reasonable to expect that improvements which give materially greater road user benefits will give greater general community benefits. In any case, we have not attempted to evaluate the community benefits.

Savings in operating costs can be reasonably well established to the extent that they represent savings through shortened travel distance. Such savings will accrue to all types of vehicles regardless of the purpose of their use and in our analysis have been set up as one of the major benefit evaluations and are hereafter referred to as distance savings. The other major benefit evaluation we have made is of time savings. These represent savings in operating costs for commercial vehicles and for passenger vehicles on business trips. For passenger vehicles used for pleasure, on shopping trips or to and from work, the time savings evaluation as here used represents an indirect measure of those intangible but important benefits developed because of the relief from congested conditions. There are additional savings in operating costs which may be developed because of the elimination of traffic stops and the improvement of grades, alignment and road surface These have been roughed out but are not included in the final evaluation

TABLE 5
BASIC COST DATA—LIFE AND SALVAGE VALUES

| | Passenger Cars | Trucks | |
|---|---|---|---|
| | | Light & Medium | Heavv & Semitrailers |
| Cost (new), dollars | 950 | 1,725 | 6,500 |
| Annual Mileage | 10,648 | 10,820 | 17,490 |
| Miles per Gallon | 15 25 | 10 98 | 5 44 |
| Average Life, years | 8 | — | — |
| Salvage Value, per cent | 10 | — | — |

TABLE 6
MILEAGE ELEMENT COSTS
(Cents per mile)

| Mileage Elements | Passenger Cars | Trucks | |
|---|---|---|---|
| | | Light & Medium | Heavy & Semitrailers |
| Gasoline at 18 cents per gal | 1 18 | — | — |
| Gasoline at 16 cents per gal | — | 1 45 | 2 94 |
| Oil at 25 cents per qt | 0 19 | — | — |
| Oil at 15 cents per qt | — | 0 17 | 0 33 |
| Tires and Tubes | 0 23 | 0 90 | 2.00 |
| Maintenance | 0 56 | 2.20 | 3 60 |
| Depreciation (67%) | 0 67 | — | — |
| Depreciation (100%) | — | 1 58 | 5.00 |
| Totals | 2 83 | 6 30 | 13.87 |

*Distance Savings* for each of the three alternative lines have been determined by applying a distance saving unit value to those traffic volumes which would be provided a shorter travel distance by utilizing the proposed facility than when following the existing route. The data upon which this distance saving unit has been based are given in Tables 5, 6 and 7.

The following example will serve to illustrate the procedure employed in determining the distance savings shown in the following summaries for each line Through north and south traffic on Routes 8 and 65 passing through stations 02 and 15 was found to cover 5 53 miles over the existing route between the established termini of the study. This same traffic would travel 5 27 miles between the same termini on Line A Thus a saving of 0 26 miles is provided by Line A over the existing route for traffic operating through stations 02 and 15 Table 2 shows that 1,174 passenger vehicles is the average daily passenger car traffic between these two stations. The distance saving unit for passenger vehicles developed above is $10.00 per vehicle per mile per year Therefore, the annual 1939 distance savings for passenger vehicles between stations 02 and 15, are 1,174 × 0 26 × $10 00 per vehicle per mile per year or $3,052 This same procedure has been used for light and medium trucks and heavy trucks and semitrailers, using, of course, the appropriate distance saving unit for each class of vehicles Travel by other types of origin and destination was treated similarly for each alternative line. The distance loss in dollars for any given route has been included only if that same route provides a greater time savings than distance loss. There are no routes which provide a distance savings and a time loss.

*Line A* The 1939 summary of the estimated distance savings for vehicles which could be expected to use Line A, B, and C by type of origin and destination is given in Tables 8, 9, 10

TABLE 7
ANNUAL MILEAGE COSTS PER DAILY VEHICLE MILE

| Type | Cents per Mile | Computation | Use |
|---|---|---|---|
| Passenger Cars | 2 83 | $\frac{2\ 83 \times 365}{100} = \$10\ 33$ | $10 |
| Light and Medium Trucks | 6 30 | $\frac{6\ 30 \times 365}{100} = \$23\ 00$ | $23 |
| Heavy Trucks & Semi-trailers | 13 87 | $\frac{13\ 87 \times 365}{100} = \$50\ 63$ | $50 |

TABLE 8
DISTANCE SAVINGS, LINE A (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semi-trailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $4,100 | $1,000 | $1,100 | $6,200 | 78 |
| Station to Zone | 900 | 300 | 0 | 1,200 | 15 |
| Zone to Zone | 500 | 100 | 0 | 600 | 7 |
| Totals | $5,500 | $1,400 | $1,100 | $8,000 | 100 |

TABLE 9
DISTANCE SAVINGS, LINE B (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semi-trailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $7,200 | $1,900 | $2,500 | $11,600 | 72 |
| Station to Zone | 3,600 | 600 | 400 | 4,600 | 28 |
| Zone to Zone | 0 | 0 | 0 | 0 | 0 |
| Totals | $10,800 | $2,500 | $2,900 | $16,200 | 100 |

TABLE 10
DISTANCE SAVINGS, LINE C (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semi-trailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $2,800 | $600 | $900 | $4,100 | 25 |
| Station to Zone | 3,700 | 1,200 | 600 | 5,500 | 33 |
| Zone to Zone | 5,100 | 1,500 | 400 | 7,000 | 42 |
| Totals | $11,400 | $3,300 | $1,900 | $16,600 | 100 |

*Time Savings* for each of the three alternate lines have been determined by applying a time saving unit value to the same traffic volumes as described under distance savings, which could travel between any two given zones, stations, or combination of zones and stations, in a shorter period by utilizing the proposed improvement than when following the existing route.

A great deal has been written concerning the value of time savings to the operator of a passenger car. If an individual is driving his vehicle for business or is the hired driver of a passenger vehicle engaged on business, the savings in time has a definite value. For example, a salesman whose salary is $2,400 per year and who works 50 weeks at 48 hours per week will provide his employer a basis for realizing definite value from travel time saving —in this case $1 per hour for salary. However, in the case of the majority of the passenger vehicles which are on pleasure trips, or bound to or from work, or shopping, time as such, may be worth little or nothing.

In our analysis as here described we used an average value for time savings for all passenger cars of 60 cents per hour. This value is consistent with what has been used by various authorities in the analysis of traffic for proposed toll facilities, and it is understood the results following completion of the toll facilities have justified its use.

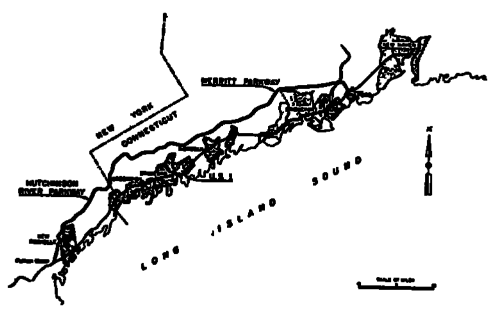


**Figure 5. Relation of Parkways to U. S. Route 1 and Shore Communities**

For passenger vehicles used for business, 60 cents is undoubtedly a very conservative value. We believe that as a measure of congestion relief for passenger cars not on business, 60 cents per hour is a reasonable average value. We are planning in Connecticut to develop some information which should shed further light on this factor. We have recently obtained data from vehicles using the toll bridge across the Connecticut River at Hartford, where there is an alternative free bridge. These data are now being analyzed. In addition, on completion of the Ansonia-Derby-Shelton project after the war, we plan to conduct a simultaneous traffic origin and destination survey on the new and old bridge crossings between Shelton and Derby The reasonableness of our values will then be checked directly on a project for which they have been used

In connection with this question of "time savings" as a measure of congestion, the Merritt Parkway in Connecticut presents an example, which would provide a great deal of significant data if the traffic movements were determined and analyzed in comparison with traffic movements on the alternative route. The Parkway, with its connections to U. S 1, via the Hutchinson River Parkway to Pelham Manor in New York, and the Milford Parkway, just west of New Haven in Connecticut, provides an alternative route of travel for passenger cars roughly paralleling U. S. 1 for about 50 miles—50.33 on U. S. 1 and 54.68 on the parkways. Numerous connections are provided to the shore cities and towns, and to U. S. 1, along the entire length of the parkways, and in all cases use of the parkways from the intermediate shore communities involves proportionately greater travel distances in inverse order to the length of parkway used in any individual trip. (See Fig. 5.)

Use of the entire length of parkways involves payment of two ten-cent tolls. The increased travel distance which amounts to 4.35 miles adds further to the increase in cost of travel over this route, as compared to U. S 1, although there may be some compensation in lower gasoline consumption on the parkways[1] For trips between intermediate points off the parkway, users may have to pay but one toll or possibly none, but will, as pointed out previously, have to travel proportionately greater distances than over U. S. 1.

Although we do not now have the data we should like to have regarding use of the parkways as alternate congestion free routes, it is believed that with rare exceptions all passenger cars bound between points beyond the parkway termini use this facility in preference

[1] Test runs conducted in 1939, and reported in the Highway Research Board Proceedings of that year (Vol 19) by Professor A J. Bone of Massachusetts Institute of Technology, indicated for the test vehicle the saving in per mile gasoline consumption on the parkway would exactly offset the increased distance of 4 35 miles insofar as total gasoline consumption is concerned A subsequent increase in the posted speed limit on the Merritt Parkway probably increased the average speed and thereby the rate of gasoline consumption per mile on the parkways

to U S. 1. In normal times these vehicles are largely bound on pleasure trips so that the time saved cannot be assigned positive value. By using the parkways, congestion on U. S 1 is avoided to the extent that on the average the longer parkway route can be traveled in about 40 min less time. On this basis and assuming that the 20 cents for the two tolls represents the minimum additional cost for use of the parkways, it appears a minimum value for "time savings" as a measure of congestion relief can be assigned at one half cent a minute or 30 cents an hour Obviously, different individuals, and the frequency of use of a facility will result in a difference in individual values, but apparently they would go up well over 30 cents on the average. As an example, an individual told me that he was using the parkways, in normal times, two or three times a year on trips from Washington to Massachusetts, and that, while his time on these trips was not worth anything, he would pay many times the current toll rate to avoid the congested U S. 1.

For trips using only portions of the parkway all sorts of conditions of saved time versus increased distance would be obtained. Some time I hope we will be able to tap this mine of information through the interviewing of users of both the parkways and U. S. 1.

The data upon which time saving unit values for trucks have been developed are given in Tables No. 5, 11 and 12. The total annual time savings as shown in Table No. 11 are converted to an average hourly value on the basis of 50 weeks of 48 hours each, or 2,400 hours per year. Thus, for light and medium trucks, $2,077/2,400 = $0 87 per hour; heavy and semitrailers, $3,501/2,400 = $1.46 per hour.

Average over-all speeds for the proposed alternate improvements have been assumed as follows. Values are in miles per hour.

| Lines | Bridge or Any One Internal Section | Bridge Plus One Internal Section | All Other Conditions |
|---|---|---|---|
| **Passenger** | | | |
| A, B, & C | 30 | 35 | 45 |
| Connector | — | — | 25 |
| **All Commercial** | | | |
| A, B, & C | 25 | 30 | 40 |
| Connector | — | — | 25 |

The following example is given to outline the procedure employed in computing the "time savings" which are summarized in Tables 13, 14 and 15 Considering the same route used in the previous example of distance saving, namely, through north and south traffic between stations 02 and 15, the average travel time over the existing route between the established termini was found to be 12 2 min The estimated travel time between the same termini over Line A, obtained by dividing the estimated distance of 5 27 miles by the assumed average over-all speed of 45 miles per hour, is 7 0 min. Thus Line A provides an

TABLE 11
FIXED (TIME) COSTS
(Per Year)

| Fixed Elements | Passenger Cars (for Business) | Trucks: Light & Medium | Trucks: Heavy & Semitrailers |
|---|---|---|---|
| Interest at 6% | $28 50 | $52 00 | $195 00 |
| License | 7 36 | 19 50 | 101 00 |
| Insurance | 45 00 | 145 00 | 220 00 |
| Garage (Storage) | 48 00 | 60 50 | 105 00 |
| Driver's Wages | 2,400 00 | 1,800 00 | 2,880 00 |
| Totals | $2,528 86 | $2,077 00 | $3,501 00 |

TABLE 12
ANNUAL FIXED (TIME) COSTS PER DAILY VEHICLE MINUTE

| Type | Cents per Vehicle Hour | Computation | Use |
|---|---|---|---|
| Passenger Car | 60 | $\frac{60}{60} \times \frac{365}{100}$ = $3 65 | $3 50 |
| Light & Medium Trucks | 87 | $\frac{87}{60} \times \frac{365}{100}$ = $5 29 | $5 00 |
| Heavy Trucks & Semitrailers | 146 | $\frac{146}{60} \times \frac{365}{100}$ = $8 88 | $9 00 |

TABLE 13
TIME SAVINGS, LINE A (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semitrailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $22,900 | $3,000 | $3,200 | $29,100 | 84 |
| Station to Zone | 3,800 | 300 | 0 | 4,100 | 12 |
| Zone to Zone | 1,100 | 100 | 100 | 1,300 | 4 |
| Totals | $27,800 | $3,400 | $3,300 | $34,500 | 100 |

estimated time savings of 5 2 min. Multiplying this savings in time of 5.2 min. by the 1,174 passenger vehicles involved and by the time saving unit developed above for passenger vehicles ($3.50 per vehicle per minute per year) the estimated annual 1939 time savings for these passenger vehicles is $21,366 Again, this same procedure has been utilized for other classes of vehicles and other types of travel as station to zone and zone to zone for each alternate line.

TABLE 14
TIME SAVINGS, LINE B (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semi-trailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $28,800 | $3,900 | $4,800 | $37,500 | 58 |
| Station to Zone | 18,200 | 2,100 | 800 | 21,100 | 33 |
| Zone to Zone | 4,900 | 500 | 300 | 5,700 | 9 |
| Totals | $51,900 | $6,500 | $5,900 | $64,300 | 100 |

TABLE 15
TIME SAVINGS, LINE C (1939 SUMMARY)

| Type of Origin and Destination | Passenger Cars | Trucks: Light & Medium | Trucks: Heavy & Semi-trailers | Total | Total |
|---|---|---|---|---|---|
| | | | | | % |
| Station to Station | $34,500 | $4,400 | $5,300 | $44,200 | 38 |
| Station to Zone | 26,000 | 3,500 | 1,200 | 30,700 | 27 |
| Zone to Zone | 33,800 | 4,600 | 1,500 | 39,900 | 35 |
| Totals | $94,300 | $12,500 | $8,000 | $114,800 | 100 |

The 1939 summaries of the estimated TIME SAVINGS for vehicles which could be expected to use Lines A, B and C by type of origin and destination are given in Tables 13, 14, 15.

No attempt was made in computing delays over existing routes to determine and utilize values representative of the average year of the retirement period The average annual benefits developed will be merely the measure of congestion as developed by the 1939 traffic count, expanded only to account for the expected normal increase of traffic. However, it is a well known fact that the degree or extent of congestion and the resultant delays on any given road in 1939 will be increased with an increase of traffic. Field measurements show that congestion on two-lane urban highways may increase as much as 100 percent for an increase of traffic from 600 to 900 vehicles per hour, an increase of but 50 percent in traffic.[3] While in this study no attempt has been made to compute such total potential congestion, it must be recognized that with the expected normal increase of traffic, congestion of a far greater magnitude will exist over the 1945–1975 period than has been estimated. As a result the monetary values of benefits for time saved will actually be much greater than those estimated.

TABLE 16
TOTAL SAVINGS

| Savings | Line A | Line B | Line C |
|---|---|---|---|
| Distance | $8,000 | $16,200 | $16,600 |
| Time | 34,500 | 64,300 | 114,800 |
| Totals (1939) | $42,500 | $80,500 | $131,400 |

TABLE 17

| Benefit | Line A | Line B | Line C |
|---|---|---|---|
| Elimination of Traffic Stops | $4,500 | $9,000 | $17,000 |
| Rise and Fall Savings | −2,500 | −1,500 | −1,500 |
| Gradient Savings | −2,000 | −1,500 | −1,000 |
| Alignment Savings | 1,500 | 2,500 | 4,000 |
| Roadway Surface Savings | 1,500 | 2,500 | 4,000 |
| Totals (1939) | $3,000 | $11,000 | $22,500 |

*Summary of Distance and Time Benefits.* The total annual benefits (distance savings and time savings) for each of the three proposed locations are given in Table 16.

*Other Benefits.* Approximate savings for several additional benefits are tabulated to show their magnitude (Table 17). Since they have been largely derived from theoretical data, without sufficient supporting factual data and coverage, details are not given and the results have *not* been used in the final analysis Values are per year.

Additional benefits due to the possibility of a reduction in accident costs have not been computed due to the lack of supporting factual data

The net effect of all benefits other than the

[3] Current study of Hartford-New Britain traffic

time and distance savings evaluated would not be reflected in the same degree to each of the alternate lines. The degree to which each alternate line would be benefited would have a relation to the amount of traffic carried by each line, and it seems likely that between lines these benefits would vary in the ratio of their traffic raised to some power greater than one.

### TRAFFIC ESTIMATES

It is axiomatic that the alternative which will attract the greatest volume of traffic, due to time and/or distance savings, will in turn provide the greatest relief of existing congested traffic conditions, not only in respect to those vehicles using the proposed facility, but also to those vehicles which remain on the existing street system and operate under lower traffic densities.

The foregoing analysis of distance and time savings provides the basis for determining the amount of traffic which can be expected to use each of the alternate lines. Vehicles operating between any two termini, that is station to station, station to zone, or zone to zone, have been estimated as using a new facility only if the time saving and distance saving together provide a net saving. The summation, therefore, of the traffic which has developed the time and distance savings shown previously represents the amount of traffic that can be expected to use each of the three proposed facilities. These traffic volumes, as of 1939, are shown by means of traffic bands in Figure 6 for each line. A single band is used to denote the summation of travel in both directions.

Line A will attract approximately 2,200 vehicles on the river crossing, thus leaving 17,800 vehicles, or 89 percent of the 1939 traffic of 20,000 vehicles, to use the existing river bridge.

Line B will attract approximately 4,200 vehicles on the river crossing, thus leaving 15,800 vehicles, or 79 percent of the 1939 traffic to use the existing river bridge.

Line C will attract approximately 9,500 vehicles on the river crossing, thus leaving 10,500 vehicles or 53 percent of the 1939 traffic to use the existing river bridge

Certain general characteristics of peak traffic movements have been deduced from data obtained by continuous automatic traffic counters on routes which carry similar traffic (heavy commercial traffic with little recreational use). The 30th from the highest hourly traffic density, during the year, which is used as a criterion of design in Connecticut, can be expected to range from 12 to 15 percent of the average daily traffic on the

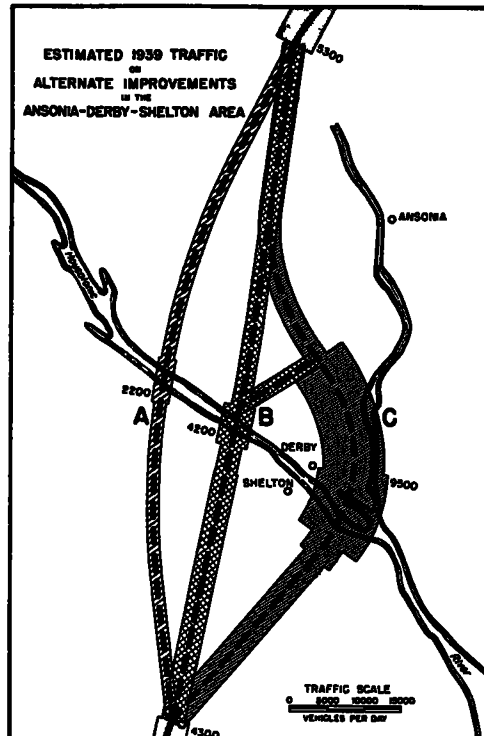


Figure 6

end sections of all three alternatives. This same range can be expected on all other sections of Line A. The 30th highest annual peak hour over the internal sections of Lines B and C, and more particularly the river crossing sections, should range from 9 to 12 percent of the average daily traffic. These values when applied to the estimated average daily traffic provide a basis for the establishment of ultimate design standards and for the planning of initial stage improvement

*Estimated Traffic Growth* The foregoing analysis is based on traffic for the year 1939. Experience has demonstrated that it is necessary to plan for future traffic requirements if early obsolescence is to be avoided. It has been necessary to retire from service many roads still structurally sound, but inadequate to carry the character and volume of traffic which has developed.

It is believed that with the elimination of such factors as inadequate width, poor alignment and excessive grades, which have tended to shorten the useful life of most of our primary highways in the past, the anticipation of a useful life of more than 30 years is not unreasonable. In this study 30 years was used as the period over which the cost of the improvement will be retired or amortized

In assuming a 30-year retirement life for the improvement, every effort must be made to anticipate the traffic requirements over that period. Consideration must be given to (1) "induced traffic" or the extent to which additional traffic may be drawn to the improvement because of its superior quality and (2) the estimated normal traffic growth.

*Induced Traffic* The creation of new traffic by the provision of a superior facility is dependent primarily on the extent to which conditions in the past have restrained traffic movements and by the extent to which other developments of superior facilities in the future may either aid or compete with the one under consideration

In this respect the Ansonia-Derby-Shelton section of Routes 8 and 65 is but one unit in the important Naugatuck Valley route (Waterbury to Bridgeport) all of which is either being reconstructed or planned for reconstruction to high standards. Induced traffic generated by the over-all improvement will use any one of the three alternates in the Ansonia-Derby-Shelton section. The amount of local traffic which may be induced to use this improvement will depend upon which alternate is constructed By comparison with other facilities of this character, both in and out of Connecticut, it appears that induced traffic of 5 to 10 percent could be expected However, while such an increase is anticipated, its magnitude is not great enough to affect the results of this study It will not, therefore, be added as an increment in the final analysis.

*Normal Traffic Growth.* In order to provide a basis for estimating the anticipated growth of traffic over the assumed 30-year retirement period of the improvement, use has been made of the trend study—"Trends of Motor Vehicle Registration and Use," previously made by the Connecticut Highway Planning Survey. This study is based on the correlation of a number of contributing factors. Figure 7 shows the results graphically. The weighted average annual traffic for the 30-year retirement period of the improvement is 153 percent of the 1939 average daily traffic. The annual traffic at the end of the retirement period, 1975, is estimated at 160 percent of the 1939 traffic.

Attention is directed to the fact that the traffic growth as estimated above is for normal traffic growth only. It does not provide for any radical change in the vehicle, or more particularly for any major improvement in

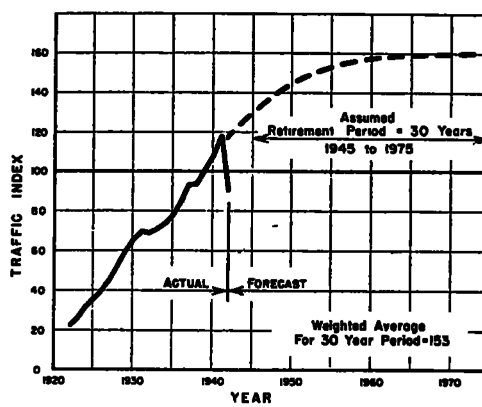


**Figure 7. Traffic Index 1939 = 100**

vehicle operating costs. However, there is support for a belief that the post-war automobile will provide more economical performance, in both gasoline consumption and tire wear, than anything we have experienced to date. Such developments could result in a more rapid growth of traffic than estimated.

## COSTS

*Proposed Design.* As a basis for computations of costs, it is proposed to acquire rights of way over the entire length of the project adequate for ultimate provision of a 4-lane divided highway. In rural areas this width is assumed to be 300 ft. and in urban areas, 120 ft Construction costs are based on providing a 22-ft. roadway where the estimated 1939 average daily traffic is 3,700 vehicles or less. On these two-lane sections, the estimated 30th highest annual peak hour traffic does not exceed 600 vehicles as of 1939. (If construction is deferred for some years and there is obtained a sharp increase in traffic, it may be desirable to increase the extent of four-lane construction.) A 4-lane divided highway is proposed for all sections on which the 1939 average daily traffic is 7,000 vehicles or more On these dual sections the estimated 30th highest annual peak hour does not exceed 1,200 vehicles There are no sections that are expected to carry more than 3,700 and less than 7,000 vehicles per day for 1939 traffic volumes. A 4-lane divided facility providing two 24-ft. roadways is proposed for all Housatonic River bridges

It is proposed that access to the new improvement be controlled. Only through such control can the full value of the facility as a traffic artery be preserved.

*Right-of-Way Cost.* The estimated cost of right-of-way for Line A, exclusive of reservoir and transmission line, is as follows

| | |
|---|---|
| Vacant land, road frontage and acreage | $25,550 |
| Residential property, land with buildings | 20,350 |
| Commercial properties | 17,000 |
| Acquisition and contingencies (15%) | 9,435 |
| Total cost—Line A | $72,335 |
| Annual cost over 30-year period | $2,400 |

The estimate of cost of right-of-way for Line B, exclusive of city park and two transmission lines, is broken down as follows.

| | |
|---|---|
| Vacant land, road frontage and acreage | $25,870 |
| Residential property, land with buildings | 220,750 |
| Commercial and industrial property | 75,800 |
| Acquisition and contingencies (15%) | 48,363 |
| Total cost—Line B | $370,783 |
| Annual cost over 30-year period | $12,400 |

The estimated cost of right-of-way for Line C, exclusive of two transmission lines, is as follows:

| | |
|---|---|
| Vacant land, road frontage and acreage | $53,950 |
| Residential property, land with buildings | 279,200 |
| Commercial and industrial property | 100,150 |
| Acquisition and contingencies (15%) | 64,995 |
| Total cost—Line C | $498,295 |
| Annual cost over 30-year period | $16,600 |

*Construction Costs* A low level bridge has been proposed on Line C even though the head of navigation on the Housatonic River is designated as being above the proposed location of this crossing. Vertical clearance for river navigation will be considerably greater than that which exists at the present railroad and highway bridges a short distance up stream. Unit prices for river structures are based on pre-war prices.

Estimated construction costs of each alternative line are as follows:

*Line A*—Length 5 27 miles—22-ft. concrete pavement—10-ft shoulders.

| | |
|---|---|
| Grading | $388,000 |
| Drainage | 116,000 |
| Minor structures | 31,000 |
| Pavement | 236,000 |
| Railing and fences | 26,000 |
| Route 110 structure | 70,000 |
| Route 110 ramps | 30,000 |
| Housatonic River Bridge (1,200 ft —57,600 sq ft at $12 per sq. ft ) | 691,000 |
| Total cost—Line A | $1,588,000 |
| Annual cost over 30-year period | $52,900 |

*Line B*—Length 4 99 miles—3 85 miles of 22-ft concrete pavement and 0 88 miles of dual lane 24-ft concrete pavement Connector —0 28 miles of 38-ft concrete pavement curbed.

| | |
|---|---|
| Grading | $450,000 |
| Drainage | 126,000 |
| Minor structures | 31,000 |
| Pavement | 277,000 |
| Railings and fences | 26,000 |
| Hawthorne Ave structure and ramps | 110,000 |
| Route 110 structure | 70,000 |
| Route 110 ramps | 30,000 |
| Connector to Atwater Avenue | 40,000 |
| Housatonic River Bridge (1,350 ft —64,800 sq. ft. at $12 per sq ft.) | 778,000 |
| Total cost—Line B | $1,938,000 |
| Annual cost over 30-year period | $64,600 |

*Line C*—Length 5 49 miles—3 49 miles of 22-ft concrete pavement and 1 59 miles of dual 24-ft concrete pavement (using the same unit costs per mile as estimated for Line B)

| | |
|---|---|
| 2-Lane—3 49 miles at $158,000 per mile | $551 000 |
| Dual lane—1 59 miles at $300,000 per mile | 477,000 |
| Division Avenue structure | 70,000 |
| Prospect Avenue ramps | 40,000 |
| Coram Avenue structure | 70,000 |
| Route 8 ramps (Shelton) | 40,000 |
| Railroad structure (Main Line) | 70,000 |
| Route 34 ramps | 60,000 |
| Railroad structure (Spur Line) | 40,000 |

| | |
|---|---|
| Route 8 at Atwater Ave structure & ramps | 180,000 |
| Hawkins Street structure | 70,000 |
| Division Street structure | 70,000 |
| Housatonic River Bridge and viaducts | 950,000 |
| (550 ft —26,400 sq ft at $12 per sq ft.—$316,800) | |
| (1,650 ft —79,200 sq ft. at $8 per sq ft.—$633,600) | |
| Total cost—Line C | $2,688,000 |
| Annual cost over 30-year period. | $89,600 |

*Maintenance Costs.* Annual maintenance costs for 2 and 4-lane roadways and for the bridges have been prepared from cost data on comparable facilities Summaries of the annual maintenance costs for each alternative are:

*Line A*

| | | | |
|---|---|---|---|
| 2-Lane roadway | = 5.04 mi | at $800 per mile = | $4,032 |
| Bridge and viaduct | = 0 23 mi | = | 4,400 |
| Totals | 5 27 mi. | = | $8,432 |
| | | Use | $8,400 |

*Line B*

| | | | |
|---|---|---|---|
| 2-Lane roadway | = 4.13 mi. | at $800 per mile = | $3,304 |
| 4-Lane roadway | = 0 88 mi | at $1,700 " " = | 1,496 |
| Bridge and viaduct | = 0 26 mi | = | 5,500 |
| Totals | = 5.27 mi | | $10,300 |
| | | Use | $10,300 |

*Line C*

| | | | |
|---|---|---|---|
| 2-Lane roadway | = 3 49 mi | at $800 per mile = | $2,792 |
| 4-Lane roadway | = 1 59 mi | at $1,700 " " = | 2,703 |
| Bridge and viaduct | = 0 41 mi | = | 8,700 |
| Totals | 5 49 mi | | $14,195 |
| | | Use | $14,200 |

*Summary of Annual Costs.* The total annual cost of each alternative line is summarized by combining the rights-of-way, construction and maintenance costs as follows:

| Type | Line A | Per cent of Total | Line B | Per Cent of Total | Line C | Per Cent of Total |
|---|---|---|---|---|---|---|
| Rights of Way | $ 2,400 | 4 | $12,400 | 14 | $16,600 | 14 |
| Construction Cost | 52,900 | 83 | 64,600 | 74 | 89,600 | 74 |
| Maintenance Cost | 8,400 | 13 | 10,300 | 12 | 14,200 | 12 |
| Totals | $63,700 | 100 | $87,300 | 100 | $120,400 | 100 |

It is noteworthy that Line A requires relatively inexpensive right-of-way and that the respective percentages of total cost are identical for Lines B and C Furthermore, although right-of-way on Lines B and C are large in relation to most of our state highway work, they are still a small portion of the total cost.

SUMMARY

*Relief of Congestion.* The analysis of traffic movements for each alternate line shows that the 1939 traffic volumes that could be expected to cross the Housatonic River on each alternate are:

| Line | Estimated 1939 Traffic Volume | Percentage of Traffic on Existing River Bridge |
|---|---|---|
| A | 2,200 | 11 |
| B | 4,200 | 21 |
| C | 9,500 | 47 |

The effect of the estimated normal traffic increase on the residual traffic over the existing river bridge with each of the alternate improvements in operation is shown in Figure 8.

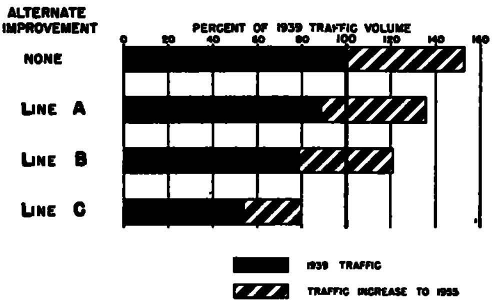


**Figure 8. Traffic on Present Bridge in 1939 and 1955 with Alternate Improvements.**

The 1939 traffic count of 20,000 vehicles per day on the existing Derby-Shelton river bridge is shown in Figure 8 as 100 per cent. Referring to Figure 7 (traffic index curve) it is seen that traffic in 1955 will be approximately 53 percent greater than in 1939. Therefore, if Line A were selected for relocation, the expected traffic on the existing bridge as early as 1955 would be 136 percent of the 1939 density Likewise, if Lines B or C were selected, the 1955 traffic densities would be 121 and 80 percent respectively, of the 1939 density.

Since the density of traffic on the existing bridge is a measure of traffic density on the city streets which serve as the bridge approaches, it is significant that only Line C provides permanent relief of the existing congested traffic conditions.

*Economic Worth.* As has been indicated in the statement of the problem, a gauge of the economic worth of an improvement can be obtained through the ratio of average annual road user benefits to average annual costs for the improvement.

The road user benefits for each alternate based on 1939 traffic have been previously summarized. The weighted average traffic over the 30-year retirement period of the improvement has been determined to be 153 percent of the 1939 traffic. Therefore, by applying 153 percent to the 1939 benefits the average annual benefits over the anticipated 30-year retirement period are found to be.

| | |
|---|---|
| Line A | $42,500 × 1.53 = $65,000 |
| Line B | $80,500 × 1.53 = $123,200 |
| Line C | $131,400 × 1.53 = $201,000 |

The index of economic worth of each line may then be determined from the ratio of annual benefits to annual costs. These are:

$$\text{Line A} \quad \frac{\text{Annual Benefits}}{\text{Annual Costs}} = \frac{\$65{,}000}{\$63{,}700} = 1.0$$

$$\text{Line B} \quad \frac{\text{Annual Benefits}}{\text{Annual Costs}} = \frac{\$123{,}200}{\$\ 87{,}300} = 1.4$$

$$\text{Line C} \quad \frac{\text{Annual Benefits}}{\text{Annual Costs}} = \frac{\$201{,}000}{\$120{,}400} = 1.7$$

From this economic evaluation of time and distance savings, it is evident that Line C provides the greatest benefit per dollar of cost.

## CONCLUSIONS

As far as the analysis of the three alternate locations is concerned, the conclusion is obvious that Line C is the most desirable of the three improvements considered. It provides the greatest relief of congestion and also the greatest benefit per dollar of cost. On the basis of our analysis, Line C has been selected for improvement.

From the study it is also obvious that only by analysis of the individual trip movements—the determination of origins and destinations—can a logical plan for a major improvement in or adjacent to urban areas be developed.

Since making the Ansonia-Derby-Shelton analysis and as a result of further consideration of it and of other problems we have studied, we have come to certain general conclusions, as follows.

1. The comparison of benefits per dollar of cost can not be accepted as the sole determinant for improvements. It is necessary also to evaluate the extent to which the alternate improvements meet the total traffic needs. As a matter of fact it appears that the latter evaluation alone, in the Ansonia-Derby-Shelton study is conclusive. Of the three alternate improvements only Line C will provide substantial relief of congestion for both the through traffic and the traffic into the urban communities. If either Line A or Line B were improved now, it appears a further major improvement would ultimately be necessary. Without the inclusion of such further improvements as parts of A and B, the benefits per dollar of cost are not fairly comparable with Line C.

As a course of procedure, it is recommended that various alternate improvements first be analyzed to determine whether they adequately meet the total traffic requirements. Those which do not should be either eliminated or supplemented to make them adequate. Only the alternative improvements which adequately meet traffic needs should be carried into the final analysis of benefits and costs.

2. It should not be concluded from the Ansonia-Derby-Shelton analysis that the location providing the greatest traffic service will necessarily develop the highest benefit cost ratio. For example, in this study a fourth line going directly through the three community centers would provide the maximum traffic service and would give the greatest total road user benefits. However, it should be obvious that the improvement cost on such a line also would be greatest. It is believed that the increase in cost of such a line over Line C would be proportionately greater than the additional benefits provided, so that such a line would develop a lower benefit value per dollar of cost than would Line C. From a practical standpoint we did not consider it necessary to evaluate this fourth alternative. For a theoretically complete analysis, such a line would require consideration

# DISCUSSION ON ORIGINS AND DESTINATIONS OF HIGHWAY TRAFFIC

JOHN T. LYNCH, *Public Roads Administration:* In the analysis of the benefits which will accrue from the construction of a particular project, the value of time saving for passenger cars is an important item—sometimes the most important single item, yet factual data concerning it are exceedingly limited. It is generally assumed that time saving is worth a considerable amount for business travel, and very little or nothing for social or recreational driving Travel to and from work is usually classed as business travel, yet time saved is not business time, but time which would be used for relaxation or recreation. The average worker would not be able to utilize the time for gainful pursuits, but he might be willing to pay for the opportunity to increase his leisure time Also, he might be willing to pay to be rid of the strain and irritations which result from traffic congestion and frequent stops, even though there were no saving in time.

Because of the importance of the traffic movements between homes and places of work, it was thought that a determination of the willingness of workers to pay for saving time and eliminating stops and traffic annoyances would be a valuable contribution to the study of the economics of expressways in metropolitan areas. As an experiment, perhaps preliminary to more extensive investigation later, it was decided to question the personnel of the Public Roads Administration in the Washington metropolitan area concerning their willingness to pay to save time and to be rid of irritating traffic congestion While such a sample could not be considered as representative of all workers, it may be fairly representative of office workers in a city like Washington.

From an experimental point of view, there were important advantages in limiting the sample to Public Roads Administration employees Returns could be obtained from almost 100 percent of those not on leave; the answers could be correlated with pay-roll data to determine variations by salary groups, and individuals could be questioned concerning any apparent misunderstandings Considerable interest was aroused and valuable suggestions were made concerning the clarification of the questions and the interpretation of the answers.

The form used is shown in Table 1. It would have been better if question A had asked for the nearest street intersection instead of the home address, as it was difficult to code the addresses by zone, in some cases. Question B should have provided a definite classification for those group riders who alternate in the use of cars belonging to different members of the group It is probable that, in most such cases, both 1 and 2 were circled, though the note concerning the circling of two numbers was intended to apply only to the case where two means were used to complete a single trip. Where two numbers were circled and neither was underscored, No. 1 was considered to be the principal means, in the coding.

TABLE 1

A What is your home address?

B. How do you normally travel to and from work? (Encircle number)
1. Own auto 2 Another's auto
3 Streetcar or bus 4 Taxi 5. Walk
6 Train 7 Other ( )
(Note If two of the above means are employed to complete a trip, encircle both numbers and underscore the principal means from the point of view of Washington traffic )

C. How long does this normally take (one way)? minutes

D How much would you pay per day to save ten minutes in going to work and ten minutes in returning home? $ How much would you pay if the time saving each way were One minute, $ , five minutes, $ , twenty minutes, $ ?

E Aside from time saving, how much would you pay per day for the privilege of using a highway free from congestion and stop lights, and pleasant to travel on? $

Questions D and E were misinterpreted by some to mean that the amount shown should be the total paid, including what is now paid. In cases where the amount for saving one minute looked large, the employee was questioned and it was invariably found that he had included his present fare throughout.

It will be noted that questions D and E ask "How much would you pay?" rather than "How much is it worth to you?" or "How much is your time worth?" In another survey made recently, the results of which have come to our attention, a question was asked concerning the value of driving time, and the average value found was $3 40 per hour A surgeon estimated his time as worth $500 per hour, and a man on a pleasure trip estimated his as worth $25 per hour It is possible that the surgeon would have paid $100 to save 12 minutes in an extreme emergency, but it is unlikely that he would have done so as a regular thing, and not probable that he would have said that he would pay that much if he had been asked how much he would pay, instead of how much his time was worth Care was taken in preparing the form, therefore, to word the questions in such a way as to avoid inflated values

The form was distributed in October, 1943, through the division chiefs, and returned through them, to make sure that it received proper attention In all, 651 employees filled out the form, but 70 of these, mostly walkers and streetcar or bus riders, did not say how much they would pay to save time or be rid of congestion Averages were therefore based on the 581 returns in which a definite statement was made as to the amount which would be paid

The total number using each form of transportation, and the number answering the questions completely, were as follows·

| Means of Travel | Total Number | Number Answering Completely |
|---|---|---|
| Own auto | 199 | 186 |
| Another's auto | 107 | 98 |
| Streetcar or bus | 297 | 268 |
| Walk | 48 | 29 |
| Total | 651 | 581 |

Included with those shown as driving their own automobiles are 56 who indicate that they rode with others part of the time, and included with those shown as driving in another's automobile are three who indicated that they sometimes drove their own cars Two who use a taxi are included with those riding in another's automobile, and a bicycle rider is included with the walkers.

In addition to the 11 per cent not answering questions D and E, 45 per cent indicated that they would pay nothing, either to save time or be rid of congestion. The percentages willing to pay something for either time saving or freedom from congestion, were as follows:

| Means of Travel | Willing to Pay to Save Time or Be Rid of Congestion (per cent) |
|---|---|
| Own auto | 52 |
| Another's auto | 49 |
| Streetcar or bus | 43 |
| Walk | 6 |
| All | 44 |

Table 2 shows that the average employee in the sample considers the saving of 2 min.

TABLE 2

TOTAL AMOUNTS AND AMOUNTS PER MINUTE, WHICH WOULD BE PAID BY THE AVERAGE EMPLOYEE FOR SAVING DIFFERENT NUMBERS OF MINUTES PER DAY

| Total Time Saving per Day | Would Pay per Day | |
|---|---|---|
| | Total | Per Minute |
| *minutes* | *cents* | *cents* |
| 2 | 0 10 | 0 05 |
| 10 | 0 70 | 0 07 |
| 20 | 3 09 | 0 15 |
| 40 | 6 65 | 0.17 |

TABLE 3

AVERAGE AMOUNTS WHICH WOULD BE PAID BY EMPLOYEES USING DIFFERENT MEANS OF TRAVEL TO SAVE 20 MIN PER DAY, AND TO BE RID OF CONGESTION

| Means of Travel | Would Pay. | | Total |
|---|---|---|---|
| | To Save 20 Min Per Day | To Be Rid of Congestion | |
| | *cents* | *cents* | *cents* |
| Own auto | 3 7 | 6 1 | 9 8 |
| Another's auto | 3 5 | 6 6 | 10 1 |
| Streetcar or bus | 2 8 | 5 3 | 8 1 |
| Walk | 0 5 | 0 5 | 1 0 |

per day, or even of 10 min. per day, split evenly between morning and afternoon, as being of very little value. However, he would be willing to pay at a substantially higher rate per minute to save 20 min. per day, and would pay almost as much per minute to save this amount of time as he would to save 40 min. per day Evidently he considers 20 min. saving a day, or 10 min each way, as the smallest amount of time that could be used to advantage

Table 3 and Figure 1 show that employees riding in others' cars would pay about the same to be rid of congestion and to save 20 min. per day, as those riding in their own cars, while streetcar and bus riders would pay lesser amounts, and walkers would pay practically nothing.

Table 4 and Figure 2 show that high salaried employees would pay substantially more than low salaried employees to save time and to be rid of congestion. Employees with basic salaries of $5,000 or more would pay more than twice as much as those with basic salaries under $2,000; however, in the intermediate range, from $3,000 to $4,800, there is little variation.

In interpreting the results of the survey it should be borne in mind that, in general, serious traffic congestion is not prevalent in Washington at this time. Traffic volume is almost 30 percent below its 1941 peak, and a number of new facilities have been provided, particularly in the vicinity of the Pentagon Building. On the other hand, traffic through the heart of the city still moves very slowly during rush hours.

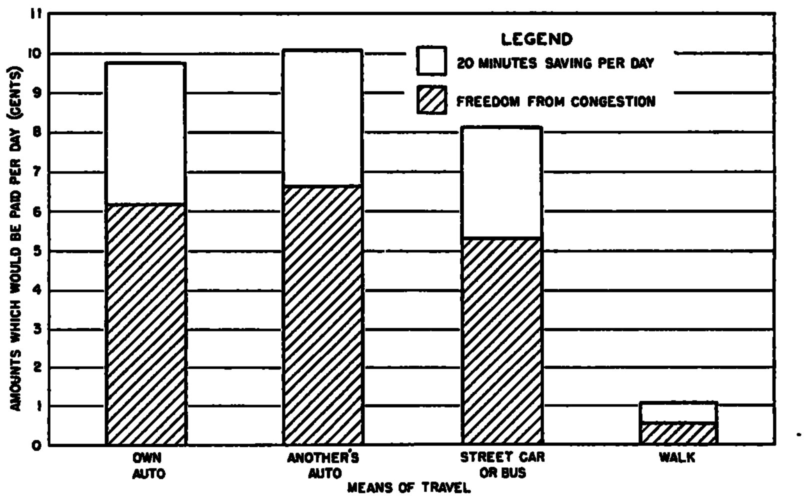


**Figure 1. Average Amounts Which Would Be Paid by Employees, Using Different Means of Travel, to Save 20 Minutes per Day and to Be Rid of Congestion**

TABLE 4
AVERAGE AMOUNTS WHICH WOULD BE PAID BY EMPLOYEES IN DIFFERENT BASIC SALARY GROUPS TO SAVE 20 MIN PER DAY AND TO BE RID OF CONGESTION

| Basic Salary Group | Would Pay | | Total |
|---|---|---|---|
| | To Save 20 Min Per Day | To Be Rid of Congestion | |
| | *cents* | *cents* | *cents* |
| Less than $2,000 | 2 1 | 4 1 | 6.2 |
| $2,000-$2,999 | 3 4 | 6 0 | 9 4 |
| $3,000-$3,999 | 3 9 | 6 4 | 10 3 |
| $4,000-$4,999 | 3.0 | 7 2 | 10 2 |
| $5,000 and over | 5 2 | 9 6 | 14 8 |

Table 5 shows the average amounts which would be paid to save 20 min. per day, and be rid of congestion, by employees other than walkers, living in different sections of the metropolitan area. The amounts which would be paid bear a close relation to the traffic situation which confronts the residents of each area. For example, residents of Prince Georges County, who must cross the heart of the city to get to the main office building, would pay about twice as much as the residents of Alexandria who have the advantages of the Mount Vernon Boulevard and the Pentagon network and can drive virtually all of the way to the office without serious traffic interference. The zones are arranged in the table in accordance with the amounts which would be paid to save travel time and be rid of congestion, and the sequence is about the same as it would be if the seriousness of the traffic problem were the governing factor in the arrangement. This suggests that the values determined by this survey might be lower than values which would be obtained by questioning only those persons who traverse a route so congested that major improvements are contemplated.

in travel-time groups, and shows the amounts which would be paid by the employees in each group to save 20 min per day and to be rid of congestion. The amounts which would be paid are also shown in Figure 3.

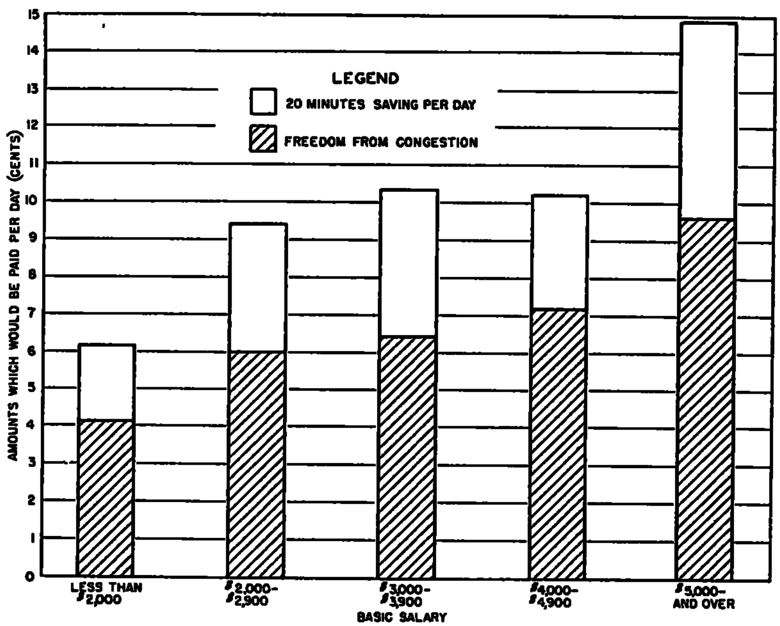


**Figure 2. Average Amounts Which Would Be Paid by Employees in Different Basic Salary Groups to Save 20 Minutes per Day and to Be Rid of Congestion**

TABLE 5

AVERAGE TRAVEL TIME, AND AMOUNTS WHICH WOULD BE PAID TO SAVE 20 MIN AND BE RID OF CONGESTION BY RESIDENTS OF DIFFERENT ZONES, EXCLUSIVE OF WALKERS

| Zone of Residence | Average Travel Time | Would Pay to Save 20 Min per Day and Be Rid of Congestion |
|---|---|---|
| | *minutes* | *cents* |
| Prince Georges County, Md. | 45 4 | 15 60 |
| Montgomery County, Md | 42 8 | 11.58 |
| District of Columbia, N E. | 39 6 | 10 91 |
| Fairfax County, Va | 41.4 | 9 83 |
| Arlington County, Va | 22 9 | 8.63 |
| District of Columbia, S E & S.W. | 31 7 | 8 39 |
| Alexandria | 32 3 | 7 95 |
| District of Columbia, N.W. | 30.2 | 7.25 |

TABLE 6

PERCENTAGE DISTRIBUTION OF EMPLOYEES, OTHER THAN WALKERS, IN TRAVEL-TIME GROUPS, AND AMOUNTS WHICH WOULD BE PAID TO SAVE 20 MIN. PER DAY AND BE RID OF CONGESTION

| Total Travel Time per Day | Distribution of Employees | Would Pay. | | Total |
|---|---|---|---|---|
| | | To save 20 Min | To Be Rid of Congestion | |
| *minutes* | *per cent* | *cents* | *cents* | *cents* |
| 0–39 | 14 4 | 2 1 | 5 7 | 7 8 |
| 40–79 | 52 1 | 3 0 | 5 3 | 8 3 |
| 80–119 | 25 4 | 3 7 | 5 5 | 9 2 |
| 120 and over | 8 1 | 4 6 | 10 4 | 15 0 |
| Total | 100 0 | 3 2 | 5 8 | 9 0 |

As would be expected, the employees requiring longer to travel to and from work would pay more to speed up their trip and make it more pleasant than those whose travel time is less. Table 6 gives the percentage distribution of employees, other than walkers,

The employees who might be expected to benefit by express highways are those traveling by automobile, either their own or another's, and requiring at least 20 minutes each way to go to and from work or, in other words, having a total travel time per day of 40 min.

or more. Table 7 shows how much these employees would pay, on the average, to be rid of congestion and save various amounts of travel time.

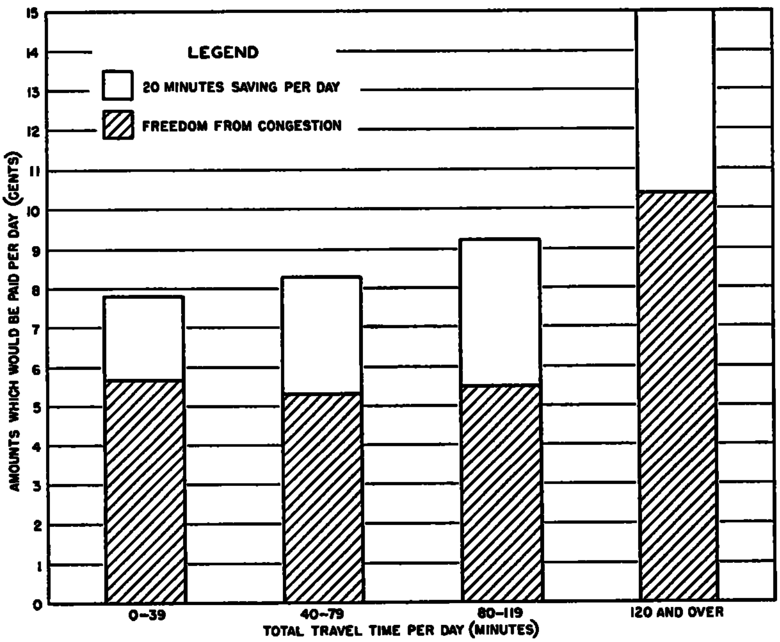


**Figure 3. Average Amounts Which Would Be Paid by Employees Requiring Different Amounts of Travel Time to Save 20 Minutes per Day and to Be Rid of Congestion**

TABLE 7

AVERAGE AMOUNTS WHICH WOULD BE PAID TO BE RID OF CONGESTION AND TO SAVE TIME, BY AUTOMOBILE RIDERS REQUIRING A TOTAL OF 40 MIN PER DAY TO DRIVE TO AND FROM WORK

| Benefit | Means of Travel | |
|---|---|---|
| | Own Auto | Another's Auto |
| | *cents* | *cents* |
| Save 2 min per day | 0.1 | 0.1 |
| " 10 " " " | 1.2 | 0.8 |
| " 20 " " " | 4.1 | 4.0 |
| " 40 " " " | 7.8 | 7.4 |
| Be rid of congestion | 6.2 | 6.9 |

According to studies made in the District of Columbia in August, 1943, in which the occupants of about 56,000 vehicles were counted, the average car occupancy during rush hours was 2.2 persons. The total benefits of an express highway per automobile would therefore be the average amount that the automobile owner would pay to eliminate serious congestion and save time, plus 1.2 times the average amount that a person riding in another's automobile would pay. Table 8 and Figure 4 show the total benefits per automobile, calculated in this manner.

TABLE 8

AVERAGE AMOUNTS WHICH WOULD BE PAID PER AUTOMOBILE, BY OWNERS AND OTHER RIDERS HAVING 40 MIN OR MORE TOTAL TRAVEL TIME PER DAY, TO BE RID OF CONGESTION AND SAVE TRAVEL TIME

| Benefit | Total Time Saving per Day | | | |
|---|---|---|---|---|
| | 2 Min | 10 Min | 20 Min. | 40 Min. |
| | *cents* | *cents* | *cents* | *cents* |
| Time saving | | | | |
| to owner. | 0.1 | 1.2 | 4.1 | 7.8 |
| to passengers | 0.1 | 1.0 | 4.8 | 8.9 |
| Freedom from congestion | | | | |
| to owner. | 6.2 | 6.2 | 6.2 | 6.2 |
| to passengers | 8.3 | 8.3 | 8.3 | 8.3 |
| Total | 14.7 | 16.7 | 23.4 | 31.2 |

The total amount, per automobile, which would be paid to save time is not as great as a

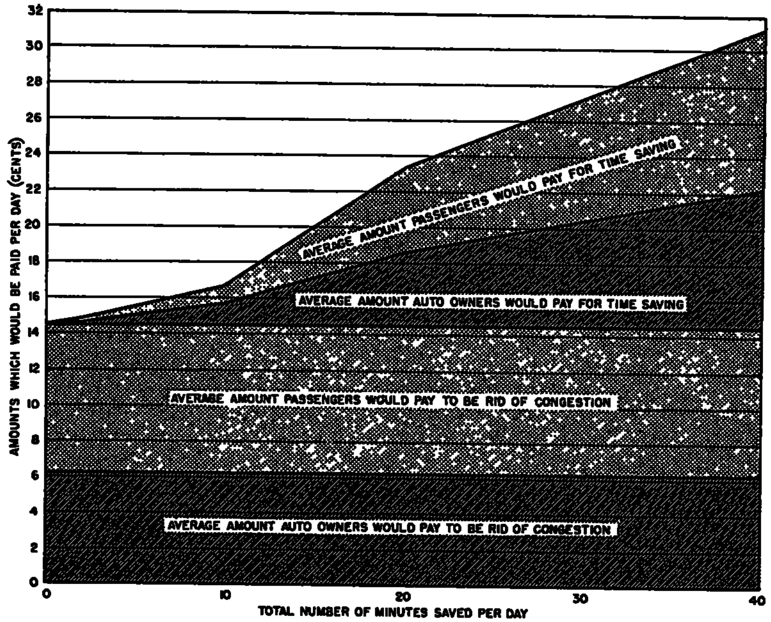


**Figure 4. Average Amounts Which Would Be Paid per Automobile by Owners and Other Riders Having 40 Minutes or More Total Travel Time per Day, to Be Rid of Congestion and Save Travel Time.**

half a cent per minute in any case. However, in the case of time savings of 10 min. or less per trip, the aggregate amounts which would be paid for the use of a congestion-free express highway, according to the returns in this survey, is greater than would be arrived at by considering time saving only, and giving it a value of one cent per minute.