76th Congress, 1st Session - - - - - - House Document No. 272

TOLL ROADS AND FREE ROADS

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES

TRANSMITTING

A LETTER FROM THE SECRETARY OF AGRICULTURE, CONCURRED IN BY THE SECRETARY OF WAR, ENCLOSING A REPORT OF THE BUREAU OF PUBLIC ROADS, UNITED STATES DEPARTMENT OF AGRICULTURE, ON THE FEASIBILITY OF A SYSTEM OF TRANSCONTINENTAL TOLL ROADS AND A MASTER PLAN FOR FREE HIGHWAY DEVELOPMENT

April 27, 1939.—Referred to the Committee on Roads and ordered to be printed with illustrations

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LETTER OF TRANSMITTAL

To the Congress of the United States:

I transmit herewith a letter from the Secretary of Agriculture, concurred in by the Secretary of War, enclosing a report of the Bureau of Public Roads, United States Department of Agriculture, on the Feasibility of a System of Transcontinental Toll Roads and a Master Plan for Free Highway Development.

The report, prepared at the request of the Congress, is the first complete assembly of data on the use being made of our national highway network. It points definitely to the corrective measures of greatest urgency and shows that existing improvements may be fully utilized in meeting ultimate highway needs.

It emphasizes the need of a special system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense and the needs of a growing peacetime traffic of longer range.

It shows that there is need for superhighways, but makes it clear that this need exists only where there is congestion on the existing roads, and mainly in metropolitan areas. Improved facilities, needed for the solution of city street congestion, are shown to occupy a fundamental place in the general replanning of the cities indicated as necessary in the report "Our Cities," issued in September 1937 by the National Resources Committee.

The report also points definitely to difficulties of right-of-way acquisition as obstacles to a proper development of both rural highways and city streets, and makes important and useful recommendations for dealing with these difficulties.

I call the special attention of the Congress to the discussion of the principle of "excess-taking" of land for highways. I lay great emphasis on this because by adopting the principle of "excess-taking" of land, the ultimate cost to the Government of a great national system of highways will be greatly reduced.

For instance, we all know that it is largely a matter of chance if a new highway is located through one man's land and misses another man's land a few miles away. Yet the man who, by good fortune, sells a narrow right-of-way for a new highway makes, in most cases, a handsome profit through the increase in value of all of the rest of his land. That represents an unearned increment of profit—a profit which comes to a mere handful of lucky citizens and which is denied to the vast majority.

Under the exercise of the principle of "excess-taking" of land, the Government, which puts up the cost of the highway, buys a wide strip on each side of the highway itself, uses it for the rental of concessions and sells it off over a period of years to home builders and others who wish to live near a main artery of travel. Thus the

Government gets the unearned increment and reimburses itself in large part for the building of the road.

In its full discussion of the whole highway problem and the wealth of exact data it supplies, the report indicates the broad outlines of what might be regarded as a master plan for the development of all of the highway and street facilities of the Nation.

I recommend the report for the consideration of the Congress as a basis for needed action to solve our highway problems.

Franklin D. Roosevelt.

The White House,
April 27, 1939.

LETTER OF SUBMITTAL

Department of Agriculture,
Washington, April 11, 1939.

The President,
The White House.

Dear Mr. President: In accord with your suggestion, the report of the Bureau of Public Roads which is now before you has been revised to present more clearly the need for a system of interregional through highways and the important relationships of such a system to the requirements of the national defense. The report has for its foundation the wealth of factual data collected through the highway planning surveys operated in cooperation between 46 of the State highway departments and the Bureau. Now consolidated, the Nationwide pattern, qualitative and quantitative, of highway usage is developed for the first time.

In part I, the report in its present form, defines the locaton of three east-west and three north-south highways conforming to the description of section 13 of the Federal Aid Highway Act of 1938, approved June 8, 1938, and indicates conclusively that financing of the full costs of such highways by direct-toll collections is not possible.

In the second part, the report discusses at length the development to date of the composite street and highway system of the country, and presents the general outlines of what in effect is a master highway plan for the Nation. The details of the plan outlined will be supplied progressively by continued studies already arranged for in cooperation with the State highway departments.

Pointing out clearly that the carrying out of the composite plan calls for appropriate and coordinated contributions by the Federal and State Governments and by all county and municipal subdivisions, the report proposes definite joint action by the Federal Government and the States.

Primary importance is attached to the designation and progressive improvement of a system of direct interregional highways designed to facilitate the long and expeditious movements that may be necessary in the national defense, and similarly wide-ranging travel of motorists in their own vehicles—a travel which, in addition to its immediate recreational benefits, is a powerful force for national unity.

In addition to this new activity the report proposes continued cooperation with the States in the modernization of the Federal-aid highway system, the elimination of hazards at railroad grade crossings, and the improvement of secondary and feeder roads properly integrated with programs of desirable land-use.

The report emphasizes the limitations hitherto placed upon highway and street improvements by inadequate provision for the acquisition of appropriate rights-of-way, and the fundamental importance of suitable provision for dealing with the right-of-way problem in connection with the more elaborate improvements that will be required in the future. To this end it proposes the creation of a Federal Land Authority empowered to buy, sell, lease, and hold land required for the various improvement projects of the Federal Government, and similarly to aid, through loans and leases, the acquisition of needed rights-of-way for important highway and street improvements of the States and cities. In an appendix it indicates the possibility, and legal status of methods of recovering the cost of highway improvements, in whole or in part, by the resale of land acquired in excess of the amount needed for the construction and protection of the highways.

Tentative location of the system of direct interregional highways proposed is indicated in the report, but the recommendation is made that final determination of the location of such highways should be made after further study in which the Bureau of Public Roads would cooperate with the War Department and the State highway departments.

In 1921 the War Department at the request of the Department of Agriculture made a comprehensive study of the highway routes important to the national defense. All of these routes were included in the Federal-aid system then established. In 1935 a restudy was made by the War Department to develop the revisions desirable and to establish priorities of route improvements. Since then the two Departments have maintained active liaison in relation to the general highway programs and the advancement of particular projects needed by the Military Establishment. Just recently a committee has been established by the War Department to work with the Bureau of Public Roads and the American Association of State Highway Officials to coordinate both the structural design and volume capacities of highway development with the requirements of the several major branches of the Military Establishment. In general terms it is the position of the War Department that a system of highways that is adequate to serve the industrial and commercial demands of the Nation will serve also the military requirements. However, the scale of the development of motorized military equipment and ordnance, and the changes in military practices taken in conjunction with the tremendous increase in the general public use of the highways, have created major problems that now require joint consideration by the two Departments.

Since it is the purpose of the report to provide a broad foundation for a sound future highway program, I recommend it be forwarded by you to the Congress with such comments as you may wish to make.

Very respectfully,

H. A. Wallace,
Secretary of Agriculture.

I concur in the recommendation of the Secretary of Agriculture that you forward the report on highways to the Congress for consideration.

Very respectfully,

Harry H. Woodring,
Secretary of War.

TOLL ROADS AND FREE ROADS

Part I

THE FEASIBILITY OF A SYSTEM OF TRANSCONTINENTAL TOLL ROADS

PART I. THE FEASIBILITY OF A SYSTEM OF TRANSCONTINENTAL TOLL ROADS

Section 13 of the Federal Aid Highway Act of 1938, approved June 8, 1938, provides that:

> The Chief of the Bureau of Public Roads is hereby directed to investigate and make a report of his findings and recommend to the Congress not later than February 1, 1939, with respect to the feasibility of building, and cost of, superhighways not exceeding three in number, running in a general direction from the eastern to the western portion of the United States, and not exceeding three in number, running in a general direction from the northern to the southern portion of the United States, including the feasibility of a toll system on such roads.

In accordance with this direction an investigation has been made, reconnaissance locations of six highways answering the general description contained in the act have been projected, and the following report is submitted with recommendations concerning the feasibility of building, and cost of, the six superhighways selected, and the feasibility of a toll system on them.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The building of the six superhighways on the selected locations, to the high standards consistent with the indicated character of the proposed facilities, is entirely feasible from a physical standpoint.

The approximate total length of the six superhighways, as projected, is 14,336 miles; and the estimated cost of constructing them to desirable standards is $2,899,800,000, which is at the average rate of $202,270 per mile.

The estimated cost per mile varies from a maximum of $1,158,400 for the section from Jersey City, N. J., to New Haven, Conn., to a minimum of $63,450 for the section from Rupert, Idaho, to Brigham, Utah. The variation results principally from differences in the estimated cost of right-of-way, the quantity of grading required, the number of access points, the number and character of bridges required to carry the highway over streams and over or under intersecting highways and railways, and the number of pavement lanes required for the accommodation of the estimated traffic.

A most conservative average estimated annual expenditure for the period 1945–60, required for financing the construction, maintaining the property, and operating the facility, for the six superhighways in their entirety is $184,054,000 per year, which is at the average rate of $12,840 per mile per year, varying from a maximum of $66,560 per mile per year for the section from Jersey City, N. J., to New Haven, Conn., to a minimum of $5,700 per mile per year for the section from Rupert, Idaho, to Brigham, Utah. These estimates of the required annual expenditure are based on reasonable assumptions with respect to the probable service life of the various elements of the construction, probable maintenance and operating costs, and financing costs based upon a 30-year loan with annual interest at 2.6 percent and an additional 2.24 percent for retirement.

The total utilization of the six superhighways in their entirety, by the most optimistic estimate, averages for the period 1945–60, 4,544,000,000 vehicle-miles of toll-paying traffic per year, of which 3,635,000,000 is accumulated by passenger automobiles and 909,000,000 by motortrucks and busses. This utilization averages per day over the entire mileage approximately 12,450,000 vehicle-miles, of which 9,960,000 is by passenger automobiles and 2,490,000 by motortrucks and busses, implying an equivalent average traffic volume on each mile of the six superhighways of 699 passenger automobiles and 175 motortrucks and busses per day.

The most optimistic estimated average daily toll-paying traffic for the period varies from a maximum of 5,998 passenger automobiles and 1,500 motortrucks and busses for the section from Jersey City, N. J., to New Haven, Conn., to a minimum of 96 passenger automobiles and 24 motortrucks and busses for the section from Spokane, Wash., to Fargo, N. Dak.

The test of the feasibility of a direct toll system on the roads is based upon assumed average rates of 3.5 cents per vehicle-mile for motortrucks and busses and 1 cent per vehicle-mile for passenger cars. Since, on the average, it is estimated that the ratio of motortrucks and busses to passenger automobiles in the traffic will be approximately as 1 is to 4, the assumed toll rates for each type of vehicle result in an average rate of 1.5 cents per vehicle-mile for vehicles of all descriptions. It is believed that the usage rates assumed are reasonable for the purpose of testing the feasibility of a direct toll system on these roads. If higher rates were assumed, it would be necessary to reduce the estimated potential toll-paying traffic, probably by an amount that would result in a net reduction of the total yield. If lower rates were assumed, it is doubtful that the increased traffic would be sufficient to produce a greater total yield. In addition to these tolls, based on miles traveled, additional tolls were assumed for certain bridges where no alternate free facilities exist.

On the basis of the assumed rates of toll, the estimated total toll collection from the maximum amount of traffic that can reasonably be expected to use the six superhighways would be $84,037,000 for the year 1960 and for the period 1945–60 would be $1,154,236,000, or an average of $72,140,000 per year for the 16-year period, which is considerably less than the $184,054,000, estimated as the probable average total annual cost of the six superhighways. It is, therefore, concluded that a direct toll system on these six superhighways, in their entirety, would not be feasible as a means of recovering the entire cost of the facilities.

However, there are two sections on which it is estimated that the annual toll collections for the year 1960 will slightly exceed the annual cost. These sections extend from a point near Philadelphia, Pa., to a point near New Haven, Conn., a distance of 172 miles. On these two sections the estimated revenue of the year 1960 represents 109 and 104 percent, respectively, of the estimated cost for that year, or a combined average of 106 percent.

Other sections most nearly approaching these sections in point of feasibility of operation as toll facilities are those from the junction of the most westerly and most southerly routes in California to Whitewater, Calif., a distance of 91 miles; from Washington, D. C., to Baltimore, Md., 39 miles; from a point near Boston, Mass., to Portland, Maine, 134 miles; from Miami to Jacksonville, Fla., 326 miles; and from Baltimore, Md., to a point near Philadelphia, Pa., 76 miles. On these sections the anticipated revenues in 1960 would produce from 91.8 to 83.2 percent of the estimated cost for that year. On no other sections of the six projected toll roads do the estimates made result in a ratio of collections to costs as large as 80 percent. On 19 other sections of the six toll roads as projected the estimates made result in ratios of maximum collections to costs varying from 50 percent to less than 80 percent. These 19 sections, described by their approximate termini and total lengths and the corresponding ratios of maximum collections to costs in 1960, are as follows:

Approximate termini		Approximate length	Ratio of estimated annual toll collection in 1960 to annual cost
From—	To—		
		Miles	*Percent*
Richmond, Va.	Washington, D. C.	108.3	76.1
San Ysidro, Calif.	Los Angeles, Calif.	124.4	76.0
Whitewater, Calif.	Indio, Calif.	32.7	73.3
Chicago, Ill.	Angola, Ind.	156.9	72.9
Brigham, Utah	Salt Lake City, Utah	52.3	69.9
Odessa, Tex.	Dallas, Tex.	337.9	67.1
Los Angeles, Calif.	San Fernando, Calif.	44.8	62.1
Buffalo, N. Y.	Albany, N. Y.	287.6	61.9
Whitewater, Calif.	Ludlow, Calif.	69.1	61.8
San Fernando, Calif.	Tracy, Calif.	[1] 291.7	61.1
Minneapolis, Minn.	Chicago, Ill.	392.6	57.6
Sacramento, Calif.	Redding, Calif.	153.7	57.3
San Antonio, Tex.	Dallas, Tex.	250.7	53.2
Portland, Maine	Bangor, Maine	121.3	52.5
St. Joseph, Mo.	Springfield, Ill.	275.7	51.7
Springfield, Ill.	Indianapolis, Ind.	203.7	51.4
Carlisle, Pa.	Philadelphia, Pa.	94.8	51.0
Angola, Ind.	Detroit, Mich.	102.2	50.9
Tracy, Calif.	Sacramento, Calif.	69.1	50.5

[1] Includes 42.3 miles of free highway.

On all other sections of the six superhighways as projected, the estimates made result in ratios of maximum collections to costs less than 50 percent.

The foregoing statement regarding collections and costs is based upon maximum estimates of traffic for sections of a complete system. If the sections were to be constructed as isolated units, the maximum collections and the ratios given would undoubtedly be materially reduced.

The comparisons made have reference to sections of substantial length extending between major controlling points on the highways. Doubtless, there would be shorter sections of the routes, perhaps some short sections of highway and some of the tunnels, but especially some of the bridges, which, if they were built and operated as local conveniences would accumulate a sufficient toll collection to cover all or a substantial part of their annual costs.

Each one of these indicated possibilities requires a thorough study in much more detail to determine the extent to which it might qualify as a sound, direct toll project.

On the basis of the investigation made and its results as briefly summarized above, a sound Federal policy for the construction of a system of transcontinental superhighways, traversing the entire extent of the United States from east to west and from north to south, cannot rest upon the expectation that the costs of constructing and operating such a system as a whole would be recoverable, in their entirety or in any large part from direct tolls collected from the users.

If, as an actual test of the feasibility of a limited mileage of toll roads, it is the desire of the Congress to make provision for the construction of a section of highway of substantial length upon which there is a reasonable prospect of the recovery of the costs through tolls, it is recommended that such provision be made applicable to a section of highway, properly located, and extending from an appropriate point near Washington, D. C., to an appropriate point near Boston, Mass.

The factual evidence presented in this report clearly indicates that the construction of direct toll highways cannot be relied upon as a sound solution of the problem of providing adequate facilities for the vitally necessary highway transportation of the United States, or to solve any considerable part of this problem.

While these conclusions are reached with reference to the limited question of financial feasibility of transcontinental superhighways and the possibility of toll collections to meet their cost, it is recognized that the report should be constructive rather than negative in character. Further, the Secretary of Agriculture is directed by the basic Federal highway legislation to submit reports or recommendations to the Congress on important highway matters. Conforming with this direction there is included in this report a discussion of the most important problems confronting both the Federal and State Governments and their subdivisions with respect to highway facilities.

From the discussion there emerges the general outline of what is in effect a master highway plan for the entire Nation. The carrying out of the plan in all its parts calls for appropriate action by the Federal and State Governments and all county and municipal subdivisions. As desirable joint contributions of the Federal and State Governments, the report lists several undertakings as follows:

1. The construction of a special, tentatively defined system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense in time of war and the needs of a growing peacetime traffic of longer range.
2. The modernization of the Federal-aid highway system.
3. The elimination of hazards at railroad grade crossings.
4. An improvement of secondary and feeder roads, properly integrated with land-use programs.
5. The creation of a Federal Land Authority empowered to acquire, hold, sell, and lease lands needed for public purposes and to acquire and sell excess lands for the purpose of recoupment.

The report emphasizes the difficulties encountered in the acquisition of adequate rights-of-way; and, in view of the fundamental necessity of such rights-of-way, proposes definite measures by which the United States could aid in the acquisition of suitable rights-of-way and simultaneously contribute helpfully to the solution of other urgent problems, especially certain problems confronting the larger cities.

RELIANCE UPON STATE-WIDE HIGHWAY PLANNING SURVEYS

For the wealth of basic data, available in great detail for the purposes of the required investigation, especially data concerning the volume, character, and range of traffic, the condition of existing

highways, and the need for new facilities, we are indebted to the State-wide highway planning surveys of 46 States. These surveys have been made possible by the availability of joint Federal and State funds under the authority of the provision contained in the Federal highway legislation authorizing expenditure from several Federal highway appropriations and matching State funds for physical and economic investigations required for the planning of future highway projects and programs.

The information furnished by these surveys made it possible within the limited time available to select the six superhighways described in this report with reasonable assurance that the selection made is probably the best that can be made, and to obtain the substantial concurrence, in the particular selection, of the responsible State highway authorities of all States. In fullness and in accuracy the facts supplied for consideration in the investigation are unmatched by the information elsewhere or to any person available. In the absence of these facts this report would necessarily be far less definite in its conclusions, and less dependable in its authority.

CHARACTERISTICS OF HIGHWAY TRAFFIC DISCLOSED BY PLANNING SURVEYS

The facts derived from the highway planning surveys were especially useful in disclosing the general characteristics of highway traffic, which have an important bearing upon the estimation of the amount of traffic that would probably use the proposed superhighways if they were constructed. Certain of these general characteristics that affect important decisions basic to the conclusions of this investigation will be described and illustrated by facts supplied mainly by the highway planning surveys of a number of States.

TRANSCONTINENTAL TRAVEL LIGHT

Some of the proposals for the construction of so-called transcontinental highways appear to be motivated by a belief that there exists an important volume of transcontinental travel; i. e., a through travel in motor vehicles between points in the Atlantic coast or far Eastern States and points in the Pacific coast or far Western States. No other explanation adequately accounts for the usual insistence upon a virtually absolute straightness of line between the continental termini.

Facts developed by the highway planning surveys definitely and conclusively show that there is no fully transcontinental travel, none even of semicontinental range, that could be accumulated in sufficient amount on any one or several highways traversing the breadth of the country, either to justify the construction, or to any considerable extent determine the character or location of such a highway or highways.

This conclusion is borne out by the planning survey facts presented graphically in plate 1. The greatest width of the tentacled central band shown in this graph represents to scale the average daily number of passenger cars traveling between points in the three Pacific-coast States and points in all States east of Idaho, Nevada, and Arizona, as actually counted at stations on all main-traveled east-west roads located approximately where such roads are crossed by the dashed line curving through the States of Idaho, Nevada, and Arizona. The average daily number of all such vehicles is 2,532, all of which are bound to or from the three Pacific-coast States in the proportions

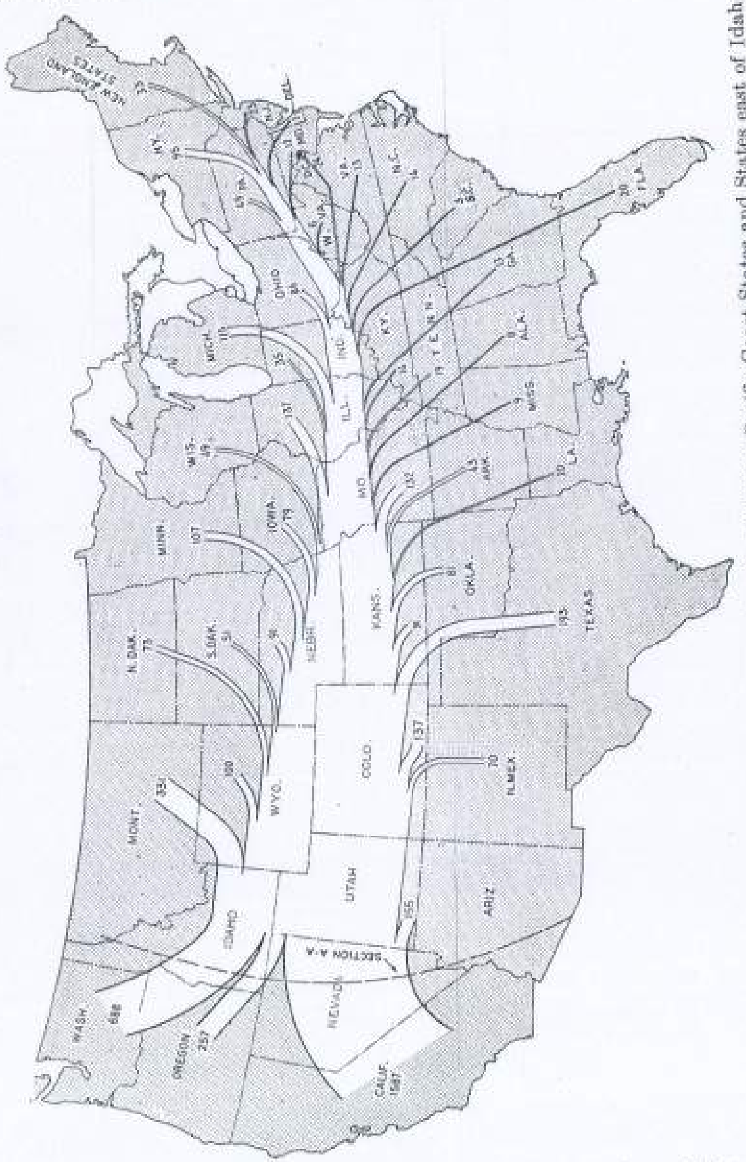

PLATE 1.—Average daily number of passenger cars traveling between Pacific Coast States and States east of Idaho, Nevada, and Arizona. Figures represent total travel in both directions on all main traveled east-west roads. Stations of observation were located along line A–A.

indicated by the numbers appearing at the end of the scaled tentacles running to the three States.

Similarly the numbers of passenger cars bound to or from points in all States eastward of the three in which the counts were made are

shown by the figures appearing at the end of the tentacles running to the respective States. The sum of the numbers of cars bound to or from points in States bordering on or near the Atlantic coast is 300. This figure represents substantially the total volume of average daily passenger-car traffic moving over all main-traveled highways between the east and west coasts. By a similar reckoning the average daily passenger-car traffic between the west-coast States and all points east of the Mississippi River over all main east-west highways will be found to be less than 800 vehicles. These vehicles could not be attracted to a single east-west route under any circumstances.

Plate 2 shows by a similar diagram the origins and destinations of motortrucks and busses observed at the same Idaho, Nevada, and Arizona points and indicates that the range of travel by such vehicles is much shorter than the passenger-car range represented in plate 1.

Similarly plates 3 and 4 show the origins and destinations of all passenger automobiles and motortrucks, respectively (other than vehicles of Florida registration), passing on an average day over the Florida State line. The traffic data represented are the results of counts made throughout the year 1937 on all main highways crossing the State line. Plate 3 shows that there is a well-developed movement between Florida and the Middle Atlantic and New England States that might conceivably be accumulated on one properly located free highway between the Potomac River and the Florida line. It shows also that there is another well-developed movement that might be accumulated on a single properly located free highway between Chicago and Florida.

It may be observed that the number of passenger cars of other than Florida registration shown, in plate 3, as bound to or from the three Pacific Coast States is 23. Cars of Florida registration, not included in the graphed totals, similarly bound to or from the three West Coast States add an average of 3 daily to this number, making a total of 26, as counted at the Florida line. It is interesting to compare this total with the 20 cars shown in plate 1 as having been found in Idaho, Nevada, and Arizona to be bound to or from Florida points. The close agreement of these figures, resulting from counts made independently at points separated by almost the width of the continent, is indicative of the high accuracy of the highway planning surveys.

HIGHWAY TRIPS ARE PREDOMINANTLY SHORT

Plate 5, based upon planning survey data from 11 representative States, shows the range in frequency distribution of the lengths of all one-way trips of passenger cars extending beyond the limits of cities. The States represented are Florida, Kansas, Louisiana, Minnesota, New Hampshire, Pennsylvania, South Dakota, Utah, Vermont, Washington, and Wisconsin. For each range of trip length, represented horizontally in miles, the graph shows by the height of the vertical bar to the bottom of the shaded areas the lowest percentage in which trips of that length are found in any of the 11 States. To the top of the shaded area the height of the bar for each range of trip length represents the highest percentage in which trips of that length were found in any of the 11 States. The vertical length of the shaded bands, represents to the percentage scale at the left the range between the maximum and minimum percentage in which trips of each range of length were found in the 11 States.

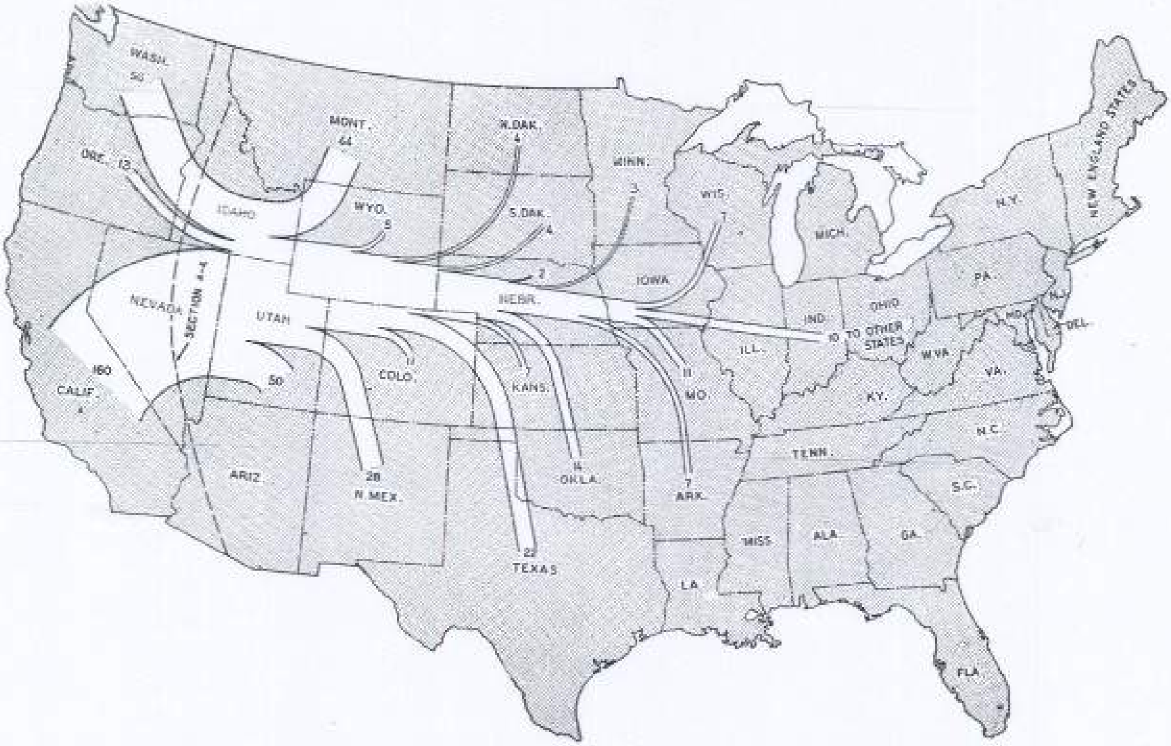

PLATE 2.—Average daily number of trucks and busses traveling between Pacific Coast States and States east of Idaho, Nevada, and Arizona. Figures represent total travel in both directions on all main traveled east-west roads. Stations of observation were located along line A–A.

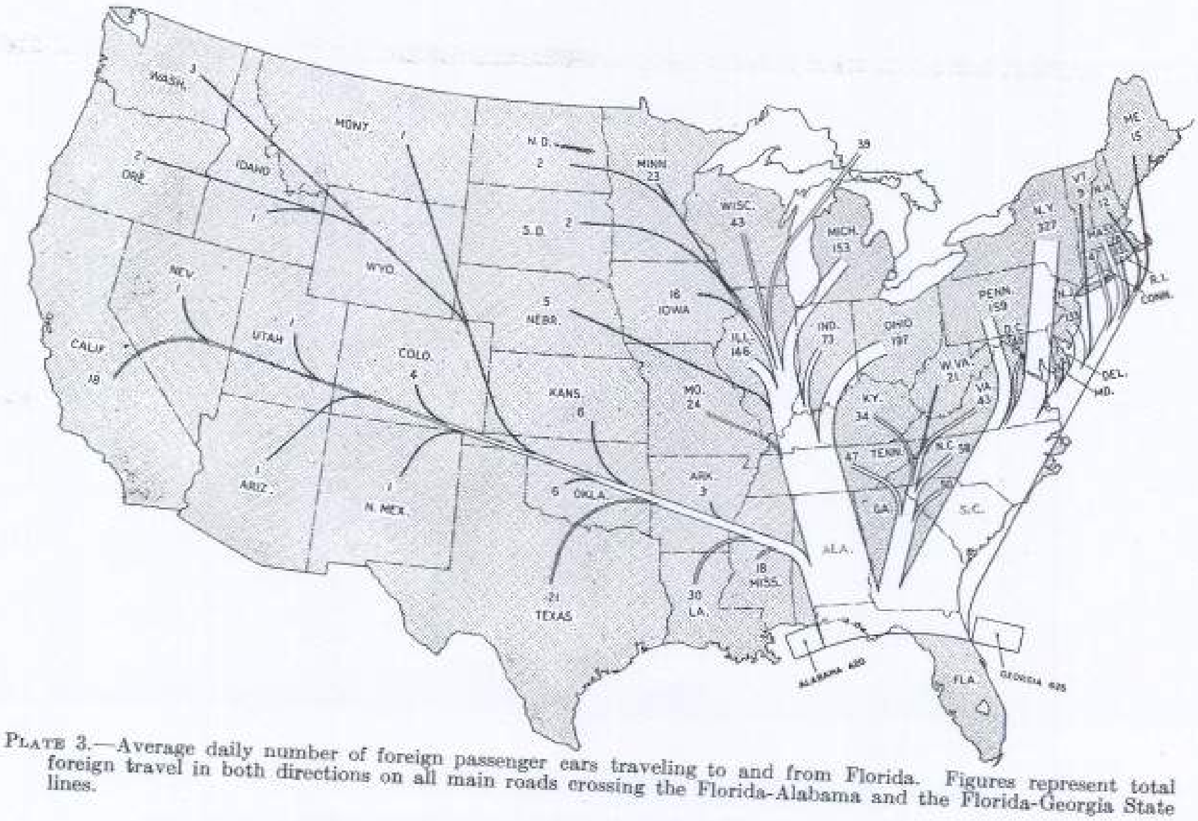

PLATE 3.—Average daily number of foreign passenger cars traveling to and from Florida. Figures represent total foreign travel in both directions on all main roads crossing the Florida-Alabama and the Florida-Georgia State lines.

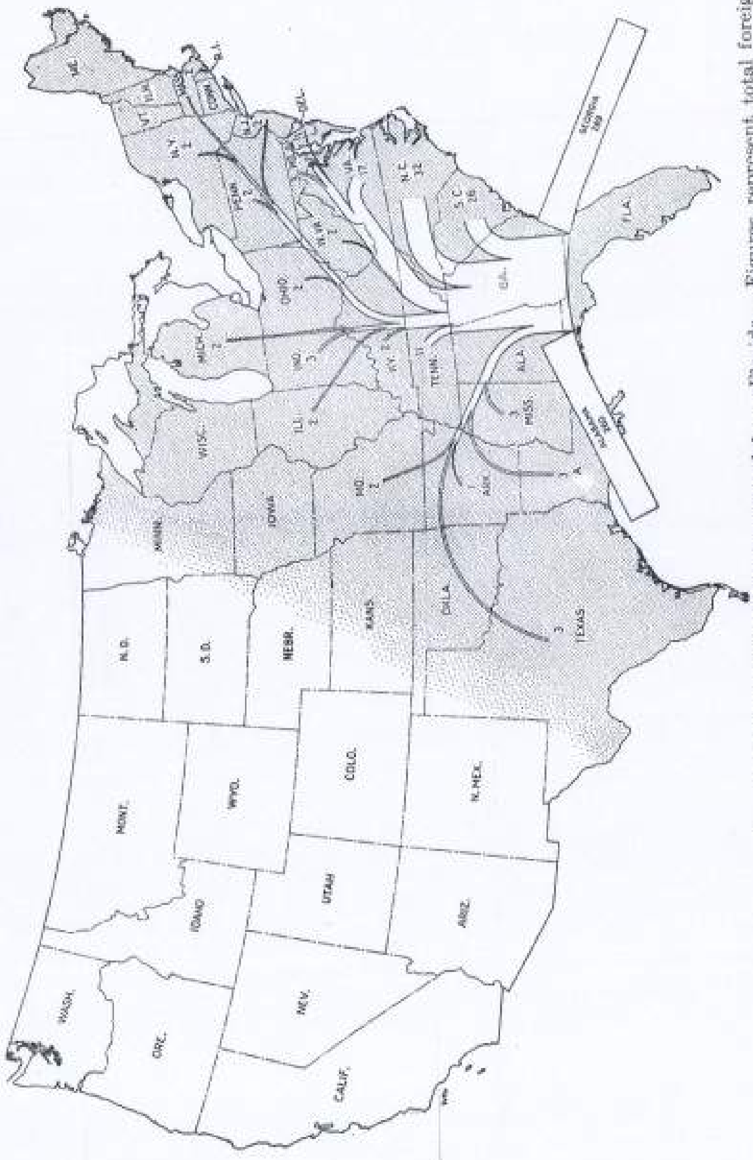

PLATE 4.—Average daily number of foreign trucks traveling to and from Florida. Figures represent total foreign travel in both directions on all main roads crossing the Florida-Alabama and the Florida-Georgia State lines.

It will be observed that trips less than 5 miles in length constitute the largest group in all States, ranging between 25.7 percent of all trips in one State and 43.8 percent in another, the percentages in the other nine States lying between these limits. Trips from 5 to 10 miles in length constitute the next largest group, and those from 10 to 20 miles long the third largest group.

The same data that are represented in plate 5 were used to compute the mean and median lengths of trip shown in table 1 for each of the 11 States. The table shows the mean and median trip lengths in miles, in each of the States, separately for cars owned in rural and urban places, in each of four population classes of urban places, and in the State as a whole. The mean of all trip lengths is shown to range from 11.7 miles to 18.7 miles; the median from 6.3 miles to 8.9 miles. The data contained in the table also indicate that trips of passenger cars owned in rural areas are generally shorter than trips of cars owned in cities; and also that the length of trip by city-owned cars increases generally with the population of the city in which they are owned.

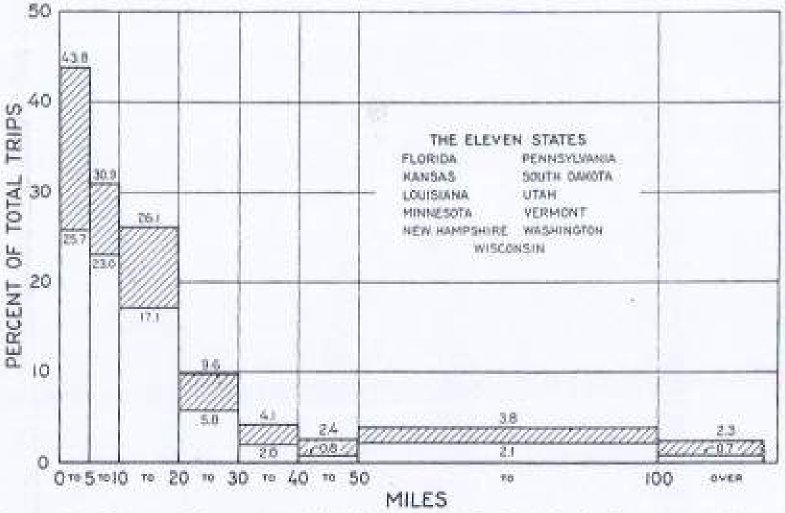

PLATE 5.—Range of frequency distribution of the length of all one-way trips of passenger cars extending outside of cities in 11 States.

TABLE 1.—*Average length of trips*[1] *traveled outside city limits by passenger cars registered in the various population groups of 11 States*[2]

State	Length of trips traveled by passenger cars registered in—													
	Rural areas		Incorporated places having a population of—								Urban areas		All places	
			2,501 to 10,000		10,001 to 25,000		25,001 to 100,000		More than 100,000					
	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
	Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
Florida	11.4	6.3	20.2	9.9	29.7	14.6	30.5	14.9	22.8	10.0	23.5	11.3	16.1	8.1
Kansas	9.6	5.0	23.2	11.6	29.7	15.6	34.6	16.0	41.0	18.5	29.6	14.6	13.3	6.3
Louisiana	9.9	5.5	17.9	7.8	22.1	11.2	26.6	13.5	74.2	57.5	28.3	12.6	14.2	6.5
Minnesota	11.4	6.1	24.9	11.6	27.4	12.3			54.3	19.7	34.7	15.1	16.4	7.3
New Hampshire	13.0	8.3	13.7	8.6	20.1	11.1	27.2	16.7			18.5	9.9	15.5	8.9
Pennsylvania	9.8	5.9	13.3	7.1	15.1	8.4	19.7	9.4	30.8	13.6	17.5	8.5	13.5	7.1
South Dakota	15.9	8.6	25.2	8.3	34.2	10.0	60.9	26.9			30.9	9.9	18.7	8.7
Utah	10.8	4.8	18.0	8.2	38.3	15.4	38.8	18.9	52.9	24.0	34.2	14.3	17.4	6.8
Vermont	9.3	5.7	20.2	9.5	24.5	11.4					21.6	9.8	11.7	6.5
Washington	11.5	5.8	20.0	8.1	30.6	13.8	26.2	14.7	40.8	20.0	30.6	14.1	14.6	6.7
Wisconsin	10.9	6.4	24.5	12.6	27.9	13.9	23.2	8.4	48.2	25.8	31.2	15.9	15.9	7.9

[1] This is the 1-way distance of all trips. A trip from Washington to Baltimore and return would be considered as 2 trips of 40 miles each.

[2] The mean is shown to indicate the arithmetic average of all the trips; the median indicates that length of trip so chosen that the number of shorter trips and the number of longer trips are equal.

The data represented in plate 5 and table 1 have a double significance in relation to the estimation of potential traffic for the proposed highways with limited access.

1. They indicate that a considerable proportion of an existing traffic moving directly along the line of the proposed facility cannot be counted upon to use the facility unless the distances between access points are very short. Any given distance between access points must be considered as excluding from potential use of the facility all or practically all of the traffic found to be desirous of moving directly along the line of the facility for distances shorter than the access spacing.

2. The data also indicate that, as a rule, the amount of traffic that would be attracted by any of the proposed limited-access highways from other generally parallel routes will vary inversely with the distance separating the new highway from the parallel routes. Generally it must be assumed that for most of the traffic moving on a parallel route, diversion to the proposed highway would involve some indirection. The amount of such indirection that would overbalance other attractions of the new highway would vary with the length of the trip possible along the new highway before diverging to destination. As long trips are shown by plate 5 and table 1 to be a small percentage of all trips, and as only a traveler embarked upon a fairly long trip would accept any considerable lateral diversion from his direct course in order to enjoy superior highway facilities, it follows that the amount of traffic that can be counted as transferable to a limited-access highway from a generally parallel normal highway at a considerable distance must be quite small.

As indicated by table 1, residents of large cities, on the average, make longer trips than residents of small cities. Evidence that will be submitted hereafter (see pl. 8) shows that as a city is approached, the volume of traffic begins to increase at a greater distance from large cities than from small ones, which corroborates the stated rule. As New York is our largest city, the traffic diagram presented in plate 6 may be considered to represent the extreme condition in respect to average length of trip and ratio of numbers of long to short trips. Yet, even at New York, as plate 6 shows, an average daily traffic of 82,166 crossing the Hudson River by all facilities between the Battery and Tarrytown dwindles to less than a fifth of that amount within 20 miles. This dwindling occurs despite the existence of a ring of satellite cities which, by their local influence tend to keep the volume up.

It is of particular interest to note in plate 6 that only 3,100 of the 82,166 vehicles crossing the Hudson River are bound from or to points in States west and south more distant than New York, Pennsylvania, and New Jersey.

MAJORITY OF AUTOMOBILE OWNERS HAVE LOW INCOMES

A survey recently made by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, shows that the majority of family passenger cars are owned by families of very moderate income. As indicated in the table below more than half of all family cars are owned by families that have an annual income of $1,500 or less. Less than 5 percent of all family cars are owned by families that have an annual income of more than $5,000. Less than a third are owned by families that have annual incomes in excess of $2,000.

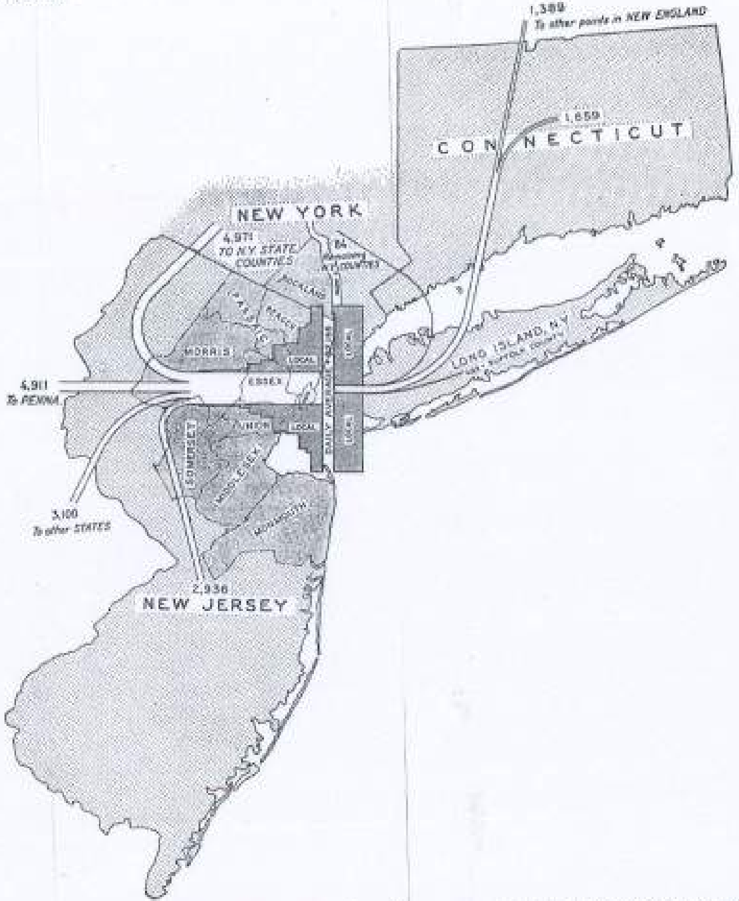

PLATE 6.—Traffic dispersion chart showing average daily trans-Hudson River traffic in vicinity of New York City. Figures represent crossings at the Holland Tunnel, George Washington Bridge, and the ferries from the Battery to Tarrytown, N. Y., for the year 1935. Traffic is distributed according to origins and destinations in States and nearby counties. Chart is based on information obtained from Port of New York Authority.

Ownership of family passenger cars by annual income groups

Annual income bracket	Percentage of family passenger cars owned by families in each income bracket	Percentage of family passenger cars owned by families with income less than the maximum of each income bracket
	Percent	*Percent*
Under $500	6.54	6.54
$500 to $1,000	20.55	27.09
$1,000 to $1,500	24.77	51.86
$1,500 to $2,000	18.07	69.93
$2,000 to $3,000	17.73	87.66
$3,000 to $5,000	8.02	95.68
Over $5,000	4.32	100.00

In estimating the probable volume of toll-paying traffic on the selected superhighways, it is necessary to give due consideration to these facts. Persons of low income who own and operate passenger automobiles are influenced in the uses they make of their cars to a greater extent by the immediate operating expense, such as gasoline and oil, than by the actual total costs, including tires, depreciation, and so forth. The cost of the gasoline consumed on a trip may amount to little more than a cent a mile. To the motorcar owner with an income of less than $1,500 a year, a toll of 1 cent per mile is likely to appear as a 100-percent increase in his cost of operation; and so viewed it is an additional cost that he is not likely to pay.

CONSIDERATIONS AFFECTING THE SELECTION OF ROUTES FOR INVESTIGATION

CONFORMITY TO THE CONGRESSIONAL DESCRIPTION

Several considerations influenced the location of the routes chosen for the superhighways to be investigated. The first requirement was that the routes selected should conform substantially to the description specified in the act, i. e., that there should be not more than three running in a general direction from the eastern to the western portion of the United States, and not more than three running in a general direction from the northern to the southern portion of the United States.

The major routes selected conform exactly to this description. Two of the north-south roads run from the Canadian line to the Mexican border, the third runs from Maine to Florida; and all three of the east-west routes run substantially from the Atlantic to the Pacific coasts.

In addition to the three major routes in each general direction, the investigation has also covered three diagonal branches from the central east-west route. One of these was included to give direct connection with the National Capital at Washington; the other two, branching northwest and southwest from points near Salt Lake City, were included because they permit the central route to give reasonably direct connection to the northern and southern Pacific coast sections during seasons when, for climatic reasons, the central route may be preferred by travelers to the northern or southern route.

DISTRIBUTION IN RELATION TO GEOGRAPHY AND POPULATION

The second consideration was that the routes chosen should be reasonably distributed geographically and in relation to the distribution of the population of the country; that, consistent with other requirements, they should pass through as many States as possible. Accordingly the northern east-west route clings to the northern tier of States from New England to Washington. The southern east-west route traverses the southern tier. The central east-west route passes almost exactly through the center of the country. The eastern and western north-south routes approximately parallel the coasts, and the central north-south route, though for valid reasons it departs somewhat from a central position geographically, intersects the central east-west route close to the center of population. The 6 major routes and 3 diagonal branches traverse for some distance 41 of the 48 States.

ACCORD WITH POPULAR TRAVEL ROUTES

A third consideration in the selection of the routes was that they should accord reasonably with recognized popular routes of travel. For their movements across the country, whether the distances were long or short, motorists have previously had a considerable choice of routes, between which, in the beginning at least, there was little advantage of improvement. By their choice, as reflected in the relative density of present traffic on various highways, they have established certain preferred routes, which stand out quite clearly as the widest bands on a traffic map of the country. (See pl. 8.) In the selection of routes for the superhighways close conformity to these preferred lines of travel was an important objective.

This consideration weighed heavily in the decision to include the two western branches of the central route among those to be investigated. These branches, one coinciding closely with the historic Oregon Trail and the other with the pioneer movement of the Mormons into southern Utah, both bear the stamp of approval of the early pathfinders and a long succession of their followers.

This consideration also strongly influenced the southwestward slant of the central north-south route, which follows closely a line selected by many travelers for winter use in driving from the populous Northeast to the Pacific coast.

IMPORTANT TERMINI AND REASONABLY DIRECT COURSE

A further consideration was that the several routes should have important continental termini and should run as directly between these ultimate objectives as might prove to be consistent with the connection of important intermediate points and the development of traffic. It is believed that the routes selected fulfill these requirements.

The eastern north-south route joins the New England and Florida playgrounds, and passes within a reasonable distance of all the coastal cities. The central north-south route has its termini at the international bridges at Port Huron, Mich., and Laredo, Tex. At the south it is the logical connection with the Inter-American Highway. For 157 miles in the north it joins with the northern east-west route, and so doing saves $42,000,000 in the construction cost at the expense of 4 or 5 miles of extra distance for traffic moving between Chicago and Detroit. The western north-south route takes a protected valley course for the most part from border to border, within easy reach of all the coastal cities.

The northern east-west route joins the hub of New England with Seattle, northernmost of west coast cities, and in its intermediate course first serves Cleveland, Chicago, and the other Great Lakes cities and the Twin Cities of Minnesota and then follows almost an air line through North Dakota and Montana.

The central east-west route begins at a junction with the Atlantic coast route, which can be reached conveniently from New York and Philadelphia, and thence follows a very direct line to San Francisco. The line first chosen for this route diverged from the final line southwestward at a point near Indianapolis, to pass close to St. Louis and Kansas City, and then followed the Missouri River northward to a point between Lincoln and Omaha, Nebr., where it entered the valley of the Platte River and thence followed the line of the historic Oregon Trail and Overland Route into Wyoming. The change to the present direct route between points near Indianapolis and Denver follows the consensus of advice received from the responsible State highway officials of all the States affected.

The southern east-west route begins near Charleston, S. C., and runs very directly through the southern tier of States to Los Angeles. It crosses the eastern north-south route at a point that nicely compromises the claims of the southern coastal cities, which there have convenient access to it. It passes near Atlanta, Birmingham, Montgomery, and Jackson, and heads directly toward Dallas and Fort Worth in Texas, whence, avoiding the Big Bend of the Rio Grande River, it passes just north of El Paso and on to its western terminus.

OPTIMUM LOCATION FOR COLLECTION OF TOLLS

Finally, and subject to a proper balance of all previous considerations, it was the intention so to locate the several routes, as to achieve an optimum condition in respect to toll collections. The results in this respect are set forth in great detail in subsequent pages. It is sufficient at this point to state that it is believed that no substantial change in the chosen lines, reasonably consistent with the several considerations previously discussed, would improve upon the potential earning power of the lines selected.

METHOD FOLLOWED IN SELECTION OF THE PROPOSED ROUTES

In January 1938 the first traffic map of the United States was compiled by the Bureau of Public Roads from the latest data then obtainable from State traffic flow charts and available tabulations, most of which had been prepared in connection with the highway planning surveys. In January 1939 this map was revised to conform with more complete and detailed information, and the revised map is reproduced in plate 7.

The traffic flow represented is that of the year 1937 on routes of the United States highway system and other main-traveled highways. Bands of varying width, centered upon the approximate lines of the various highways, indicate by their scaled width at all points the volume of passenger-car traffic using the highways at such points. The over-all width of the open bands represents the total passenger-car traffic, and the width of the narrower black bands the volume of that part of the traffic, described as "foreign," consisting of passenger cars registered in all States other than the State in which they were observed.

As it was the purpose of the map to show only the passenger-car movements of longer range, local increases of total traffic caused by short trips in and out of cities and local increases of "foreign" traffic caused by short trips over State lines are not shown. Shorn of these increases, the band widths, as shown, represent approximately the volume of all passenger-car traffic flowing, exclusive of the numerous extremely local movements mentioned. Thus, even the open bands represent traffic of relatively long range, and the black bands represent generally movements that are still longer and at least of interstate extent.

Examining the map, some of these existing routes are seen to stand out above others as relatively important in respect to both their total traffic and the volume of "foreign" traffic they serve; and it was by such a visual comparison, qualified by the various general considerations previously described, that certain routes were tentatively chosen as representing the approximate lines of the six superhighways to be investigated.

The routes thus chosen are indicated by the darker traffic bands on plate 8. On this map the width of the shaded bands represents the same total traffic that is indicated on plate 7 by the width of the open bands; and the generally superior importance of the selected routes is borne out by the generally greater width of the darker bands.

Tentative locations for three east-west and three north-south superhighways approximately paralleling the existing routes indicated in plate 8 were defined by the Bureau and submitted for consideration and criticism to the highway departments of each of the 48 States. In accordance with the comments received, several adjustments were made, and a final decision was reached, with the concurrence of all States except South Dakota, upon the routes as shown and numbered on plate 9.[1]

For purposes of designation, the three north-south routes were numbered from the easternmost to the westernmost 1, 3, and 5; and the three east-west routes were numbered from the northernmost to the southernmost 2, 4, and 6. The diagonal route running northwestward from Salt Lake City was designated 4N (north) and the diagonal running southwestward from the same city, 4S (south). The branch of route 4 added to connect with Washington, D. C., was designated 4A; and because route 3 is broken where its location coincides with that of route 2, east of Chicago, the section extending northeastward from route 2 was designated as route 3 Mich.

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[1] It was the opinion of the South Dakota State Highway Commission that route 2 should pass through the northern half or central portion of South Dakota, connecting westward with U S 10 at Billings, Mont., and eastward with Minneapolis and St. Paul. The South Dakota department contended that such a location would shorten the length of route 2 by 100 miles, that the construction would be more economical, and that the route would be accessible to a greater number of users. However, the location of the route through Montana, as finally chosen, runs considerably north of Billings, and this more direct final alinement eliminated the possibility of locating a shorter line through South Dakota. As the topography of the section traversed by U S 10 is not less favorable from the standpoint of construction than that of the section traversed by more southerly locations in South Dakota, the reference to more economical construction undoubtedly was based upon an assumed shorter line. Since such shortening of the line would not result, the basis of the second claim no longer exists. With respect to the relative service to be expected, the preferred line of travel now follows U S 10, as evidenced by the width of the foreign traffic bands on plate 7. Furthermore, with the exception of the Black Hills area, the largest increases in population are occurring in centers located along U S 10.

ESTIMATES OF PROBABLE TRAFFIC ON SELECTED ROUTES

In estimating the traffic that would probably use the selected routes all available information was carefully considered. The 1937 volumes of total and "foreign" passenger-car traffic on existing highways approximately parallel to the routes chosen, were known, as indicated by plate 7. General information concerning the relative

PLATE 9.—Location of routes selected for study.

percentages of passenger-car trips of various lengths in a normal highway movement, and concerning the percentages of all car owners having annual incomes of various orders, was also available as previously set forth in this report. And finally, the Bureau was also in possession of information concerning the volume of motortruck and bus traffic on various main highways and in various sections, which, though not so complete as the available passenger-car traffic data, was still sufficient for the purpose.

As a first step in estimating their probable traffic, the selected highways were assumed to be free highways of limited access, but with access points located as they probably would be in a toll system. Guided by this assumption, an estimate was made, for each section of the proposed routes, of the amount of traffic the new facility would probably attract from existing free highways located at various distances from it and approximately parallel to it.

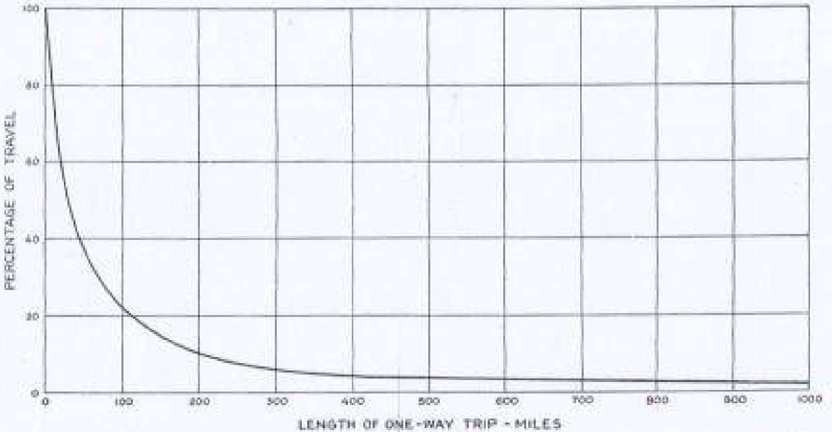

PLATE 10.—Percentage of vehicle-miles of travel composed of trips exceeding any given length, up to 1,000 miles based on data from which intracity trips have been excluded.

The first consequence of the assumed condition was to exclude as potential traffic for the limited-access route that part of the movement on any parallel free highway composed of trips shorter than the assumed distance between access points. Since vehicles making such shorter trips would be forced by the limitation of access to travel further than necessary between their origins and destinations they would not use the new facility even if it were immediately adjacent to the existing free route.

In estimating the percentage of the known volumes of traffic on parallel free routes that, for this reason, would be excluded from the limited access routes, the facts concerning the distribution of trip lengths developed by the highway planning surveys of 11 States, provided helpful guidance. These facts are presented in plate 5 and corresponding vehicle-mile data are generalized in the single curve on plate 10. Referring to this curve it will be seen that if the interval between any two access points were 10 miles, at least 20 percent of the vehicle-mileage of traffic moving on an immediately adjacent free highway would have to be counted as unavailable for the limited-access route. If the distance between access points were 20 miles the excluded portion of the free highway vehicle-mileage would be increased to 40 percent.

That part of the traffic on parallel free highways not excluded from the limited-access route by the distance between accesses, might be attracted by the superior facility of the new route. Whether it would be or not would depend upon the distance it would be necessary to travel and the character of service available over existing roads from the point of origin to the new route and from the route to the point of destination, and also upon the whole extra distance entailed by use of the new facility. While the superior design of the new route, if operated as a free facility, would doubtless be considered by potential users as outweighing some extra distance, there would obviously be no advantage in its use if to reach it at one end of a trip and continue from it at the other it were necessary to travel as far over existing cross roads as the distance via a comparable parallel road directly from origin to destination. This consideration would impose a definite limit upon the lateral distance over which the superior facility of the new route would attract traffic from existing parallel roads. Of the traffic moving over a closely parallel existing road it would definitely exclude only the traffic of comparatively short trip length; of the traffic moving over more distant parallel roads it would definitely exclude larger parts as the separating distance increased.

Beyond these definite limits use of the new facility would involve greater travel over existing roads than would be necessary for direct travel by a comparable existing road from origin to destination. Under this condition use of the new facility would be inspired only by a quickly satisfied curiosity. Within the limits mentioned, use of the new facility would not require greater travel over existing roads than would be necessary to travel entirely over such roads from origin to destination but would increase the total travel distance. Under this condition, the decision whether or not to use the new road would depend upon an individual appraisal, by potential users, of the competing attractions of short distance on the one hand and a better facility for part of a longer distance on the other. The number of potential users who, under this condition, would actually choose to use the new facility would increase with reduction in the amount of extra distance involved in such use in relation to the total length of the possible trip over the new facility. Traffic of long range moving in the general direction of the new facility would obviously be attracted to it from a greater lateral distance than any short-ranging traffic. For this reason, the greatest potential usage of the new facilities would naturally be expected to be generated by the existing-road traffic indicated on plate 7 as "foreign."

In estimating the traffic that would probably use the proposed new facilities if they were operated as free limited-access roads, these several considerations were kept in mind in a section-by-section appraisal of the probabilities with respect to the entire mileage involved. The relation of each section of the routes with respect to all possibly competing highways was carefully studied and a judgment was formed as to the part of the known traffic using such competing roads that could be attracted to the new facility. Mathematical exactness in such judgments was an impossibility; and to avoid underestimation there was studied effort to maintain a liberal bias. The resulting estimates, therefore, are believed to represent the maximum traffic that could reasonably be expected to make use of the proposed facilities if operated as free limited-access routes.

Having considered every section of the proposed routes from this point of view, the next step was to convert the estimates made upon the assumption of free use into estimates of the probable toll-paying traffic.

A consideration of the ability of people to pay tolls, as indicated by the distribution of automobile owners by income groups, and further consideration of actual fees which would be charged for specific trips over various sections of the routes, led to the conclusion that not more than about one-third of the vehicles that might use a typical free road of limited access could be regarded as potential traffic for the same road operated as a toll facility.[2]

The general estimate of one-third as the proportion of users of a free limited-access facility who would use a similar toll facility and estimates of toll-road traffic based thereon were submitted to responsible highway authorities of all the States with a request that they comment upon the reasonableness of the assumptions and the resultant traffic estimates. In arriving at the final estimates of traffic likely to use the proposed routes, if operated as toll facilities, comments received from the State officials were considered together with a first-hand review of the particular attractiveness of each section of the routes and of the ability of the potential users in each section of the country to pay a toll of 1 cent per mile for passenger cars.

On the basis of this further study various factors, ranging from 0.167 to 0.40, were decided upon for application to the estimated free-facility traffic to convert it to an estimate of traffic on the toll facility. In densely populated areas, where highway congestion in considerable degree has already been experienced and where there are relatively large numbers of potential users who are able to pay tolls, factors as high as 0.40 were used. This value was used, for example, on the section of route 1 between New York City and central Connecticut. In sparsely populated areas, where thus far little or no congestion has been experienced and existing modern highways afford excellent service, factors in the lower range were used. For example, a factor of 0.20 was used for the section of route 4 between Evanston, Wyo., and Rock Springs, Wyo.

The estimates thus made of the traffic that would have used the various sections of the selected routes, if operated as toll facilities in 1937, total, for the entire system, 5,823,745 vehicle-miles per day. In table 2, this figure is shown as the sum of the average daily vehicle-mileage on each of 75 sections into which the entire system is divided. The table shows the length of each section and the estimated average number of vehicles that would have used it, in addition to the utilization expressed in vehicle-miles. The sections are arranged in the descending order of estimated average daily traffic and the sectional lengths and estimated vehicle-mileages are progressively accumulated in that order. For each accumulation of length and vehicle-mileage a corresponding average daily volume of traffic is shown in the last column of the table.

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[2] In this connection it is interesting to note the results of a study of a selected cross section of car owners throughout the country, conducted by Dr. George Gallup, Director, American Institute of Public Opinion in March 1938. The Gallup poll indicated that 27 percent of car owners, when making a long trip, would be willing to pay 1 cent per mile, and that 39 percent would be willing to pay from one-half to 1 cent. In commenting upon the results of the poll, Dr. Gallup said: "Many motorists who would be willing to pay tolls happen to live far off the probable lanes. All that can be safely estimated about the public attitude today is that about a third of all motorists in reach of the toll roads think they would use them on occasion."

TABLE 2.—*Length of selected routes and estimated average daily traffic that would have used them if operated as toll facilities in 1937, by sections, arranged in descending order of traffic volume*

Section				Length	Accumulated length	Average daily number of of vehicles	Average daily number of vehicle-miles	Accumulated vehicle-miles	Average daily number of vehicles for accumulated length
Number	Route	From—	To—						
				Miles	*Miles*				
1	1	Jersey City, N. J	New Haven, Conn	65.6	65.6	3,508	230,125	230,125	3,508
2	1	Junction Route 4, Pa	Jersey City, N. J	106.8	172.4	2,651	283,127	513,252	2,977
3	5	Junction Route 6, Calif	San Fernando, Calif	44.8	217.2	1,734	77,683	590,935	2,721
4	1	Washington, D. C	Baltimore, Md	39.3	256.5	1,602	62,959	653,894	2,549
5	1	Junction Route 2, Mass	Portland, Maine	133.9	390.4	1,348	180,497	834,391	2,137
6	6	Junction Route 5, Calif	Whitewater, Calif	91.0	481.4	1,310	119,210	953,601	1,981
7	1	Baltimore, Md	Junction Route 4, Pa	76.2	557.6	1,272	96,926	1,050,527	1,884
8	5	San Ysidro, Calif	Junction Route 6, Calif	124.4	682.0	1,140	141,816	1,192,343	1,748
9	2	Junction Route 3, Ill	Junction Route 3, Mich., Ind	156.9	838.9	1,119	175,571	1,367,914	1,631
10	1	New Haven, Conn	Junction Route 2, Mass	99.8	938.7	1,048	104,590	1,472,504	1,569
11	2	Buffalo, N. Y	Albany, N. Y	287.6	1,226.3	1,020	293,352	1,765,856	1,440
12	1	Richmond, Va	Washington, D. C	108.3	1,334.6	946	102,452	1,868,308	1,400
13	4	Carlisle, Pa	Junction Route 1, Pa	94.8	1,429.4	852	80,770	1,949,078	1,364
14	5	Salem, Oreg	Portland, Oreg	56.9	1,486.3	822	46,772	1,995,850	1,343
15	3 Michigan	Junction Route 2, Ind	Detroit, Mich	102.2	1,588.5	805	82,271	2,078,121	1,308
16	4	Oakland, Calif	Auburn, Calif	110.0	1,698.5	750	82,500	2,160,621	1,272
17	2	Albany, N. Y	Junction Route 1, Mass	147.2	1,845.7	748	110,106	2,270,727	1,230
18	2	Cleveland, Ohio	Buffalo, N. Y	220.7	2,066.4	744	164,201	2,434,928	1,178
19	4	Pittsburgh, Pa	Carlisle, Pa	166.6	2,233.0	715	119,119	2,554,047	1,144
20	2	Perrysburg, Ohio	Cleveland, Ohio	79.3	2,312.3	676	53,607	2,607,654	1,128
21	5	San Fernando, Calif	Tracy, Calif	[1]291.7	2,604.0	658	164,105	2,771,759	1,082
22	5	Portland, Oreg	Junction Route 2, Wash	146.7	2,750.7	654	95,942	2,867,701	1,059
23	5	Tracy, Calif	Junction Route 4, Calif	69.1	2,819.8	625	43,188	2,910,889	1,048
24	6	Whitewater, Calif	Indio, Calif	32.7	2,852.5	600	19,620	2,930,509	1,043
25	5	Junction Route 2, Wash	Canadian Boundary	124.7	2,977.2	567	70,705	3,001,214	1,022
26	2	Minneapolis, Minn	Junction Route 3, Ill	392.6	3,369.8	550	215,930	3,217,144	967
27	6	Junction Route 3, Tex	Shreveport, La	190.4	3,560.2	548	104,339	3,321,483	944
28	4	Indianapolis, Ind	Columbus, Ohio	156.6	3,716.8	511	80,023	3,401,506	926
29	3 Michigan	Detroit, Mich	Port Huron, Mich	72.5	3,789.3	510	36,975	3,438,481	918
30	1	Portland, Maine	Bangor, Maine	121.3	3,910.6	491	59,558	3,498,039	904
31	6	Odessa, Tex	Junction Route 3, Tex	337.9	4,248.5	484	163,544	3,661,583	870
32	4	Columbus, Ohio	Pittsburgh, Pa	195.0	4,443.5	475	92,625	3,754,208	853
33	3	Junction Route 4, Ill	Junction Route 2, Ill	155.5	4,599.0	468	72,774	3,826,982	840
34	1	Miami, Fla	Jacksonville, Fla	326.5	4,925.5	446	145,619	3,972,601	814
35	4 North	Brigham, Utah	Salt Lake City, Utah	52.3	4,977.8	412	21,548	3,994,149	809
36	3	San Antonio, Tex	Junction Route 6, Tex	250.7	5,228.5	398	99,779	4,093,928	789
37	4	Junction Route 3, Ill	Indianapolis, Ind	203.7	5,432.2	396	80,665	4,174,593	774
38	3	St. Louis, Mo	Junction Route 4, Ill	88.8	5,521.0	360	31,968	4,206,561	768
39	5	Roseburg, Oreg	Salem, Oreg	133.3	5,654.3	354	47,188	4,253,749	758
40	2	Junction Route 3—Mich, Ind	Perrysburg, Ohio	69.9	5,724.2	352	24,605	4,278,354	753
41	4	St. Joseph, Mo	Junction Route 3, Ill	275.7	5,999.9	331	91,257	4,369,611	733
42	4 South	Junction Route 6, Calif	Ludlow, Calif	69.1	6,069.0	320	22,112	4,391,723	729
43	3	Springfield, Mo	St. Louis, Mo	165.2	6,234.2	316	52,203	4,443,926	718
44	5	Junction Route 4, Calif	Redding, Calif	153.7	6,387.9	313	48,108	4,492,034	708
45	2	Fargo, N. Dak	Minneapolis, Minn	219.1	6,607.0	301	65,949	4,557,983	694
46	4	Auburn, Calif	Reno, Nev	106.5	6,713.5	300	31,950	4,589,933	688
47	5	Ashland, Oreg	Roseburg, Oreg	122.9	6,836.4	298	36,624	4,626,557	681
48	3	Tulsa, Okla	Springfield, Mo	171.3	7,007.7	296	50,705	4,677,262	671
49	1	Jacksonville, Fla	Junction Route 6, S. C	219.3	7,227.0	288	63,158	4,740,420	660
50	1	Junction Route 6, S. C	Richmond, Va	362.6	7,589.6	279	101,165	4,841,585	641
51	4-A	Junction Route 4, Pa	Junction Route 1, Md	88.5	7,678.1	274	24,249	4,865,834	637
52	4 North	Portland, Oreg	Boardman, Oreg	[2]163.4	7,841.5	272	30,328	4,896,162	632
53	2	Seattle, Wash	Ellensburg, Wash	90.0	7,931.5	270	24,300	4,920,462	628
54	4	Greeley, Colo	St. Joseph, Mo	529.7	8,461.2	258	136,663	5,057,125	604
55	3	Junction Route 6, Tex	Tulsa, Okla	270.5	8,731.7	252	68,166	5,125,291	593
56	6	El Paso, Tex	Odessa, Tex	245.2	8,976.9	248	60,810	5,186,101	584
57	4 North	Boise, Idaho	Rupert, Idaho	182.2	9,159.1	235	42,817	5,228,918	577
58	4 South	Ludlow, Calif	Las Vegas, Nev	117.0	9,276.1	210	24,570	5,253,488	572
59	5	Redding, Calif	Ashland, Oreg	138.2	9,414.3	204	28,193	5,281,681	567
60	6	Shreveport, La	Vicksburg, Miss	168.8	9,583.1	195	32,916	5,314,597	560
61	6	Phoenix, Ariz	El Paso, Tex	391.1	9,974.2	192	75,091	5,389,688	546
62	6	Indio, Calif	Phoenix, Ariz	254.0	10,228.2	165	41,910	5,431,598	536
63	4 North	Boardman, Oreg	Boise, Idaho	253.1	10,481.3	158	39,990	5,471,588	527
64	6	Birmingham, Ala	Atlanta, Ga	141.2	10,622.5	155	21,886	5,493,474	522
65	4 South	Las Vegas, Nev	Salt Lake City, Utah	407.5	11,030.0	140	57,050	5,550,524	508
66	4	Salt Lake City, Utah	Greeley, Colo	463.3	11,493.3	136	63,009	5,613,533	492
67	6	Vicksburg, Miss	Birmingham, Ala	270.5	11,763.8	121	32,730	5,646,263	484
68	1	Bangor, Maine	Canadian Boundary	196.6	11,960.4	119	23,395	5,669,658	478
69	3	Mexican Boundary	San Antonio, Tex	156.2	12,116.6	96	14,995	5,684,653	473
70	6	Augusta, Ga	Charleston, S. C	116.3	12,232.9	91	10,583	5,695,236	469
71	4 North	Rupert, Idaho	Brigham, Utah	119.7	12,352.6	80	9,576	5,704,812	465
72	6	Atlanta, Ga	Augusta, Ga	153.2	12,505.8	78	11,950	5,716,762	460
73	4	Reno, Nev	Salt Lake City, Utah	514.9	13,020.7	63	32,439	5,749,201	445
74	2	Ellensburg, Wash	Spokane, Wash	145.9	13,166.6	62	9,046	5,758,247	440
75	2	Spokane, Wash	Fargo, N. Dak	1,169.6	14,336.2	56	65,498	5,823,745	409
		Total		[3]14,336.2			5,823,745		

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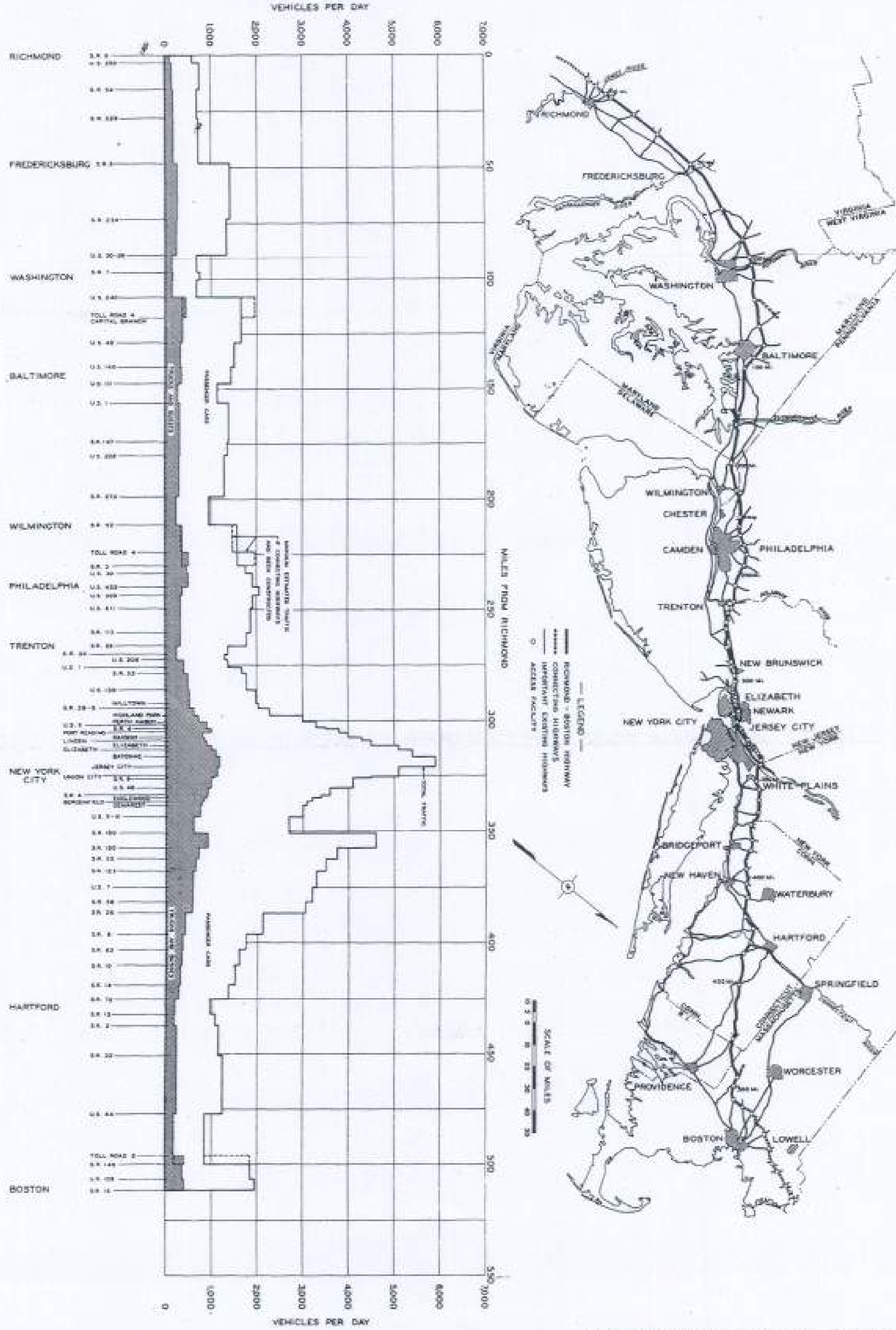
[1] Includes 42.3 miles of free highway.

[2] Includes 51.9 miles of free highway.

[3] The total mileage of revenue-producing sections is 14,242.0. Accumulated lengths of revenue-producing sections were used in computing values for the last three columns of this table.

Plate 11.—Estimated average daily traffic on routes selected for study if operated as toll roads.

PLATE 12.—Location and estimate of traffic on Richmond-Boston section of proposed system of toll roads. Estimate of traffic based on traffic counts for 1937 and an average toll rate of 1¼ cents per vehicle-mile



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The section of the routes selected on which it is estimated there would have been the largest volume of toll-paying traffic in 1937 is the 65.6 miles from Jersey City, N. J., to New Haven, Conn. It is estimated that 3,508 vehicles would have used that section daily, resulting in a total utilization of 230,125 vehicle-miles.

The lightest 1937 traffic estimated for any section is the 56 daily vehicles corresponding to the 1,169.6-mile section from Spokane, Wash., to Fargo, N. Dak. Although 18 times as long as the Jersey City-New Haven section the vehicle-mileage generated is barely more than one-fourth of the utilization of the most heavily traveled section.

The estimated 1937 traffic on all sections of the selected routes, operated as a toll system, is shown on the flow chart, plate 11. Estimates for the section between Richmond, Va. and Boston, Mass. are shown in greater detail in plate 12.

PLATE 13.—Map showing location of most important 939 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

The 10 most heavily traveled sections of the selected routes, as listed in table 2, have an aggregate length of 938.7 miles. The location of these sections is shown in the map, plate 13. It will be noted that these most heavily traveled sections form a continuous route from Washington, D. C., to Portland, Maine, and shorter stretches east of Chicago, Ill., and in the vicinity of Los Angeles, Calif.

Adding eight more sections, as listed in table 2, raises the aggregate mileage to 2,066.4 miles; and, with the exception of a section between Cleveland, Ohio, and the Ohio-Indiana line, completes a route from Boston, Mass., to Chicago, Ill., with a spur to Detroit, Mich. In the West, sections are added near Oakland, Calif., and between Portland and Salem, Oreg., as shown in plate 14.

If, in a similar manner, sections are added successively in groups, in the order of their estimated traffic volume, the locations of the accumulating sections are shown on plates 15 to 21, inclusive. Comparison of this entire series of plates gives a good idea of the relative traffic importance of the selected routes in various sections of the country. If the roads were built in the order of their traffic importance as toll facilities they would be built in the order of progression indicated by this series of maps.

PLATE 14.—Map showing location of most important 2,066 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

PLATE 15.—Map showing location of most important 2,977 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

In table 3 the traffic that would probably have used the selected routes in 1937, operated both as free and toll facilities of limited access, is compared with the actual traffic moving in that year over existing highways closely paralleling the selected routes, and with the traffic on these highways with and without their urban connections. In one-half of the table the comparison is made in terms of

PLATE 16.—Map showing location of most important 4,042 miles of selected system as indicatep by estimates of traffic based on operation as a toll facility.

PLATE 17.—Map showing location of most important 4,978 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

average daily vehicle-mileage, in the other half it is made in terms of average daily traffic volume.

PLATE 18.—Map showing location of most important 6,069 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

PLATE 19.—Map showing location of most important 7,931 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

It will be noted that the total vehicle-mileage estimated for the toll facility on all routes is about one-seventh of the vehicle-mileage

served by all sections of the parallel existing highways, about a fifth of the vehicle-mileage on rural sections of the existing highways, and

PLATE 20.—Map showing location of most important 10,228 miles of selected system as indicated by estimates of traffic based on operation as a toll facility.

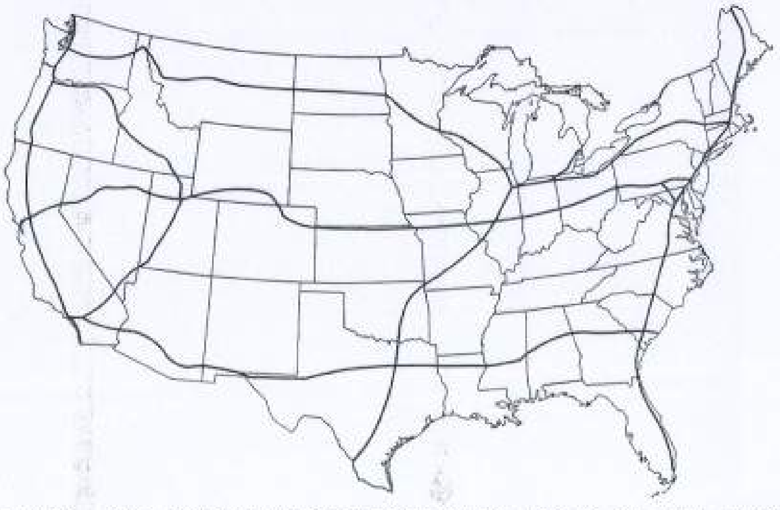

PLATE 21.—Map showing location of entire system selected for study, 14,336 miles in length.

one-fourth or a little more of the vehicle-mileage estimated for a limited access route operated as a free facility.

TABLE 3.—*Comparison of estimated 1937 traffic on the selected routes operated as limited-access facilities with and without tolls with actual 1937 traffic on closely paralleling existing highways*

Route	Length of sections of—			Average daily vehicle-miles in 1937				Average daily traffic density in 1937			
				On parallel existing highway		On selected limited-access route		On parallel existing highway		On selected limited-access route	
	Existing highways, urban and rural	Existing highways, rural only	Limited-access highways	Urban and rural sections [1]	Rural sections only	Operated as free facility	Operated as toll facility	Urban and rural sections [1]	Rural sections only	Operated as free facility	Operated as toll facility
	Miles	*Miles*	*Miles*								
1	2,066.0	1,624.7	1,856.2	9,342,414	5,683,349	5,208,578	1,453,417	4,522	3,498	2,806	783
2	3,153.5	2,717.3	2,978.8	6,335,003	4,725,059	4,536,926	1,199,604	2,009	1,739	1,523	403
3	1,493.1	1,300.3	1,258.2	3,772,750	3,156,505	1,428,139	390,590	2,527	2,428	1,135	310
3 Michigan	226.6	166.8	174.7	989,940	608,267	427,772	119,220	4,369	3,647	2,449	682
4	3,150.7	2,800.6	2,816.8	6,490,525	5,107,920	3,387,126	891,455	2,060	1,824	1,202	316
4-A	100.3	85.6	88.5	457,565	321,614	87,261	24,283	4,562	3,757	986	274
4 South	675.9	616.8	593.6	776,033	631,113	408,172	103,626	1,148	1,023	688	175
4 North	863.7	771.4	[2] 770.7	1,143,524	894,599	608,314	147,336	1,324	1,160	789	191
5	1,453.9	1,223.2	[3] 1,406.4	5,771,231	4,377,166	3,079,054	799,614	3,969	3,578	2,189	569
6	2,623.2	2,327.1	2,392.3	5,392,157	4,060,813	2,912,549	694,600	2,056	1,745	1,217	290
Total	15,806.9	13,633.8	[4] 14,336.2	40,471,142	29,566,405	22,083,891	5,823,745	2,560	2,169	1,540	406

[1] Intraurban traffic excluded.
[2] 51.9 miles of free highway.
[3] 42.3 miles of free highway.
[4] On toll system mileage of revenue-producing sections totals 14,242.0.

The traffic shown for the existing highways is that which actually used them in 1937. Had these roads been thoroughly modernized throughout, it is conservatively estimated that their traffic would have been from 15 to 30 percent greater than it actually was.

FUTURE INCREASE OF TRAFFIC

Based upon estimates of probable future changes in population, in the number of motor vehicles per capita, in motor fuel consumed per vehicle, and upon an estimate of the increase in miles traveled per gallon of fuel by the average vehicle as a result of improvements in motor vehicles and changes in driving habits, plate 22 shows a predicted trend in the vehicle-mileage of travel on all rural roads.

It is assumed that the rate of increase in vehicle-miles of travel on main highways will exceed the average rate of increase on all rural roads because: (1) A faster rate of development of abutting properties is anticipated for main roads than for local roads; and (2) the average length and number of long trips (50 miles or more) is expected to increase at a faster rate than the average length and number of shorter trips. The allowance for each of these factors depends, of course, upon the specific section of highway considered.

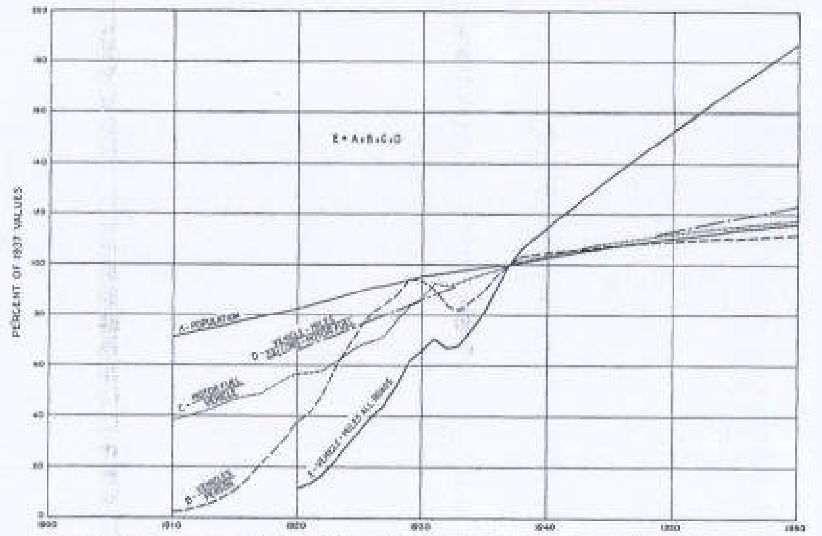

PLATE 22.—Predicted trend in vehicle-miles of travel on all rural roads.

In considering an allowance for the first of these factors for the selected system composed of three east-west and three north-south routes, it must be remembered that access is assumed to be denied to all abutting property owners except at designated points where approach facilities are provided. This condition restricts development of abutting property to areas close to access points. Where the selected route is located in such manner that it provides an attractive connection between such areas and nearby marketing or metropolitan areas, a very fast rate of development may be anticipated. However, to keep pace with the average rate of development of abutting property on all roads having unrestricted access, the fast rate of development in favorably located areas close to access points on the selected routes must be great enough to compensate for the lack of traffic contributing development along the balance of the system. It seems doubtful that it would be great enough even were the selected routes operated as free facilities, but in the absence of a definite means of determining the extent to which these items balance, it is assumed that the average rate of development on such a system operated as a free facility would keep pace with the average rate of development on all routes. For a system of toll highways, a slower rate of development must be assumed.

In considering the probable faster rate of increase in the average length and number of long trips, it becomes apparent again that the allowance made for the selected routes operated as toll facilities should be different from that which would be made if they were operated as free facilities. This difference is caused by the fact that the more money people spend for tolls, the less they have left to spend for operation of their vehicles. However, this rate of increase should be greater for the selected routes, operated on either a free or toll basis, than the rate of increase for main highways, because the long trips, which tend to increase in number faster than short ones, form a larger percentage of the traffic on limited-access roads than on normal main highways.

A thorough consideration of all of these points indicates that it would be reasonable to assume that the trend of travel on the selected routes, operated as toll facilities, would increase approximately one-third faster than travel on all roads.

Before expanding the maximum estimates of 1937 traffic by application of these trends, one further factor must be considered. That factor is generated traffic which, for this purpose, may be defined as the traffic which results from a new desire for travel on the part of certain people who would not care to perform the same travel in the absence of the improved facilities. This traffic would appear during the first years of operation of the new facilities, after which time its entire effect upon the rate of increase may be assumed to be eliminated. It is estimated that 3 years after completion of a route this traffic would increase the total diverted traffic by 20 percent, if it were operated as a toll facility.

Using these relationships, the multiplying factors derived for converting the maximum estimates of 1937 traffic on the selected routes, operated as toll facilities, were 2.5 for 1960 traffic and 34.2 for the traffic of the entire period from 1944 to 1960, assuming that one-half of the system could be placed in operation January 1, 1944, and the remaining half could be placed in operation January 1, 1946.

NUMBER OF LANES REQUIRED FOR FREEDOM OF MOVEMENT OF TOLL-PAYING TRAFFIC

One of the elements of highway design most affected by the volume of traffic to be served is the width of the pavement or the number of lanes provided.

In determining the number of traffic lanes required for toll roads, it is necessary to base the determination upon factors that are not present in the same degree in dealing with free public highways. Highway departments have built the existing roads with definitely limited funds and it has been their problem to distribute these funds over the roads under their control so as to meet the most urgent traffic requirements. Provision of facilities has always lagged behind the evident needs. Often a needed widening of surface has been deferred in order to meet more pressing demands for surfacing earth roads or to replace low-type surfaces with more durable construction. Any system of highways constructed with public funds for the free use of the public must be designed on the basis of compromise, and all highway users have been inconvenienced at times by the lack of both wide and smooth surfaces.

It is understood, however, that these conditions must either be accepted or that funds must be provided more rapidly for their correction. The prospective user of a toll highway will regard lack of adequate width in an entirely different light. He will be in a position to choose between the free and the toll route. To attract the motorist the toll roads must offer advantages that loom larger than the tolls charged. There must be no retarding of traffic flow because of lack of width. Therefore the traffic volume at which a toll facility should be widened is inevitably much lower than that at which free highways have been widened. To provide unrestricted movement of the traffic anticipated 20 years hence requires wide pavements at relatively low present volumes.

PAVEMENT WIDTH DEPENDENT ON MAXIMUM RATHER THAN AVERAGE VOLUMES

In considering the possibilities of self-liquidation of any toll highway, the measure of use must be the total volume for a year or some average volume that takes into account seasonal fluctuations. Estimates of probable use are prepared on such a basis for use in financial studies. But such figures do not indicate the necessary widths of pavements because width must be based on the maximum estimated traffic that will use the road at peak periods throughout the year. Not only does the average daily traffic for any month vary considerably from the average on a yearly basis, but also the traffic on the different days of the week varies to a similar or an even greater degree.

To provide means of determining the probable maximum daily and hourly traffic volumes from the estimated average daily volume on the selected routes, records from a number of automatic traffic recorders were analyzed. Selection was made of records from highways on which the fluctuation of traffic was thought to be comparable with that which may be expected on the routes of the selected system.

The results of this analysis are shown in plates 23 and 24. Plate 23 shows that with an average daily volume of 1,500 vehicles, for example, the average daily volume in the month of maximum traffic may be expected to be 2,000 vehicles. Plate 24 shows that 2,000 vehicles per day correspond to a maximum hourly traffic of 520 vehicles.

The next step was to establish a relation between traffic volume and needed width on a toll road. Recently, the Bureau of Public Roads has conducted studies of highway capacity in which exhaustive analysis has been made of the movements of all vehicles using highways of

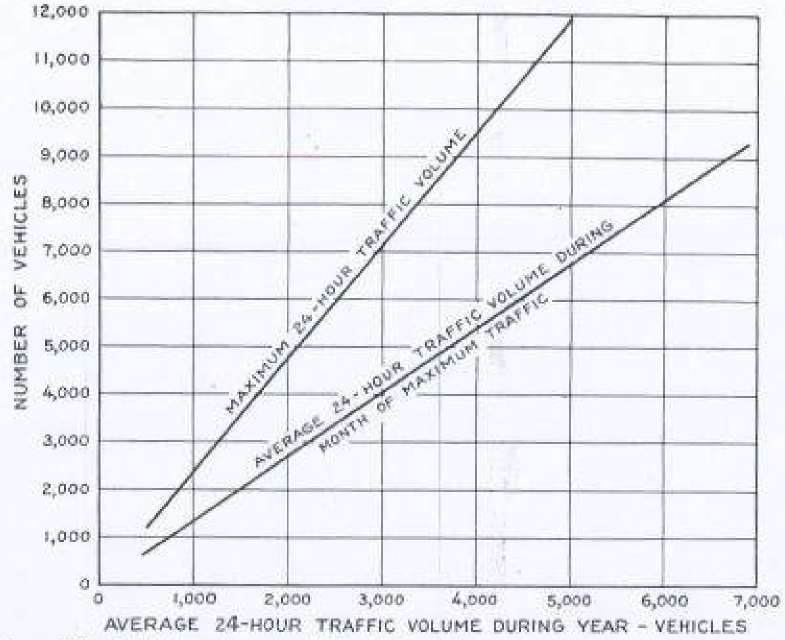

PLATE 23.—Relation of average daily traffic volume during year to both maximum 24-hour traffic volume during year, and average 24-hour traffic volume during month of maximum traffic.

PLATE 24.—Relation between maximum hourly traffic volume and average 24-hour traffic volume.

various widths, carrying a wide range of traffic volumes. Over 300,000 vehicles have been observed in these studies. A number of interesting facts are revealed by analysis of the data collected on a four-lane divided highway representing the highest standards of design, and on a two-lane road, of reasonably good design, both carrying traffic of the same character. The graphical presentation in plate 25 shows that the speed of vehicles begins to decrease with increase in traffic volume, even at very low volumes.

With a zero traffic volume there are no vehicles and consequently there can be no value for vehicle speed, but vehicle speed at zero traffic is approximated when a vehicle moves by itself, so separated from other traffic that the driver is not influenced by the presence of other vehicles on the road. His speed is then uninfluenced by that of other vehicles, and represents a free choice at the particular time on the particular road. The average speed for all vehicles using the road under that condition was, in the case of the two-lane width, 44 miles per hour, and on the divided highway 48 miles per hour. Increase of the total traffic volume to 500 vehicles per hour resulted in a decrease of the average vehicle speeds to 40 and 47.5 miles per hour respectively, and at a volume of 1,000 vehicles per hour in both directions, the speeds become 35.5 and 47 miles per hour. It is significant that there was no serious reduction in speed with increasing volumes on the four-lane road and also that at low traffic volume the traffic moved faster over the divided highway, with its invitation to faster and safer travel, than over the two-lane road.

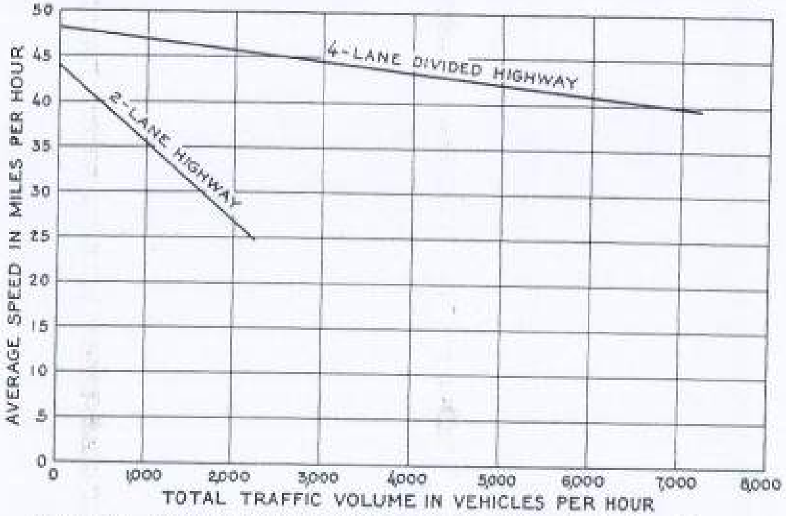

PLATE 25.—Relation between average speed and hourly traffic volume.

DIFFERENCE IN SPEED OF SUCCESSIVE VEHICLES BEST INDEX OF CONGESTION

It has been found that the average speed of all vehicles does not represent a final criterion of the freedom of movement or congestion. Results of various analyses show that the average difference in speed between successive vehicles is a much more positive index of congestion. In periods of light traffic when passing is generally unrestricted, any desired difference in speed between successive vehicles may be maintained. As the traffic volume increases the opportunity for passing diminishes, lines of vehicles form and, accordingly, the difference in speed between successive vehicles becomes less, even though the average speed of all vehicles may not be affected greatly. Plate 26 shows that such difference in speeds is a much more sensitive index of congestion than is the average speed of all vehicles. This graph shows, for roads of the different widths, the mean difference in speed between successive vehicles under various traffic volumes. Here again, a straight-line relation exists between the traffic volume and the speed differences, again indicating that there is an effect on the freedom of movement even with relatively light traffic volumes, and that there is no point at which congestion suddenly occurs.

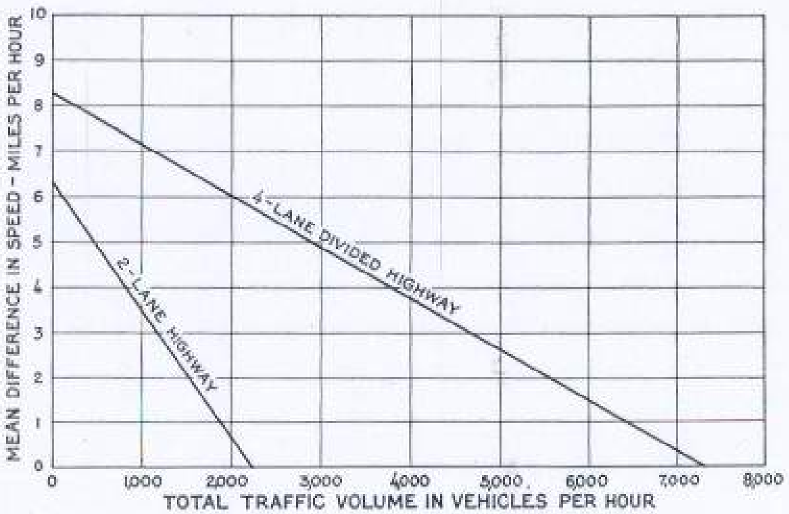

PLATE 26.—Relation between hourly traffic volume and mean difference in speed between successive vehicles.

Beginning with a speed difference of 6.4 miles per hour at zero volume, this figure on the two-lane road drops to 3.5 at 1,000 vehicles per hour in the two directions, while the initial speed difference on the divided highway of 8.3 miles per hour drops only to 7.1 at 1,000 vehicles per hour. To restrict the freedom of movement on the divided highway to a speed difference of 3.5 miles per hour requires a total of over 4,000 vehicles per hour, or over 2,000 vehicles per hour in each direction.

DESIRE FOR SPEEDS FASTER THAN THOSE NOW GENERALLY POSSIBLE

Investigation of the distribution of vehicle speeds, on the two-lane road studied, shows that no vehicles traveled over 60 miles per hour even in traffic as low as 200 vehicles per hour in both directions, and only 7 percent exceeded 50 miles per hour. On the divided highway, however, at similar volumes 5.1 percent of the vehicle speeds exceeded 60 miles per hour and 36.6 percent exceeded 50 miles per hour. The width of the two-lane road studied was narrower than the 24-foot width recommended for the toll roads, and similar studies on wider two-lane pavements might show a somewhat greater percentage of fast driving, but it is certainly indicated that on any two-lane road speed of operation would be limited to a greater extent than on four-lane divided highways. These figures add to the evidence that even under conditions of light traffic, four-lane divided highways induce higher speed and therefore will prove more attractive to drivers wishing to save time with safety.

The faster travel speeds in themselves indicate a willingness of the driver to pay for saving in time, since increasing speed increases gasoline consumption. Composite figures obtained by averaging the results of tests on several makes of modern passenger cars show that with steady driving on concrete pavements at a speed of 40 miles per hour, gasoline consumption is 0.0575 gallon per mile. At 60 miles per hour the consumption becomes 0.082 gallon per mile. With gasoline at 18 cents per gallon the cost per mile would increase from 1.03 to 1.47 cents per mile, representing a cost for the higher speed of over 0.4 cent per mile for gasoline alone. Should the availability of a large mileage of high-speed highway induce the more general usage of over-drive transmissions, or the introduction of engines performing more efficiently in the higher speed ranges, the final cost of fast driving on toll highways might be no higher than present costs of traveling at similar speeds, desired but seldom possible, on existing highways.

Since the studies of highway capacity are still incomplete, the figures presented are based on data obtained on the best alinement; that is, a level straight highway. Introduction of grades and curves, even of the low magnitude recommended for the selected routes will tend to reduce somewhat the freedom of movement possible. Therefore, in any section of the country where curves and grades must be incorporated frequently in the design of the highway, there will be on two-lane roads a further restriction to the freedom of movement.

It may be thought that differences in speeds will not be significant on such roads since only persons desiring to travel at the highest reasonable speed will be willing to pay the required fees. This might be true with reference to passenger vehicles, even though the data of plates 25 and 26 tend to dispute that thought, but it must be remembered that the value of time and distance saved over such roads will be largest for commercial vehicles. It may be expected that commercial vehicles, particularly the heavier units, would be attracted to these roads in greater proportion than that in which they are found on the existing roads.

FOUR HUNDRED VEHICLES PER HOUR IN BOTH DIRECTIONS CAUSE INCONVENIENCE TO TRAFFIC

Results of studies of the movement of many thousands of vehicles in many sections of the country show that the spacing of vehicles traveling normally over a highway follows rather definite laws. Analysis of observations shows that with a traffic volume of 200 vehicles per hour in one direction, spaces between these vehicles long enough to permit vehicles moving in the opposite direction to pass each other are available only 50 percent of the time, if the time required for the completion of the passing maneuver is 10 seconds. While it is believed that 10 seconds is entirely reasonable, reduction of the time required to 8 seconds would still leave only 55 percent of the time available for passing. It is believed, therefore, that a volume of 400 vehicles per hour with traffic approximately evenly divided in the two directions is a maximum which it is safe to assume may be carried over a two-lane road without inconvenience at some time during the year. Plate 24 shows that this maximum volume of 400 vehicles per hour corresponds to an average daily volume of 1,500 vehicles. Sections of the selected system on which the average daily traffic volume is expected to exceed 1,500 in 1960 are, therefore, planned to be more than two lanes in width.

THREE-LANE PAVEMENTS UNDESIRABLE

Neither in theory not in practice is there complete agreement as to the width of road to build when more than two lanes are required. Were adequate accident records available, the proper width for highways wider than two lanes could be based entirely on the factor of safety. In no State, however, are accident data sufficiently complete to permit a reliable analysis of the accident rate on roads of various widths. In theory, a three-lane road has a definite place where the traffic in one direction is much heavier than that in the other direction and where the direction of heavy traffic flow reverses as, for example, between morning and evening. In the case of toll highways, however, it is not anticipated that there will be any such marked difference in the volume of traffic in the two directions and therefore this theoretical advantage of the three-lane highway is not present. Furthermore, many studies of vehicular movement on three-lane highways definitely show a reluctance of drivers to utilize the center lane to the maximum advantage.

From the point of view of driver behavior, the three-lane highway suffers a psychological disadvantage which might well result in an abnormally high accident rate. On a two-lane road, a driver engaged in a passing maneuver must encroach upon the left lane, the lane which is definitely reserved for traffic in the opposite direction, and he does it with full realization that his passing is accomplished only in the face of the superior rights of drivers in the opposing lane. In the case of the three-lane road, particularly with traffic evenly divided in the two directions, there is no clear-cut right-of-way distinction. A vehicle moving in one direction has as much right in the center lane as one moving in the other direction, and passings may involve much greater traffic hazards.

Furthermore, for the selected routes the three-lane pavement could be regarded only as an expedient. Its traffic capacity is somewhat higher than that of a two-lane pavement, but four lanes will permit, without inconvenience, traffic volumes several times as high as those which may be accommodated on a two-lane road. Inasmuch as the three-lane road does not lend itself readily to remodeling as a four-lane divided highway, which is believed to be the ultimately desirable type of construction, the three-lane road has no place on the selected routes. Although the available accident figures are not sufficiently reliable or voluminous to be employed as a criterion, it is interesting that in one State the reported accidents on undivided roadways of two-, three- and four-lane width show but a small difference in the accident expectancy on the basis of accidents per million vehicle-miles. Very limited data from another State in which a modern four-lane highway has recently been opened to traffic show a remarkable reduction in accidents on the four-lane divided section as compared with those of an adjacent four-lane highway. There was 0.31 accident per million vehicle-miles on the undivided highway as compared to 0.13 accident per million vehicle-miles on the four-lane divided section. Although both figures are low, they are fairly comparable, and the advantage of the divided highway is striking.

DIVIDED FOUR-LANE HIGHWAYS RECOMMENDED FOR HEAVY TRAFFIC

It is recommended that when the traffic volume becomes too great to be reasonably accomodated by a two-lane highway, a four-lane divided highway should be provided. All the cost estimates have been based upon this recommendation. The dividing line between two- and four-lane pavements has been taken at an average traffic of 1,500 vehicles per day in 1960. It is unwise to recommend for general use a capacity limit for four-lane highways in terms of total traffic since it is felt that local conditions producing traffic volumes sufficient to justify more than four lanes will be so individual in their characteristics that each case will require special study. Serious congestion on four-lane pavements would occur only in proximity to large cities, where in the periods of heavy volume, the traffic is not evenly divided between the two directions. Accordingly, the volume justifying an increase in width beyond four lanes is based on the traffic in one direction only, rather than on the total in both directions.

Figures show that the same freedom of movement possible on a two-lane road with a total hourly volume of 400 vehicles will be found on a four-lane divided highway with an hourly volume of 2,600 vehicles, or 1,300 vehicles in each direction. Using the ratio between the maximum hourly volume and the average daily volume throughout the year found on two-lane roads, 1,300 vehicles per hour represent a daily average of 5,000 vehicles in each direction. Typical heavily traveled roads show that in periods of heavy volume, the volume in one direction is seldom more than double that in the other. Therefore, an average of 7,500 vehicles per day in both directions is considered a conservative figure for the capacity of a four-lane divided highway without inconvenience at any time. This figure is offered only as a rough indication, and should not be used where it is possible to study and analyze traffic characteristics. Traffic volumes far higher than 7,500 vehicles per day may be accomodated on four-lane surfaces with slight inconvenience at certain times, but still at relatively high average speeds. The 1,300 vehicles per hour in each direction could travel at an average speed of 45 miles per hour, but the traffic may be increased to 3,400 vehicles per hour in each direction with an average speed of 40 miles per hour. Each of these figures represents an average speed, and with the distribution of speeds normally encountered, some vehicles must travel at 60 miles per hour or faster to offset those which travel under 40 miles per hour even in light volumes.

CHARACTER OF THE APPROXIMATE LOCATIONS SELECTED

In accordance with criteria and standards previously established the selected routes were approximately fixed by detailed location on large-scale maps, chiefly county maps, prepared in connection with the State highway planning surveys. A typical section of one of these maps is shown in plate 27. The lines were located either by Bureau of Public Roads engineers resident in the several States or by engineers of the State highway departments, or both, working together. In all cases the locating engineers were intimately familiar with the areas in which they worked.

Wherever necessary a field reconnaissance was made. It is thus reasonably assured that the approximate locations chosen are practicable of development and conform closely to the criteria adopted. The field inspections also permitted a better judgment to be formed of the quantities of the various construction items that should be accounted for in the estimates of cost.

The alinements chosen extend as directly as possible from one major source of traffic to another, deviating from such direct lines to serve minor sources of traffic only where it has been estimated that the resulting increase of traffic would be substantial. Sources of traffic, in general, consist of cities and towns, intersecting highways, and points of travel interest, such as national parks, resorts, etc.

In all but two sections, totaling 94.2 miles, the detailed locations have been made entirely on new lines apart from existing roads. One of the excepted sections, 51.9 miles in length, lies along the Columbia River in Oregon; the other, 42.3 miles long, crosses the Sierra Madre Range north of Los Angeles, Calif. In these sections the alinement chosen coincides with that of existing highways because no other topographically feasible line could be found.

The chosen approximate locations bypass cities and towns, but pass sufficiently close to them, wherever possible, to attract their traffic. In detail, the locations are such that (1) control of access may be readily obtained wherever possible; (2) obstruction to the outward development of cities and interference with communication across the selected route are avoided to the greatest extent possible; (3) the cost of grade separation structures is reduced to the feasible minimum; and (4) a maximum feasible benefit of low land values is gained.

STANDARDS OF DESIGN ADOPTED

It was considered necessary that the design standards of the selected routes be sufficiently superior to the standards of existing roads to attract traffic, insure a maximum of safety and utility in their present use, and conform so far as possible to the probable requirements of future traffic. At the same time the standards were not set so far in advance of the requirements of existing traffic as to incur excessive initial costs which present users should not be asked to pay. For example, over three-fourths of the mileage of the routes, as designed, consists of two-lane roads, but to meet the possibility of future expansion to four lanes the initial pavement would be placed at one side of the right-of-way.

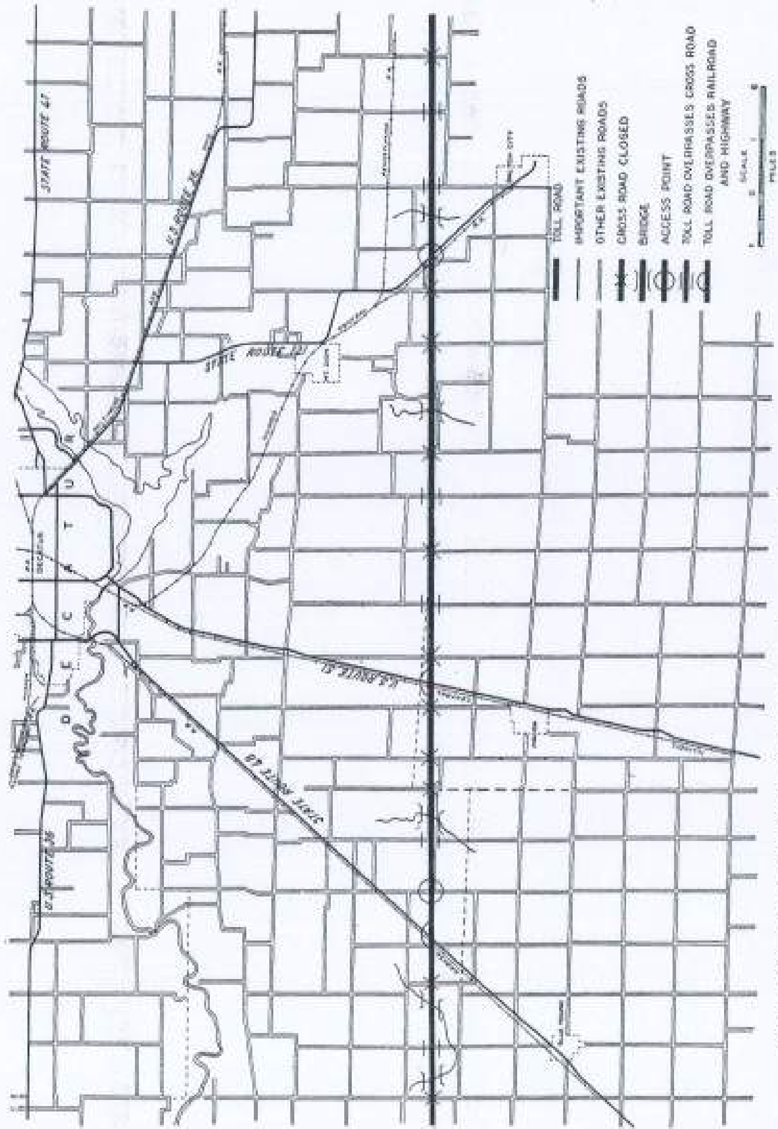

PLATE 27.—Typical section of a large county map showing projected location of selected route.

RIGHTS-OF-WAY

In general, the design provides a right-of-way width of 300 feet in rural areas and 160 feet in suburban areas. These are in the nature of minimum widths. In rural areas it is expected that they may be exceeded where (1) land values are very low; (2) it may be less expensive to acquire extra land to avoid the cost of constructing grade-separation structures for roads to connect private property divided by the road; or (3) where additional land is needed for some special construction or border control. In suburban areas the minimum width may be exceeded where (1) the additional land is required to allow for expected future growth or to insure effective control of the road; (2) it may be economically feasible to purchase parcels of real estate in their entirety instead of paying damages for areas left isolated by the construction of the road; or (3) it may be less expensive to acquire additional land and so to avoid costly construction, such as retaining walls. In rare instances it may be advisable to restrict the right-of-way to less than the minimum widths mentioned to avoid the purchase of very expensive or important land or buildings, even though the result may be an apparently excessive construction cost; but in no case should this be done at a sacrifice of the minimum standards of design.

CURVATURE AND GRADES

It was the purpose to design the selected routes for use at a normal maximum speed of 70 miles per hour. Consistent with this purpose, the normal standards of curvature and gradient were set at maxima of 3° for curves and 3 percent for grades. In applying these standards, however, it was necessary to make some concession to topography to avoid costs clearly exceeding the benefits to be gained by adherence. In rugged mountainous terrain an effort was made to keep within maxima of 4° curvature and 4-percent gradient, and this was found possible at reasonable cost except on four sections having and aggregate length of 153.8 miles. For these four sections alternate locations were made, one conforming to the 4° curvature and 4-percent grade requirement, and one permitting curves of 6° and grades of 6 percent.

The estimated cost of constructing the 153.8 miles to the lower standard is $26,107,000. Built to the higher standard these lines would aggregate 172.4 miles in length and their cost would be $42,124,600. It is concluded that the advantage to be gained by building to the higher standard would not justify the additional 18.6 miles of travel and the increased construction cost of $16,017,600.

The sections involved and the estimated lengths and costs of each are as follows:

Section	6°—6-percent standard		4°—4-percent standard	
	Length	Estimated cost	Length	Estimated cost
	Miles		*Miles*	
Castaic Junction, Calif., to Wheeler Ridge, Calif.	50.6	$12,798,564	55.9	$26,409,860
Wells, Nev., to Nevada-Utah State line	58.3	4,819,140	64.4	5,285,090
In Sierra County, Calif.	14.7	3,098,980	16.0	3,577,380
In Nevada County, Calif.	30.2	5,390,310	36.1	6,852,270
Total	153.8	26,106,994	172.4	42,124,600

Considerations of safety require that the length of road ahead visible to drivers of vehicles be at all points at least as great as the distance required to stop a vehicle moving at the assumed design speed, allowing 2 seconds for perception and brake reaction and a braking distance based upon a uniform coefficient of friction of 0.4. The distance thus required is 614 feet. Three-degree curvature in unwidened cuts allows a minimum sight distance of 690 feet; 4° curvature under similar circumstances provides a minimum sight distance of 590 feet. The higher of these standards, therefore, would conform to the requirements of safety corresponding to the assumed design speed of 70 miles per hour, the lower would be only slightly deficient; but 6° curvature under similar conditions would provide seriously insufficient sight distance for safety of operation. On the 153.8 miles located to the latter standard it might be necessary in places either to widen cuts where they occur on the sharper curves or indicate the necessity for caution by warning signs.

Modern passenger cars in good condition are capable of maintaining relatively high speeds on 3- and 4-percent grades and even on grades of 6 percent. Motortrucks, as at present designed, are incapable of such performance. Tests by the Bureau of Public Roads indicate that the larger vehicles now in general use, when loaded in accordance with the manufacturer's gross-weight rating, cannot be expected to climb 4-percent grades at a speed greater than 25 miles per hour. On 3-percent grades a speed of 30 miles per hour is the maximum that may be expected under the same conditions. With vehicles loaded 50 percent over the manufacturer's rating—a practice that is not uncommon—the corresponding maximum speeds for 4- and 3-percent grades are 16 and 22 miles per hour respectively. Under either condition of loading a 6-percent grade slows the larger modern trucks to a crawling speed.

On grades of steepness approaching either the 3- or 4-percent standards and, of course, on the exceptional 6-percent grades, ample provision is required to permit the passing of trucks by passenger cars.

On 2-lane roads the sight distance, wherever possible, should be sufficient to permit passing of the slower vehicles when the visible length of road is clear of opposing traffic, even if opposing traffic appears after the operation of passing is begun. Where such a sight distance cannot feasibly be obtained signs must be placed to prohibit passing. Such limited sections should be permitted only as exceptions, and in no case should their continuous length exceed about 2 miles.

PAVEMENTS AND THEIR FOUNDATIONS

For roads of the character of those proposed only high-type pavements are appropriate. The pavement thickness should be designed in each section to be consistent with the wheel loads to be expected. A smooth-riding surface, as nonskid and glareproof as possible, should result. Subbases should be used wherever required; and, both for pavements and subbases, good local materials should preferably be used, if available.

Material encountered in foundations should be analyzed, and, if found to be unstable, should be replaced or improved by stabilization, using cementing admixtures as required. To the extent possible measures should be taken to insure a uniform moisture content of the subgrade.

CROSS SECTIONS

Typical cross sections are shown in plate 28. As indicated, all traffic lanes of the proposed roads would be 12 feet wide. On two-lane roads these lanes are shown as separated by a traversable dividing strip 2 feet wide. This is believed to be a desirable feature; in fact a more positive division between the lanes of opposing traffic would be desirable, but on two-lane roads is impossible because of the necessity of using the opposing traffic lane as a passing lane. For this reason the narrow dividing strip provided should be built as a traversable surface, flush with the surface of the traffic lanes, but contrasting with them in color and texture, so that drivers will be warned both visually and physically when they cross it or encroach upon it.[1]

Where the expected traffic volume justifies the construction of more than two traffic lanes, four lanes built in pairs, the pairs separated by a parkway strip at least 20 feet wide in suburban areas and 40 feet wide in rural areas, would be provided. These widths of medial parkway strips are ample and may, in exceptional cases, be reduced, since the separation of grades at intersections obviates need of the parkway for protection of crossing vehicles.

Sections of the selected routes on which two- and four-lane pavements would be required are shown on plate 29.

Each two-lane pavement would be designed to drain to both sides and drainage would be provided in the medial parkway strip. This design is particularly advantageous in sections subject to snow. The parkway is a convenient area on which to store the snow which, when melted, runs off into the central drain instead of flowing across the pavements to create a serious hazard in case of sudden freezing.

Shoulders would be invariably 10 feet wide to provide adequate space for stopping off the pavement. In construction they would be sufficiently strong to support the weight of vehicles in all weather.

Slopes of cuts and fills would be designed to prevent erosion. Where feasible, fills would be made to a slope of 1 on 4 or flatter to avoid the use of guardrails and in no case, except perhaps in some mountain locations, would their slope be steeper than 1 on 2. Cut slopes would be varied according to the character of the materials encountered and the depth of cut. All cut slopes would be liberally rounded for both stability and appearance; and no hazardous breaks, such as deep ditches, would be permitted. At ends of cuts and fills, slopes would be made progressively flatter so that they would gradually merge with the ground and with each other.

Low curbs, with flat slopes readily mounted in emergencies, would be used in park areas and on the inside of curves where necessary to control drainage and reduce the maintenance of shoulders or medial parkway strips. Curbs of this character would be contiguous with the pavement proper. Curbs intended to prevent vehicles from leaving the pavement, as at walls and bridges, would be of the barrier type, set at least 2 feet from the edge of pavement. All curbs should be highly visible day and night.

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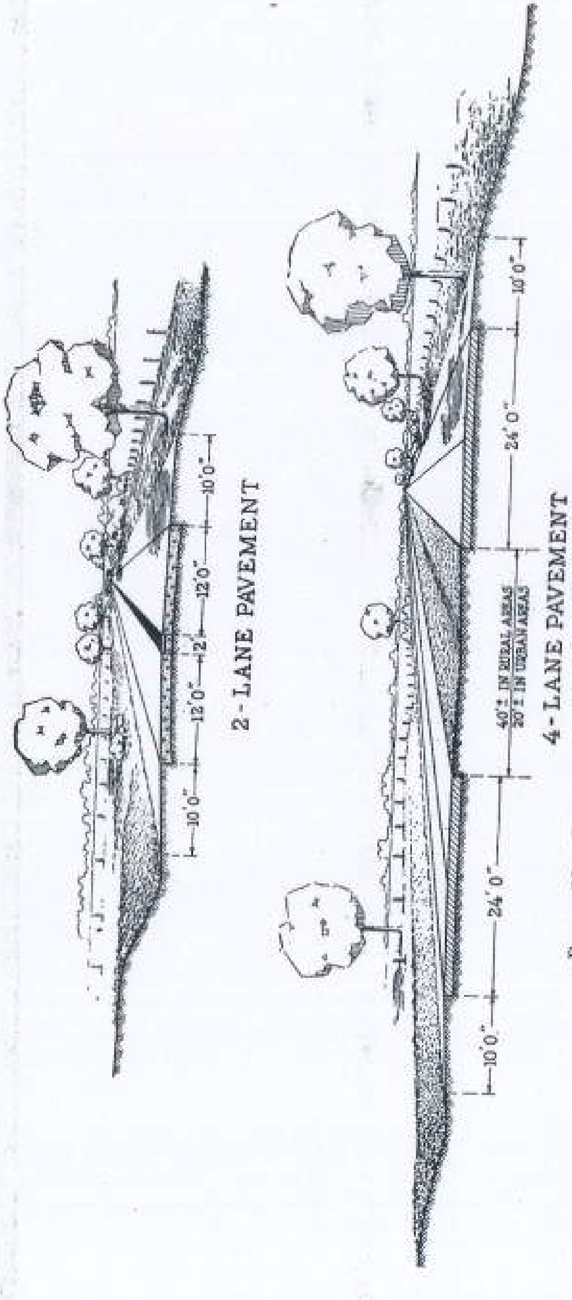
[1] The cost of such dividing strips is not included in the subsequently tabulated estimates.



Palte 28.—Typical cross sections proposed for toll-highway system.

PLATE 29.—Roadway widths planned for selected system.

The grade of the toll road, wherever possible, would be laid above the general level of the surrounding land. Where divided roads are located on slopes, the two sides would be placed at different levels in the interest of economy of construction, additional safety through the reduction of headlight glare, and a more pleasing appearance.

INTERSECTIONS

On the roads as planned there would be no intersections at grade. At no point would a driver encounter another vehicle crossing his path; and at no point, except at the especially designed accesses, would he encounter another vehicle entering the roadway.

Railroad grade crossings would be avoided generally by carrying the highway overhead. In fewer instances the highway would pass beneath the railroad.

All intersecting highways of importance would be carried over or under the proposed roads. Cross roads serving light traffic would be closed and their traffic diverted via existing roads, or roads constructed for the purpose, to the nearest grade-separated intersection. The same considerations would govern in respect to the treatment of intersecting streets in suburban areas. Traffic on unimportant intersecting streets is frequently much greater than on the lesser roads in rural areas. For this reason grade-separation structures would probably be much closer. The construction of parallel streets would not only serve rerouted traffic from unimportant streets but also serve adjacent property cut off by the construction of the proposed road. A typical 4-lane highway in an urban area is shown in plate 30.

At all points where the selected routes intersect, the design would be such that traffic, regardless of direction, would be able to proceed or turn without crossing traffic on either road. All traffic would leave or enter at the right on suitable acceleration and deceleration lanes. The full clover-leaf type of grade-separation structure meets all conditions and requires but one structure. It is more confusing to the driver, however, than some "braided" types of intersection which may require more than one separation structure but which result in more direct access roads.

PRIVATE PROPERTY CROSSINGS AND CATTLE PASSES

Where private property is divided by the construction of the roads use of the land would be restricted to a considerable extent. To minimize the restriction it would be necessary to provide crossing-separation structures to permit passage from one part of the property to the other sufficiently close together and of sufficient size to insure reasonable use of the land as a whole for its intended purpose. In rural areas simple cattle passes will often suffice though sometimes the structures may have to be built large enough to accommodate wagons and motor vehicles. In suburban areas, where the land is subdivided, the structure clearances and load capacities would have to be sufficient for use as a future street. In some cases it may be sufficient to agree to construct a grade separation structure at a future time when the need develops. In other cases, where the value of the land is low, acquisition of the affected land may be the most economical procedure.

BRIDGES AND OTHER STRUCTURES

Culverts, bridges over streams, railroad and highway separation structures, and all other structures such as retaining walls would be constructed so that vehicles will have adequate clearance and drivers will feel no sense of restriction at any point.

Structures carrying the traffic of the proposed roads would be designed in all respects except their clearances, in accordance with the Standard Specifications for Highway Bridges of the American Association of State Highway Officials. The live loading would be H-20. Structures carrying intersecting roads would be designed in accordance with the standard practice of the agency in control of the intersecting road but in no case for a live loading less than H-15.

The vertical clearance provided at undercrossings would be at least 14 feet within the limits of the pavement; and horizontal clearances would be such that the shoulders would be carried through the structure opening without reduction in width. Medial parkway strips would not be narrowed and one pier only would be permitted in the middle of them. Future sidewalks, if required, would be carried through in the shoulder area.

When the proposed roads are carried on structures of moderate length (up to about 100 feet) the width of the medial strip would not be reduced and the normal shoulder area would be used for sidewalks. For bridges over 100 feet long the medial strip might be narrowed but in no case to less than 6 feet between curbs. All curbs on bridges would be 2 feet outside the normal edge of the pavement so that the minimum medial distance between normal inside edges of pavements on divided roads would be at least 10 feet. Changes in width of medial strip would be accomplished by gradual transition to avoid all sense of forced alinement.

Substantial bridge railings would be located at the pavement curbs. Sidewalks would be located between the curb and pedestrian railings at the sides of the bridge.

Where it is necessary to omit shoulders, as at high retaining walls, barrier curbs would be placed 2 feet outside the normal edge of pavement and the nearest face of the retaining wall would be at least 2 feet from the face of the curb.

Guardrails, where required, would be placed clear of the normal shoulder and carried continuously past all culverts. The width of embankment would be increased to accommodate the rail. Railings would be extended well beyond the ends of fills to overlap adjacent cuts or shallow sloping fills.

ACCESS POINTS AND TOLL FACILITIES

Access points would not be spaced at regular intervals but would be located to give the maximum service commensurate with the cost of maintaining toll booths and toll operators. For example, the average distance between the access points proposed in New Jersey is 2.6 miles, the minimum 0.5 mile, and the maximum 7.5 miles. In Montana, the average distance between proposed access points is 79.4 miles, the minimum 9.2 miles, and the maximum 140 miles.

A typical grade separation, access roads, and toll booths for a four-lane toll road are shown in plate 31. Traffic would always enter and leave the toll road on the right. Liberal deceleration and acceleration

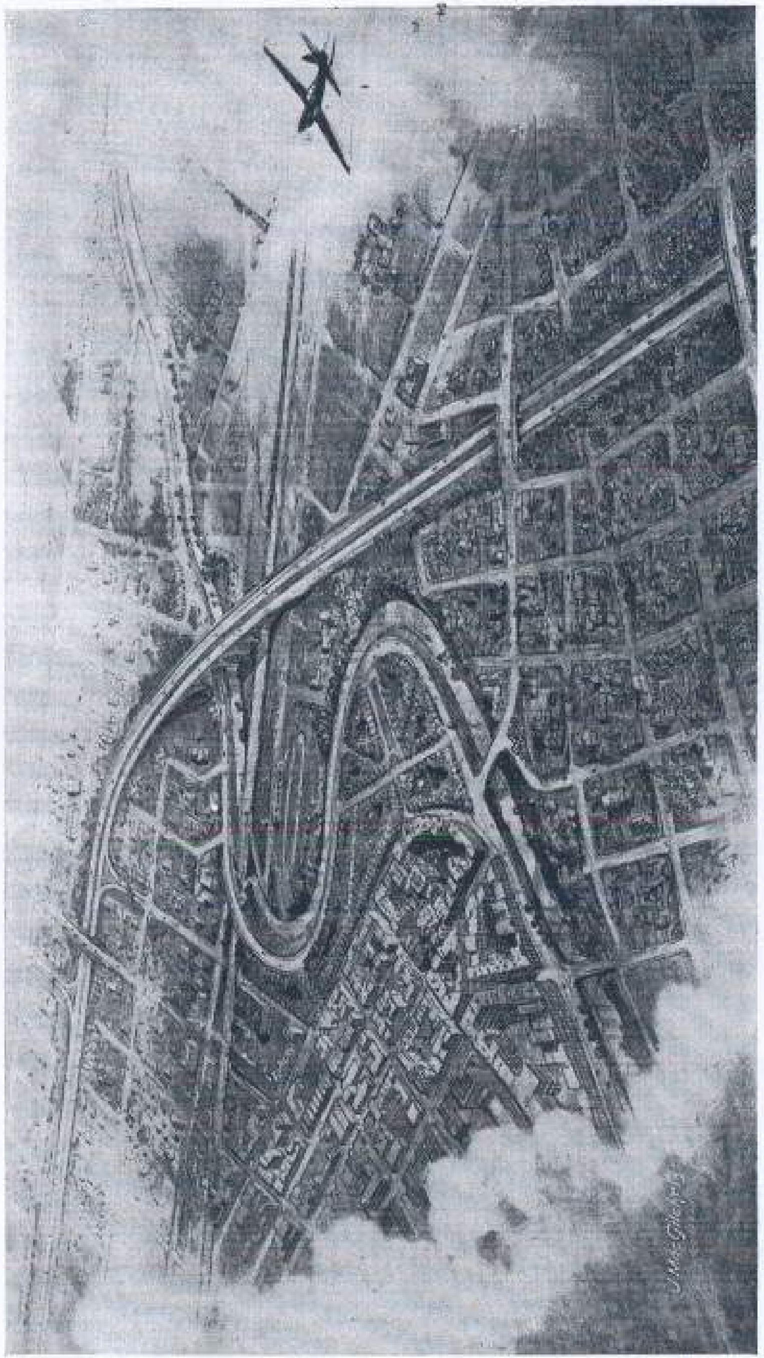


PLATE 30.—A four-lane toll highway in a suburban and urban area, showing relation to existing streets.

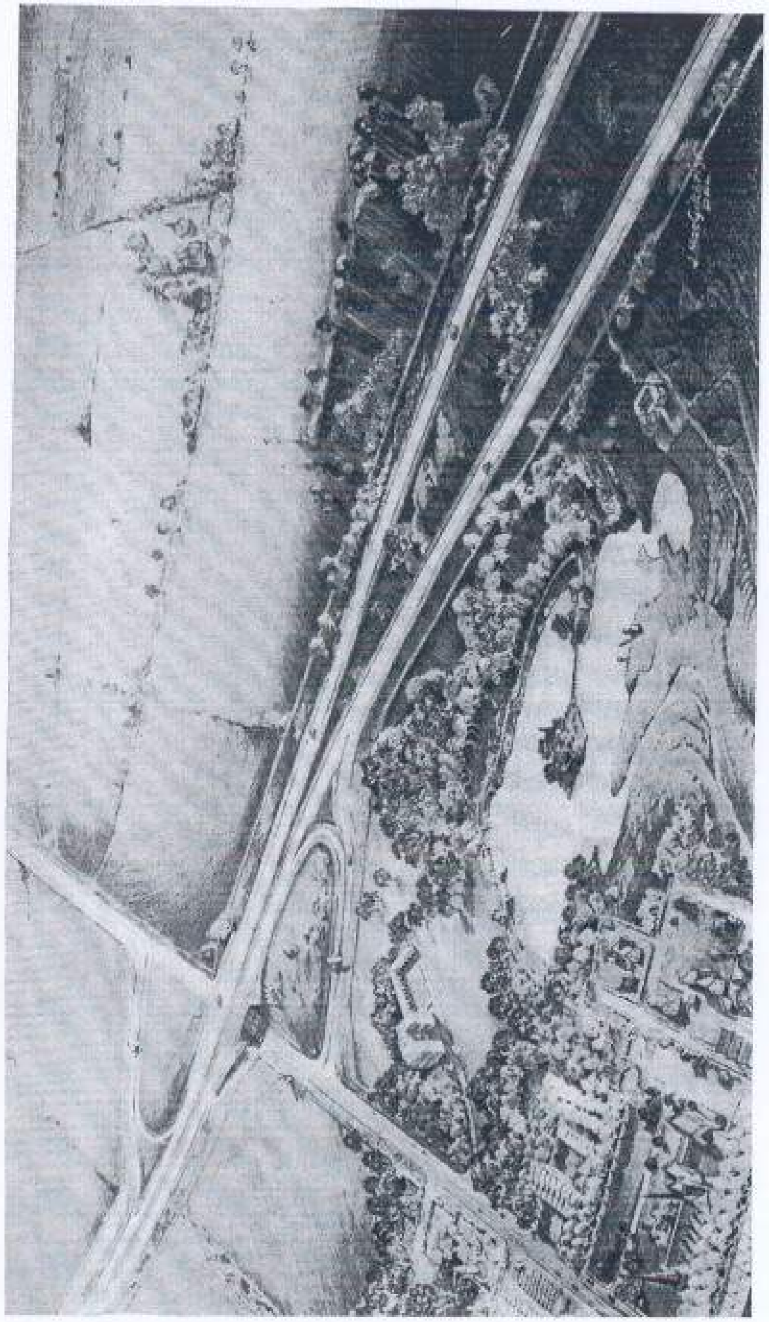


PLATE 31.—A typical grade separation, access roads, and toll booths for a four-lane road.

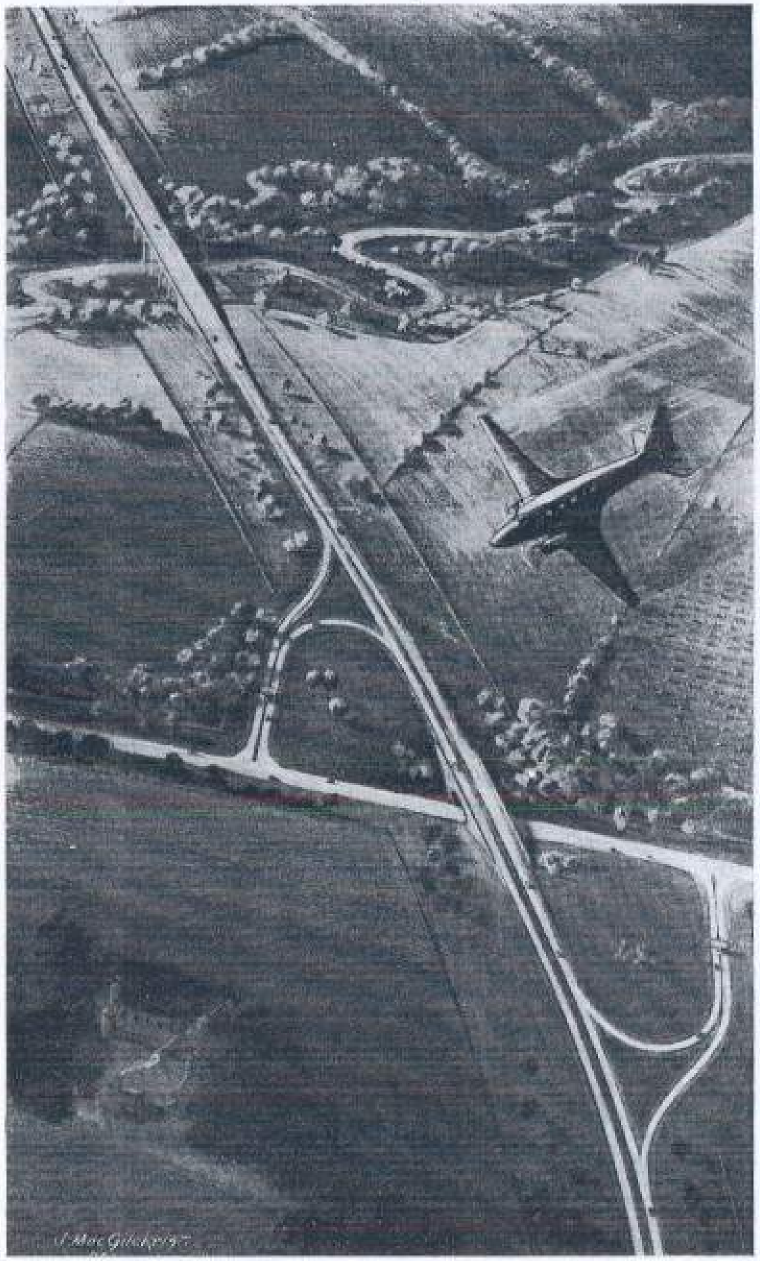


PLATE 32.—A typical grade separation, access roads, and toll booths for a two-lane road widened to three lanes at the approach to an access point by addition of a central lane of contrasting color and surface texture.

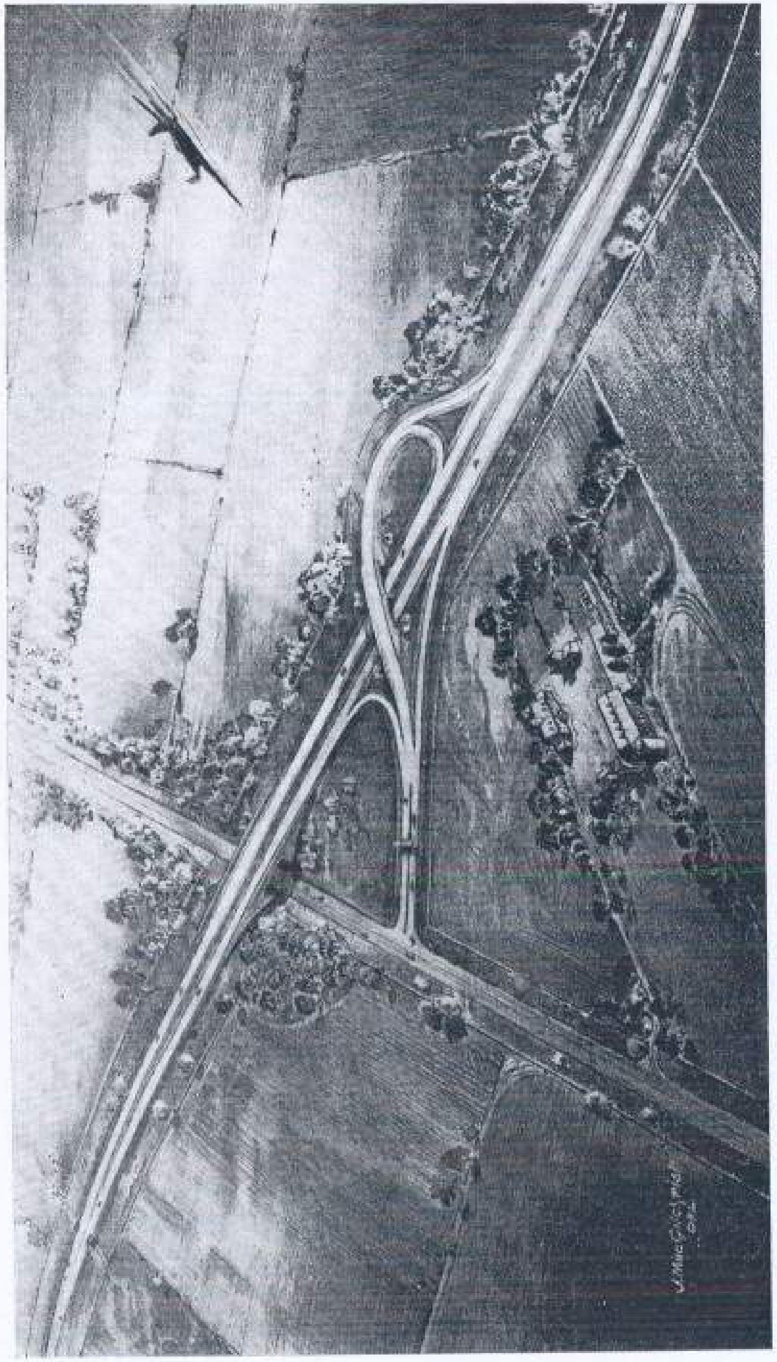


PLATE 33.—A two-lane toll road widened to four lanes approaching an access point at which only one toll booth is provided, showing the grade separating structure necessary to avoid hazards of left turns on the toll road.

lanes would be provided, clear of the normal traffic lanes, to permit traffic to slow down before entering the access drive and to pick up speed before weaving into the high-speed traffic stream on the toll road.

Access drives would lead by easy grades and curves past the toll booths which would be visible from the toll road and the intersecting road. Ample storage space for entering vehicles would be provided approaching the toll booths.

A typical grade separation, access roads, and toll booths for a two-lane toll road are shown in plate 32. Traffic on the toll road should be prevented from making left turns. Two access drives and two toll booths, therefore, would be provided regardless of traffic density. To prevent all possible conflicts of turning traffic the toll road would have to be designed as a four-lane divided road at the intersection. A less complete facility, but one which might suffice on the more lightly traveled roads, would be provided by widening the two-lane road to three lanes, as shown in plate 32. The middle lane, in this case, should contrast in color and surface texture with the outside traffic lanes and generally would be used only by through traffic to pass vehicles slowing down to leave the toll road or vehicles just entering the toll road. Acceleration and deceleration lanes, therefore, would not be necessary with this type of facility.

As toll collection constitutes an appreciable operating expense, study was made of the possibility of utilizing only one toll booth at each access and providing traffic circulation so that all crossing of traffic would be avoided. The result is shown in plate 33. On a conservative basis it was estimated that the annual cost of operation of a second toll booth would be less than the excess of the annual interest and amortization charges on the cost of the extra grade separation structure and other additional construction over the relatively simple arrangement of two accesses. This is particularly marked for two-lane roads where the cost of constructing an appreciable length of four-lane divided road as against a three-lane road must be added to the extra cost.

At intersections with important existing highways on which the making of left turns is hazardous, four access roads or a full cloverleaf type of grade separation with four toll booths should be provided.

LIGHTING

The proposed roads would be lighted to the extent justified. Lighting is considered to be necessary in tunnels, on long bridges, and access drives and in suburban areas where lighting of adjacent streets would confuse drivers if similar lighting were not provided on the road. While fixed sources of light are generally to be preferred, other methods of outlining the road at night, such as the use of reflectors, may be considered as supplements and possibly as a substitute for fixed-source lighting.

SIGNS

Because of the relatively high speeds expected on the proposed roads some variation from the standards recommended by the Manual on Uniform Traffic Control Devices of the Joint Committee of the American Association of State Highway Officials and the Conference on Street and Highway Safety would be required in the design, erection, and location of signs. Generally the signs would be much larger than those recommended in the manual so that they could be read at greater distances; and those intended to give notice of the approach to access points would be erected in multiple so that drivers would be informed repeatedly of the facility ahead some time before reaching it. The character of the road should obviate the necessity for a multiplicity of warning signs. All signs would be lighted or of the reflecting type so as to be easily readable at night.

LANDSCAPE DEVELOPMENT

The roadside and slopes would be protected against erosion largely by the use of flat and rounded slopes. Additional protection would be given by topsoiling and seeding to produce vegetative cover suited to location, soil, and climate.

The roadsides would be planted under the supervision of landscape architects with the general objective of giving a pleasing appearance and making the new construction fit into the surrounding landscape. Only native trees and shrubs that require little or no maintenance would be planted. They would be arranged naturally in groups at some distance from the pavement so as not to present secondary hazards to cars out of control.

The desirability of providing roadside parks, picnic areas, and other facilities inviting drivers to stop and rest must be determined by future policy. Facilities that would invite short-trip traffic and make the long trips more pleasant would build up public good will and might add appreciably to the revenues collected.

FENCING AND PROTECTION OF RIGHT-OF-WAY

Protection from encroachment is necessary on a toll road. Both sides of the road would have to be fenced except where steep slopes, dense forests, canyons or other natural conditions give the needed protection. The type of fence required will depend upon local conditions.

DETAIL OF ROUTES DIAGRAMMED THROUGHOUT

The standards of design described in the foregoing pages have been applied in detail to the approximate route locations as fixed on the large-scale maps, and all design decisions necessary for an estimate of cost have been made in great detail. Such decisions have been recorded in tables for the entire mileage of the selected routes. Straight-line diagrams of the tabulated data for portions of the mileage, representative of various sections of the country, are shown in plates 34 to 45.

On each of these diagrams the section of the selected routes covered is represented by a central line or lines. A single line indicates that the pavement designed for the particular section is two lanes wide; double lines indicate sections that would be constructed with divided four-lane pavements. Scaled distances along the central line or lines represent the lengths of continuous sections of each width of pavement; and at properly scaled intervals the positions of all cross roads, intersecting railroads, rivers, State and county lines, and other significant features of the locations as fixed are symbolically indicated.

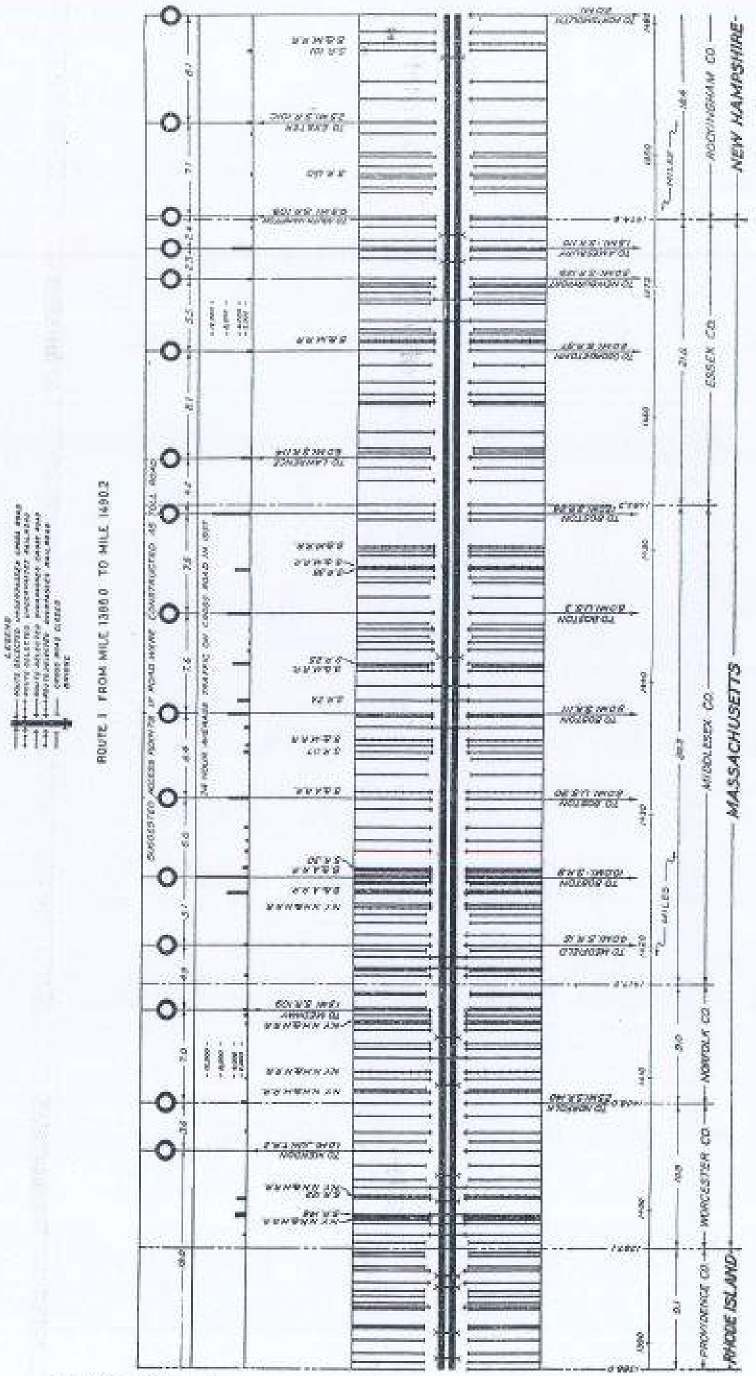


PLATE 34.—Straight-line diagram showing physical features of a typical New England section of the selected system.

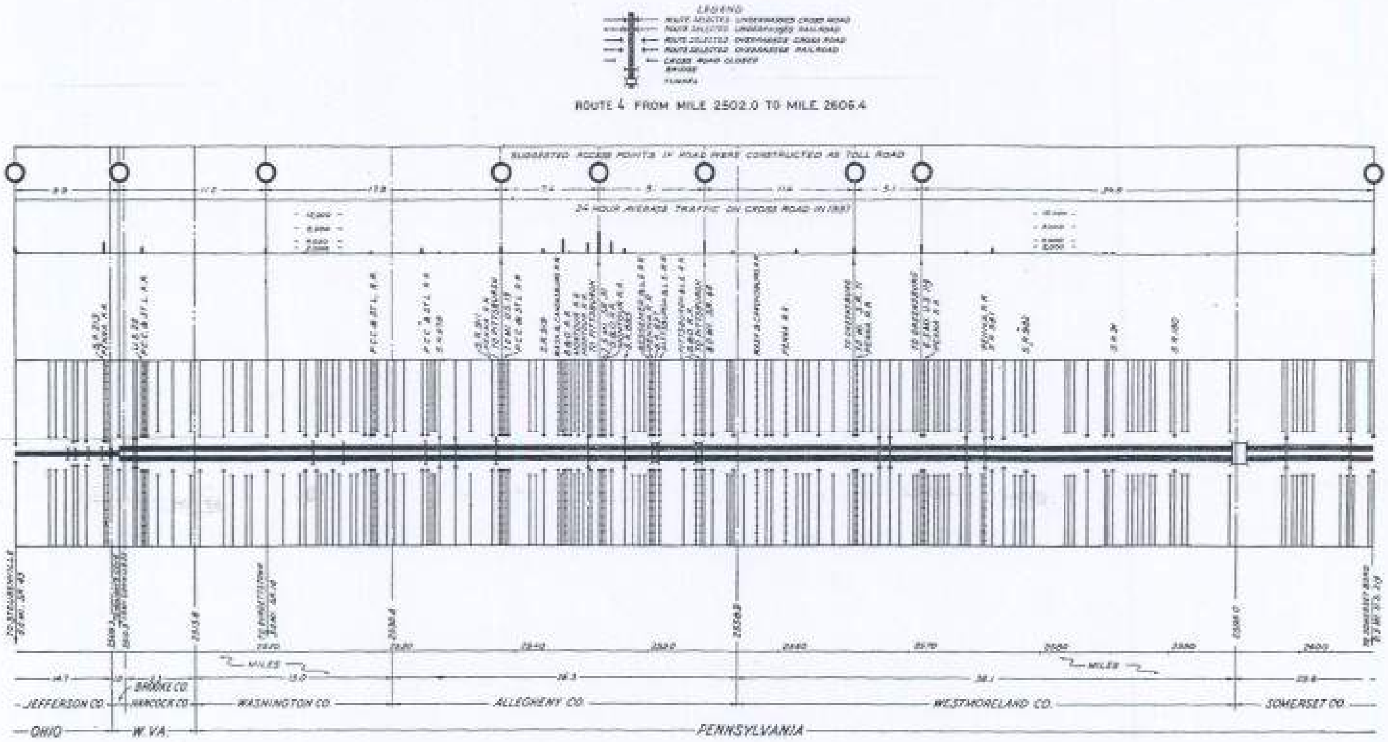


PLATE 35.—Straight-line diagram showing physical features of a typical Appalachian Mountain section of the selected system.

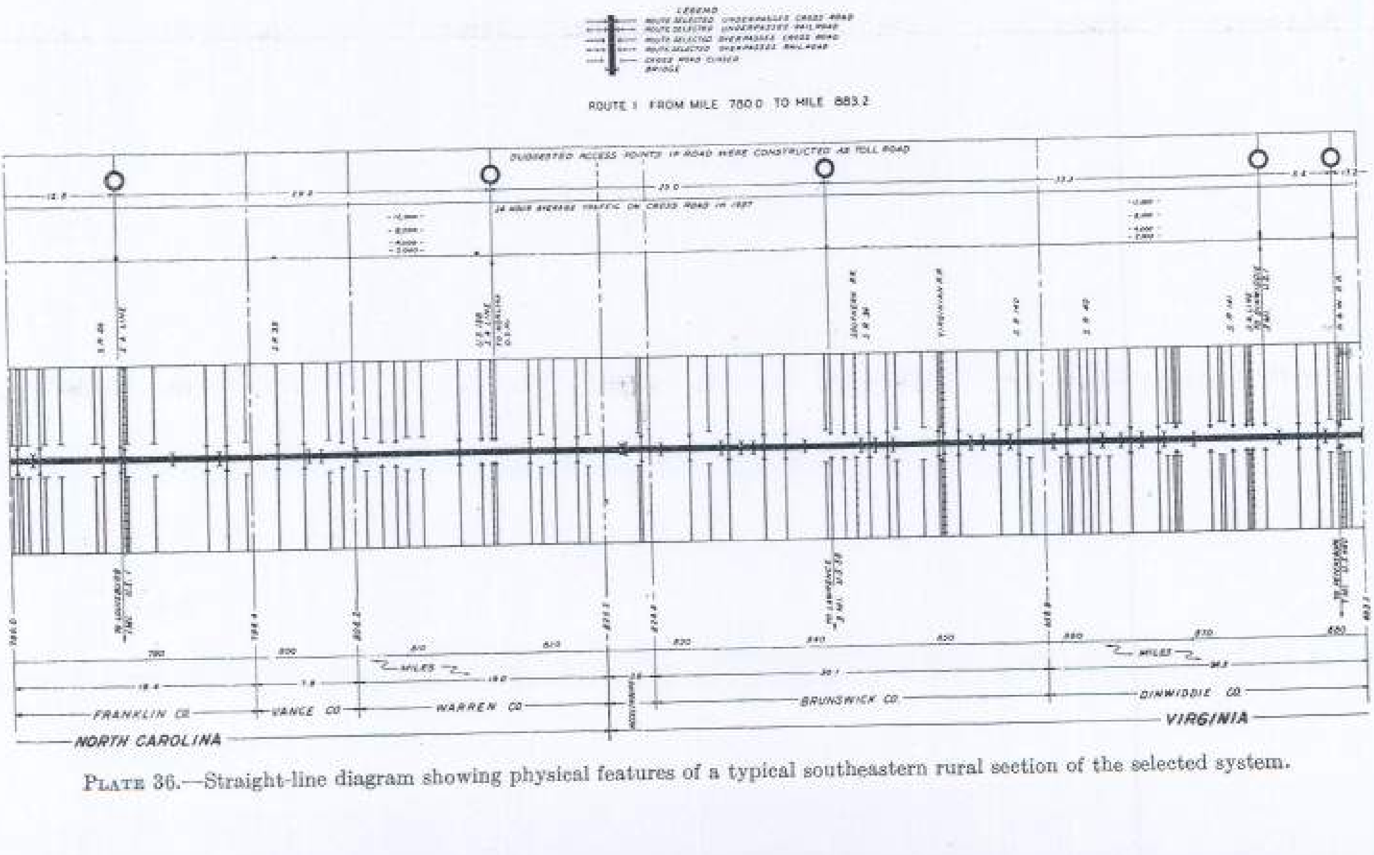


PLATE 36.—Straight-line diagram showing physical features of a typical southeastern rural section of the selected system.

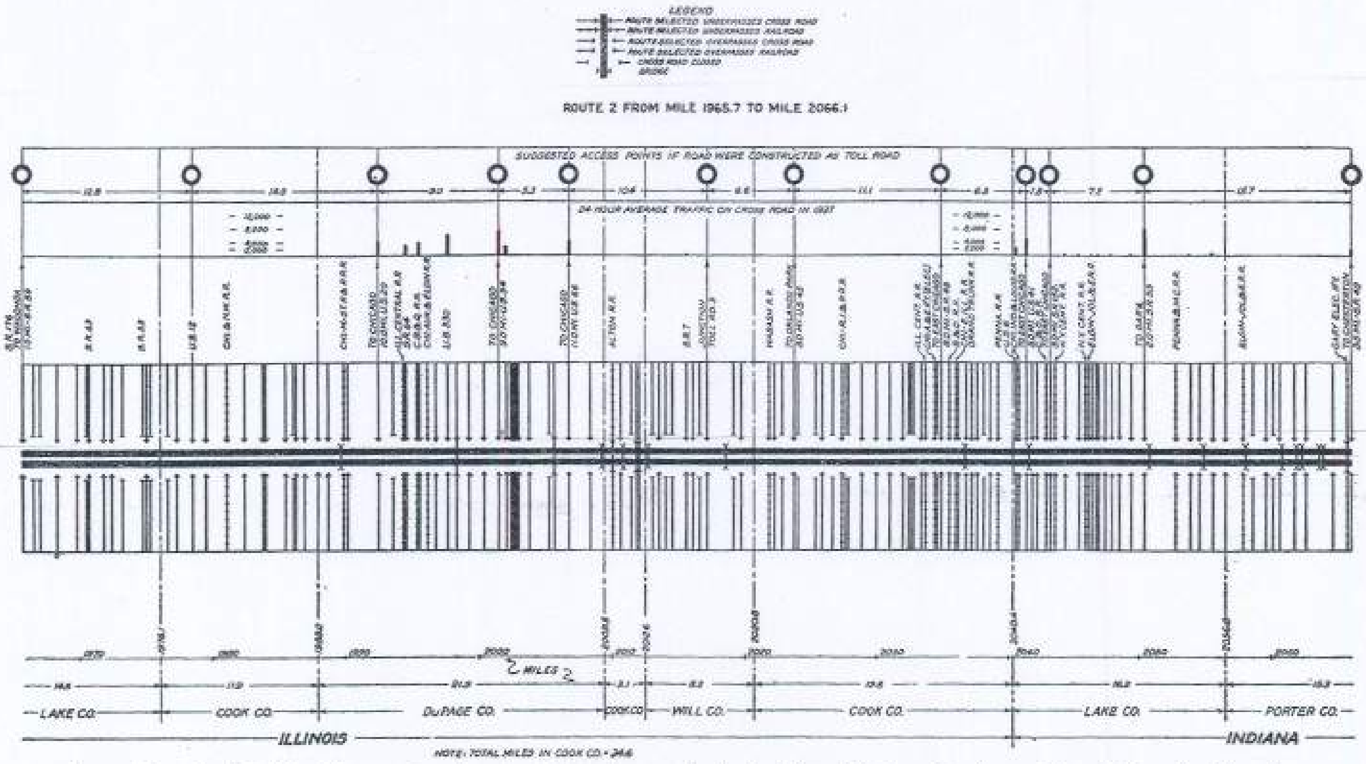


PLATE 37.—Straight-line diagram showing physical features of a typical Great-Lakes suburban section of the selected system.

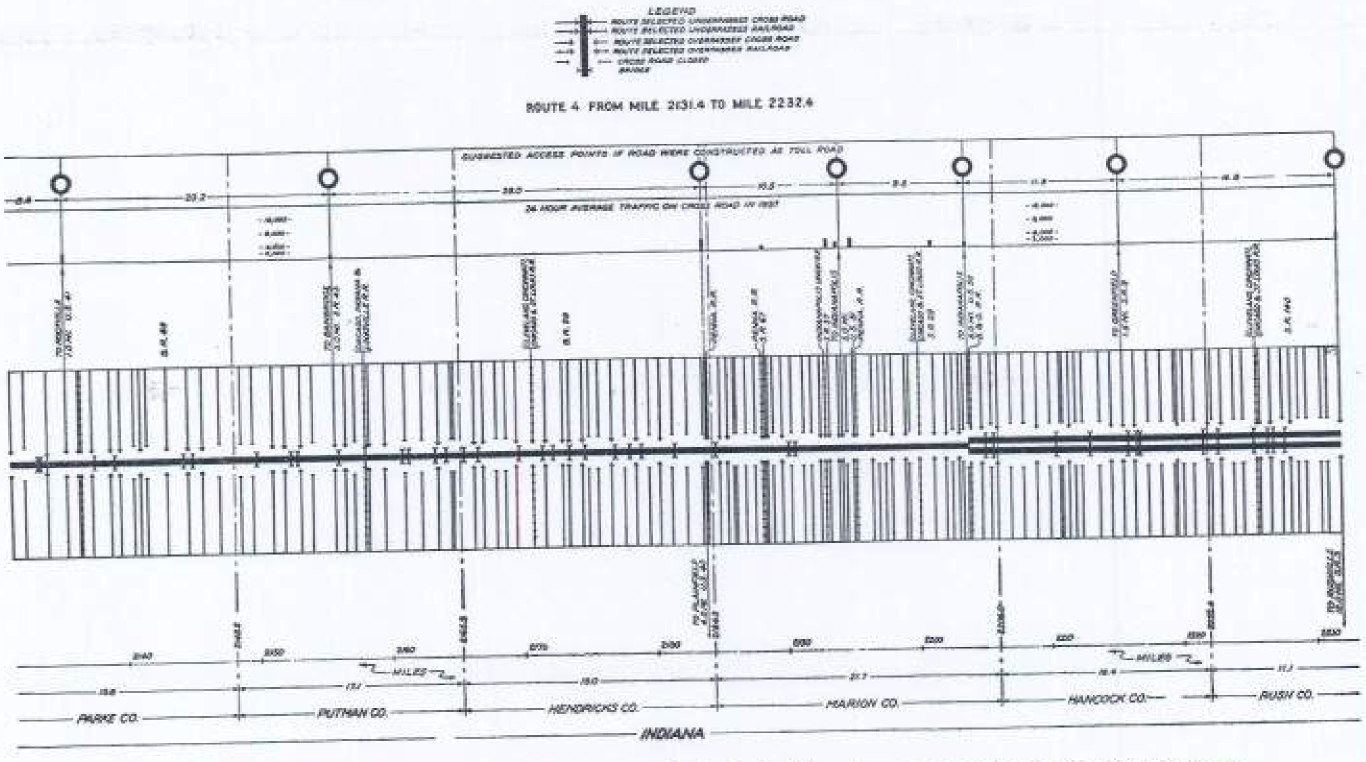


PLATE 38.—Straight-line diagram showing physical features of a typical midwestern rural section of the selected system.

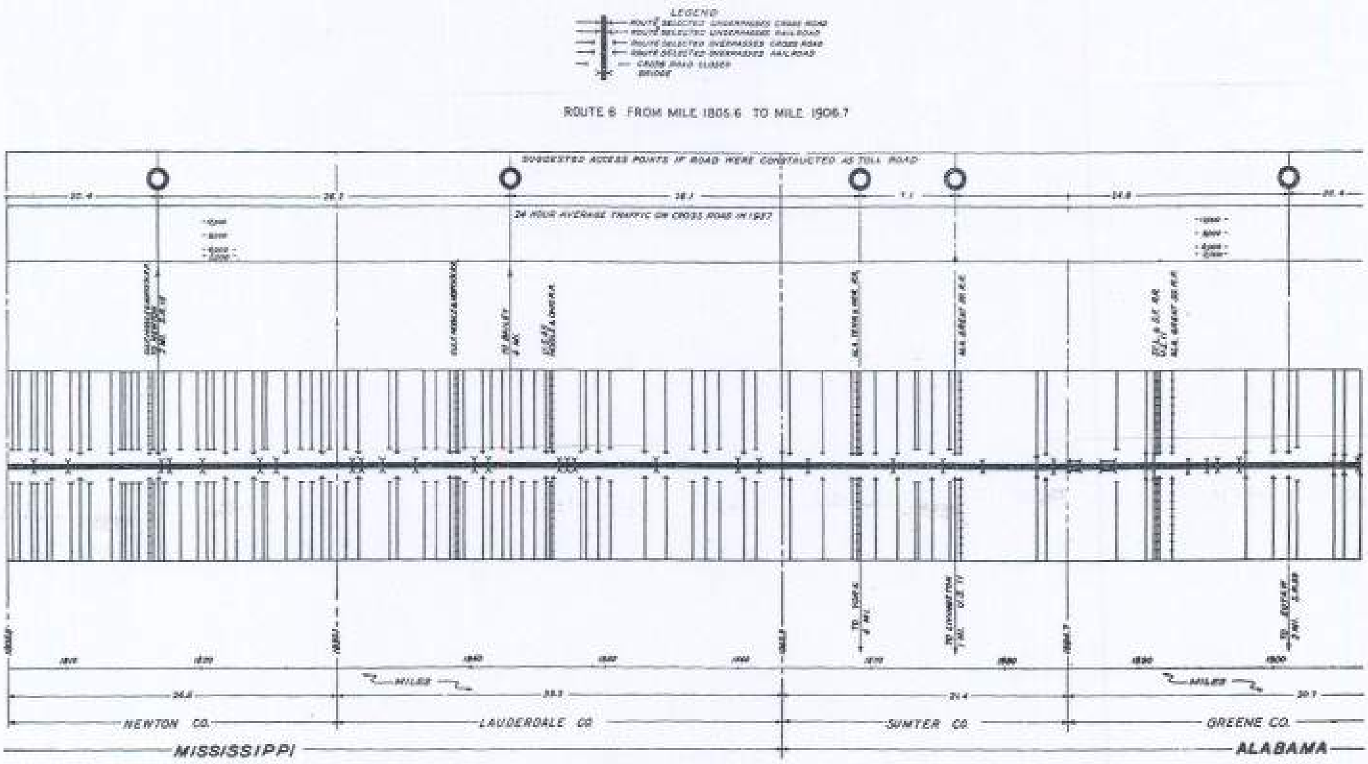


PLATE 39.—Straight-line diagram showing physical features of a typical south-central rural section of the selected system.

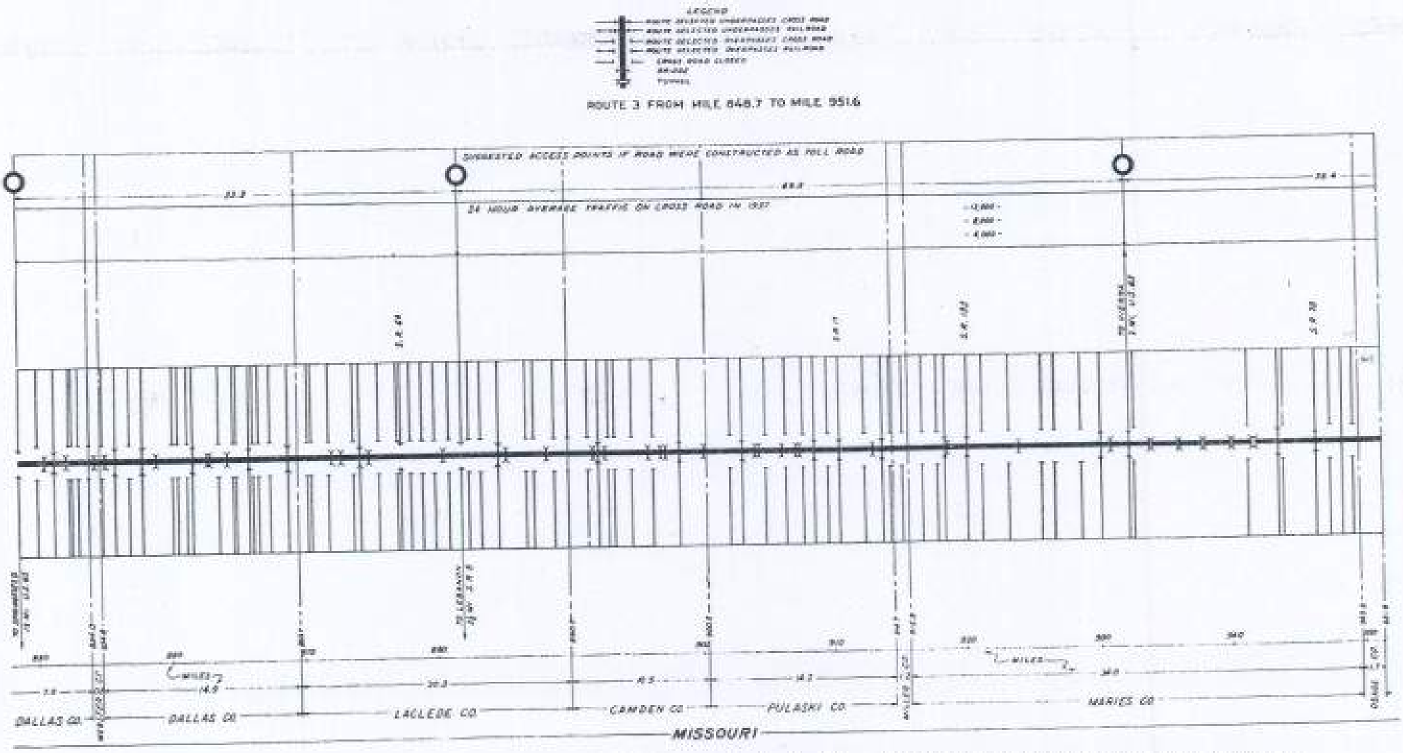


PLATE 40.—Straight-line diagram showing physical features of a typical Ozark Mountain section of the selected system.

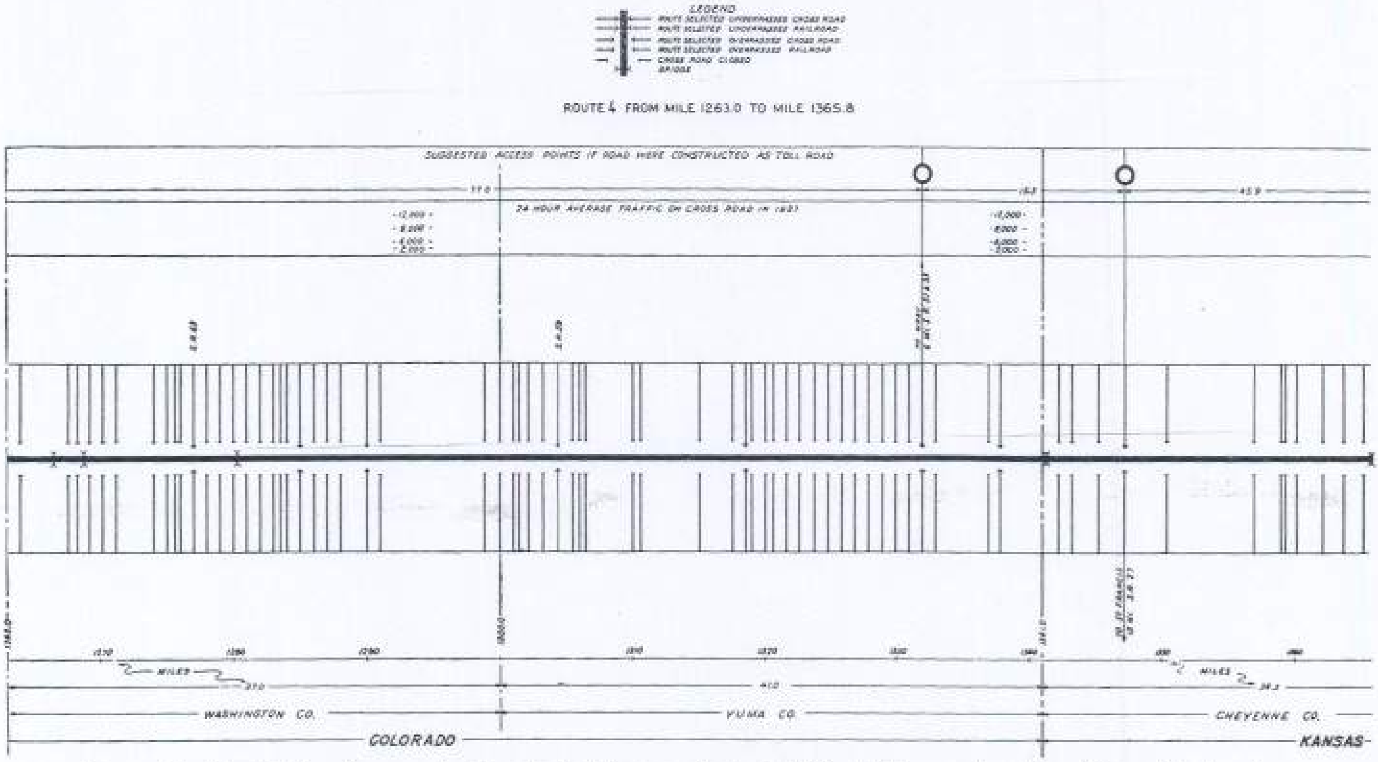


Plate 41.—Straight-line diagram showing physical features of a typical Great Plains rural section of the selected system.

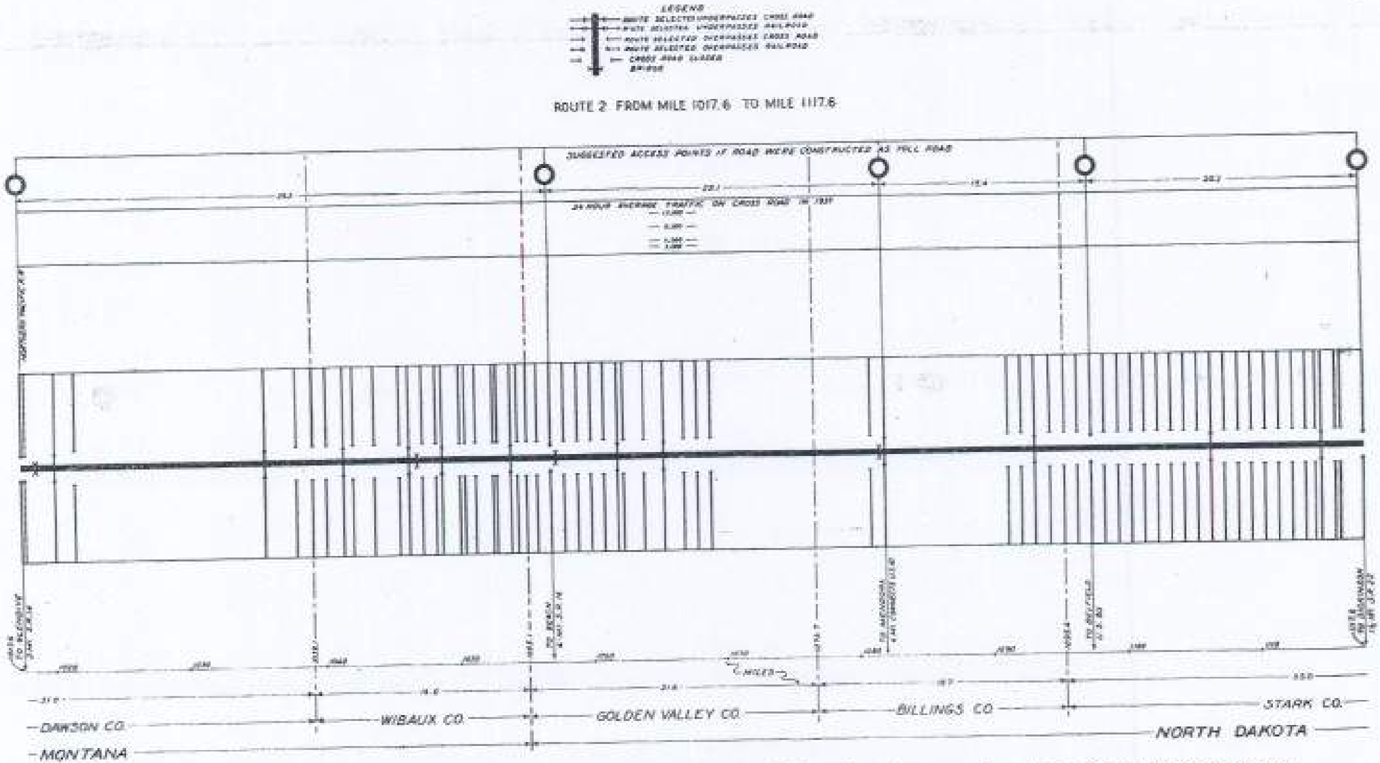


Plate 42.—Straight-line diagram showing physical features of a typical northwestern rural section of the selected system.

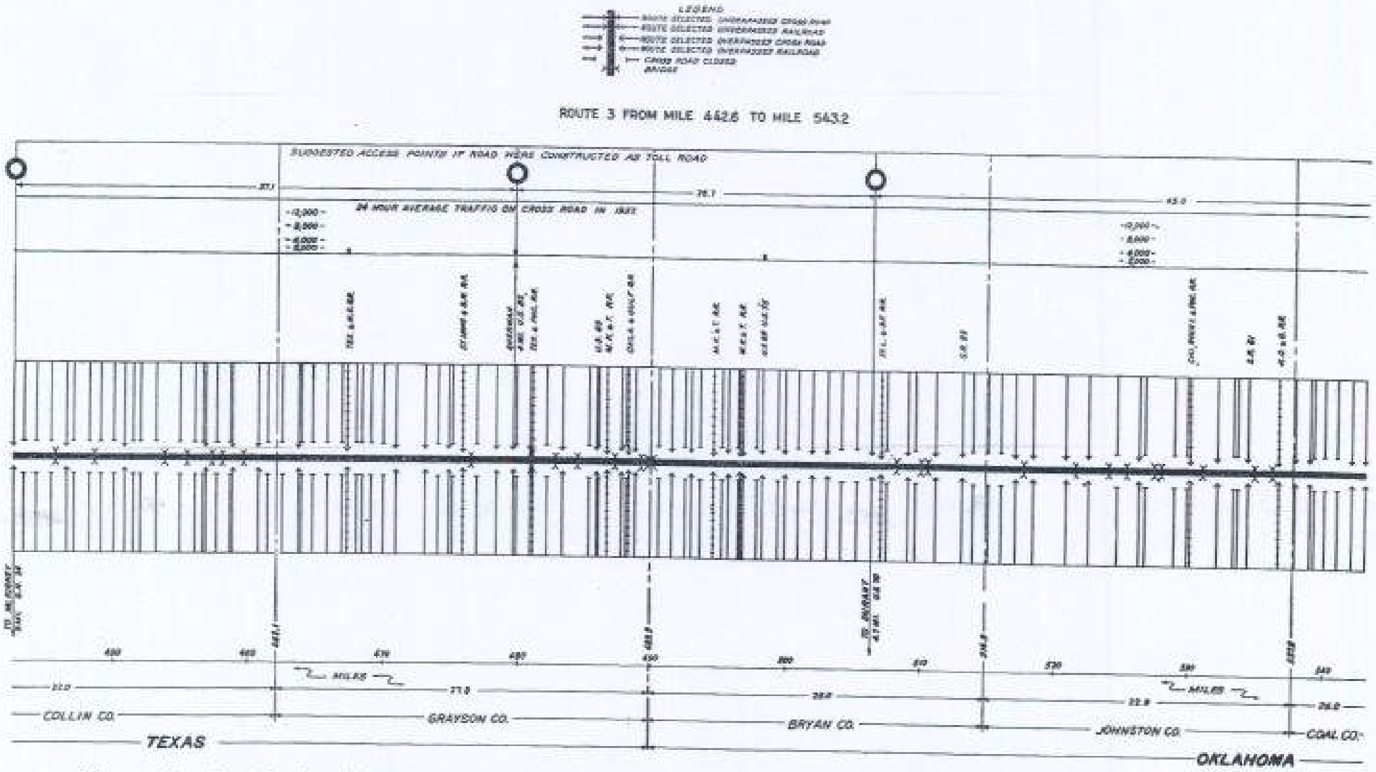


PLATE 43.—Straight-line diagram showing physical features of a typical southwestern rural section of the selected system.

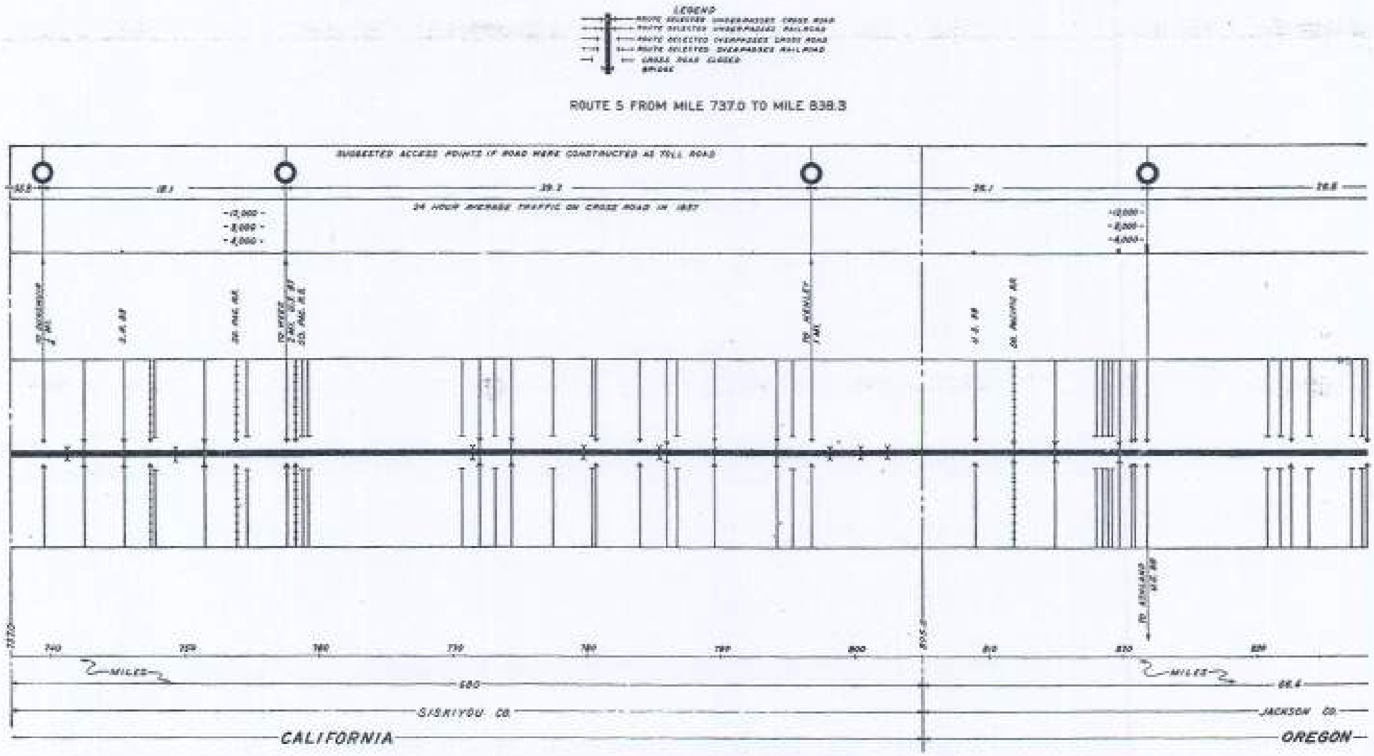


PLATE 44.—Straight-line diagram showing physical features of a typical Pacific coast mountain section of the selected system.

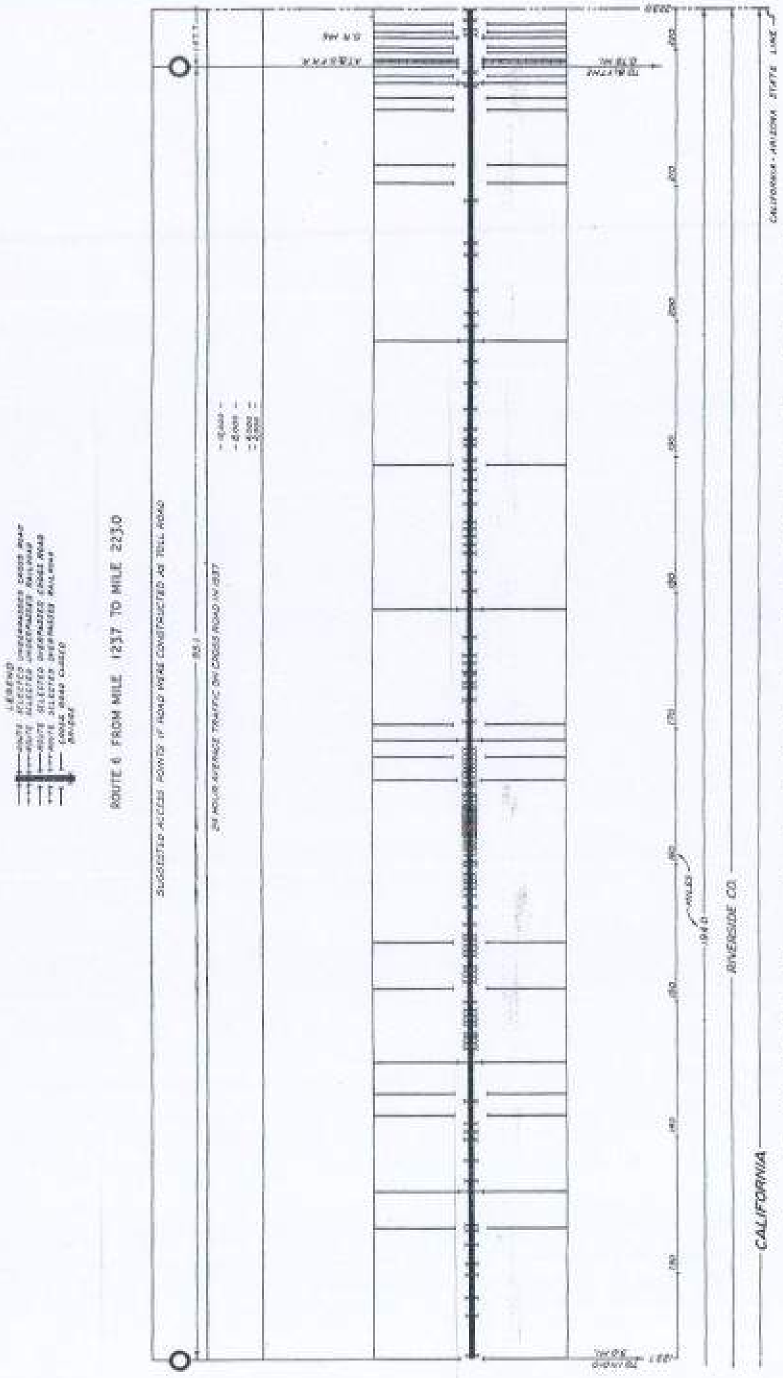


Plate 45.—Straight-line diagram showing physical features of a typical desert section of the selected system.

Wherever bridges or trestles over rivers and streams would be required on the route locations as projected they are shown on these diagrams. At intersections of the projected lines with all other roads and railroads the diagrams indicate the probable manner in which the grades at the intersection would be separated, whether by underpass or overpass.

The estimated 1937 traffic on all cross roads at their points of intersection with the projected route locations is shown by the length, to an indicated traffic scale, of short vertical bars appropriately positioned above the points at which the corresponding cross roads intersect the projected line. Consistent with the indications of this traffic scale, numerous lightly traveled cross roads are shown as scheduled for closing if the projected road is built, their traffic to be diverted to nearby crossings.

Finally, the straight-line diagrams and the tabulated information on which they are based show the location of all proposed access points on the routes as located, and their relation to cities and towns and important intersecting roads.

Coupled with the large-scale maps showing the approximate geographic position and courses of the routes, the diagrammed and tabulated decisions with respect to the design of the roads serve as the basis for the estimated cost of the proposed facilities.

ESTIMATED COSTS OF RIGHT-OF-WAY AND CONSTRUCTION

The estimates of right-of-way and construction costs were made and compiled in the several district offices of the Bureau of Public Roads in accordance with uniform basic decisions laid down by the Chief of Bureau. All unit costs and construction quantities used were based on intimate knowledge of all local conditions and the current prices paid for the various items of work.

Right-of-way.—Right-of-way, exclusive of accesses, was assumed to consist of 36 acres per mile for rural areas and a minimum of 19 acres per mile for urban areas. These values are based on widths of 300 feet and 160 feet, respectively. For each access point, from 3 to 10 acres were added for two-lane construction and from 10 to 15 acres were added for four-lane construction. Property damage, if any, was estimated and added as a lump sum between control points. Right-of-way and property damage varied from a minimum of $5 per acre to $50,000 per acre.

Where it was necessary to relocate existing highways or construct new service roads between control points so that traffic on closed cross roads could be rerouted to nearby separated crossings or to restore service on public roads occupied by the new construction, estimates were made of the mileage involved and the costs per mile.

Grading.—Estimates of grading quantities were based upon a uniform schedule of earthwork volumes per mile corresponding to five general types of topography, from which an appropriate selection was made for each varying section of the located lines.

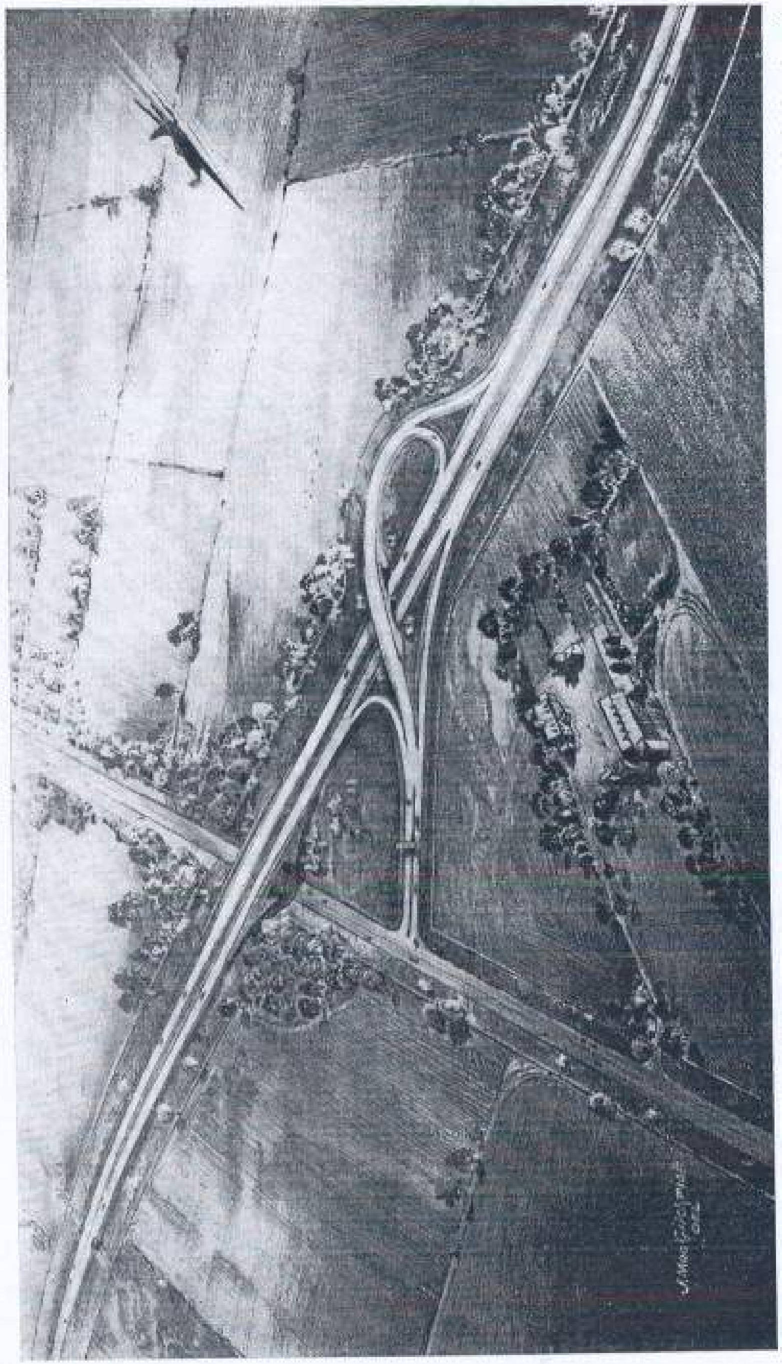


PLATE 33.—A two-lane toll road widened to four lanes approaching an access point at which only one toll booth is provided, showing the grade separating structure necessary to avoid hazards of left turns on the toll road.

lanes would be provided, clear of the normal traffic lanes, to permit traffic to slow down before entering the access drive and to pick up speed before weaving into the high-speed traffic stream on the toll road.

Access drives would lead by easy grades and curves past the toll booths which would be visible from the toll road and the intersecting road. Ample storage space for entering vehicles would be provided approaching the toll booths.

A typical grade separation, access roads, and toll booths for a two-lane toll road are shown in plate 32. Traffic on the toll road should be prevented from making left turns. Two access drives and two toll booths, therefore, would be provided regardless of traffic density. To prevent all possible conflicts of turning traffic the toll road would have to be designed as a four-lane divided road at the intersection. A less complete facility, but one which might suffice on the more lightly traveled roads, would be provided by widening the two-lane road to three lanes, as shown in plate 32. The middle lane, in this case, should contrast in color and surface texture with the outside traffic lanes and generally would be used only by through traffic to pass vehicles slowing down to leave the toll road or vehicles just entering the toll road. Acceleration and deceleration lanes, therefore, would not be necessary with this type of facility.

As toll collection constitutes an appreciable operating expense, study was made of the possibility of utilizing only one toll booth at each access and providing traffic circulation so that all crossing of traffic would be avoided. The result is shown in plate 33. On a conservative basis it was estimated that the annual cost of operation of a second toll booth would be less than the excess of the annual interest and amortization charges on the cost of the extra grade separation structure and other additional construction over the relatively simple arrangement of two accesses. This is particularly marked for two-lane roads where the cost of constructing an appreciable length of four-lane divided road as against a three-lane road must be added to the extra cost.

At intersections with important existing highways on which the making of left turns is hazardous, four access roads or a full clover-leaf type of grade separation with four toll booths should be provided.

LIGHTING

The proposed roads would be lighted to the extent justified. Lighting is considered to be necessary in tunnels, on long bridges, and access drives and in suburban areas where lighting of adjacent streets would confuse drivers if similar lighting were not provided on the road. While fixed sources of light are generally to be preferred, other methods of outlining the road at night, such as the use of reflectors, may be considered as supplements and possibly as a substitute for fixed-source lighting.

SIGNS

Because of the relatively high speeds expected on the proposed roads some variation from the standards recommended by the Manual on Uniform Traffic Control Devices of the Joint Committee of the American Association of State Highway Officials and the Conference on Street and Highway Safety would be required in the design, erection, and location of signs. Generally the signs would be much larger than those recommended in the manual so that they could be read at greater distances; and those intended to give notice of the approach to access points would be erected in multiple so that drivers would be informed repeatedly of the facility ahead some time before reaching it. The character of the road should obviate the necessity for a multiplicity of warning signs. All signs would be lighted or of the reflecting type so as to be easily readable at night.

LANDSCAPE DEVELOPMENT

The roadside and slopes would be protected against erosion largely by the use of flat and rounded slopes. Additional protection would be given by topsoiling and seeding to produce vegetative cover suited to location, soil, and climate.

The roadsides would be planted under the supervision of landscape architects with the general objective of giving a pleasing appearance and making the new construction fit into the surrounding landscape. Only native trees and shrubs that require little or no maintenance would be planted. They would be arranged naturally in groups at some distance from the pavement so as not to present secondary hazards to cars out of control.

The desirability of providing roadside parks, picnic areas, and other facilities inviting drivers to stop and rest must be determined by future policy. Facilities that would invite short-trip traffic and make the long trips more pleasant would build up public good will and might add appreciably to the revenues collected.

FENCING AND PROTECTION OF RIGHT-OF-WAY

Protection from encroachment is necessary on a toll road. Both sides of the road would have to be fenced except where steep slopes, dense forests, canyons or other natural conditions give the needed protection. The type of fence required will depend upon local conditions.

DETAIL OF ROUTES DIAGRAMMED THROUGHOUT

The standards of design described in the foregoing pages have been applied in detail to the approximate route locations as fixed on the large-scale maps, and all design decisions necessary for an estimate of cost have been made in great detail. Such decisions have been recorded in tables for the entire mileage of the selected routes. Straight-line diagrams of the tabulated data for portions of the mileage, representative of various sections of the country, are shown in plates 34 to 45.

On each of these diagrams the section of the selected routes covered is represented by a central line or lines. A single line indicates that the pavement designed for the particular section is two lanes wide; double lines indicate sections that would be constructed with divided four-lane pavements. Scaled distances along the central line or lines represent the lengths of continuous sections of each width of pavement; and at properly scaled intervals the positions of all cross roads, intersecting railroads, rivers, State and county lines, and other significant features of the locations as fixed are symbolically indicated.

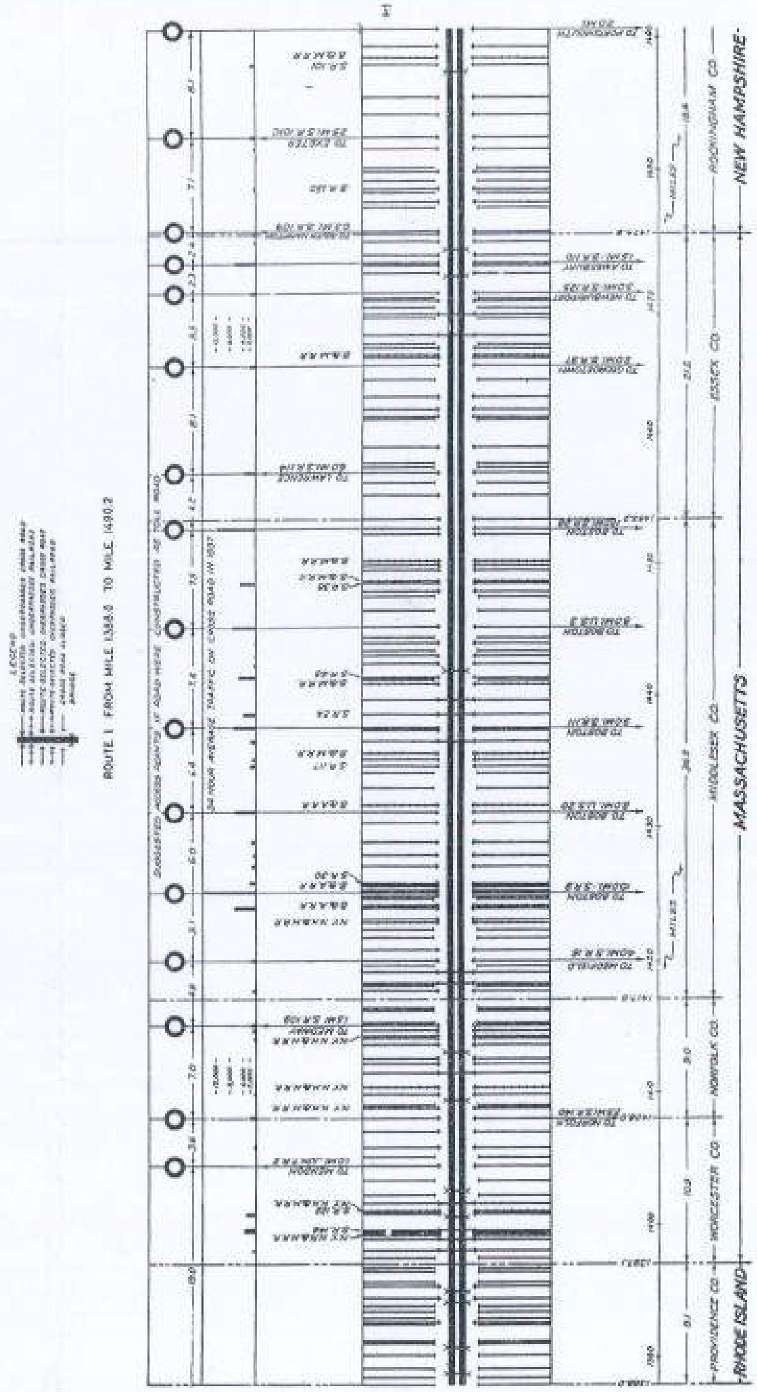


PLATE 34.—Straight-line diagram showing physical features of a typical New England section of the selected system.

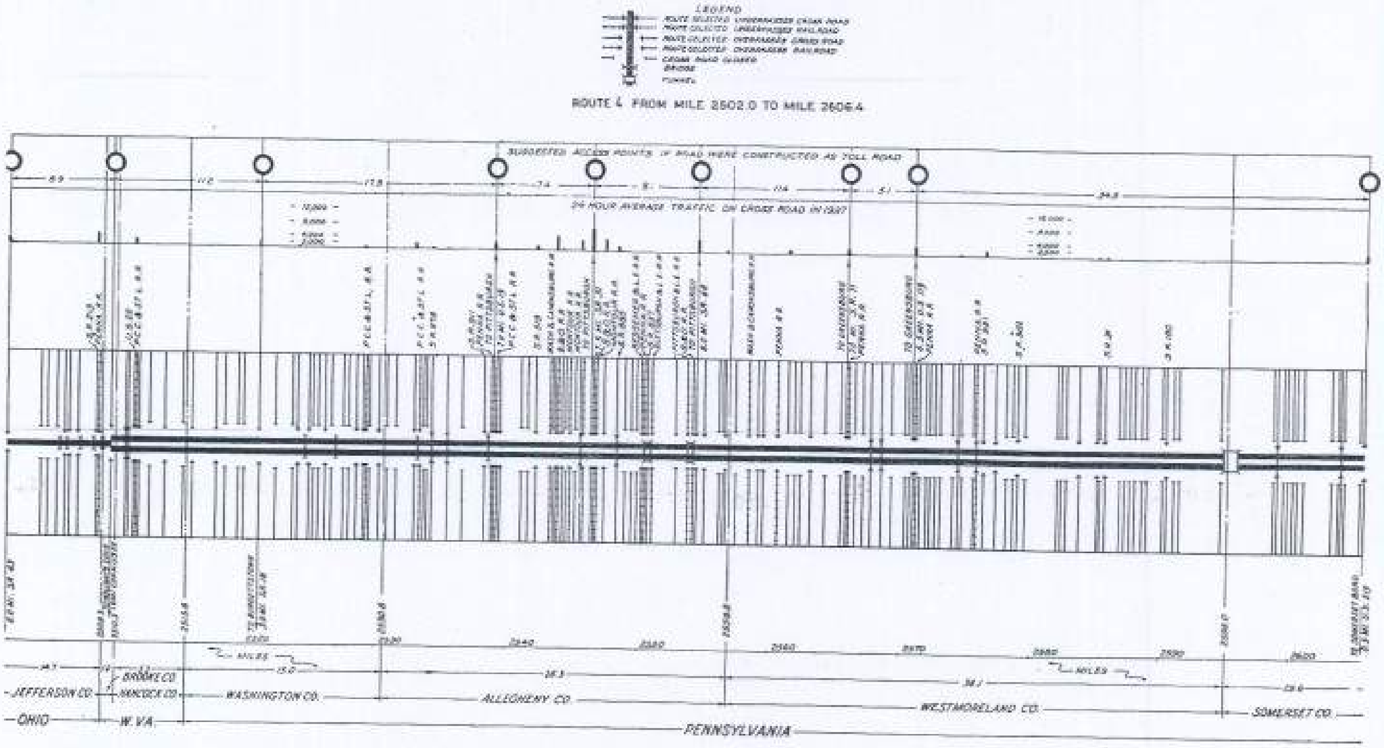


Plate 35.—Straight-line diagram showing physical features of a typical Appalachian Mountain section of the selected system.

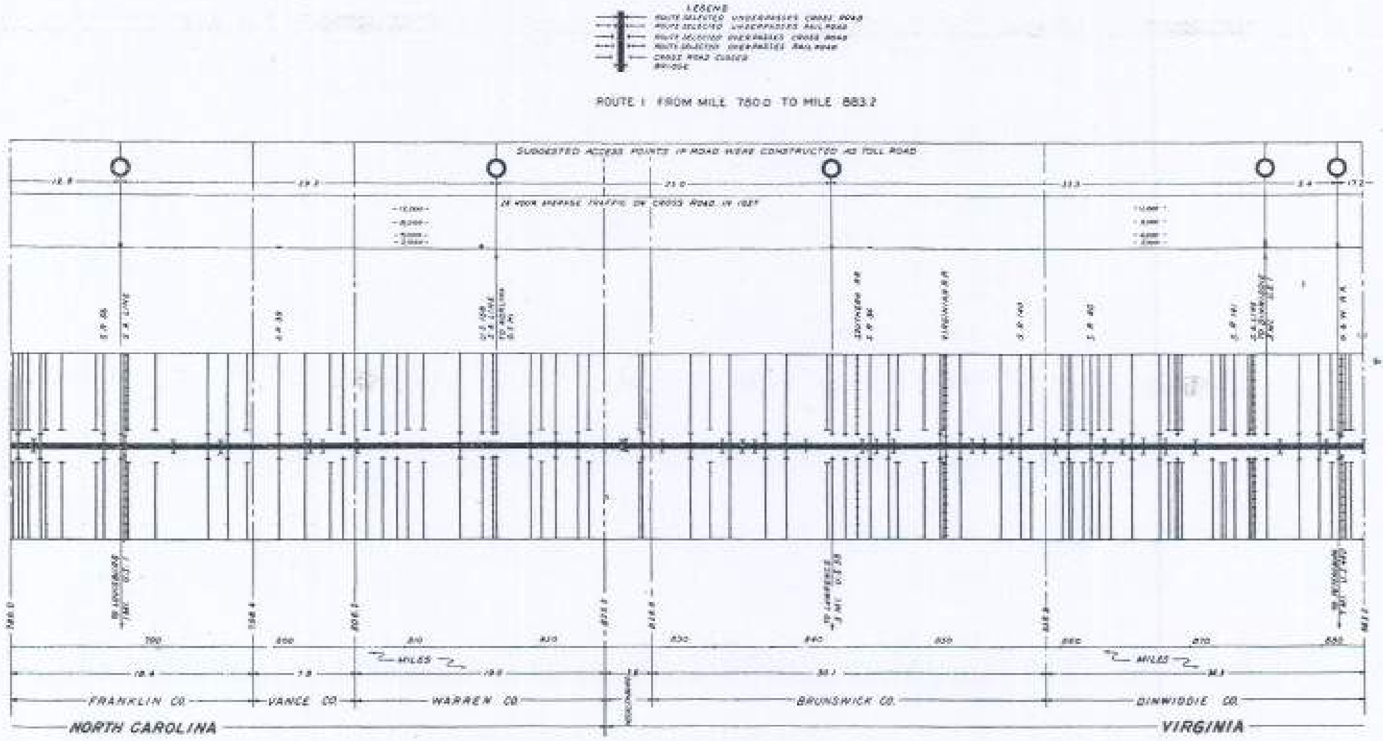


Plate 36.—Straight-line diagram showing physical features of a typical southeastern rural section of the selected system.

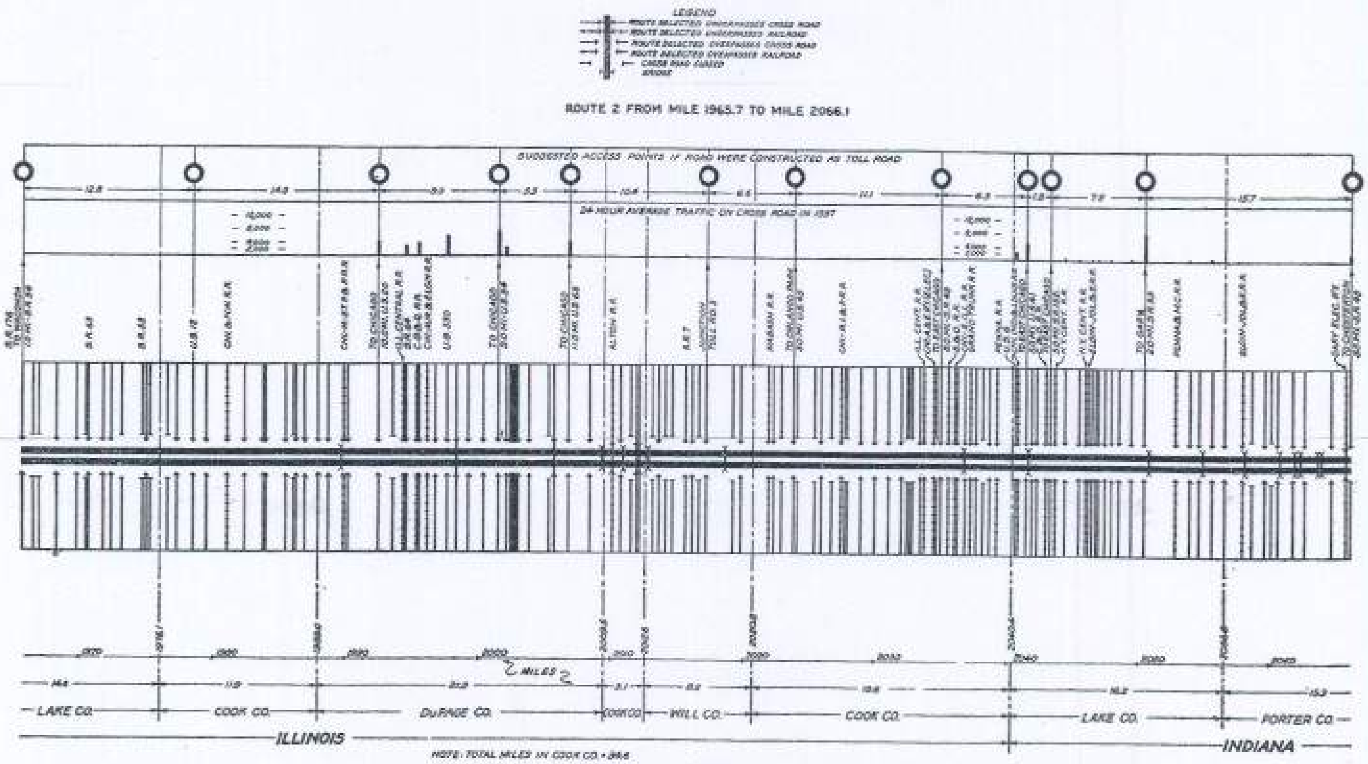


PLATE 37.—Straight-line diagram showing physical features of a typical Great-Lakes suburban section of the selected system.

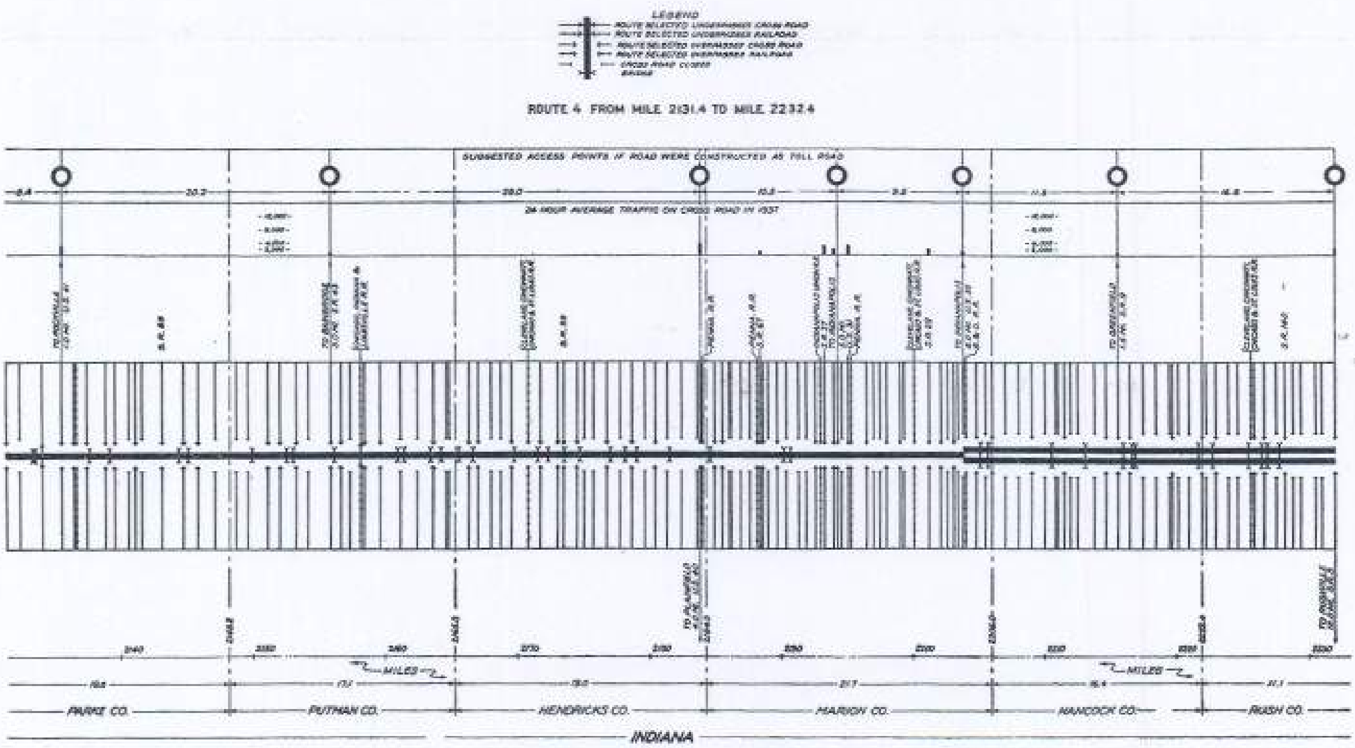


PLATE 38.—Straight-line diagram showing physical features of a typical midwestern rural section of the selected system.

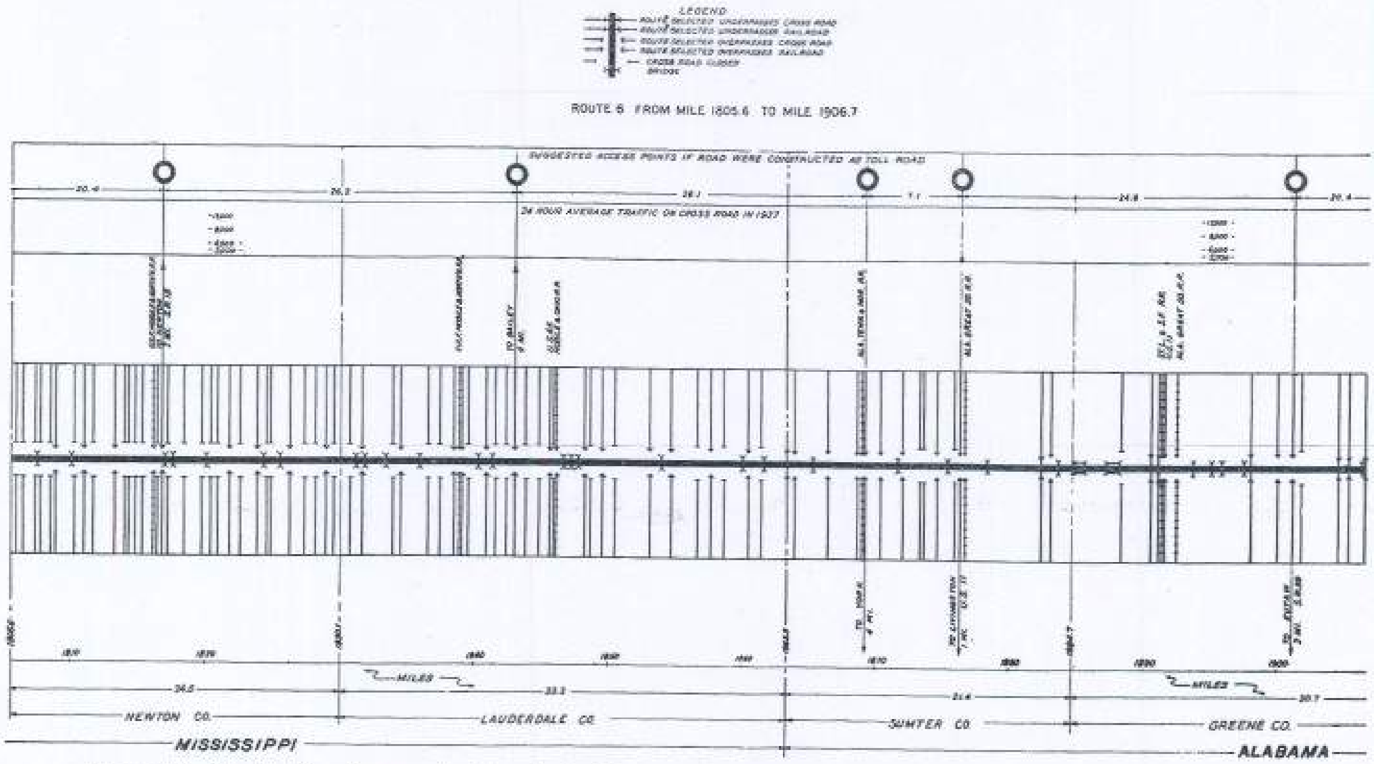


PLATE 39.—Straight-line diagram showing physical features of a typical south-central rural section of the selected system.

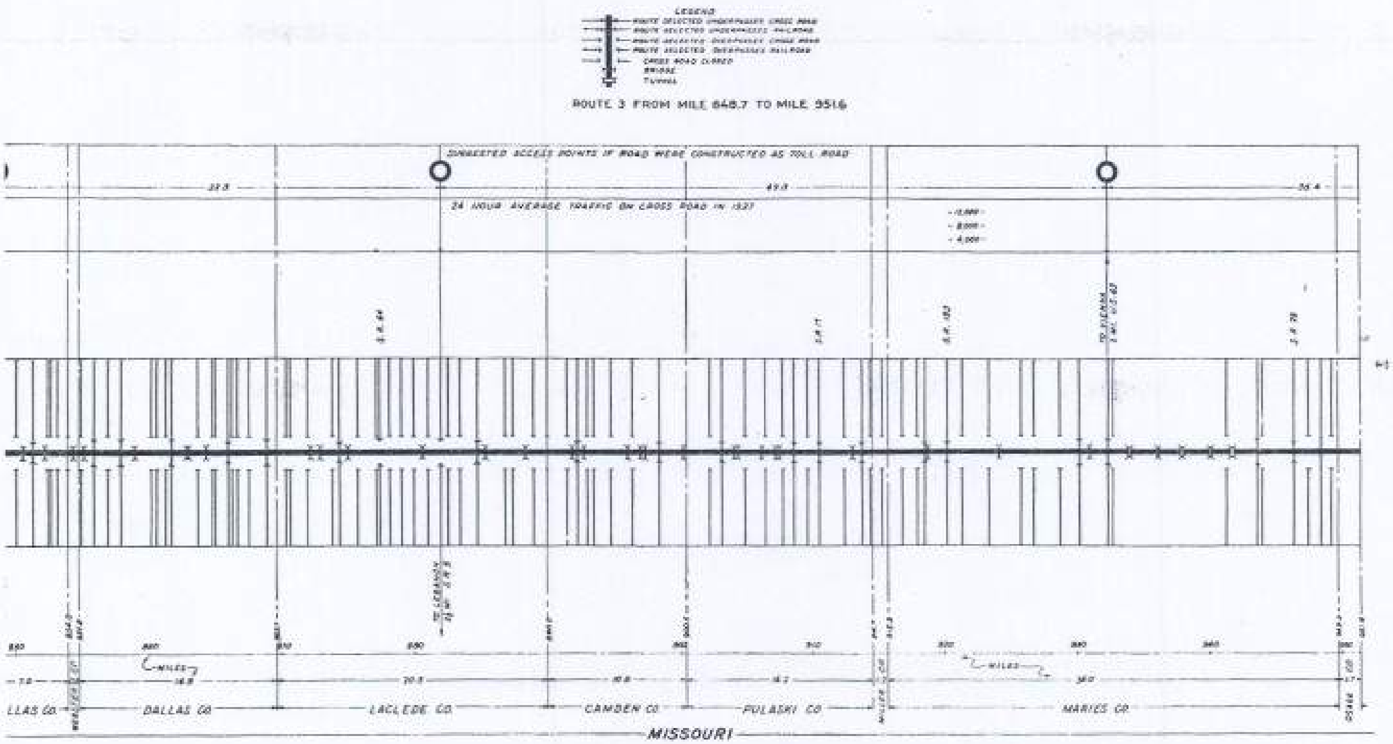


PLATE 40.—Straight-line diagram showing physical features of a typical Ozark Mountain section of the selected system.

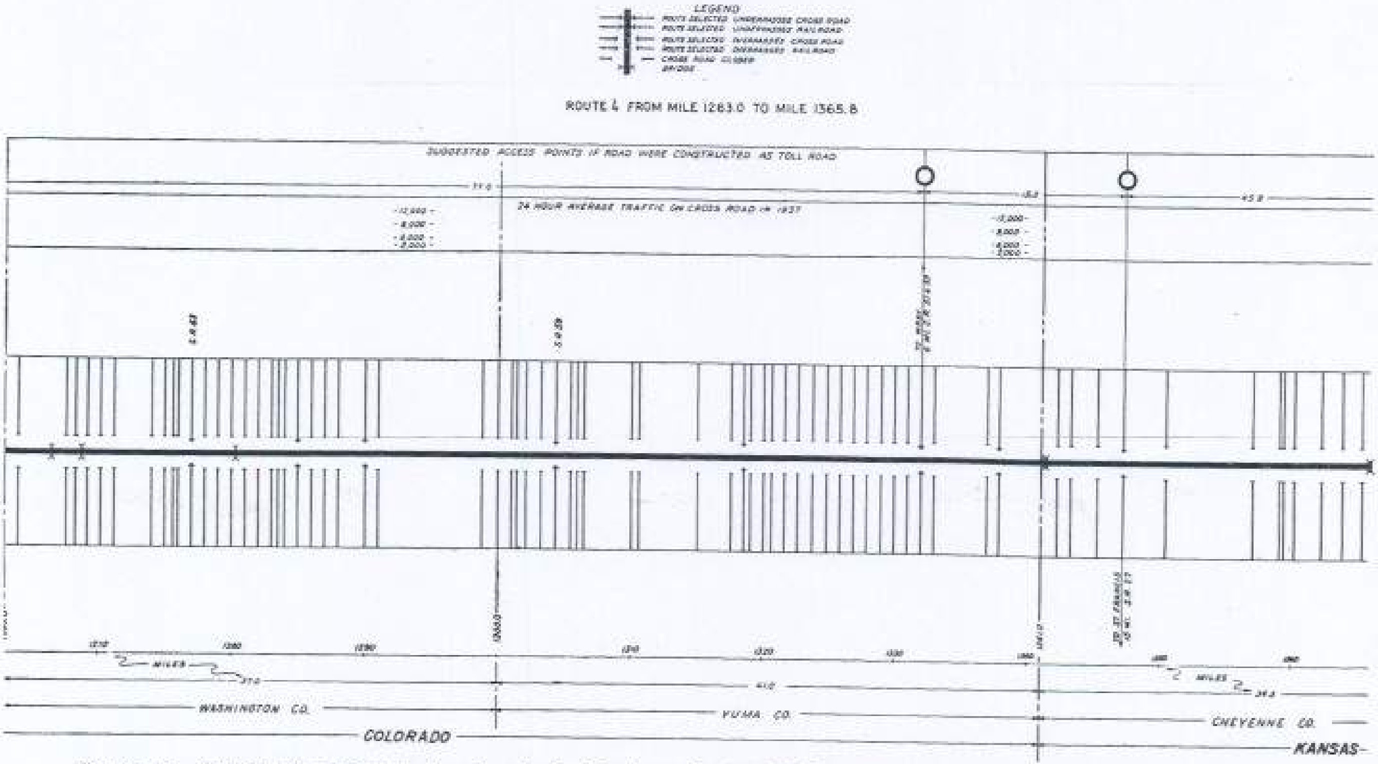


PLATE 41.—Straight-line diagram showing physical features of a typical Great Plains rural section of the selected system.

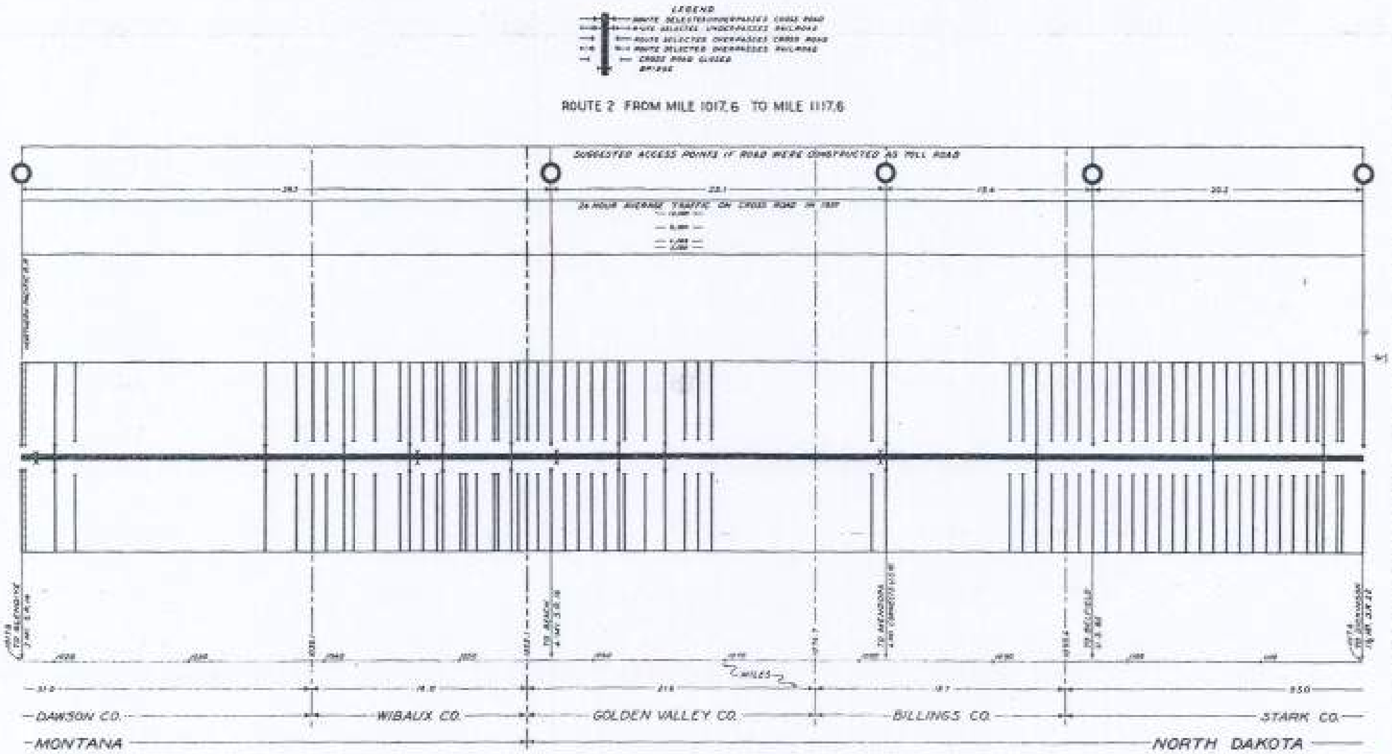


PLATE 42.—Straight-line diagram showing physical features of a typical northwestern rural section of the selected system.

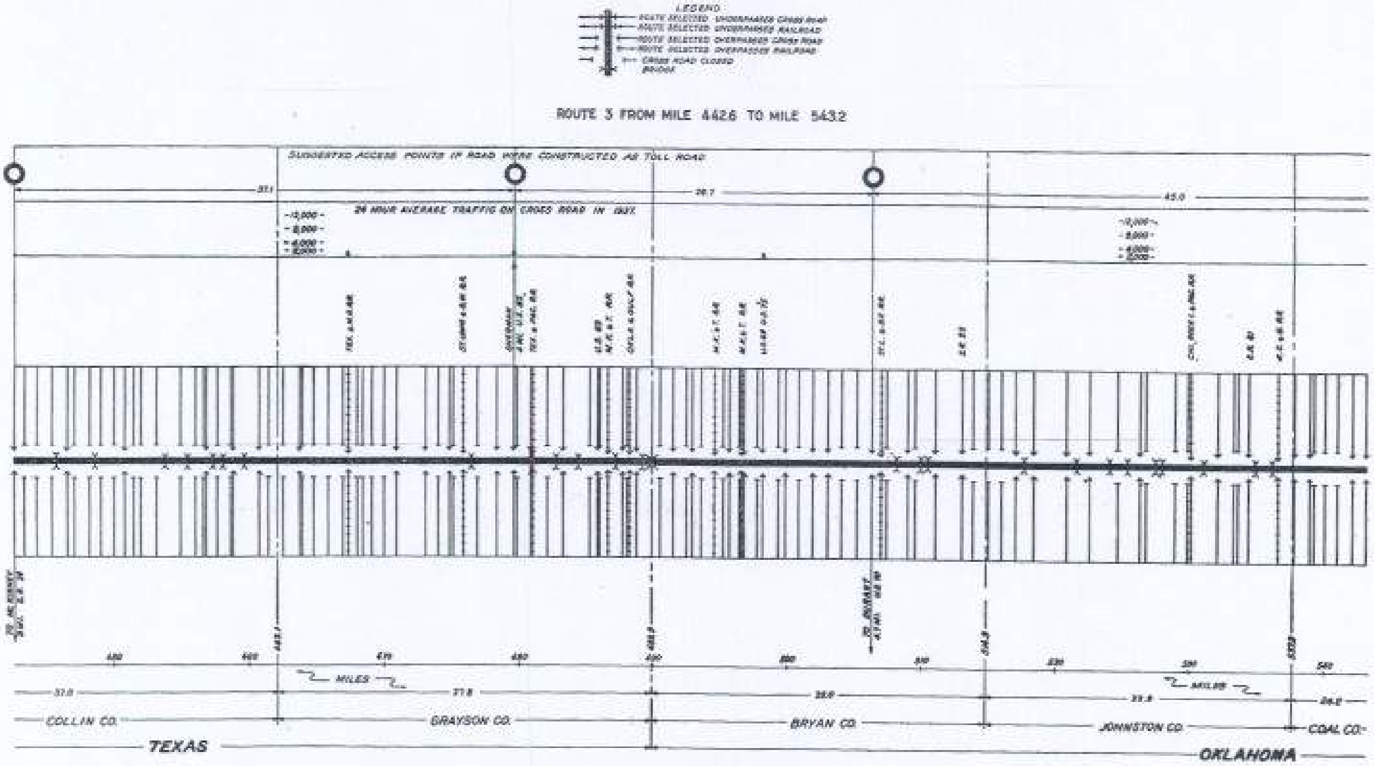


PLATE 43.—Straight-line diagram showing physical features of a typical southwestern rural section of the selected system.

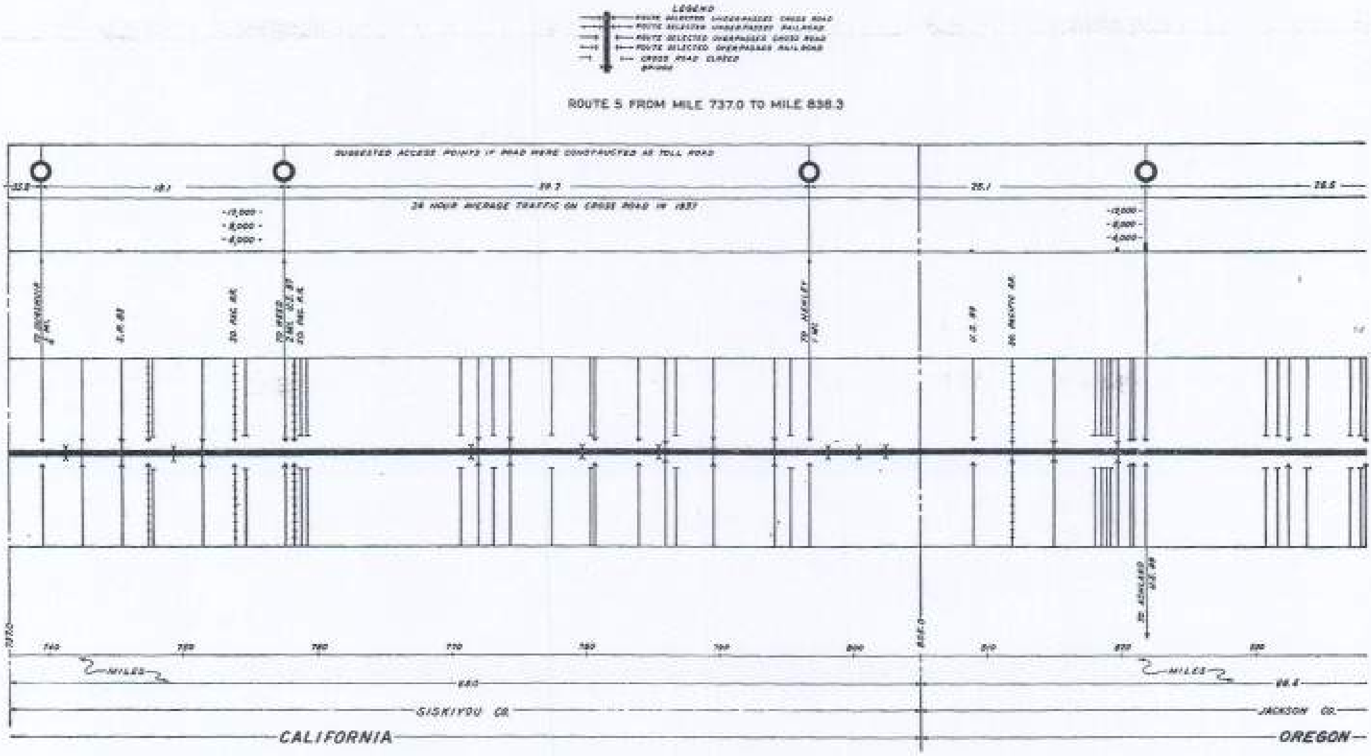


PLATE 44.—Straight-line diagram showing physical features of a typical Pacific coast mountain section of the selected system.

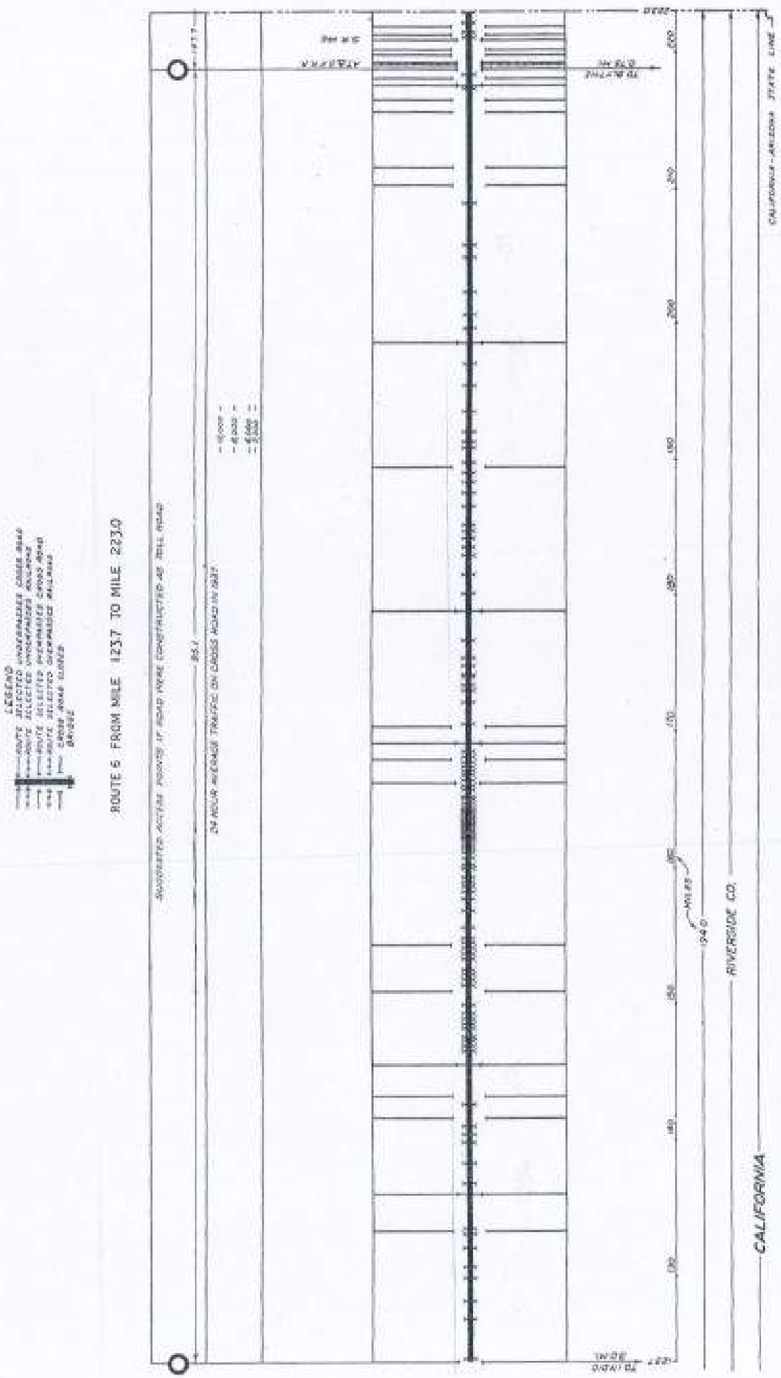


PLATE 45.—Straight-line diagram showing physical features of a typical desert section of the selected system.

Wherever bridges or trestles over rivers and streams would be required on the route locations as projected they are shown on these diagrams. At intersections of the projected lines with all other roads and railroads the diagrams indicate the probable manner in which the grades at the intersection would be separated, whether by underpass or overpass.

The estimated 1937 traffic on all cross roads at their points of intersection with the projected route locations is shown by the length, to an indicated traffic scale, of short vertical bars appropriately positioned above the points at which the corresponding cross roads intersect the projected line. Consistent with the indications of this traffic scale, numerous lightly traveled cross roads are shown as scheduled for closing if the projected road is built, their traffic to be diverted to nearby crossings.

Finally, the straight-line diagrams and the tabulated information on which they are based show the location of all proposed access points on the routes as located, and their relation to cities and towns and important intersecting roads.

Coupled with the large-scale maps showing the approximate geographic position and courses of the routes, the diagrammed and tabulated decisions with respect to the design of the roads serve as the basis for the estimated cost of the proposed facilities.

ESTIMATED COSTS OF RIGHT-OF-WAY AND CONSTRUCTION

The estimates of right-of-way and construction costs were made and compiled in the several district offices of the Bureau of Public Roads in accordance with uniform basic decisions laid down by the Chief of Bureau. All unit costs and construction quantities used were based on intimate knowledge of all local conditions and the current prices paid for the various items of work.

Right-of-way.—Right-of-way, exclusive of accesses, was assumed to consist of 36 acres per mile for rural areas and a minimum of 19 acres per mile for urban areas. These values are based on widths of 300 feet and 160 feet, respectively. For each access point, from 3 to 10 acres were added for two-lane construction and from 10 to 15 acres were added for four-lane construction. Property damage, if any, was estimated and added as a lump sum between control points. Right-of-way and property damage varied from a minimum of $5 per acre to $50,000 per acre.

Where it was necessary to relocate existing highways or construct new service roads between control points so that traffic on closed cross roads could be rerouted to nearby separated crossings or to restore service on public roads occupied by the new construction, estimates were made of the mileage involved and the costs per mile.

Grading.—Estimates of grading quantities were based upon a uniform schedule of earthwork volumes per mile corresponding to five general types of topography, from which an appropriate selection was made for each varying section of the located lines.

The schedule referred to follows:

Symbol	Type of topography	Earthwork quantities per mile of selected route		
		For sections with 2-lane pavements	For sections with 4-lane pavements and 20-foot central parkway	For sections with 4-lane pavements and 40-foot central parkway
		Cubic yards	*Cubic yards*	*Cubic yards*
RL	Relatively level	30,000	50,000	60,000
GR	Gently rolling	50,000	90,000	100,000
HR	Heavy rolling	100,000	180,000	200,000
LM	Light mountainous	200,000	350,000	
HM	Heavy mountainous	350,000	500,000	

These quantities were understood to represent averages per mile and were not construed as applying to short sections of the most rugged topography. Quantities intermediate between the tabulated values were used where conditions warranted. The estimated unit cost of grading varied from $0.15 to $1 per cubic yard, the average being about $0.32 per cubic yard.

Retaining walls.—Where retaining walls were recommended, as in heavy mountainous areas, estimated quantities were determined between control points. Consideration was given to the use of viaducts in lieu of high fills and grading quantities were appropriately modified.

Drainage structures.—Costs of drainage structures up to 20-foot spans were determined at an estimated cost per mile between given control points.

Surfacing.—High-type surfaces of a thickness consistent with anticipated traffic requirements were estimated on the basis of 14,100 square yards per mile for two-lane sections and 28,200 square yards per mile for four-lane sections. The unit costs varied from $0.65 to $3.30 per square yard, depending upon the type of surfacing used.

Miscellaneous.—Areas of clearing and grubbing were estimated to vary from about 8 acres per mile for two-lane sections to about 25 acres per mile for four-lane sections.

Curbs, where required to control drainage, were placed 2 feet outside the normal road surfacing and the estimated cost per mile included the cost of the extra 2 feet of pavement.

Guard railing was estimated where slopes as steep as 1 on 2 were required.

Large reflecting signs were provided in repetition approaching all accesses. A maximum amount of $1,000 per mile of highway regardless of width was allowed for this item.

Fencing, on both sides of the highway, was estimated at an average of $3,000 per mile.

Topsoiling, seeding, and planting costs depend to a considerable degree on topography and climate. Allowances were made for this item in the amounts of $5,000 to $8,000 per mile in suburban areas, and $3,000 to $6,000 per mile in rural areas.

Bridges, viaducts, tunnels, and accesses.—The width of bridges was defined as the perpendicular distance face to face of the bridge; the length as the distance face to face of the abutments measured parallel to the centerline of the road. An undercrossing was defined as one at which the selected route would pass under, and an overcrossing as

one at which the selected route would pass over, the intersecting road.

On the above bases of length and width, estimates were made for the following classes of structures at the costs assigned to each:

For stream bridges, less than 100 feet in length, $10 per square foot. For long stream bridges the estimates varied in accordance with conditions found at the sites. Costs ranged from $6.50 to $28.50 per square foot.

For bridges over railroads $15 per square foot plus $10,000 and for railroad bridges $20 per square foot plus $10,000.

For highway separation bridges in rural areas $15 per square foot plus $10,000, and in urban areas $17 per square foot plus $16,000.

Cattle passes, or equivalent land purchases, were estimated at about $8,000 for each two-lane and $15,000 for each four-lane highway crossing.

Costs of tunnels were estimated individually in accordance with the geological formation encountered.

Three general types of accesses were estimated at the following lump sums:

(A) Accesses to two-lane roads widened to three lanes at the intersection, with two toll booths, at a lump sum of $70,000 for each point of access. This lump sum included:

Grading, paving, and appurtenances of the accesses.

Widening to a three-lane highway for about 2,000 feet.

Transitions for the approaches to the widened portion.

Additional width of grade-separation structure.

(B) Accesses to two-lane roads widened to four lanes divided at the intersection, with two toll booths, at a lump sum of $240,000 for each point of access. The items involved are the same as for type A except that the item of widening involves a four-lane divided highway for about 3,700 feet.

(C) Accesses to four-lane roads, with two or more toll booths, at a lump sum of $50,000 for each point of access. The items involved are the same as for type A except those due to the widening of the selected route.

Type A was used for all two-lane sections except those which are expected to carry near-capacity traffic, where widening to a four-lane divided highway may reasonably be expected in a comparatively short time, in which case type B was used.

The field form used for estimating costs is illustrated by the typical sheets shown in plates 46 and 47. Estimates prepared on these forms were summarized by access points, by counties, by sections, and by routes.

The total cost for right-of-way and construction of the 14,336.2 miles of the selected routes, as estimated in the manner above described, including 10 percent for engineering, contingencies, and interest during construction, is $2,899,770,145, which is at the average rate of $202,270 per mile. The average costs estimated vary from a maximum of $1,158,412 per mile for the 65.6-mile section from Jersey City, N. J., to New Haven, Conn., to a minimum of $63,450 per mile for the 119.7-mile section from Rupert, Idaho, to Brigham, Utah.

Table 4 gives a summary of the physical features involved and the estimated costs by routes.

Tables 5 to 15 show a distribution of construction costs by items for the system and for each route, subdivided by States.

TABLE 4.—*Summary of physical features and construction costs by routes*

Route No.	Route	Length in miles			Number of roads closed	Number of underpasses	Number of overpasses	Number of railroad underpasses	Number of railroad overpasses	Number of bridges	Number of tunnels	Number of accesses	Total construction cost by routes
		Total	2-lane pavement	4-lane pavement									
1	Miami, Fla., to Madawaska, Maine	1,856.2	1,151.5	704.7	554	288	600	15	139	360		144	$464,886,080
2	Seattle, Wash., to Boston, Mass	2,978.8	2,007.6	971.2	1,272	378	697	29	167	383	2	145	548,053,850
3	Laredo, Tex., to Chicago, Ill	1,258.2	1,173.9	84.3	676	70	327	6	81	255	4	44	223,176,151
3 Mich	Angola, Ind., to Port Huron, Mich	174.7	54.7	120.0	123	12	100	3	13	37		16	48,363,666
4	Oakland, Calif., to Philadelphia, Pa	2,816.8	2,373.1	443.7	1,148	232	442	19	148	496	11	105	466,339,733
4-A	Capital Branch	88.5	88.5		52	9	26	1	4	12		7	13,087,200
4 S	Whitewater, Calif., to Salt Lake City, Utah	593.6	593.6		60	10	37	2	13	259		12	58,039,418
4 N	Portland, Oreg., to Salt Lake City, Utah	770.7	770.7		183	40	72	2	22	93	1	31	104,810,492
5	San Ysidro, Calif., to Blaine, Wash	1,406.4	604.0	802.4	377	253	275	6	64	333	8	84	371,527,504
6	Los Angeles, Calif., to Charleston, S. C	2,392.3	2,172.7	219.6	753	139	382	1	101	683	1	80	337,870,583
Total		14,336.2	10,990.3	3,345.9	5,198	1,431	2,958	84	752	2,911	27	668	2,636,154,677

TABLE 5.—*Summary of construction costs by routes*

Route No.	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
1	$39,301,135	$75,698,021	$16,747,530	$91,773,392	$3,003,165	$1,798,035	$2,663,385	$1,882,900	$5,427,750	$7,799,480	$209,731,287		$9,060,000	$464,886,080
2	43,875,413	113,092,140	29,979,265	131,954,429	3,928,303	1,628,970	4,082,810	2,379,300	8,931,000	12,088,000	179,602,220	$7,572,000	8,940,000	548,053,850
3	13,588,986	37,850,560	11,622,130	45,408,033	1,439,182	1,638,259	1,233,270	1,256,210	3,765,430	5,691,720	95,040,371	1,003,000	3,650,000	223,176,151
3 Mich	5,541,355	9,007,485	3,720,450	8,400,386	165,625	929,550	401,830	174,290	523,370	739,590	17,124,735		1,635,000	48,363,666
4	32,113,959	104,202,015	23,823,660	106,102,994	2,563,400	1,186,800	4,594,570	2,630,025	8,448,375	9,872,585	142,360,050	19,931,500	8,510,000	466,339,733
4-A	1,497,000	3,382,500	942,250	3,277,000	64,350	27,000	96,500	89,100	264,900	357,100	2,639,500		450,000	13,087,200
4 S	1,234,520	27,117,175	2,936,300	10,232,123	113,980		743,080	528,300	1,780,800	1,211,000	11,302,140		840,000	58,039,418
4 N	11,211,930	24,328,130	1,808,730	24,251,381	633,180		903,100	777,500	2,303,700	2,854,200	33,131,841	316,800	2,290,000	104,810,492
5	33,980,230	76,131,450	11,850,350	72,442,440	3,398,750	506,000	1,844,425	1,390,300	4,167,150	6,415,500	147,486,409	6,149,500	5,765,000	371,527,504
6	14,442,990	65,182,807	11,381,360	70,504,607	2,400,384	1,443,979	1,848,900	2,255,330	6,882,910	9,627,480	146,424,836		5,475,000	337,870,583
Total	196,787,518	535,992,283	114,712,025	564,436,785	17,710,319	9,158,393	18,411,870	13,362,255	42,495,385	56,656,665	984,843,389	34,972,800	46,615,000	[1] 2,636,154,677

[1] Plus 10 percent for engineering, contingencies, and interest during construction, $263,615,468; grand total, $2,899,770,145.

TABLE 6.—*Summary of construction cost of route 1 by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guard-rail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Florida	$3, 216, 360	$3, 672, 000	$657, 430	$14, 735, 000	$322, 400	----------	$178, 655	$358, 000	$1, 074, 000	$1, 136, 790	$16, 239, 440	----------	$1, 060, 000	$42, 650, 075
Georgia	411, 630	2, 122, 500	962, 200	3, 357, 512	205, 815	----------	----------	150, 000	226, 400	200, 000	5, 658, 485	----------	560, 000	13, 854, 542
South Carolina	838, 550	2, 158, 500	400, 400	7, 018, 275	423, 710	$237, 270	237, 270	200, 200	600, 600	800, 800	14, 267, 290	----------	700, 000	27, 882, 865
North Carolina	756, 850	4, 467, 250	609, 850	4, 317, 420	237, 900	----------	562, 350	153, 100	459, 300	765, 500	5, 599, 440	----------	560, 000	18, 488, 960
Virginia	2, 233, 520	5, 659, 781	1, 085, 150	9, 974, 675	309, 900	60, 715	549, 450	183, 150	549, 450	909, 790	8, 096, 746	----------	940, 000	30, 552, 327
Maryland	3, 248, 000	11, 655, 400	1, 639, 500	6, 718, 900	149, 700	120, 900	39, 000	95, 200	324, 800	549, 900	20, 813, 900	----------	450, 000	45, 805, 200
Delaware	391, 800	1, 541, 000	248, 500	965, 000	21, 400	28, 500	9, 000	14, 000	48, 800	99, 600	2, 065, 800	----------	100, 000	5, 533, 400
Pennsylvania	2, 160, 000	1, 514, 000	1, 102, 000	3, 950, 000	66, 000	45, 000	89, 000	56, 000	165, 000	224, 000	12, 148, 000	----------	550, 000	22, 069, 000
New Jersey	13, 189, 600	6, 714, 100	732, 400	6, 462, 900	144, 300	163, 000	216, 900	77, 200	231, 600	527, 000	38, 147, 800	----------	1, 250, 000	67, 876, 800
New York	4, 844, 000	795, 090	978, 500	2, 064, 240	48, 800	58, 100	73, 200	24, 400	73, 200	163, 000	36, 115, 260	----------	250, 000	45, 487, 790
Connecticut	3, 564, 750	12, 712, 500	5, 113, 500	7, 309, 440	432, 000	918, 000	270, 000	108, 000	270, 000	648, 000	24, 148, 400	----------	600, 000	56, 094, 590
Rhode Island	182, 800	364, 000	72, 800	513, 240	21, 840	95, 550	4, 550	4, 550	27, 300	45, 500	392, 340	----------	----------	1, 724, 470
Massachusetts	1, 735, 700	4, 725, 600	380, 700	4, 933, 000	109, 200	----------	49, 100	77, 700	233, 100	332, 800	10, 020, 880	----------	700, 000	23, 297, 780
New Hampshire	146, 075	1, 419, 000	214, 200	1, 556, 640	77, 100	----------	18, 310	18, 400	55, 200	92, 000	3, 684, 000	----------	150, 000	7, 430, 925
Maine	2, 381, 500	16, 177, 300	2, 530, 400	17, 897, 150	433, 100	71, 000	366, 600	363, 000	1, 089, 000	1, 304, 800	12, 333, 506	----------	1, 190, 000	56, 137, 356
Total	39, 301, 135	75, 698, 021	16, 747, 530	91, 773, 392	3, 003, 165	1, 708, 035	2, 663, 385	1, 882, 900	5, 427, 750	7, 799, 480	209, 731, 287	----------	9, 060, 000	464, 886, 086

TABLE 7.—*Summary of construction cost of route 2 by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guard-rail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Washington	$1,508,003	$20,597,750	$3,505,550	$8,378,117	$633,250	----------	$569,000	$277,400	$832,200	$832,200	$10,668,140	$7,392,000	$770,000	$55,053,610
Idaho	477,800	2,146,200	287,800	2,149,200	106,000	----------	246,100	87,100	261,300	261,300	4,381,600	----------	210,000	10,614,400
Montana	1,441,420	18,783,000	1,064,500	16,046,505	944,400	----------	636,400	92,900	2,071,000	2,071,000	8,432,980	180,000	560,000	52,324,105
North Dakota	883,200	3,486,100	822,600	14,506,400	7,500	----------	177,700	351,000	1,053,000	1,404,000	5,478,000	----------	1,120,000	29,289,500
Minnesota	4,323,555	5,038,750	379,840	8,282,622	386,560	----------	352,000	246,200	738,600	1,253,000	6,826,100	----------	870,000	28,697,227
Wisconsin	3,142,125	6,496,810	1,066,965	9,540,275	273,413	----------	337,760	294,400	883,200	1,255,200	10,057,330	----------	1,010,000	34,357,478
Illinois	4,950,200	7,770,100	1,174,060	6,683,400	179,730	$709,420	126,650	94,800	284,400	578,500	22,915,000	----------	480,000	45,946,260
Indiana	1,725,550	6,925,550	1,361,700	8,320,410	71,500	487,100	123,000	142,700	428,100	509,100	9,456,750	----------	750,000	30,301,460
Ohio	9,877,000	10,701,750	5,619,250	14,292,500	264,750	142,750	150,000	242,000	727,000	1,176,000	29,181,500	----------	800,000	73,174,500
Pennsylvania	1,051,000	1,381,000	962,000	3,712,000	50,000	35,000	96,000	48,000	144,000	166,000	9,347,200	----------	200,000	17,192,200
New York	12,531,560	12,725,130	13,979,000	32,571,000	770,000	235,200	1,155,000	385,100	1,155,100	2,025,800	51,874,260	----------	1,400,000	130,807,150
Massachusetts	1,964,000	17,040,000	666,000	7,472,000	241,200	19,500	113,200	117,700	353,100	555,900	10,983,360	----------	770,000	40,295,960
Total	43,875,413	113,092,140	29,979,265	131,954,429	3,928,303	1,628,970	4,082,810	2,379,300	8,931,000	12,088,000	179,602,220	7,572,000	8,940,000	548,053,850

TABLE 8.—*Summary of construction cost of route 3 by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Texas	$4,048,076	$8,513,310	$1,688,430	$15,232,445	$309,602	$482,559	$36,625	$486,760	$1,460,280	$2,562,570	$36,139,356	----------	$1,150,000	$72,110,013
Oklahoma	3,203,450	8,882,500	1,478,000	9,457,000	231,600	161,000	216,900	268,500	805,300	1,122,800	17,782,726	----------	630,000	44,240,376
Missouri	2,968,700	14,570,800	5,730,800	11,768,538	694,150	86,150	711,175	280,650	841,950	1,256,450	12,555,174	$1,003,000	1,070,000	54,537,537
Illinois	3,368,760	5,883,950	1,624,300	9,040,050	203,830	908,550	268,570	219,300	657,900	749,900	28,563,115	----------	800,000	52,288,225
Total	13,588,986	37,850,560	11,522,130	45,498,033	1,439,182	1,638,259	1,233,270	1,255,210	3,765,430	5,691,720	95,040,371	1,003,000	3,650,000	223,176,151

TABLE 9.—*Summary of construction cost of route 3–Michigan by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Indiana	$115,750	$477,750	$118,500	$535,800	$5,400	$10,000	$5,900	$9,500	$28,500	$28,500	$586,200	----------	$200,000	$2,121,800
Ohio	390,000	549,000	251,500	645,000	10,500	6,000	3,000	9,000	27,500	41,000	521,000	----------	----------	2,453,500
Michigan	5,035,605	7,980,735	3,350,450	7,219,586	149,725	913,550	392,930	155,790	467,370	670,090	16,017,535	----------	1,435,000	43,788,366
Total	5,541,355	9,007,485	3,720,450	8,400,386	165,625	929,550	401,830	174,290	523,370	739,590	17,124,735	----------	1,635,000	48,363,666

TABLE 10.—*Summary of construction cost of route 4 by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guard-rail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
California	$4,635,150	$16,889,115	$1,535,700	$10,098,850	$583,800	----------	$431,900	$215,460	$611,280	$572,640	$22,872,075	----------	$890,000	$39,335,970
Nevada	634,230	12,381,950	1,563,600	6,502,300	40,000	----------	239,250	200,000	1,199,200	800,000	2,285,590	$1,319,500	420,000	27,585,620
Utah	829,425	9,532,500	834,000	4,604,355	59,200	----------	468,000	191,000	573,000	573,000	2,969,160	----------	550,000	21,183,640
Wyoming	949,300	11,450,000	3,310,000	11,773,500	66,800	----------	445,000	334,000	1,002,000	1,278,000	5,621,940	----------	350,000	36,580,540
Colorado	421,230	4,554,250	1,574,100	7,780,029	19,220	----------	503,420	216,100	648,300	1,080,500	6,311,700	----------	490,000	23,598,849
Kansas	2,027,374	4,346,100	1,399,795	12,315,494	64,125	----------	491,360	361,200	1,083,600	1,800,100	6,647,380	----------	1,120,000	31,656,528
Missouri	2,134,700	2,808,450	1,490,800	8,772,420	448,700	----------	206,900	207,400	622,200	632,500	9,128,680	----------	490,000	26,942,750
Illinois	3,525,400	5,377,250	1,298,550	7,375,550	168,200	$554,300	283,450	209,400	627,900	624,500	15,186,479	----------	630,000	35,860,979
Indiana	1,827,530	5,046,800	1,086,400	5,881,109	101,400	217,300	171,700	146,600	439,800	439,800	9,023,938	----------	1,000,000	25,382,397
Ohio	9,097,500	12,686,000	3,795,250	9,369,750	285,000	174,000	684,750	241,000	719,500	1,107,500	19,897,874	----------	1,020,000	59,078,124
West Virginia	180,100	867,600	53,380	382,580	6,955	----------	18,840	5,865	17,595	23,045	2,719,400	----------	50,000	4,325,360
Pennsylvania	5,852,000	18,262,000	5,882,085	21,247,057	720,000	241,000	650,000	302,000	904,000	941,000	39,695,834	18,612,000	1,500,000	114,808,976
Total	32,113,959	104,202,015	23,823,660	106,102,994	2,563,400	1,186,600	4,594,570	2,630,025	8,448,375	9,872,585	142,360,050	19,931,500	8,510,000	466,339,733

TABLE 11.—*Summary of construction cost of route 4–A by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Pennsylvania	$873,000	$756,500	$487,500	$1,663,000	$29,000	$17,000	$79,000	$43,000	$127,000	$127,000	$1,602,600	----------	$140,000	$5,944,600
Maryland	624,000	2,626,000	454,750	1,614,000	35,350	10,000	17,500	46,100	137,900	230,100	1,036,900	----------	310,000	7,142,600
Total	1,497,000	3,382,500	942,250	3,277,000	64,350	27,000	96,500	89,100	264,900	357,100	2,639,500	----------	450,000	13,087,200

TABLE 12.—*Summary of construction cost of route 4–S by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
California	$47,500	$4,659,700	$1,464,000	$2,166,300	----------	----------	$388,300	$146,400	$439,200	----------	$4,836,600	----------	$140,000	$14,288,000
Nevada	145,290	2,477,400	366,000	1,805,500	$12,200	----------	34,100	61,000	366,000	$244,000	686,320	----------	140,000	6,337,810
Arizona	1,565	683,200	25,800	126,400	8,600	----------	18,920	4,300	25,800	17,200	91,200	----------	----------	1,002,985
Utah	1,040,165	19,296,875	1,080,500	6,133,923	93,180	----------	301,760	316,600	949,800	949,800	5,688,020	----------	560,000	36,410,623
Total	1,234,520	27,117,175	2,936,300	10,232,123	113,980	----------	743,080	528,300	1,780,800	1,211,000	11,302,140	----------	840,000	58,039,41

TABLE 13.—*Summary of construction cost of route 4–N by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubbing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
Oregon	$9,625,900	$18,650,780	$679,250	$13,444,000	$473,600	----------	$264,300	$381,500	$1,115,700	$1,666,200	$23,936,461	$316,800	$1,260,000	$71,814,491
Idaho	953,500	4,173,600	899,600	6,726,700	136,500	----------	584,900	272,600	817,800	817,800	7,027,700	----------	770,000	23,180,700
Utah	632,530	1,503,750	229,880	4,080,681	23,080	----------	53,900	123,400	370,200	370,200	2,167,680	----------	260,000	9,815,301
Total	11,211,930	24,328,130	1,808,730	24,251,381	633,180	----------	903,100	777,500	2,303,700	2,854,200	33,131,841	316,800	2,290,000	104,810,492

TABLE 14.—*Summary of construction cost of route 5, by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
California	$13,661,690	$41,790,000	$6,220,000	$39,125,200	$728,800	----------	$1,164,925	$806,700	$2,417,850	$3,392,200	$57,384,591	$2,189,500	$2,915,000	$171 796 456
Oregon	16,111,500	21,745,800	1,332,350	15,235,050	883,600	$287,000	362,500	345,200	1,034,100	1,833,800	52,231,236	3,960,000	1,420,000	116,782,136
Washington	4,207,040	12,595,650	4,298,000	18,082,190	1,786,350	219,000	317,000	238,400	715,200	1,189,500	37,870,582	----------	1,430,000	82,948,912
Total	33,980,230	76,131,450	11,850,350	72,442,440	3,398,750	506,000	1,844,425	1,390,300	4,167,150	6,415,500	147,486,409	6,149,500	5,765,000	371,527,504

TABLE 15.—*Summary of construction cost of route 6, by States*

State	Right-of-way, property damage, and relocation	Grading	Minor drainage	Surfacing	Clearing and grubing	Curbs	Guardrail	Signs and markers	Fencing	Topsoil, seeding, and planting	Bridges	Tunnels	Accesses	Total
California	$1,780,390	$9,849,265	$2,110,750	$8,670,200	----------	----------	$410,800	$222,700	$668,100	$478,800	$14,683,260	----------	$520,000	$39,294,265
Arizona	1,855,370	8,334,800	2,070,200	5,699,470	----------	----------	589,100	235,760	825,000	1,247,600	8,535,380	----------	420,000	29,782,680
New Mexico	352,290	1,877,000	546,400	4,911,300	$77,400	$275,000	108,000	154,800	464,400	476,700	1,744,300	----------	245,000	11,232,580
Texas	5,537,015	26,582,352	3,313,200	26,938,000	759,014	992,458	162,730	777,020	2,331,060	4,155,630	61,018,876	----------	1,490,000	134,057,355
Louisiana	595,670	3,035,650	817,900	5,840,403	544,650	92,821	----------	182,550	547,650	547,650	11,361,290	----------	350,000	23,916,234
Mississippi	1,181,480	2,934,020	353,560	3,543,270	274,500	----------	140,170	152,400	457,200	609,600	10,526,300	----------	350,000	20,422,500
Alabama	1,014,825	6,100,720	1,394,650	5,036,089	168,120	----------	144,400	210,100	629,500	629,500	13,802,870	----------	700,000	29,830,774
Georgia	1,712,630	5,155,000	541,500	5,653,500	401,000	3,000	243,000	200,500	601,500	1,004,000	20,236,900	----------	840,000	36,592,530
South Carolina	413,330	1,414,000	233,200	4,212,375	175,700	80,700	80,700	119,500	358,500	478,000	4,515,660	----------	560,000	12,641,665
Total	14,442,990	65,182,807	11,381,360	70,504,607	2,400,384	1,443,979	1,848,900	2,255,330	6,882,910	9,627,480	146,424,836	----------	5,475,000	337,870,583

Finally, table 16 gives the construction costs of each of the 75 sections of the entire mileage of selected routes, traffic facts for which are recorded in table 2. The various sections are arranged in table 16 in the descending order of average cost per mile, and the descending order of traffic importance is indicated by the serial numbers in column 2 of the table.

TABLE 16.—*Estimated construction costs for each section of the selected routes studied, if operated as a toll facility, arranged in descending order of average cost per mile*

Section			Number in order of cost per mile	Number in order of traffic volume	Route	Construction cost	10 percent engineering, contingency, and interest during construction	Total costs each section	Average cost per mile each section
From—	To—	Length							
		Miles							
Jersey City, N. J.	New Haven, Conn.	65.6	1	1	1	$69,083,460	$6,908,346	$75,991,806	$1,158,412
Junction, Route 4, Pa.	Jersey City, N. J.	106.8	2	2	1	76,458,300	7,545,830	83,004,130	777,192
Junction, Route 6, Calif.	San Fernando, Calif.	44.8	3	3	5	23,703,930	2,370,393	26,074,323	582,016
Baltimore, Md.	Junction, Route 4, Pa.	76.2	4	7	1	35,874,400	3,587,440	39,461,840	517,872
New Haven, Conn.	Junction, Route 2, Mass.	99.8	5	10	1	46,407,020	4,640,702	51,047,722	511,500
Portland, Oreg.	Junction, Route 2, Wash.	146.7	6	22	5	64,155,201	6,415,520	70,570,721	481,055
Salem, Oreg.	Portland, Oreg.	56.9	7	14	5	23,502,849	2,350,285	25,853,134	454,361
Pittsburgh, Pa.	Carlisle, Pa.	166.6	8	19	4	64,806,102	6,480,610	71,286,712	427,891
Junction, Route 2, Wash.	Canadian boundary	124.7	9	25	5	47,631,362	4,763,136	52,394,498	420,164
Albany, N. Y.	Junction, Route 1, Mass.	147.2	10	17	2	54,495,650	5,449,565	59,945,215	407,237
Washington, D. C.	Baltimore, Md.	39.3	11	4	1	14,105,600	1,410,560	15,516,160	394,813
Seattle, Wash.	Ellensburg, Wash.	90.0	12	53	2	29,315,255	2,931,526	32,246,781	358,298
Carlisle, Pa.	Junction, Route 1, Pa.	94.8	13	13	4	33,181,874	3,318,187	36,500,061	385,022
Cleveland, Ohio	Buffalo, N. Y.	220.7	14	18	2	77,012,745	7,701,274	84,714,019	383,842
Perrysburg, Ohio	Cleveland, Ohio	79.3	15	20	2	27,136,750	2,713,675	29,850,425	376,424
Oakland, Calif.	Auburn, Calif.	110.0	16	16	4	38,279,100	3,827,910	42,107,010	373,700
Buffalo, N. Y.	Albany, N. Y.	287.6	17	11	2	91,696,915	9,169,691	100,866,606	350,718
San Ysidro, Calif.	Junction, Route 6, Calif.	124.4	18	8	5	38,175,881	3,817,588	41,993,469	337,568
Columbus, Ohio	Pittsburgh, Pa.	195.0	19	32	4	58,448,516	5,844,852	64,293,368	329,710
Junction, Route 2, Mass.	Portland, Maine	133.9	20	5	[1] 1	39,096,255	3,909,625	42,994,880	321,097
Junction, Route 2, Ind.	Detroit, Mich.	102.2	21	15	[1] 3	29,801,059	2,980,106	32,781,165	320,755
Junction, Route 3, Ill.	Junction, Route 3, Mich.-Ind.	156.9	22	9	2	43,446,360	4,344,636	47,790,996	304,595
Junction, Route 5, Calif.	Whitewater, Calif.	91.0	23	6	6	25,036,495	2,503,650	27,540,145	302,639
Detroit, Mich.	Port Huron, Mich.	72.5	24	29	[1] 3	18,562,607	1,856,261	20,418,868	281,640
Tracy, Calif.	Junction, Route 4, Calif.	69.1	25	23	5	17,125,370	1,712,537	18,837,907	272,618
Ashland, Oreg.	Roseburg, Oreg.	122.9	26	47	5	30,370,800	3,037,080	33,407,880	271,830
Junction, Route 3, Tex.	Shreveport, La.	190.4	27	27	6	46,775,118	4,677,512	51,452,630	270,234
Portland, Oreg.	Boardman, Oreg.	[3] 162.4	28	52	4N	39,832,601	3,983,269	43,815,960	268,152
Junction, Route 4, Ill.	Junction, Route 2, Ill.	155.5	29	33	3	37,131,697	3,713,170	40,844,867	262,668
Richmond, Va.	Washington, D. C.	108.3	30	12	1	25,609,005	2,560,900	28,169,905	260,110
Redding, Calif.	Ashland, Oreg.	138.2	31	59	5	31,735,255	3,173,526	34,908,781	252,596
Indianapolis, Ind.	Columbus, Ohio	156.6	32	28	4	35,796,228	3,579,623	39,375,851	251,442
St. Louis, Mo.	Junction, Route 4, Ill.	88.8	33	38	3	19,529,208	1,952,921	21,482,129	241,916
Springfield, Mo.	St. Louis, Mo.	165.2	34	43	3	36,045,892	3,604,589	39,650,481	240,015
Auburn, Calif.	Reno, Nev.	106.5	35	46	4	22,439,290	2,243,929	24,683,219	231,767
Roseburg, Oreg.	Salem, Oreg.	133.3	36	39	5	27,240,636	2,724,064	29,964,700	224,791
Minneapolis, Minn.	Junction Route 3, Ill.	392.6	37	26	2	73,009,823	7,300,982	80,310,805	204,561
Atlanta, Ga.	Augusta, Ga.	153.2	38	72	6	28,108,255	2,810,826	30,919,081	201,822
Portland, Maine	Bangor, Maine	121.3	39	30	1	22,203,316	2,220,332	24,423,648	201,349
San Fernando, Calif.	Tracy, Calif.	[2] 291.7	40	21	5	51,864,880	5,186,488	57,051,368	195,582
Junction Route 3, Mich.-Ind.	Perrysburg, Ohio	69.9	41	40	2	12,044,750	1,204,475	13,249,225	189,545
Junction Route 6, Tex.	Tulsa, Okla.	270.5	42	55	3	46,561,539	4,656,154	51,217,693	189,345
San Antonio, Tex.	Junction Route 6, Tex.	250.7	43	36	3	38,987,901	3,898,790	42,886,691	171,068
Junction Route 3, Ill.	Indianapolis, Ind.	203.7	44	37	4	31,647,470	3,164,747	34,812,217	170,899
Tulsa, Okla.	Springfield, Mo.	171.3	45	48	3	26,347,441	2,634,744	28,982,185	169,190
Odessa, Tex.	Junction Route 3, Tex.	337.9	46	31	6	50,921,061	5,092,106	56,013,167	165,768
Junction Route 4, Pa.	Junction Route 1, Md.	88.5	47	51	4–A	13,087,200	1,308,720	14,395,920	162,666
El Paso, Tex.	Odessa, Tex.	245.2	48	56	6	35,798,286	3,579,829	39,378,115	160,596
Jacksonville, Fla.	Junction Route 6, S. C.	219.3	49	49	1	31,732,987	3,173,299	34,906,286	159,171
Boardman, Oreg.	Boise, Idaho	253.1	50	63	4–N	36,334,400	3,633,440	39,967,840	157,913
Shreveport, La.	Vicksburg, Miss.	168.8	51	60	6	24,137,084	2,413,708	26,550,792	157,291
Birmingham, Ala.	Atlanta, Ga.	141.2	52	64	6	20,178,426	2,017,843	22,196,269	157,197
St. Joseph, Mo.	Junction Route 3, Ill.	275.7	53	41	4	39,238,016	3,923,802	43,161,818	156,554
Vicksburg, Miss.	Birmingham, Ala.	270.5	54	67	6	37,264,038	3,726,404	40,990,442	151,536
Whitewater, Calif.	Indio, Calif.	32.7	55	24	6	4,417,710	441,771	4,859,481	148,608
Junction Route 6, S. C.	Richmond, Va.	362.6	56	50	1	48,077,192	4,807,719	52,884,911	145,849
Ellensburg, Wash.	Spokane, Wash.	145.9	57	74	2	19,061,250	1,906,125	20,967,375	143,711
Salt Lake City, Utah	Greeley, Colo.	463.3	58	66	4	56,632,098	5,663,210	62,295,308	134,460
Bangor, Maine	Canadian boundary	196.6	59	68	1	23,595,360	2,359,536	25,954,896	132,019
Mexican boundary	San Antonio, Tex.	156.2	60	69	3	18,572,473	1,857,247	20,429,720	130,792
Augusta, Ga.	Charleston, S. C.	116.3	61	70	6	12,293,750	1,229,375	13,523,125	116,278
Brigham, Utah	Salt Lake City, Utah	52.3	62	35	4–N	5,474,940	547,494	6,022,434	115,152
Junction Route 4, Calif.	Redding, Calif.	153.7	63	44	5	16,021,340	1,602,134	17,623,474	114,662
Miami, Fla.	Jacksonville, Fla.	326.5	64	34	1	33,653,185	3,365,318	37,018,503	113,380
Las Vegas, Nev.	Salt Lake City, Utah	407.5	65	65	4–S	41,854,303	4,185,430	46,039,733	112,981
Fargo, N. Dak.	Minneapolis, Minn.	219.1	66	45	2	22,213,242	2,221,324	24,434,566	111,522
Junction Route 6, Calif.	Ludlow, Calif.	69.1	67	42	4–S	6,642,760	664,276	7,307,036	105,746
Greeley, Colo.	St. Joseph, Mo.	529.7	68	54	4	49,445,719	4,944,572	54,390,291	102,681
Indio, Calif.	Phoenix, Ariz.	254.0	69	62	6	23,393,120	2,339,312	25,732,432	101,309
Boise, Idaho	Rupert, Idaho	182.2	70	57	4–N	16,264,000	1,626,400	17,890,400	98,191
Spokane, Wash.	Fargo, N. Dak.	1,169.6	71	75	2	98,621,110	9,862,111	108,483,221	92,752
Ludlow, Calif.	Las Vegas, Nev.	117.0	72	58	4–S	9,542,355	954,235	10,496,590	89,714
Phoenix, Ariz.	El Paso, Tex.	391.1	73	61	6	29,547,240	2,954,724	32,501,964	83,104
Reno, Nev.	Salt Lake City, Utah	514.9	74	73	4	36,425,320	3,642,532	40,067,852	77,817
Rupert, Idaho	Brigham, Utah	119.7	75	71	4–N	6,904,461	690,446	7,594,907	63,450
Total		14,336.2				2,636,154,677	263,615,468	2,899,770,145	

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[1] Michigan.

[2] 51.9 miles of free highway.

[3] 42.3 miles of free highway.

It is concluded that:

The system of roads selected, conforming closely to the direction of section 13 of the act of June 8, 1938, is feasible of construction at approximately the cost indicated. Moreover, it is probable that no reasonable change in the precise location of a system of approximately the same extent would materially affect the indicated average cost per mile.

ESTIMATES OF ANNUAL COST AND REVENUE

It is assumed that construction on the selected routes, if it is undertaken, will be completed one-half by January 1, 1944, and the remaining half by January 1, 1946. Without any significant error it can be assumed that the whole system would come into use on January 1, 1945, with collection of revenues from that date on the entire system.

Traffic estimates have been projected to 1960, and cannot, with reasonable assurance of accuracy, be projected beyond that year. From January 1, 1945, to December 31, 1960, is a period of 16 years, and it is for that period only that revenues can be estimated with substantial accuracy.

The roads, as built, would have a probable average service life, as a whole, extending far beyond this 16-year period. Some elements of the construction obviously have longer lives than others, but all elements, with the possible exception of some very minor ones, such as signs, fencing, etc., should last well beyond the 16-year period.

For example, the probable average service life of the surfaces or pavements may be assumed to be at least 30 years. This life period reflects experience tables of similar past construction, together with the more favorable quality of the proposed construction. The estimated construction cost of the pavements, including curbs and accesses is $682,231,200, which is 23.5 percent of the $2,899,770,000, estimated as the total cost of all construction and right-of-way. The average life of the graded roadbed and right-of-way may be assumed to be at least 100 years. Only a general change in the geometric design of the roads as built could materially affect the accuracy of this assumption.[4] The estimated cost of right-of-way, clearing and grubbing, grading, minor drainage, topsoil, seeding, and planting, totalling $1,014,044,700, represents 35 percent of the estimated total cost. The average life of major structures, such as bridges and tunnels, similarly may be estimated conservatively at 60 years, although for the modern types of structure proposed such a life period is probably short. Bridges and tunnels are estimated to cost $1,121,797,800, which is about 38.5 percent of the estimated total cost. Other miscellaneous items of the construction, such as guardrails, signs and markers, and fences are generally of shorter life than the three major items above mentioned. Their estimated cost, $81,606,400, is only 3 percent of the total estimated cost. If these elements are assumed to have an average service life of only 10 years, the probable composite average life of all elements of the routes as constructed, including their rights-of-way, would be:

$$\frac{23.5\times30+35.0\times100+38.5\times60+3.0\times10}{100}=65.5\text{ years}$$

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[4] For example, a revision of the projected alinement that might be necessary if vehicle speeds well above those now contemplated should become common.

As previously stated, this estimated average service life of the selected roads as a whole materially exceeds the 16-year period for which it is reasonable to estimate revenues. It also is about twice as long as the 30-year period fixed for retirement of the debt.

Annual debt service charge.—Retirement of the debt in 30 years will, it is estimated, entail an annual debt service charge of 4.84 percent of the total estimated cost. This 4.84 percent rate covers annual interest on the loan at 2.6 percent and provides for retirement in 30 years by an added 2.24 percent. The 2.6 percent interest rate on the loan is approximately the composite rate of United States Treasury borrowing charges as of January 1939. It reflects the rates on both short-term and long-term Treasury borrowings. It therefore can be assumed that with this rate borrowing for the proposed road construction may either be of short- or long-term character. The retirement annuity of 2.24 percent to be added to the interest rate will retire or amortize the total cost in about 30 years if compounded at 2.6 percent annually. Thirty years is a common term for highway loans.[5] It is also slightly longer than the term of any outstanding United States borrowings. The assumed annual debt service cost, on the basis of the United States Treasury borrowing rate, therefore, is 4.84 percent of $2,899,770,000 or about $140,401,000 annually. The corresponding annual debt service on an average construction cost of $202,270 per mile is approximately $9,790.

The annual debt service is the largest item of annual cost. It could be decreased by extending the term of the loan. The total cost of the loan, on the other hand, increases directly as the term increases. The 30-year loan, at 2.6 percent annual interest rate as indicated, reflects the United States Treasury rate and the longest term of Federal borrowing.[6]

Annual costs of maintenance and minor reconstruction.—The annual costs of maintenance and minor reconstruction are entailed principally by the strict maintenance of the surfaced roadway and operating facilities and the drainage, and other structures, plus the maintenance of a good appearance of the right-of-way, together with any necessary reconstruction during the interval 1945–60. These annual costs vary from section to section. They are estimated to amount to $18,637,000 and are equivalent to approximately $1,300 per year for the average mile during the period 1945–60.

Annual operating cost.—The assumed annual operating cost consists principally of the collection and management of the tolls, the operation of a sufficient traffic police force, and the removal of snow. These items vary from section to section, but combined they are estimated at a total cost of $25,016,000, or approximately $1,740 per average mile per year for the period 1945–60.

Total annual cost.—The estimated total annual cost which is the sum of debt service, maintenance and minor reconstruction, and operating costs, is $184,054,000, or an average of approximately $12,840 per mile per year. This total cost figure is shown, as of the year 1960, in table 17, which table also shows the corresponding accumulated cost of $2,944,861,936 for the period 1945–60.

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[5] Recent records indicate a shorter term.

[6] Longest term is 27 years at 2.55 percent basis.

TABLE 17.—*Combined debt service, maintenance, and operating costs for the year 1960 and for the period 1945–60*

Description		Number in order of revenue as a percentage of cost	Number in order of traffic volume	Route	For the year 1960							For the period 1945–60	
						By individual sections				Totals accumulated by sections			
From—	To—				Length	Debt service¹	Maintenance and operation	Total costs	Average cost per mile	Length	Costs	Total costs for each section	Total costs accumulated by sections
					Miles					*Miles*			
Jersey City, N. J.	New Haven, Conn.	1	1	1	65. 6	$3, 679, 371	$686, 800	$4, 366, 171	$66, 557	65. 6	$4, 366, 171	$69, 858, 736	$69, 858, 736
Junction, Route 4, Pa.	Jersey City, N. J.	2	2	1	106. 8	4, 018, 894	1, 160, 400	5, 179, 294	48, 495	172. 4	9, 545, 465	82, 868, 704	152, 727, 440
Junction, Route 5, Calif.	Whitewater, Calif.	3	6	6	91. 0	1, 333, 439	437, 500	1, 770, 939	19, 461	263. 4	11, 316, 404	28, 335, 024	181, 062, 464
Washington, D. C.	Baltimore, Md.	4	4	1	39. 3	751, 261	218, 250	969, 511	24, 669	302. 7	12, 285, 915	15, 512, 176	196, 574, 640
Junction, Route 2, Mass.	Portland, Maine	5	4	1	133. 9	2, 081, 726	943, 650	3, 025, 376	22, 594	436. 6	15, 311, 291	48, 406, 016	244, 980, 656
Miami, Fla.	Jacksonville, Fla.	6	34	1	326. 5	1, 792, 362	689, 750	2, 482, 112	7, 602	763. 1	17, 793, 403	39, 713, 792	284, 694, 448
Baltimore, Md.	Junction, Route 4, Pa.	7	7	1	76. 2	1, 910, 663	430, 500	2, 341, 163	30, 724	839. 3	20, 134, 566	37, 458, 608	322, 153, 056
Richmond, Va.	Washington, D. C.	8	12	1	108. 3	1, 363, 931	470, 750	1, 834, 681	16, 941	947. 6	21, 969, 247	29, 354, 896	351, 507, 952
San Ysidro, Calif.	Junction, Route 6, Calif.	9	8	5	124. 4	2, 033, 240	511, 000	2, 544, 240	20, 452	1, 072. 0	24, 513, 487	40, 707, 840	392, 215, 792
Whitewater, Calif.	Indio, Calif.	10	24	6	32. 7	235, 286	129, 750	365, 036	11, 163	1, 104. 7	24, 878, 523	5, 840, 576	398, 056, 368
Junction, Route 3, Ill.	Junction, Route 3, Mich.-Ind.	11	9	2	156. 9	2, 313, 944	969, 150	3, 283, 094	20, 925	1, 261. 6	28, 161, 617	52, 529, 504	450, 585, 872
Brigham, Utah	Salt Lake City, Utah	12	35	4–N.	52. 3	291, 594	128, 450	420, 044	8, 031	1, 313. 9	28, 581, 661	6, 720, 704	457, 306, 576
Odessa, Tex.	Junction, Route 3, Tex.	13	31	6	337. 9	2, 712, 046	611, 850	3, 323, 896	9, 837	1, 651. 8	31, 905, 557	53, 182, 336	510, 488, 912
Junction, Route 6, Calif.	San Fernando, Calif.	14	3	5	44. 8	1, 262, 467	442, 000	1, 704, 467	38, 046	1, 696. 6	33, 610, 024	27, 271, 472	537, 760, 384
Buffalo, N. Y.	Albany, N. Y.	15	11	2	287. 6	4, 883, 759	1, 581, 600	6, 465, 359	22, 480	1, 984. 2	40, 075, 383	103, 445, 744	641, 206, 128
Junction, Route 6, Calif.	Ludlow, Calif.	16	42	4–S.	69. 1	353, 792	133, 650	487, 442	7, 054	2, 053. 3	40, 562, 825	7, 799, 072	649, 005, 200
San Fernando, Calif.	Tracy, Calif.	17	21	5	291. 7	2, 762, 313	898, 500	3, 660, 813	12, 550	2, 345. 0	44, 223, 638	58, 573, 008	707, 578, 208
Minneapolis, Minn.	Junction, Route 3, Ill.	18	26	2	392. 6	3, 888, 489	1, 431, 500	5, 319, 989	13, 551	2, 737. 6	49, 543, 627	85, 119, 824	792, 698, 032
Junction, Route 4, Calif.	Redding, Calif.	19	44	5	153. 7	853, 293	290, 550	1, 143, 843	7, 442	2, 891. 3	50, 687, 470	18, 301, 488	810, 999, 520
San Antonio, Tex.	Junction, Route 6, Tex.	20	36	3	250. 7	2, 076, 488	481, 050	2, 557, 538	10, 202	3, 142. 0	53, 245, 008	40, 920, 608	851, 920, 128
Portland, Maine	Bangor, Maine	21	30	1	121. 3	1, 182, 544	363, 250	1, 545, 794	12, 744	3, 263. 3	54, 790, 802	24, 732, 704	876, 652, 832
St. Joseph, Mo.	Junction, Route 3, Ill.	22	41	4	275. 7	2, 069, 809	583, 550	2, 653, 359	9, 624	3, 539. 0	57, 444, 161	42, 453, 744	919, 106, 376
Junction, Route 3, Ill.	Indianapolis, Ind.	23	37	4	203. 7	$1, 685, 538	$455, 550	$2, 141, 088	$10, 511	3, 742. 7	$59, 585, 249	$34, 257, 408	$953, 363, 984
Carlisle, Pa.	Junction, Route 1, Pa.	24	13	4	94. 8	1, 767, 260	392, 000	2, 159, 260	22, 777	3, 837. 5	61, 744, 509	34, 548, 160	987, 912, 144
Junction, Route 2, Ind.	Detroit, Mich.	25	15	²3	102. 2	1, 587, 198	617, 700	2, 204, 898	21, 574	3, 939. 7	63, 949, 407	35, 278, 368	1, 023, 190, 512
Tracy, Calif.	Junction, Route 4, Calif.	26	23	5	69. 1	912, 094	252, 750	1, 164, 844	16, 857	4, 008. 8	65, 114, 251	18, 637, 504	1, 041, 828, 016
Junction, Route 3, Tex.	Shreveport, La.	27	27	6	190. 4	2, 491, 233	447, 600	2, 938, 833	15, 435	4, 199. 2	68, 053, 084	47, 021, 328	1, 088, 849, 344
Ludlow, Calif.	Las Vegas, Nev.	28	58	4–S.	117. 0	508, 224	190, 500	698, 724	5, 972	4, 316. 2	68, 751, 808	11, 179, 584	1, 100, 028, 928
Fargo, N. Dak.	Minneapolis, Minn.	29	45	2	219. 1	1, 183, 073	697, 750	1, 880, 823	8, 584	4, 535. 3	70, 632, 631	30, 093, 168	1, 130, 122, 096
New Haven, Conn.	Junction, Route 2, Mass.	30	10	1	99. 8	2, 471, 629	524, 400	2, 996, 029	30, 020	4, 635. 1	73, 628, 660	47, 936, 464	1, 178, 058, 560
Greeley, Colo.	St. Joseph, Mo.	31	54	4	529. 7	2, 633, 469	1, 359, 400	3, 992, 869	7, 538	5, 164. 8	77, 621, 529	63, 885, 904	1, 241, 944, 464
Indianapolis, Ind.	Columbus, Ohio	32	28	4	156. 6	1, 906, 500	468, 200	2, 374, 700	15, 164	5, 321. 4	79, 996, 229	37, 995, 200	1, 279, 939, 664
Phoenix Ariz.	El Paso, Tex.	33	61	6	391. 1	1, 573, 680	736, 650	2, 310, 330	5, 907	5, 712. 5	82, 306, 559	36, 965, 280	1, 316, 904, 944
Cleveland, Ohio	Buffalo, N. Y.	34	18	2	220. 7	4, 101, 683	962, 100	5, 063, 783	22, 944	5, 933. 2	87, 370, 342	81, 020, 528	1, 397, 925, 472
Oakland, Calif.	Auburn, Calif.	35	16	4	110. 0	2, 038, 737	530, 000	2, 568, 737	23, 352	6, 043. 2	89, 939, 079	41, 099, 792	1, 439, 025, 264
Boise, Idaho	Rupert, Idaho	36	57	4–N.	182. 2	866, 217	484, 400	1, 350, 617	7, 413	6, 225. 4	91, 289, 696	21, 609, 872	1, 460, 635, 136
Shreveport, La.	Vicksburg, Miss.	37	60	6	168. 8	1, 285, 536	343, 200	1, 628, 736	9, 649	6, 394. 2	92, 918, 432	26, 059, 776	1, 486, 694, 912
Salem, Oreg.	Portland, Oreg.	38	14	5	56. 9	1, 251, 757	292, 250	1, 544, 007	27, 135	6, 451. 1	94, 462, 439	24, 704, 112	1, 511, 399, 024
Junction, Route 4, Ill.	Junction, Route 2, Ill.	39	33	3	155. 5	1, 977, 627	451, 000	2, 428, 627	15, 618	6, 606. 6	96, 891, 066	38, 858, 032	1, 550, 257, 056
Perrysburg, Ohio	Cleveland, Ohio	40	20	2	79. 3	1, 445, 298	357, 900	1, 803, 198	22, 739	6, 685. 9	98, 694, 264	28, 851, 168	1, 579, 108, 224
Junction, Route 6, S. C.	Richmond, Va.	41	50	1	362. 6	2, 560, 582	843, 900	3, 404, 482	9, 389	7, 048. 5	102, 098, 746	54, 471, 712	1, 633, 579, 936
St. Louis, Mo.	Junction, Route 4, Ill.	42	38	3	88. 8	1, 040, 122	238, 200	1, 278, 322	14, 396	7, 137. 3	103, 377, 068	20, 453, 152	1, 654, 033, 088
Albany, N. Y.	Junction, Route 1, Mass.	43	17	2	147. 2	2, 902, 427	841, 600	3, 744, 027	25, 435	7, 284. 5	107, 121, 095	59, 904, 432	1, 713, 937, 520
Pittsburgh, Pa.	Carlisle, Pa.	44	19	4	166. 6	3, 451, 560	606, 500	4, 058, 060	24, 358	7, 451. 1	111, 179, 155	64, 928, 960	1, 778, 866, 480
Tulsa, Okla.	Springfield, Mo.	45	48	3	171. 3	1, 403, 259	346, 950	1, 750, 209	10, 217	7, 622. 4	112, 929, 364	28, 003, 344	1, 806, 869, 824
Junction, Route 3, Mich.-Ind.	Perrysburg, Ohio	46	40	2	69. 9	641, 501	219, 750	861, 251	12, 321	7, 692. 3	113, 790, 615	13, 780, 016	1, 820, 649, 840
Jacksonville, Fla.	Junction, Route 6, S. C.	47	49	1	219. 3	1, 690, 093	523, 950	2, 214, 043	10, 096	7, 911. 6	116, 004, 658	35, 424, 688	1, 856, 074, 528
Detroit, Mich.	Port Huron, Mich.	48	29	²3	72. 5	988, 641	321, 250	1, 309, 891	18, 067	7, 984. 1	117, 314, 549	20, 958, 256	1, 877, 032, 784
Springfield, Mo.	St. Louis, Mo.	49	43	3	165. 2	1, 919, 797	357, 800	2, 277, 597	13, 787	8, 149. 3	119, 592, 146	36, 441, 552	1, 913, 474, 336
Junction, Route 4, Pa.	Junction, Route 1, Mo.	50	51	4–A	88. 5	697, 022	207, 750	904, 772	10, 223	8, 237. 8	120, 496, 918	14, 476, 352	1, 927, 950, 688
Roseburg, Oreg.	Salem, Oreg.	51	39	5	133. 3	1, 450, 831	356, 600	1, 807, 431	13, 559	8, 371. 1	122, 304, 349	28, 918, 896	1, 956, 869, 584
El Paso, Tex.	Odessa, Tex.	52	56	6	245. 2	1, 906, 610	442, 800	2, 349, 410	9, 582	8, 616. 3	124, 653, 759	37, 590, 560	1, 994, 460, 144
Indio, Calif.	Phoenix, Ariz.	53	62	6	254. 0	1, 245, 913	426, 000	1, 671, 913	6, 582	8, 870. 3	126, 325, 672	26, 750, 608	2, 021, 210, 752
Columbus, Ohio	Pittsburgh, Pa.	54	32	4	195. 0	3, 112, 956	630, 000	3, 742, 956	19, 195	9, 065. 3	130, 068, 628	59, 887, 296	2, 081, 098, 048
Portland, Oreg.	Junction, Route 2, Wash.	55	22	5	146. 7	3, 416, 893	716, 750	4, 133, 643	28, 178	9, 212. 0	134, 202, 271	66, 138, 288	2, 147, 236, 336
Junction, Route 2, Wash.	Canadian boundary	56	25	5	124. 7	2, 536, 837	519, 400	3, 056, 237	24, 509	9, 336. 7	137, 258, 508	48, 899, 792	2, 196, 136, 128

[1] Based on financing with interest at 2.6 percent, amortized over a period of 30 years.

[2] Michigan.

TABLE 17.—*Combined debt service, maintenance, and operating costs for the year 1960 and for the period 1945–60*—Continued

Description		Number in order of revenue as a percentage of cost	Number in order of traffic volume	Route	Length	For the year 1960						For the period 1945-60	
						By individual sections				Totals accumulated by sections			
From—	To—					Debt service	Maintenance and operation	Total costs	Average cost per mile	Length	Costs	Total costs for each section	Total costs accumulated by sections
					Miles					*Miles*			
Junction, Route 6, Tex.	Tulsa, Okla	57	55	3	270.5	$2,479,858	$555,750	$3,035,608	$11,222	9,607.2	$140,294,116	$48,569,728	$2,244,705,856
Auburn, Calif	Reno, Nev	58	46	4	106.5	1,195,112	374,500	1,569,612	14,738	9,713.7	141,863,728	25,113,792	2,269,819,648
Ashland, Oreg	Roseburg, Oreg	59	47	5	122.9	1,617,543	413,700	2,031,243	16,528	9,836.6	143,894,971	32,499,888	2,302,319,536
Las Vegas, Nev	Salt Lake City, Utah.	60	65	4-S.	407.5	2,229,152	965,000	3,194,152	7,838	10,244.1	147,089,123	51,106,432	2,353,425,968
Birmingham, Ala	Atlanta, Ga	61	64	6	141.2	1,074,699	346,800	1,421,499	10,067	10,385.3	148,510,622	22,743,984	2,376,169,952
Boardman, Oreg	Boise, Idaho	62	63	4-N.	253.1	1,935,163	767,750	2,702,913	10,679	10,638.4	151,213,535	43,246,608	2,419,416,560
Salt Lake City, Utah	Greeley, Colo	63	66	4	463.3	3,016,214	1,293,250	4,309,464	9,302	11,101.7	155,522,999	68,951,424	2,488,367,984
Rupert, Idaho	Brigham, Utah	64	71	4-N.	119.7	367,730	314,250	681,980	5,697	11,221.4	156,204,979	10,911,680	2,499,279,664
Redding, Calif	Ashland, Oreg	65	59	5	138.2	1,690,213	336,400	2,026,613	14,664	11,359.6	158,231,592	32,425,808	2,531,705,472
Seattle, Wash	Ellensburg, Wash	66	53	2	90.0	1,561,325	285,000	1,846,325	20,515	11,449.6	160,077,917	29,541,200	2,561,246,672
Vicksburg, Miss	Birmingham, Ala	67	67	6	270.5	1,984,675	555,750	2,540,425	9,392	11,720.1	162,618,342	40,646,800	2,601,893,472
Bangor, Maine	Canadian boundary	68	68	1	196.6	1,256,684	581,500	1,838,184	9,350	11,916.7	164,456,526	29,410,944	2,631,304,416
Portland, Oreg	Boardman, Oreg	69	52	4-N.	163.4	2,121,481	343,000	2,464,481	15,083	12,080.1	166,921,007	39,431,696	2,670,736,112
Mexican boundary	San Antonio, Tex	70	69	3	156.2	989,166	279,300	1,268,466	8,121	12,236.3	168,189,473	20,295,456	2,691,031,568
Augusta, Ga	Charleston, S. C	71	70	6	116.3	654,763	294,450	949,213	8,162	12,352.6	169,138,686	15,187,408	2,706,218,976
Reno, Nev	Salt Lake City, Utah.	72	73	4	514.9	1,940,005	1,149,800	3,089,805	6,001	12,867.5	172,228,491	49,436,880	2,755,655,856
Spokane, Wash	Fargo, N. Dak	73	75	2	1,169.6	5,252,541	3,344,000	8,596,541	7,350	14,037.1	180,825,032	137,544,656	2,893,200,512
Ellensburg, Wash	Spokane, Wash	74	74	2	145.9	1,015,199	351,800	1,366,999	9,369	14,183.0	182,192,031	21,871,984	2,915,072,496
Atlanta, Ga	Augusta, Ga	75	72	6	153.2	1,497,040	364,800	1,861,840	12,153	14,336.2	184,053,871	29,789,440	2,944,861,936
Total					14,336.2	140,401,071	43,652,800	184,053,871	12,838			2,944,861,936	

The annual cost would continue after 1960 at approximately the same average annual rate; and, until 1975, when the indebtedness would be completely retired, it would include the regular annual payment for debt service. The total of these payments over the 30-year period would be $4,212,032,130; and the difference between this amount and the $2,899,770,145 borrowed, or $1,312,261,985, represents the total cost of borrowing. This $1,312,261,985 of direct finance cost is 45.3 percent of the net cost of construction.

With payment of the sixteenth annual installment of the 4.84 percent debt service charge at the end of the year 1960, approximately 44 percent of the debt would have been retired. On the basis of the composite service life of 65.5 years, as previously estimated for all elements of the facilities, and assuming a straight-line depreciation, the accumulated depreciation by 1960 would be less than 25 percent. Comparison of the residual value of more than 75 percent with the unretired 56 percent of the debt, indicates adequate security for the refinancing of any necessary reconstruction.

COMPARISON OF REVENUES AND COSTS

For the entire system and 75 constituent sections, what is believed to be the maximum possible estimate of toll-paying traffic that would have used the selected routes in 1937 is shown in table 2. (See p. 24.) The total for all routes is 5,823,745 vehicle-miles per day, or 2,125,666,925 vehicle-miles per year. These estimates are based on actual traffic counts made during the year 1937.

In consideration of growth trends of population and motor-vehicle registration and the increased annual travel of vehicles, it has been estimated (see pp. 33 and 34) that utilization of the system in 1960 would be 2.5 times the 1937 value, and that the accumulated utilization during the period 1945 to 1960, inclusive, would be 34.2 times the 1937 value. It has not been considered advisable to attempt to estimate traffic beyond the year 1960.

It has been concluded that the toll rates that would probably produce the most favorable return for the system as a whole would average 1 cent per mile for each passenger car and 3.5 cents per mile for each motortruck and bus, the latter rate varying considerably with the weight and capacity of the vehicles. Assuming motortruck and bus traffic to constitute 20 percent of the total traffic, these rates result in an approximate average rate of 1½ cents per mile for each vehicle without regard to type.

This rate has been applied to the forecast vehicle mileage for the year 1960 and for the period 1945–60, for the system as a whole and for each of the 75 sections previously identified, and the corresponding gross revenues are shown respectively in tables 18 and 19. For the entire system of 14,336 miles, the gross revenue for the year 1960 totals $84,037,000, as shown in table 18. For the period 1945–60 the revenues are estimated at a total of $1,154,237,000, as shown in table 19.[7]

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[7] About 5.5 percent of these gross earnings are derived from special bridge tolls collectible where no free competition exists.

TABLE 18.—*Ratio of revenue from the toll-road system to combined debt service, maintenance, and operating costs for the year 1960*

Description		Number in order of revenue as a percentage of cost	Number in order of traffic volume	Route	By individual sections				Totals accumulated by sections			
From—	To—				Length	Revenue	Costs	Revenue as a percentage of cost	Length	Revenue	Costs	Revenue as a percentage of cost
					Miles			*Percent*	*Miles*			*Percent*
Jersey City, N. J.	New Haven, Conn.	1	1	1	65.6	$4,773,166	$4,366,171	109.3	65.6	$4,773,166	$4,366,171	109.3
Junction Route 4, Pa.	Jersey City, N. J.	2	2	1	106.8	5,359,401	5,179,294	103.5	172.4	10,132,567	9,545,465	106.2
Junction Route 5, Calif.	Whitewater, Calif.	3	6	6	91.0	1,625,161	1,770,939	91.8	263.4	11,757,728	11,316,404	103.9
Washington, D. C.	Baltimore, Md.	4	4	1	39.3	858,305	969,511	88.5	302.7	12,616,033	12,285,915	102.7
Junction Route 2, Mass.	Portland, Maine	5	5	1	133.9	2,566,097	3,025,376	84.8	436.6	15,182,130	15,311,201	99.2
Miami, Fla.	Jacksonville, Fla.	6	34	1	326.5	2,066,984	2,482,112	83.3	763.1	17,249,114	17,793,403	96.9
Baltimore, Md.	Junction Route 4, Pa.	7	7	1	76.2	1,948,475	2,341,163	83.2	839.3	19,197,589	20,134,566	95.3
Richmond, Va.	Washington, D. C.	8	12	1	108.3	1,396,703	1,834,651	76.1	947.6	20,594,292	21,969,247	93.7
San Ysidro, Calif.	Junction Route 6, Calif.	9	8	5	124.4	1,933,343	2,544,240	76.0	1,072.0	22,527,635	24,513,487	91.9
Whitewater, Calif.	Indio, Calif.	10	24	6	32.7	267,473	365,036	73.3	1,104.7	22,795,108	24,878,523	91.6
Junction Route 3, Ill.	Junction Route 3, Mich.-Ind.	11	9	2	156.9	2,393,515	3,283,094	72.9	1,261.6	25,188,623	28,161,617	89.4
Brigham, Utah	Salt Lake City, Utah	12	35	4-N.	52.3	293,758	420,044	69.9	1,313.9	25,482,381	28,581,661	89.2
Odessa, Tex.	Junction Route 3, Tex.	13	31	6	337.9	2,229,553	3,323,896	67.1	1,651.8	27,711,934	31,905,557	86.9
Junction Route 6, Calif.	San Fernando, Calif.	14	3	5	44.8	1,059,032	1,704,467	62.1	1,696.6	28,770,966	33,610,024	85.6
Buffalo, N. Y.	Albany, N. Y.	15	11	2	287.6	3,999,194	6,465,359	61.9	1,984.2	32,770,160	40,075,383	81.8
Junction Route 6, Calif.	Ludlow, Calif.	16	42	4-S.	69.1	301,447	487,442	61.8	2,053.3	33,071,607	40,562,825	81.5
San Fernando, Calif.	Tracy, Calif.	17	21	5	291.7	2,237,203	3,660,813	61.1	2,345.0	35,308,810	44,223,638	79.8
Minneapolis, Minn.	Junction Route 3, Ill.	18	26	2	392.6	3,066,415	5,319,989	57.6	2,737.6	38,375,225	49,543,627	77.5
Junction Route 4, Calif.	Redding, Calif.	19	44	5	153.7	655,844	1,143,843	57.3	2,891.3	39,031,069	50,687,470	77.0
San Antonio, Tex.	Junction Route 6, Tex.	20	36	3	250.7	1,360,262	2,557,538	53.2	3,142.0	40,391,331	53,245,008	75.9
Portland, Maine	Bangor, Maine	21	30	1	121.3	811,939	1,545,794	52.5	3,263.3	41,203,270	54,790,802	75.2
St. Joseph, Mo.	Junction Route 3, Ill.	22	41	4	275.7	1,371,323	2,653,359	51.7	3,539.0	42,574,593	57,444,161	74.1
Junction Route 3, Ill.	Indianapolis, Ind.	23	37	4	203.7	1,099,686	2,141,088	51.4	3,742.7	43,674,279	59,585,249	73.3
Carlisle, Pa.	Junction Route 1, Pa.	24	13	1	94.8	1,101,118	2,159,260	51.0	3,837.5	44,775,397	61,744,509	72.5
Junction Route 2, Ind.	Detroit, Mich.	25	15	3 Mich.	102.2	1,121,581	2,204,898	50.9	3,939.7	45,896,978	63,949,407	71.8
Tracy, Calif.	Junction Route 4, Calif.	26	23	5	69.1	588,770	1,164,844	50.5	4,008.8	46,485,748	65,114,251	71.4
Junction Route 3, Tex.	Shreveport, La.	27	27	6	190.4	1,422,427	2,938,833	48.4	4,199.2	47,908,175	68,053,084	70.4
Ludlow, Calif.	Las Vegas, Nev.	28	58	4-S.	117.0	334,957	698,724	47.9	4,316.2	48,243,132	68,751,808	70.2
Fargo, N. Dak.	Minneapolis, Minn.	29	45	2	219.1	899,067	1,880,823	47.8	4,535.3	49,142,199	70,632,631	69.6
New Haven, Conn.	Junction Route 2, Mass.	30	10	1	99.8	1,425,849	2,996,029	47.6	4,635.1	50,568,048	73,628,660	68.7
Greeley, Colo.	St. Joseph, Mo.	31	54	4	529.7	1,863,093	3,992,869	46.7	5,164.8	52,431,141	77,621,529	67.5
Indianapolis, Ind.	Columbus, Ohio	32	28	4	156.6	1,090,934	2,374,700	45.9	5,321.4	53,522,075	79,996,229	66.9
Phoenix, Ariz.	El Paso, Tex.	33	61	6	391.1	1,023,696	2,310,330	44.3	5,712.5	54,545,771	82,306,559	66.3
Cleveland, Ohio	Buffalo, N. Y.	34	18	2	220.7	2,238,510	5,063,783	44.2	5,933.2	56,784,281	87,370,342	65.0
Oakland, Calif.	Auburn, Calif.	35	16	4	110.0	1,124,703	2,568,737	43.8	6,043.2	57,908,984	89,939,079	64.4
Boise, Idaho	Rupert, Idaho	36	57	4-N	182.2	583,713	1,350,617	43.2	6,225.4	58,492,697	91,289,696	64.1
Shreveport, La.	Vicksburg, Miss.	37	60	6	168.8	673,674	1,628,736	41.4	6,394.2	59,166,371	92,918,432	63.7
Salem, Oreg.	Portland, Oreg.	38	14	5	56.9	637,632	1,544,007	41.3	6,451.1	59,804,003	94,462,439	63.3
Junction Route 4, Ill.	Junction Route 2, Ill.	39	33	3	155.5	992,111	2,428,627	40.9	6,606.6	60,796,114	96,891,066	62.7
Perrysburg, Ohio	Cleveland, Ohio	40	20	2	79.3	730,810	1,803,198	40.5	6,685.9	61,526,924	98,694,264	62.3
Junction Route 6, S. C.	Richmond, Va.	41	50	1	362.6	1,379,156	3,404,482	40.5	7,048.5	62,906,080	102,098,746	61.6
St. Louis, Mo.	Junction Route 4, Ill.	42	38	3	88.8	517,609	1,278,322	40.5	7,137.3	63,423,689	103,377,068	61.4
Albany, N. Y.	Junction Route 1, Mass.	43	17	2	147.2	1,501,047	3,744,027	40.1	7,284.5	64,924,736	107,121,095	60.6
Pittsburgh, Pa.	Carlisle, Pa.	44	19	4	166.6	1,623,921	4,058,060	40.0	7,451.1	66,548,657	111,179,155	59.9
Tulsa, Okla.	Springfield, Mo.	45	48	3	171.3	691,249	1,750,209	39.5	7,622.4	67,239,906	112,929,364	59.5
Junction Route 3, Mich.-Ind.	Perrysburg, Ohio	46	40	2	69.9	335,433	861,251	38.9	7,692.3	67,575,339	113,790,615	59.4
Jacksonville, Fla.	Junction Route 6, S. C.	47	49	1	219.3	861,017	2,214,043	38.9	7,911.6	68,436,356	116,004,658	59.0
Detroit, Mich.	Port Huron, Mich.	48	29	3 Mich.	72.5	504,071	1,309,891	38.5	7,984.1	68,940,427	117,314,549	58.8
Springfield, Mo.	St. Louis, Mo.	49	43	3	165.2	847,997	2,277,597	37.2	8,149.3	69,788,424	119,592,146	58.4
Junction Route 4, Pa.	Junction Route 1, Md.	50	51	4-A	88.5	330,580	904,772	36.5	8,237.8	70,119,004	120,496,918	58.2
Roseburg, Oreg.	Salem, Oreg.	51	39	5	133.3	643,301	1,807,431	35.6	8,371.1	70,762,305	122,304,349	57.9
El Paso, Tex.	Odessa, Tex.	52	56	6	245.2	829,008	2,349,410	35.3	8,616.3	71,591,313	124,653,759	57.4
Indio, Calif.	Phoenix, Ariz.	53	62	6	254.0	571,348	1,671,913	34.2	8,870.3	72,162,661	126,325,672	57.1
Columbus, Ohio	Pittsburgh, Pa.	54	32	4	195.0	1,262,734	3,742,956	33.7	9,065.3	73,425,395	130,068,628	56.5
Portland, Oreg.	Junction Route 2, Wash.	55	22	5	146.7	1,307,952	4,133,643	31.6	9,212.0	74,733,347	134,202,271	55.7
Junction Route 2, Wash.	Canadian boundary	56	25	5	124.7	963,904	3,056,237	31.5	9,336.7	75,697,251	137,258,508	55.1
Junction Route 6, Tex.	Tulsa, Okla.	57	55	3	270.5	929,290	3,035,608	30.6	9,607.2	76,626,541	140,294,116	54.6
Auburn, Calif.	Reno, Nev.	58	46	4	106.5	435,566	1,569,612	27.7	9,713.7	77,062,107	141,863,728	54.3
Ashland, Oreg.	Roseburg, Oreg.	59	47	5	122.9	499,285	2,031,243	24.6	9,836.6	77,561,392	143,894,971	53.9
Las Vegas, Nev.	Salt Lake City, Utah	60	65	4-S	407.5	777,749	3,194,152	24.3	10,244.1	78,339,141	147,089,123	53.3
Birmingham, Ala.	Atlanta, Ga.	61	64	6	141.2	298,367	1,421,499	21.0	10,385.3	78,637,508	148,510,622	53.0
Boardman, Oreg.	Boise, Idaho	62	63	4-N	253.1	545,173	2,702,913	20.2	10,638.4	79,182,681	151,213,535	52.4
Salt Lake City, Utah	Greeley, Colo.	63	66	4	463.3	858,985	4,309,464	19.9	11,101.7	80,041,666	155,522,999	51.5
Rupert, Idaho	Brigham, Utah	64	71	4-N	119.7	130,548	681,980	19.1	11,221.4	80,172,214	156,204,979	51.3
Redding, Calif.	Ashland, Oreg.	65	59	5	138.2	384,349	2,026,613	19.0	11,359.6	80,556,563	158,231,592	50.9
Seattle, Wash.	Ellensburg, Wash.	66	53	2	90.0	331,277	1,846,325	17.9	11,449.6	80,887,840	160,077,917	50.5
Vicksburg, Miss.	Birmingham, Ala.	67	67	6	270.5	446,201	2,540,425	17.6	11,720.1	81,334,041	162,618,342	50.0
Bangor, Maine	Canadian boundary	68	68	1	196.6	318,939	1,838,184	17.4	11,916.7	81,652,980	164,456,526	49.7
Portland, Oreg.	Boardman, Oreg.	69	52	4-N	163.4	413,455	2,464,481	16.8	12,080.1	82,066,435	166,921,007	49.2
Mexican boundary	San Antonio, Tex.	70	69	3	156.2	204,424	1,268,466	16.1	12,236.3	82,270,859	168,189,473	48.9
Augusta, Ga.	Charleston, S. C.	71	70	6	116.3	144,276	949,213	15.2	12,352.6	82,415,135	169,138,686	48.7
Reno, Nev.	Salt Lake City, Utah	72	73	4	514.9	442,234	3,089,805	14.3	12,867.5	82,857,369	172,228,491	48.1
Spokane, Wash.	Fargo, N. Dak.	73	75	2	1,169.6	892,919	8,596,541	10.4	14,037.1	83,750,288	180,825,032	46.3
Ellensburg, Wash.	Spokane, Wash.	74	74	2	145.9	123,322	1,366,999	9.0	14,183.0	83,873,610	182,192,031	46.0
Atlanta, Ga.	Augusta, Ga.	75	72	6	153.2	162,911	1,861,840	8.8	14,336.2	84,036,521	184,053,871	45.7
Total					14,336.2	84,036,521	184,053,871	45.7				

Total annual costs for the year 1960	$184,053,871
Total annual revenue for the year 1960	84,036,521
Deficit for the year 1960	100,017,350
Percentage revenue is of cost for the year 1960	45.7

TABLE 19.—*Ratio of revenue from the toll road system to combined debt service, maintenance, and operating costs for the period 1945–60*

Description		Number in order of revenue as a percentage of cost	Number in order of traffic volume	Route	By individual sections				Total accumulated by sections			
From—	To—				Length	Revenue	Costs	Revenue as a percentage of cost	Length	Revenue	Costs	Revenue as a percentage of cost
					Miles			*Percent*	*Miles*			*Percent*
Jersey City, N. J.	New Haven, Conn.	1		1	65. 6	$65, 559, 143	$69, 858, 736	93. 8	65. 6	$65, 559, 143	$69, 858, 736	93. 8
Junction Route 4, Pa.	Jersey City, N. J.	2		1	106. 8	73, 611, 054	82, 868, 704	88. 8	172. 4	139, 170, 197	152, 727, 440	91. 1
Junction Route 5, Calif.	Whitewater, Calif.	3	6	6	91. 0	22, 321, 485	28, 335, 024	78. 8	263. 4	161, 491, 682	181, 062, 464	89. 2
Washington, D. C.	Baltimore, Md.	4	4	1	39. 3	11, 788, 774	15, 512, 176	76. 0	302. 7	173, 280, 456	196, 574, 640	88. 1
Junction Route 2, Mass.	Portland, Maine	5	5	1	133. 9	35, 245, 186	48, 406, 016	72. 8	436. 6	208, 525, 642	244, 980, 656	85. 1
Miami, Fla.	Jacksonville, Fla.	6	34	1	326. 5	28, 389, 899	39, 713, 792	71. 5	763. 1	236, 915, 541	284, 694, 448	83. 2
Baltimore, Md.	Junction Route 4, Pa.	7	7	1	76. 2	26, 762, 184	37, 458, 608	71. 4	839. 3	263, 677, 725	322, 153, 056	81. 8
Richmond, Va.	Washington, D. C.	8	12	1	108. 3	19, 183, 635	29, 354, 896	65. 4	947. 6	282, 861, 360	351, 507, 952	80. 5
San Ysidro, Calif.	Junction Route 6, Calif.	9	8	5	124. 4	26, 554, 351	40, 707, 840	65. 2	1, 072. 0	309, 415, 711	392, 215, 792	78. 9
Whitewater, Calif.	Indio, Calif.	10	24	6	32. 7	3, 673, 730	5, 840, 576	62. 9	1, 104. 7	313, 089, 441	398, 056, 368	78. 7
Junction Route 3, Ill.	Junction Route 3, Mich., Ind.	11	9	2	156. 9	32, 874, 784	52, 529, 504	62. 6	1, 261. 6	345, 964, 225	450, 585, 872	76. 8
Brigham, Utah	Salt Lake City, Utah	12	35	4–N.	52. 3	4, 034, 745	6, 720, 704	60. 0	1, 313. 9	349, 998, 970	457, 306, 576	76. 5
Odessa, Tex.	Junction Route 3, Tex.	13	31	6	337. 9	30, 622, 783	53, 182, 336	57. 6	1, 651. 8	380, 621, 753	510, 488, 912	74. 6
Junction Route 6, Calif.	San Fernando, Calif.	14	3	5	44. 8	14, 545, 739	27, 271, 472	53. 3	1, 696. 6	395, 167, 492	537, 760, 384	73. 5
Buffalo, N. Y.	Albany, N. Y.	15	11	2	287. 6	54, 928, 688	103, 445, 744	53. 1	1, 984. 2	450, 096, 180	641, 206, 128	70. 2
Junction Route 6, Calif.	Ludlow, Calif.	16	42	4–S.	69. 1	4, 140, 355	7, 799, 072	53. 1	2, 053. 3	454, 236, 535	649, 005, 200	70. 0
San Fernando, Calif.	Tracy, Calif.	17	21	5	291. 7	30, 727, 845	58, 573, 008	52. 5	2, 345. 0	484, 964, 380	707, 578, 208	68. 5
Minneapolis, Minn.	Junction Route 3, Ill.	18	26	2	392. 6	42, 117, 026	85, 119, 824	49. 5	2, 737. 6	527, 081, 406	792, 698, 032	66. 5
Junction Route 4, Calif.	Redding, Calif.	19	44	5	153. 7	9, 007, 972	18, 301, 488	49. 2	2, 891. 3	536, 089, 378	810, 999, 520	66. 1
San Antonio, Tex.	Junction Route 6, Tex.	20	36	3	250. 7	18, 683, 118	40, 920, 608	45. 7	3, 142. 0	554, 772, 496	851, 920, 128	65. 1
Portland, Maine	Bangor, Maine	21	30	1	121. 3	11, 151, 936	24, 732, 704	45. 1	3, 263. 3	565, 924, 432	876, 652, 832	64. 6
St. Joseph, Mo.	Junction Route 3, Ill.	22	41	4	275. 7	18, 835, 034	42, 453, 744	44. 4	3, 539. 0	584, 759, 466	919, 106, 576	63. 6
Junction Route 3, Ill.	Indianapolis, Ind.	23	37	4	203. 7	15, 104, 122	34, 257, 408	44. 1	3, 742. 7	599, 863, 588	953, 363, 984	62. 9
Carlisle, Pa.	Junction Route 1, Pa.	24	13	4	94. 8	15, 123, 787	34, 548, 160	43. 8	3, 837. 5	614, 987, 375	987, 912, 144	62. 3
Junction Route 2, Ind.	Detroit, Mich.	25	15	3–Mich.	102. 2	15, 404, 843	35, 278, 368	43. 7	3, 939. 7	630, 392, 218	1, 023, 190, 512	61. 6
Tracy, Calif.	Junction Route 4, Calif.	26	23	5	69. 1	8, 086, 727	18, 637, 504	43. 4	4, 008. 8	638, 478, 945	1, 041, 828, 016	61. 3
Junction Route 3, Tex.	Shreveport, La.	27	27	6	190. 4	19, 536, 955	47, 021, 328	41. 5	4, 199. 2	658, 015, 900	1, 088, 849, 344	60. 4
Ludlow, Calif.	Las Vegas, Nev.	28	58	4–S.	117. 0	4, 600, 618	11, 179, 584	41. 2	4, 316. 2	662, 616, 518	1, 100, 028, 928	60. 2
Fargo, N. Dak.	Minneapolis, Minn.	29	45	2	219. 1	12, 348, 628	30, 093, 168	41. 0	4, 535. 3	674, 965, 146	1, 130, 122, 096	59. 7
New Haven, Conn.	Junction Route 2, Mass.	30	10	1	99. 8	19, 583, 946	47, 936, 464	40. 9	4, 635. 1	694, 549, 092	1, 178, 058, 560	59. 0
Greeley, Colo.	St. Joseph, Mo.	31	54	4	529. 7	25, 589, 466	63, 885, 904	40. 1	5, 164. 8	720, 138, 558	1, 241, 944, 464	58. 0
Indianapolis, Ind.	Columbus, Ohio	32	28	4	156. 6	14, 983, 909	37, 995, 200	39. 4	5, 321. 4	735, 122, 467	1, 279, 939, 664	57. 4
Phoenix, Ariz.	El Paso, Tex.	33	61	6	391. 1	14, 060, 407	36, 965, 280	38. 0	5, 712. 5	749, 182, 874	1, 316, 904, 944	56. 9
Cleveland, Ohio	Buffalo, N. Y.	34	18	2	220. 7	30, 745, 800	81, 020, 528	37. 9	5, 933. 2	779, 928, 674	1, 397, 925, 472	55. 8
Oakland, Calif.	Auburn, Calif.	35	16	4	110. 0	15, 447, 730	41, 099, 792	37. 6	6, 043. 2	795, 376, 404	1, 439, 025, 264	55. 3
Boise, Idaho	Rupert, Idaho	36	57	4–N.	182. 2	8, 017, 267	21, 609, 872	37. 1	6, 225. 4	803, 393, 671	1, 460, 635, 136	55. 0
Shreveport, La.	Vicksburg, Miss.	37	60	6	168. 8	9, 252, 878	26, 059, 776	35. 5	6, 394. 2	812, 646, 549	1, 486, 694, 912	54. 7
Salem, Oreg.	Portland, Oreg.	38	14	5	56. 9	8, 757, 833	24, 704, 112	35. 5	6, 451. 1	821, 404, 382	1, 511, 399, 024	54. 3
Junction Route 4, Ill.	Junction Route 2, Ill.	39	33	3	155. 5	13, 626, 580	38, 858, 032	35. 1	6, 606. 6	835, 030, 962	1, 550, 257, 056	53. 9
Perrysburg, Ohio	Cleveland, Ohio	40	20	2	79. 3	10, 037, 632	28, 851, 168	34. 8	6, 685. 9	845, 068, 594	1, 579, 108, 224	53. 5
Junction Route 6, S. C.	Richmond, Va.	41	50	1	362. 6	18, 942, 628	54, 471, 712	34. 8	7, 048. 5	864, 011, 222	1, 633, 579, 936	52. 9
St. Louis, Mo.	Junction Route 4, Ill.	42	38	3	88. 8	7, 109, 325	20, 453, 152	34. 8	7, 137. 3	871, 120, 547	1, 654, 033, 088	52. 7
Albany, N. Y.	Junction Route 1, Mass.	43	17	2	147. 2	20, 616, 786	59, 904, 432	34. 4	7, 284. 5	891, 737, 333	1, 713, 937, 520	52. 0
Pittsburgh, Pa.	Carlisle, Pa.	44	19	4	166. 6	22, 304, 453	64, 928, 960	34. 4	7, 451. 1	914, 041, 786	1, 778, 866, 480	51. 4
Tulsa, Okla.	Springfield, Mo.	45	48	3	171. 3	9, 494, 262	28, 003, 344	33. 9	7, 622. 4	923, 536, 048	1, 806, 869, 824	51. 1
Junction Route 3, Mich., Ind.	Perrysburg, Ohio	46	40	2	69. 9	4, 607, 150	13, 780, 016	33. 4	7, 692. 3	928, 143, 198	1, 820, 649, 840	51. 0
Jacksonville, Fla.	Junction Route 6, S. C.	47	49	1	219. 3	11, 826, 018	35, 424, 688	33. 4	7, 911. 6	939, 969, 216	1, 856, 074, 528	50. 6
Detroit, Mich.	Port Huron, Mich.	48	29	3–Mich.	72. 5	6, 923, 380	20, 958, 256	33. 0	7, 984. 1	946, 892, 596	1, 877, 032, 784	50. 4
Springfield, Mo.	St. Louis, Mo.	49	43	3	165. 2	11, 647, 186	36, 441, 552	32. 0	8, 149. 3	958, 539, 782	1, 913, 474, 336	50. 1
Junction Route 4, Pa.	Junction Route 1, Mo.	50	51	4–A.	88. 5	4, 540, 495	14, 476, 352	31. 4	8, 237. 8	963, 080, 277	1, 927, 950, 688	50. 0
Roseburg, Oreg.	Salem, Oreg.	51	39	5	133. 3	8, 835, 707	28, 918, 896	30. 6	8, 371. 1	971, 915, 984	1, 956, 869, 584	49. 7
El Paso, Tex.	Odessa, Tex.	52	56	6	245. 2	11, 386, 377	37, 590, 560	30. 3	8, 616. 3	983, 302, 361	1, 994, 460, 144	49. 3
Indio, Calif.	Phoenix, Ariz.	53	62	6	254. 0	7, 847, 429	26, 750, 608	29. 3	8, 870. 3	991, 149, 790	2, 021, 210, 752	49. 0
Columbus, Ohio	Pittsburgh, Pa.	54	32	4	195. 0	17, 343, 572	59, 887, 296	29. 0	9, 065. 3	1, 008, 493, 362	2, 081, 098, 048	48. 5
Portland, Oreg.	Junction Route 2, Wash.	55	22	5	146. 7	17, 964, 644	66, 138, 288	27. 2	9, 212. 0	1, 026, 458, 006	2, 147, 236, 336	47. 8
Junction Route 2, Wash.	Canadian Boundary	56	25	5	124. 7	13, 239, 162	48, 899, 792	27. 1	9, 336. 7	1, 039, 697, 168	2, 196, 136, 128	47. 3
Junction Route 6, Tex.	Tulsa, Okla.	57	55	3	270. 5	12, 763, 748	48, 569, 728	26. 3	9, 607. 2	1, 052, 460, 916	2, 244, 705, 856	46. 9
Auburn, Calif.	Reno, Nev.	58	46	4	106. 5	5, 982, 469	25, 113, 792	23. 8	9, 713. 7	1, 058, 443, 385	2, 269, 819, 648	46. 6
Ashland, Oreg.	Roseburg, Oreg.	59	47	5	122. 9	6, 857, 647	32, 499, 888	21. 1	9, 836. 6	1, 065, 301, 032	2, 302, 319, 536	46. 3
Las Vegas, Nev.	Salt Lake City, Utah	60	65	4–S.	407. 5	10, 682, 336	51, 106, 432	20. 9	10, 244. 1	1, 075, 983, 368	2, 353, 425, 968	45. 7
Birmingham, Ala.	Atlanta, Ga.	61	64	6	141. 2	4, 098, 049	22, 743, 984	18. 0	10, 385. 3	1, 080, 081, 417	2, 376, 169, 952	45. 5
Boardman, Oreg.	Boise, Idaho	62	63	4–N.	253. 1	7, 487, 919	43, 246, 608	17. 3	10, 638. 4	1, 087, 569, 336	2, 419, 416, 560	45. 0
Salt Lake City, Utah	Greeley, Colo.	63	66	4	463. 3	11, 798, 111	68, 951, 424	17. 1	11, 101. 7	1, 099, 367, 447	2, 488, 367, 984	44. 2
Rupert, Idaho	Brigham, Utah	64	71	4–N.	119. 7	1, 793, 072	10, 911, 680	16. 4	11, 221. 4	1, 101, 160, 519	2, 499, 279, 664	44. 1
Redding, Calif.	Ashland, Oreg.	65	59	5	138. 2	5, 279, 009	32, 425, 808	16. 3	11, 359. 6	1, 106, 439, 528	2, 531, 705, 472	43. 7
Seattle, Wash.	Ellensburg, Wash.	66	53	2	90. 0	4, 550, 071	29, 541, 200	15. 4	11, 449. 6	1, 110, 989, 599	2, 561, 246, 672	43. 4
Vicksburg, Miss.	Birmingham, Ala.	67	67	6	270. 5	6, 128, 538	40, 646, 800	15. 1	11, 720. 1	1, 117, 118, 137	2, 601, 893, 472	42. 9
Bangor, Maine	Canadian Boundary	68	68	1	196. 6	4, 380, 610	29, 410, 944	14. 9	11, 916. 7	1, 121, 498, 747	2, 631, 304, 416	42. 6
Portland, Oreg.	Boardman, Oreg.	69	52	4–N.	163. 4	5, 678, 773	39, 431, 696	14. 4	12, 080. 1	1, 127, 177, 520	2, 670, 736, 112	42. 2
Mexican Boundary	San Antonio, Tex.	70	69	3	156. 2	2, 807, 752	20, 295, 456	13. 8	12, 236. 3	1, 129, 985, 272	2, 691, 031, 568	42. 0
Augusta, Ga.	Charleston, S. C.	71	70	6	116. 3	1, 981, 616	15, 187, 408	13. 0	12, 352. 6	1, 131, 966, 888	2, 706, 218, 976	41. 8
Reno, Nev.	Salt Lake City, Utah	72	73	4	514. 9	6, 074, 057	49, 436, 880	12. 3	12, 867. 5	1, 138, 040, 945	2, 755, 655, 856	41. 3
Spokane, Wash.	Fargo, N. Dak.	73	75	2	1, 169. 6	12, 264, 188	137, 544, 656	8. 9	14, 037. 1	1, 150, 305, 133	2, 893, 200, 512	39. 8
Ellensburg, Wash.	Spokane, Wash.	74	74	2	145. 9	1, 693, 823	21, 871, 984	7. 7	14, 183. 0	1, 151, 998, 956	2, 915, 072, 496	39. 5
Atlanta, Ga.	Augusta, Ga.	75	72	6	153. 2	2, 237, 569	29, 789, 440	7. 5	14, 336. 2	1, 154, 236, 525	2, 944, 861, 936	39. 2
Total					14, 336. 2	1, 154, 236, 525	2, 944, 861, 936	39. 2				

Total costs for the period 1945–60	$2, 944, 861, 936
Total revenue for the period 1945–60	1, 154, 236, 525
Deficit for the period 1945–60	1, 790, 625, 411
Percentage revenue is of cost for the period 1945–60	39. 2

In addition to the estimated toll revenues tables 18 and 19 also show the combined debt service, maintenance, and operating costs for the system as a whole and separately for each of its 75 sections, for the year 1960 and for the period 1945–60, respectively. Relations of sectional and total revenues and costs are also indicated by solvency or operating ratios.

Table 18 shows for the year 1960 a deficit of $100,017,350, with a corresponding solvency or operating ratio of 45.7 percent.

Table 19 shows for the period 1945–60 a deficit of $1,790,625,411 with a corresponding solvency or operating ratio of 39.2 percent.

In both tables 18 and 19, the 75 sections are arranged in the descending order of the solvency or operating ratios; and their order on the basis of traffic volume is indicated by the serial numbers in column 2.

It is to be noted that the indicated deficits, which are believed to be minimum values, occur for the system as a whole, notwithstanding the use of a liberal estimate of initial use of the toll roads in 1945 and a liberal rate of annual increase of the toll-paying traffic—a rate substantially greater than the estimated general rate of increase in all motor-vehicle traffic.

It may be argued that, since State gasoline taxes have been justified as charges for road use, such tax earnings should contribute to the support of the system of toll roads in proportion to the gasoline consumed on them. Assuming gasoline tax earnings at 0.28 cent per mile for passenger cars and 0.56 cent per mile for trucks and busses the average annual earnings in the period 1945–60 would amount to $15,270,000. Should it be found possible to credit this amount to the toll system it would make no important change in the conclusions reached since the average annual deficit for the entire system would be reduced by only about 14 percent.

From the fact that the system as a whole shows the above-noted deficits, it does not necessarily follow that all sections would show a deficit, since the various sections operate under different relative conditions of first cost, annual cost, and annual revenue. However, examination of the data presented in table 19, particularly the solvency or operating ratios in column 9 and the accumulated ratio in column 13, shows that there is no section or combination of sections that has a solvency or operating ratio above 93.8 percent for the period 1945–60. In the year 1960, table 18 indicates that four sections cumulatively might earn a slight excess of revenue over costs.

It is here to be observed, however, that, in general, unless the various sections and groups of sections form parts of a larger connected toll system the previously estimated toll-paying traffic may not be realized.

Finally, therefore, it is concluded:

That, since a liberal estimate of revenue for the period 1945–60 is less than 40 percent of a conservative estimate of debt service, maintenance, and operating costs for the same period, a toll system on the roads selected as directed in section 13 of the act of June 8, 1938, is not feasible.

TOLL ROADS AND FREE ROADS

PART II

A MASTER PLAN FOR FREE HIGHWAY DEVELOPMENT

PART II. A MASTER PLAN FOR FREE HIGHWAY DEVELOPMENT

THE MOST IMPORTANT HIGHWAY PROBLEMS

The demonstrated improbability of a return from tolls sufficient to recover the costs of constructing and operating six transcontinental highways, such as were described in the Federal Aid Highway Act of 1938, results from the consequences of direct toll impositions. It does not follow that there is not a sufficient traffic to warrant and require facilities of a higher standard than are provided at present. On the contrary, the studies show the potential use of such facilities in many sections is more than sufficient to justify their provision.

The probability that from this traffic there could not be accumulated in tolls the amount required to repay the costs of building and operating the highways arises mainly from the following circumstances inseparable from a toll system:

1. To establish a margin of advantage over competing free highways sufficient to attract a toll-paying traffic, it is necessary to afford conditions conducive to uninterrupted movement, which can exist only if there is a rather long distance between points of access to the highways. The same condition is prescribed by the necessity to hold costs of toll collection to a feasible minimum. Yet these conditions, inseparable from a toll system, automatically exclude as potential toll payers a large number of vehicles moving in approximately the same direction as the toll facility, but for shorter distances than those between the toll-highway access points.

2. Of the remaining traffic of longer range, moving in the same general direction as the proposed toll facility, a large part cannot be counted upon for toll payment because of the financial inability or unwillingness of the operators to pay an additional fee for highway service in the presence of a parallel "free" service afforded by normal public highways of reasonable adequacy.

3. The exclusion of the two traffic groups described leaves, of the total anticipated traffic, a remainder able and willing to pay toll at a reasonable rate. This fraction in practically all cases is too small to support the costs of the desired facility except at a rate exceeding the willingness or ability of even these relatively willing and able potential toll payers. Moreover the number of such potential payers of moderate toll charges is in most instances so reduced as to promise by their diversion from the normal public highways little reduction of the traffic burden that now overtaxes those highways.

Because of these and other related circumstances the net contribution of any toll highways to the service of highway transportation as a whole could not be other than relatively small, even if the roads proposed were constructed and operated at a loss. The bulk of the traffic will continue to use the main public highways, for which it pays wholly or in large part through special user taxes; and, increasing in future years, would ultimately force the substantial rebuilding which on many sections of these highways is already urgently necessary.

The needed rebuilding and improvement of the main rural highways is only one element in the larger program of work required for the adequate modernization and extension of the public street and highway facilities of the country which is described in the following pages.

TRANS-CITY CONNECTIONS AND EXPRESS HIGHWAYS

One of the striking characteristics common to all highway traffic maps (see pl. 8) is the sharp enlargement of the bands representing the volume of traffic on the important highways as they approach the larger cities. Obviously these enlargements have a local cause. They are in fact caused by a multiplicity of short movements into and out of the city; and it is not uncommon to find that the traffic on a main route approaching the city is thus swelled to several times its volume a few miles from the city limits. Unfortunately, it is not common to find the capacity of the highway proportionately enlarged. In consequence there is often on such relatively short sections of highway an actual development of congestion or an approach to it.

If we inquire into the reason for the failure to augment the traffic facility in proportion to the increase in traffic we usually encounter right-of-way difficulties. At the approach to the city road-bordering developments thicken to such an extent that the additional space required for the widening or other increase of the highway facility may be obtainable only at heavy cost because of the closely crowding suburban residences and industrial establishments.

Once inside the city, where the block plan offers alternate avenues of travel, it might be assumed that the congestion would be substantially relieved. In some instances a measure of relief is observed; but generally such a desirable condition is not realized. The particular street joining directly with the main highway at the city's edge usually serves as a trunk line far into the city, generally to its very center. It thus conveys the in-bound traffic to convenient points of departure toward its ultimate destinations, and reciprocally collects the out-bound traffic at similar points. Frequently such a street is identified by United States or State route numbers as the direct inward extension of the external highway, so that strangers as well as local citizens are channeled into it. Quite often, particularly in the older cities of the East, the present internal street, which before the city's growth was actually the external highway, still follows its historic radial course toward the center of the city, and cuts conveniently across the rectangular block plan of younger city streets. In alinement, the present street is in such cases distinctly the preferable route for much of the traffic entering the city; but its convenience on this score may be largely nullified by the fact that it retains the narrow width of the old country road it was meant to be. When this is the case, traffic conditions may become so bad, approaching the center of the city, as to force the abandonment of the route by the through traffic despite its convenient alinement. A condition of this sort is illustrated in plate 48.

PLATE 48.—As its name implies, Harford Avenue in Baltimore was long ago the Harford Turnpike penetrating to the heart of the old city. Its width today is that of the old pike and allows barely sufficient room for the trolley cars to pass parked vehicles held snugly against the curb by an admonitory painted line on the pavement.

For the various reasons mentioned, the traffic congestion that exists on a main rural highway at the approach to a city is usually augmented on the connecting city street toward the center of the city and continues on the same or even another street to the continuation of the rural route at the other side of the city.

The remedy commonly proposed for these conditions is the construction of a bypass highway. It is inaccurately assumed that the congestion results from the joining of the local with the through traffic, and that a substantial relief would be obtained if the through traffic were diverted at a point outside the city beyond the beginning of congestion, and carried on a bypass to a similar point on the rural route at the other side of the city. In rare cases this remedy alone may prove sufficiently effective, but, as hereafter elaborated, bypass routes are of advantage mainly to a relatively small part of the highway traffic normally approaching a city, i. e., to that small part of the traffic that is actually desirous of avoiding the city.

As all traffic maps show, the greater part of the heavy traffic at a city entrance is an in-and-out movement of local generation. That part cannot be drained off by a bypass route. Of the remaining traffic of longer range, there is a further considerable part destined to, or originated in the city, that also would not use a bypass route if one were offered.

An idea of the relation that may exist, on a main road approaching large cities, between the bypassable through traffic and the traffic that is desirous of entering the city and cannot be diverted by a bypass route may be obtained from plate 49. This plate shows a traffic profile of the highway between Washington, D. C. and Baltimore, Md. As shown by the topmost line in this graph, the total traffic on the route rises to a peak at each city line and drops to a trough between the two cities. Of this total traffic, that part above the highest of the horizontal lines represents movements of less length than the distance between the cities. At each city line this part consists of movements into and out of the city all of which are of shorter range than the distance to the neighboring city. The uniform vertical distance between the highest and next lower horizontal lines measures the amount of traffic on the road moving between points in each city. The height of the next lower horizontal band represents the traffic moving between Washington and points beyond Baltimore; that of the next, the traffic moving between Baltimore and points beyond Washington; while the height of the lowest horizontal band measures the volume of the traffic moving between points that lie beyond both Baltimore and Washington. Of all the traffic shown as entering the two cities, only this last part plus that represented by one or the other of the next two higher bands can be counted as potentially bypassable around the two cities. At Washington this bypassable maximum is 2,269 of a total of 20,500 entering vehicles; at Baltimore it is 2,670 of a total of 18,900 vehicles. The remainder of the entering traffic in each case will not only continue into, but in large part will penetrate to the very heart of the city, because that is where most of it is destined, and conversely it is at or through the same center that one must look for the source of most of the city-originated emerging traffic.

In numerous cities conditions of the sort here described are fast reaching a critical point. Some measures of relief are imperative, and the only course that promises a really satisfactory solution is the provision of adequate facilities for conduct of the heavier entering traffic streams through the city at or near its center, and on to appropriate exit points.

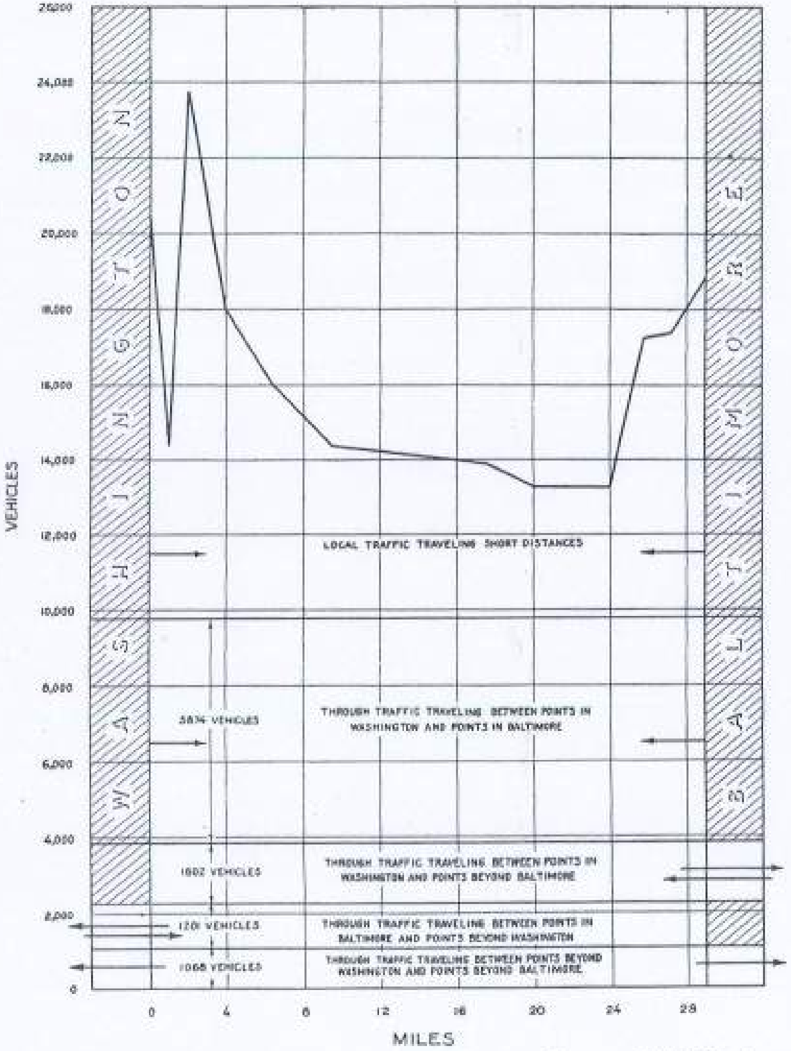

Plate 49.—Origin and destination of vehicles traveling on U S 1 between Washington and Baltimore

The nature of the facilities required will depend upon conditions peculiar to each city. In some cases redesign and widening of the main highways and connecting city streets may suffice and may be feasible; although on the rural highway sections involved, widening should always include a physical separation of the opposing traffic streams, and any widening in the downtown areas of cities is certain to be beset with difficulties.

In the larger cities generally only a major operation will suffice—nothing less than the creation of a depressed or an elevated artery (the former usually to be preferred) that will convey the massed movement pressing into, and through, the heart of the city, under or over the local cross streets without interruption by their conflicting traffic. Such facilities are not required in any city for the service of through highway traffic alone. They are not required solely for the service of the traffic entering the city from typically rural highways. There usually is added to these streams in the outer reaches of the city or its immediate suburbs a heavy movement of purely city traffic that mounts to high peaks in the morning and evening rush hours. Movements of this latter sort largely follow the same lines as the traffic entering the city from main rural highways simply because the peripheral city areas and suburbs in which they are generated have developed along such highways. There are cases in which the daily peak of "in-and-out" city traffic exists without any substantial addition from main rural highways. For such cases the requisite facility—an express highway—is in all essentials similar to facilities designed to carry external traffic across the city.

Whether the needed facility be a transcity connection or an express highway, or whether the traffic to be served includes large or insignificant contributions from extra-city highways, in either case the nature of the traffic within the city is much the same.

It always is largely a movement from the periphery to the center of the city, and is little concerned with intermediate city sections, but it must pass through them and, in so doing, is obstructed more or less frequently at the cross streets. The congestion that results, under present conditions, is due in part to the usually inadequate width of the existing artery and in part to conflict with cross traffic, generally complicated by parked vehicles.

It has been remarked previously that back of the failure to enlarge the capacity of a main rural highway at the approach to the city there are basically right-of-way difficulties. If this is true in the environs of the city, it is most emphatically true with respect to such needed improvements within the city as have been described in the foregoing paragraphs. Because these difficulties seem to the municipal administration virtually insurmountable such major improvements have thus far been attempted in very few instances.

Outstanding among the few instances that can be cited, both for their completeness and the vigor of their execution are the West Side Highway and Henry Hudson Parkway in New York City, together with their connecting parkways in Westchester County, N. Y., and the Merritt Parkway in Connecticut. Less complete but still admirable in its conception and bold in execution is the short section of depressed highway recently constructed in St. Louis; and remarkable as an earlier, less daring venture, that can be converted with relative ease into a highly efficient modern facility—the Roosevelt Boulevard in Philadelphia. In its present form the latter consists of a central artery for through traffic, bordered at each side by local service lanes, all set within a wide right-of-way. Depression of the central artery to separate its grade from that of the intersecting streets will be only a matter of construction, and is desirable.

In general, however, city administrations have been deterred from following these inspiring examples by what appear to be the literally stupendous difficulties and expense involved—difficulties and expense partly of an engineering nature, but first and usually in much the greater measure generated by the acquisition of right-of-way and the damage to, or obliteration of, private property. In the improvement of Woodward Avenue in Detroit, the property damage and right-of-way cost was $9,806,400 of a total cost of $11,127,900. Twenty years ago, it has been said, the right-of-way could have been obtained at a cost of about $250,000. Widening of this important artery affords needed space for the large number of vehicles moving over it. It does not dispose of the problem raised by the interruption of the heavy stream of traffic at the cross streets. The recently completed traffic survey indicates that eventually it will be necessary to consider the construction of express highways across the city and into its central business section which will serve through traffic without frequent cross-street stoppage.

In the circumstances it is easy to understand and sympathize with the hesitation of the city administrations. Yet the problem remains and is becoming more acute with each passing year. Soon it must be faced; and the strongest reasons urge against delay. To present them properly requires a brief digression.

Reference has previously been made to the leapfroglike movement of traffic from the periphery of the cities over intervening areas to their centers. The motor vehicle itself is the primary cause of this phenomenon. It made possible the outward transfer of the homes of citizens with adequate income from the inner city to the suburbs and it now conveys these citizens daily back and forth to their city offices and places of business.

The former homes of the transferred population have descended by stages to lower and lower income groups, and some of them (each year an increasing number, and generally those nearest the center of the city) have now run the entire gamut. (See pl. 50.) Almost untenable, occupied by the humblest citizens, they fringe the business district, and form the city's slums—a blight near its very core! Each year a few of these once prouder tenements, weakened by want of repair, tumble into piles of brick, not infrequently taking a human life in their fall. Each year a few of them make way for parking lots—unsightly indexes to needed facilities of higher dignity! Each year the city "takes over" a few of them for unpaid taxes. And now—the Federal Government is beginning to acquire them in batches in connection with its slum-clearance projects. Heralds of a better future though they are, these acquisitions comprise one of the reasons for avoidance of delay in dealing with the problem of transcity highway connections and express highways.

Another reason lies in the fact that, here and there, in the midst of the decaying slum areas, substantial new properties of various sorts are beginning to rise—some created by private initiative, some by public.

There is growing danger that these new properties, sporadically arising, and the more compact developments by the Government in its slum-clearance projects, will block the logical projection of the

PLATE 50.—A decadent area fringing a city business section.

needed new arteries into the city center. Since the actual accomplishment of such projects will at best require time they should now be planned in order that their eventual courses may not be barred by newly created property.

There is another, and perhaps still more important, reason for avoidance of delay in the carrying out, or at least in the planning, of new transcity arteries and express highways. It is that in the business district itself—in most cities, but particularly the older ones—there is a slow decay that will not be arrested until there is radical revision of the city plan. Such a revision will have to provide the greater space now needed for the unfettered circulation of traffic, and will have to permit a reintegration of facilities for the various forms of transportation—railway terminals, docks, airports and the highway approaches to each—more consistent with their modern relationships. For such a revision of the city plan decision upon the location and character of the new highway facilities here described is a basic necessity. Toward the actual accomplishment of the much needed revision, little else that might be done by Government would be so likely to supply the impetus.

What has been done in recent years in the city of Washington in cutting Constitution Avenue and the new arteries approaching the Union Station through the former mean clutter of narrow streets is indicative of the least that somehow must be done in many of the larger, and especially in the older, cities. When one observes the countless impediments that embarrass the movement of twentieth-century traffic through the eighteenth century streets of some eastern cities one wonders how long it will be, with the assured further increase in traffic, before complete congestion will result.

Because of their urgent need to facilitate highway transportation where it is now most seriously hampered, and because of the impetus that through them may be given to needed changes in the central plan of our cities, the construction of transcity connections of the main rural highways and other express routes into the center of the cities ranks first in the list of highway projects worthy of consideration by the Congress. Possibly no other work that might be done would so profitably provide employment coincident with the centers of present unemployment.

BELT LINES AND BYPASSES

Next to provisions for the safer and more efficient conduct of large traffic streams into and across cities, the new facilities most urgently required are belt-line distribution roads around the larger cities and bypasses around many of the smaller cities and towns.

As previously pointed out, the traffic on a main highway approaching a large city, that will use a bypass route if offered, is a small part of the total. By far the greater part is originated in or destined to points in the city and largely points near its center or customarily reached by traveling through the center.

Bypass routes, therefore, may not be regarded as means for the relief of congestion on the highway-connecting streets of large cities. Further evidence of the correctness of this observation is afforded by plate 51, which shows profiles of the traffic volume on the two alternate connections of U S 40 across the city of Columbus, Ohio. From these profiles it will be observed that even if the entire traffic on this important route at the city limits could be diverted over a bypass route around the city, the volume of traffic on the connecting streets at the center of the city would not be reduced in any large proportion; and, as previously stated, no large part of the existing traffic at the city entrances could be diverted.

At all large cities, however, and many smaller ones, there is need for the construction of what are called in this report belt-line distribution roads. Such roads have some of the characteristics of bypass routes, and may actually serve to bypass a considerable amount of through highway traffic around the city. Their primary purpose, however, is something different.

From most large cities a number of relatively important highways radiate in several directions. Between each of these highways there is a certain interchange of traffic that normally enters the city only because it is there that the routes have their junction. A major part of the traffic on each of the routes has its origins or destinations within, but in various parts of, the city, some near and some remote from the points at which the respective routes enter the city.

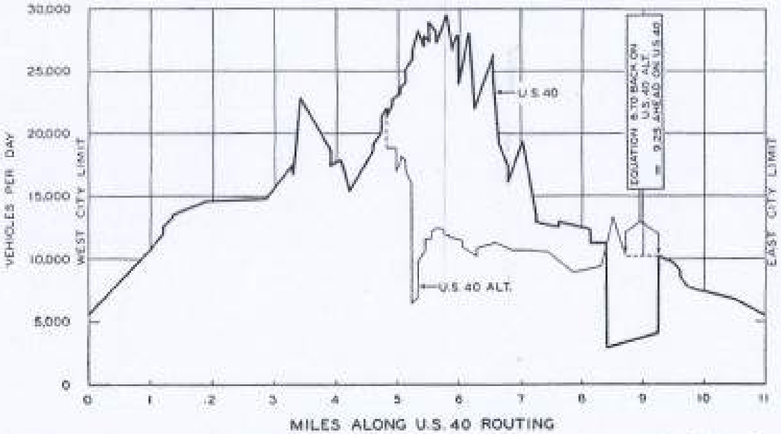

Plate 51.—Traffic profiles for U. S. 40 and U. S. 40 alternate through Columbus, Ohio, based on 1936 data.

That portion of the traffic from each of the roads that is bound to or from the center of the city is best served, if it is a considerable movement, by the transcity connecting routes and expressways previously described. These same kinds of facilities also most directly serve the needs of traffic between each city-entering highway and points in or beyond the city that lie approximately diametrically opposite its point of entrance.

But, for those parts of the traffic on each entering highway that are (*a*) interchanged with other entering highways not nearly opposite across the city and (*b*) originated in or destined to sections of the city similarly situated, the facility that will generally provide the best service is a circumferential or belt-line route forming an approximate circle around the city at its outer fringe.

The principal function of such a route is the distribution of traffic approaching the city on any highway, either to the other highways to which it may need to transfer or to points on the circumference of the city nearest the urban section of its ultimate destination, and the distribution of outbound traffic in a reciprocal manner.

In some cases it may be feasible to construct the distributing belt line within the city—generally somewhere within the ring of decadent property surrounding the central business area. Such a belt line, connecting at appropriate points with radial arteries extending out of the city, may avoid the cutting of a new route directly through the business sections, and may either serve as a substitute or supplement for the outer belt line.

At smaller cities the case is somewhat different. It is necessary to consider the volume of traffic carried by the rural highway as well as the size of the city to determine whether a bypass would be useful. Where such a smaller city lies between larger ones closely spaced, the usually heavy traffic moving between the larger cities is likely to be a preponderant part of the volume on the main highway at the limits of the smaller intermediate city, and the diversion of this traffic over a bypass around the smaller city may considerably reduce the traffic volume on the connecting streets in the city. A bypass in this case may be not only a great convenience to the through traffic but also may considerably relieve a troublesome condition within the city. A case in point is the town of Havre de Grace, Md., a small city of 4,000 population located at the head of Chesapeake Bay between Baltimore on the south and Wilmington, Del., and Philadelphia on the north. It is obvious that very little of the average daily traffic of 5,000 vehicles on U S 40 at this town is destined or has any reason to enter the town.

Where, on the other hand, the main highway approaching such a small city carries a relatively light traffic and larger cities are fairly distant, as is often the case in the more sparsely settled sections of the country, a major part of the traffic may either be originated in or destined to the small city or for other reasons desirous of entering it. As an illustration of this case, the city of Las Vegas, N. Mex., may be cited. A large part of the average daily traffic of 700 vehicles on U S 85 approaching this small city of 4,700 population may be desirous of entering the town and construction of a bypass might solve no traffic problem and accommodate very few vehicles.

If further, we consider the case of the smallest urban communities—the highway or ribbon towns that at intervals stretch out along main highways and vary from a block or two to several blocks in width—the bypassing of such places is not only helpful to the preponderant through traffic, but is usually necessary for the avoidance of congestion and serious accidents and the protection of life on the main street of the little community.

At cities large and small throughout the country there exists today a need for the belt-line routes and bypasses here described. But if they are to be and remain the useful facilities they should be, they will have to possess one feature that is present in none or virtually none of the circuit routes thus far built around urban communities; i. e., they will have to permit access only at their points of junction with the main routes approaching the cities or towns and a very limited number of intermediate points.

A so-called bypass route or belt line that is left open to access from the side at all points becomes in a very short time just another city street. The business-generating potentiality of a heavy traffic stream is so great that there is an immediate development of a great variety of roadside establishments all along every new heavily traveled route that is created. Every new highway also, especially in the vicinity of cities, immediately encourages residential development and attracts commercial establishments more interested in the new facility provided by it than in catering to its traffic.

If, therefore, a bypass or belt-line route is to remain the through-traffic facility it is intended to be, it must be protected from the encroachment of bordering developments that would quickly engulf it and destroy its special character. This means that bypass routes must be built as limited-access highways, cut off from the bordering land except at a very limited number of points, and separated from all but a very limited number of the cross streets and highways intersected by them.

As right-of-way difficulties have been shown to have been paramount in the past in discouraging the enlargement of main highway facilities at the entrances to cities and halting the provision of really adequate connections across cities and expressways into cities, so also they have thus far discouraged in many cases the construction of any kind of city belt-line or bypass facilities, and have absolutely prevented the protection of such routes from the encroachments referred to above. In this latter connection there enters also something more than the usual difficulty of obtaining space for the highway from unwilling or rapacious individuals. There enters here the further difficulty, rarely dealt with heretofore, of publicly acquiring the legal authority or right to prohibit entrance upon the highway except at designated points. Railroad companies have acquired such rights with respect to their rights-of-way, and there have been a few instances in which they have been similarly acquired for highway purposes.

Although it has not previously been mentioned the same need for the control and limitation of access will exist frequently in the development of main highways, particularly at city approaches and in the provision of adequate transcity connections and express highways, and wherever this need exists it obviously will complicate and render more expensive the acquisition of required rights-of-way.

In the construction of future belt lines and bypasses control of lateral access and separation from the grade of cross highways at intersections always should be provided. Only by so doing can the bypasses be preserved for their proper function of serving through traffic. So protected, the cities can expand beyond the circuit routes provided without interfering with the discharge of the duty of such routes. Without such protection, particularly at the larger cities, we must face the necessity of building at frequent intervals a succession of intended belt-line or bypass routes each further removed from the cities, and never for long accomplishing the intended purpose.

BALTIMORE AS AN EXAMPLE

The location and design of transcity connecting streets, express highways, and belt lines or bypasses is a matter that requires particular study of the physical and traffic conditions peculiar to each city. For purposes of illustration only a limited study has been made of the conditions existing at Baltimore, Md., and a general plan involving a combination of the various types of city-vicinal facilities as

they might be employed for relief of the critical traffic situation in that city is shown on plate 52.[1]

An old city, growing by the coalescence of numerous ancestor villages, the irregular and discontinuous street plan of Baltimore is the despair of the stranger and the daily inconvenience of its own citizens. The city lies in the path of one of the heaviest highway-traffic streams in the country, and by millions of travelers who have moved with that stream the difficulties of the Baltimore passage are well remembered.

The close block plan and narrow streets of the older sections of the city are chiefly an inheritance from the early nineteenth century. The principal business section lies in a relatively small area centrally located from east to west and clings closely to an inner harbor on the Patapsco River, into which formerly there came the many small vessels that maintained the trade of the city with the Chesapeake Bay country of the Eastern and Western Shores.

The old residential section of the city clustered closely about the central business section, which has grown little in size in the last 50 years. But, since 1900, the more well-to-do families that formerly lived in this older section have moved in large numbers to outlying suburban areas, some of which have been included within revised limits of the growing city. The old homes, vacated by this movement, have descended to the less well-to-do, and by stages large areas have finally reached a critical stage of decay.

Symptomatic of the low state of a large part of the property in these slum areas, the map shows the block locations of numerous properties upon which the city has acquired tax liens after failure of tax payment, and also the location of certain areas now in process of acquisition by the Federal Government as sites of slum-clearance projects. Within the business district itself there are many properties which probably are not included among those taken by the city for nonpayment of taxes only because the improvements that once occupied the land have been razed and the land converted into parking lots, most of which are of an order of unsightliness that is an affront to the pride of the city.

It is apparent that the whole interior of the city is ripe for the major change that it must undergo to afford the necessary relief to pressures generated by the effort to force the stream of twentieth-century traffic through arteries of the early nineteenth century. The map shows where properties are dying. In places, new and important developments are beginning to occur—developments of great possible significance in relation to the future plan of the city and particularly to the new major arteries that should supply the skeletal structure for that plan.

For example, the map shows that two of the planned slum-clearance projects of the Federal Government lie directly athwart the possible courses of major new radial arteries. The new development of these areas and other developments of similar character that will certainly follow should not proceed far in the absence of a definite plan for the needed new street and highway facilities. If it does, new and

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[1] The block location of properties acquired by the city under tax liens, and the location of areas to be acquired for slum clearance, as shown on the map (plate 52), are correct as of February 1, 1939. In number and location the various classes of highway facilities indicated have an illustrative purpose only. Although, as shown, they are consistent generally with the principles enunciated in this report, it is not asserted that all of the indicated facilities are at present required or feasible, nor that, if needed, they are practicably located.

more serious obstacles will certainly be placed in the way of a proper meeting of growing traffic needs, where obstructing private interests are now reaching their point of least resistance.

Northeast of the intersection of Harford and North Avenues, and also on the line of one of the possible new arteries, another area is indicated that until recently formed the largely open grounds of a private school. On this site there has already arisen a large and important new retail mercantile establishment, that conceivably might conflict (though it probably will not) with the best location of a needed express highway and trans-city connection serving the northeastern suburbs and the northern extension of U S 1.

The new street and highway facilities indicated on the map illustrate the several classes described in the preceding pages of this report, and in their location illustrate the manner in which such facilities may utilize to advantage existing topographic and other conditions that favor the accomplishment of a sound and adequate plan.

The main rural highways approaching the city are continued at present as streets running directly to the city center, some on diagonal lines cutting across the rectangular block plan. Historically, these streets are, in fact, the lines of the old turnpikes which, a century ago, radiated from the small Baltimore town of that period, located at what is now the center of the modern city.

Not only are these streets so located as to form the logical connections of the principal rural highways through the city and with its center, but also, they occupy the most favorable lines for the highway facilities needed to accommodate the daily movement between the city and the suburban sections that have developed naturally along and around each of the entering highways.

But, while in location the streets referred to would seem to offer the best possible avenues for the movement of traffic into and out of the central city, they do not actually serve this purpose; and the reason is that in the older part of the city they retain the narrow width of the old turnpikes.

The traffic map, plate 53, shows the radial lines of Belair Road, Harford Road, Reisterstown Road, and Park Heights Avenue at the north of the city bringing heavy traffic flows as far in as North Avenue. At this line all of these streets suddenly narrow and continue into the center of the city with the width of the early 19th-century roads they once were. In consequence a large part of their traffic turns along North Avenue and proceeds east or west to Charles Street or Mount Royal Avenue and immediately adjacent streets, which then carry it in concentrated streams southward to the business section.

The condition on Harford Avenue immediately south of North Avenue is illustrated in plate 48.

The new street plan, illustrated in plate 52, contemplates the construction of modern express arteries along the approximate lines of several of the existing radial streets, running to suitably designed intersections and distributing squares, located at the east and west sides of the central business section.

At least through the older parts of the city these express routes should be constructed as depressed, or elevated highways, or subways; and the topography and other conditions suggest an appropriate employment of each method, but principally the first.

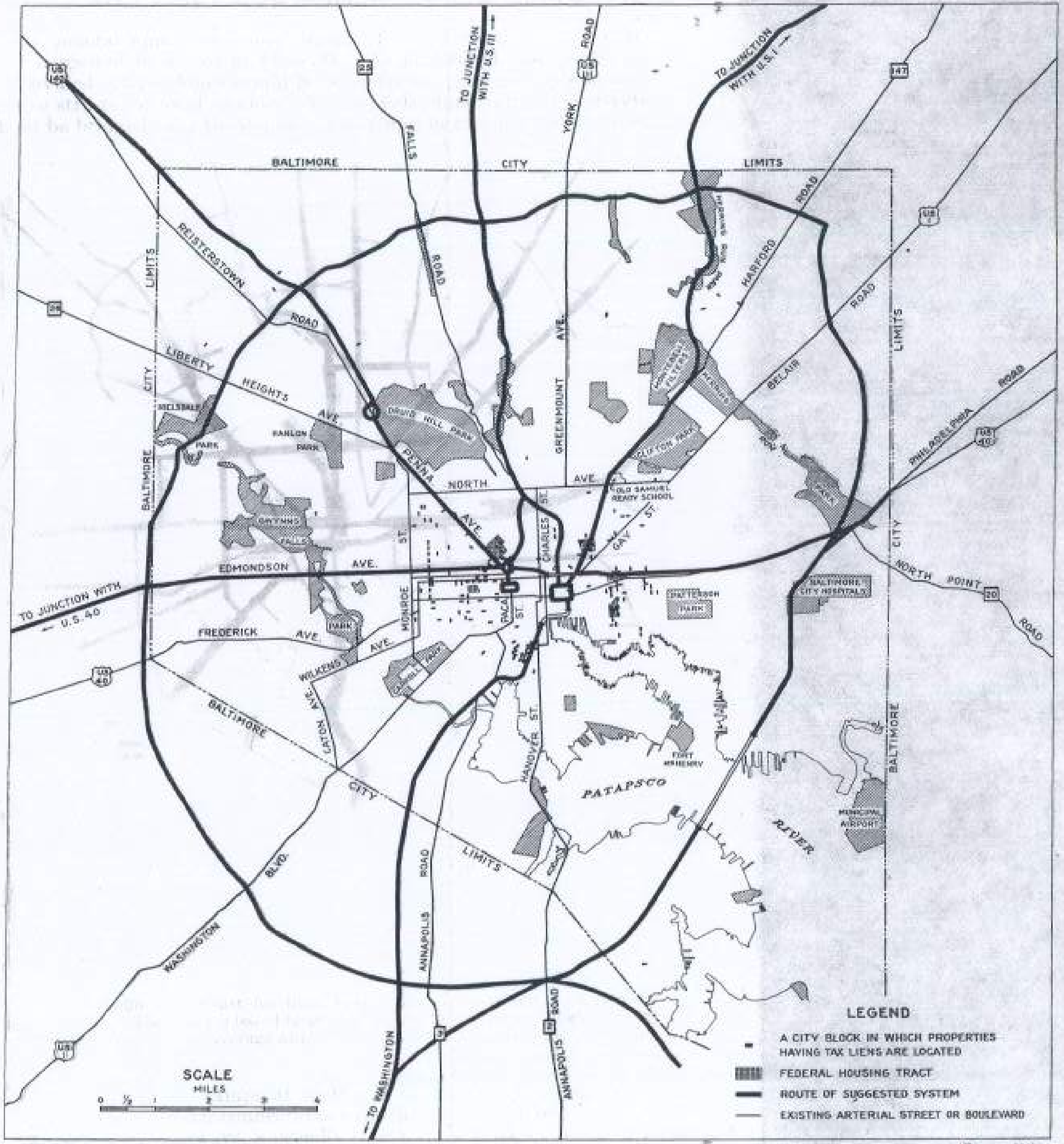

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PLATE 52.—Tentative study of locations for Baltimore trans-city connections and express highways shown in

The general appearance and design of a depressed artery of the type suggested is shown in plate 54. As illustrated, the depressed and divided arterial lanes would be bordered on each side by one-way surface streets for local service. At intervals, important cross streets would be bridged over the depressed way and in the first blocks from each of such bridges, ramps at each side of the artery would afford separated up-and-down connections with the surface streets.

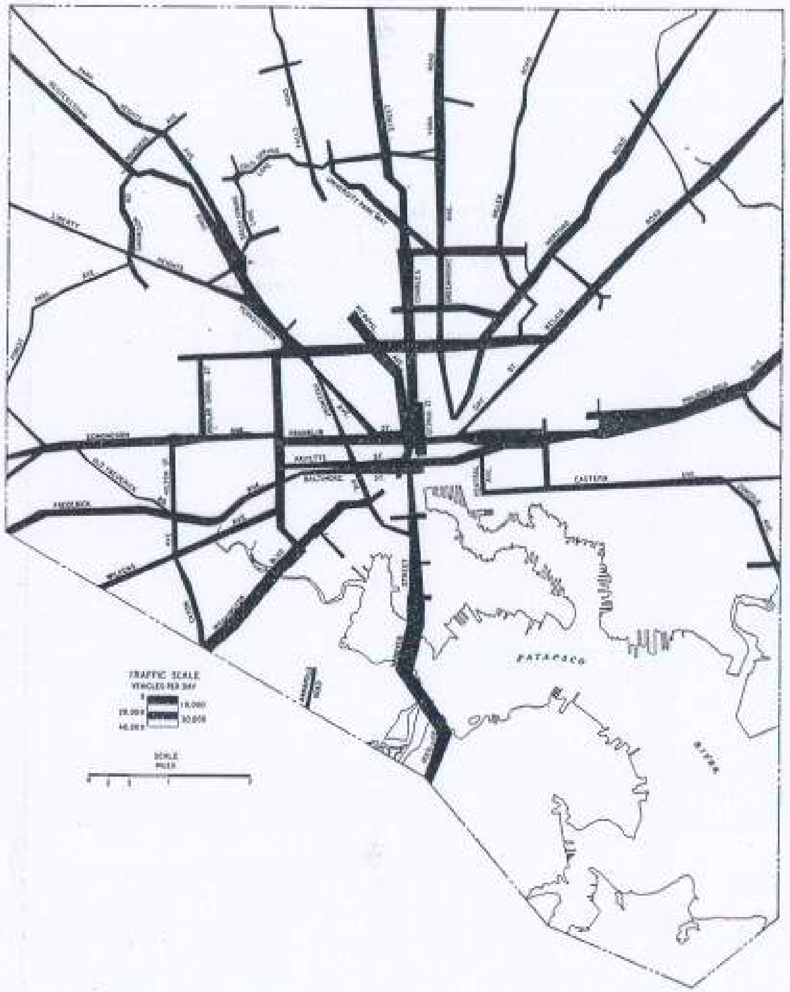

Plate 53.—Traffic flow chart for important arterial streets and boulevards in Baltimore. The chart is based largely on single 12-hour counts made in 1938, expanded to 24-hour average annual traffic by applying average factors for metropolitan areas.

The depressed highways, especially, would necessitate acquisition of wide rights-of-way, and it is because property along several of the suggested lines has already dropped close to its lowest level, and land can therefore be obtained at approximately minimum cost, that the time is now ripe for the undertaking of such improvements.

The belt line, shown as encircling the city, would be a limited-access facility, with all intersecting highway grades separated and access provided only from the more important roads. It is probable that the greatest single contributions to this belt line would be those of U S 1 at the south of the city and U S 40 at the east. Between these two highways the belt line would serve as a bypass route for that part of the Atlantic coastal movement that is desirous of avoiding the city entirely. The same section, including, as it does, a bridge across the city's outer harbor, would serve to connect two rapidly growing industrial sections on opposite sides of the river.

Because of the probably heavy volume of turning movement at the intersections of the belt line with U S 1 and 40, a special Y connection at these points might be desirable. Such a connection with U S 1 at the south of the city is illustrated in plate 55. In this sketch the belt line is shown in the middle distance coming from the west and continuing eastward toward the southern riverside industrial suburbs. In the center of the picture is shown the Y connection with U S 1, and the route of the belt line crossing the distant river toward the northeast.

DIRECT INTERREGIONAL ROUTES AND MODERNIZED RURAL HIGHWAYS

Beyond the vicinity of cities the existing main rural highways of the United States lack a sufficient capacity to discharge the flow of present traffic moving over them with reasonable convenience only at relatively few points.

In the discussion of routes to be operated as toll facilities (see p. 40) a traffic of 1,500 vehicles was adopted as the criterion for determining whether a two-lane or a wider pavement was required. Average daily traffic in volumes less than that amount it was assumed would require no more than two lanes for its free movement; traffic exceeding that average was assumed at some time during the year to produce a maximum hourly flow that would be slightly inconvenienced unless more than two pavement lanes were provided.

It was pointed out that a toll road, for use of which a special fee is asked, would have to provide a capacity that at any time would not be likely to limit the freedom of motion of its users. So high a standard of service is not to be expected in a system of roads built with general taxes. On such roads a slight restriction of absolute freedom of movement is to be expected during the few short periods of maximum hourly traffic volume that occur in the course of a year. So long as such occasional restrictions do not result in the creation of a dangerous condition or in substantial congestion or retardation of the traffic they may be accepted as reasonable. On this basis, an average daily volume of 2,000 vehicles may be considered as within the reasonably convenient discharge capacity of a two-lane highway.

Accepting this figure as a criterion, the highway planning survey data for 12 representative States, presented in table 20, show that in these States there are only some 4,651 miles, or 0.6 percent of their total of 766,314 miles of rural highways on which the traffic is of such density as possibly to tax the capacity of a two-lane pavement to provide reasonably convenient service. On January 1, 1938, there were

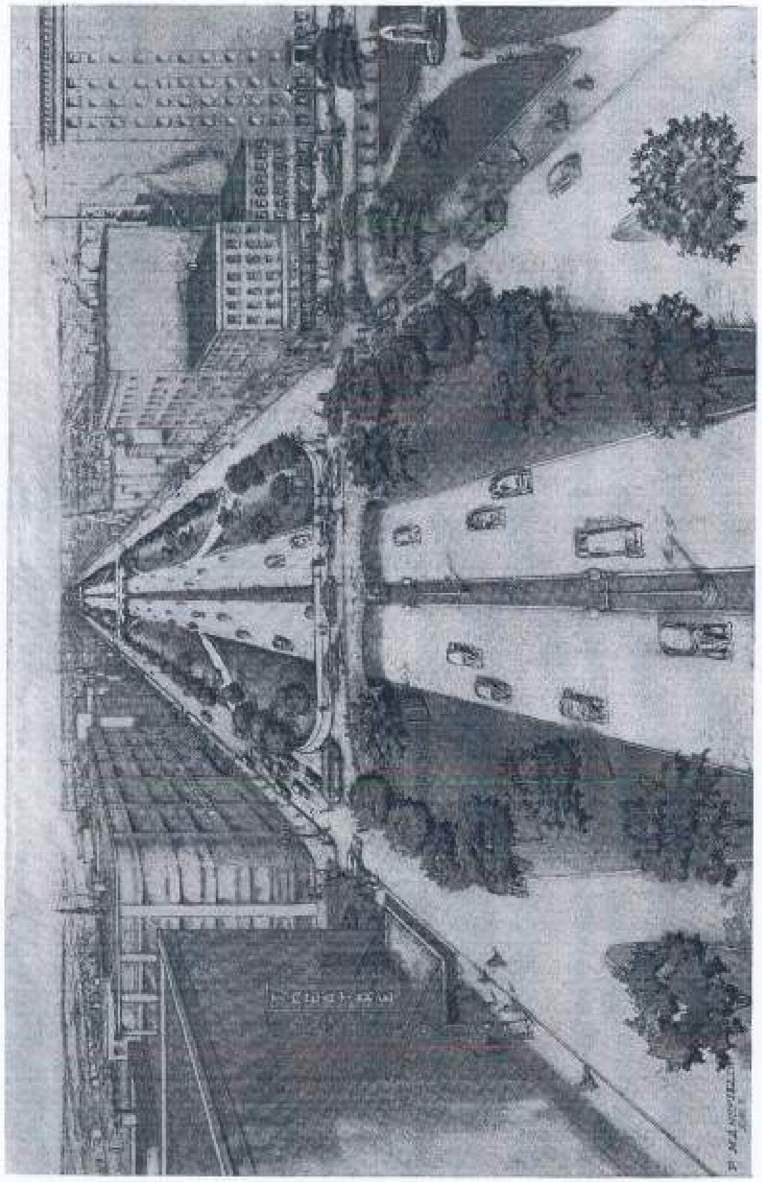

PLATE 54.—Sketch showing the general features of a desirable design for a depressed express highway in a city.

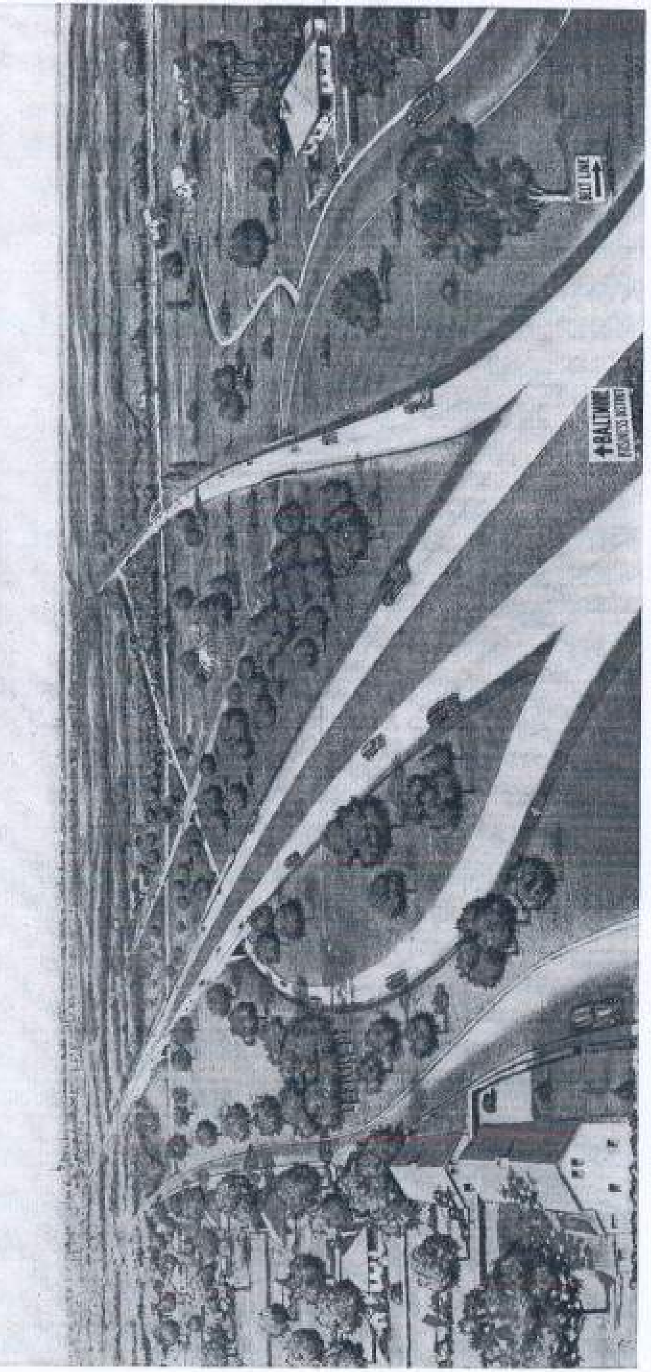

PLATE 55.—Sketch of suggested intersection of U S 1 and a possible belt line around Baltimore.

in these same States approximately 1,155 miles of rural roads that were improved with pavements more than two lanes wide. On the basis of pavement width only, therefore, there may be in these 12 States some 3,000 miles of rural roads on which the traffic has reached such a volume as to suggest the possible need of greater pavement width than has been provided.

TABLE 20.—*Mileage of rural highways in 12 representative States; mileage and percentage of total rural mileage carrying more than 2,000 vehicles per day, and mileage of paved rural roads having more than 2 traffic lanes*

State	Length of rural highways	Length and percentage of total length of all rural highways carrying more than 2,000 vehicles per day		Length of paved rural highways having more than 2 traffic lanes
	Miles	*Miles*	*Percent*	*Miles*
Arizona	27, 547	78	0. 3	33
Florida	28, 912	273	. 9	48
Idaho	33, 540	110	. 3	8
Illinois	102, 684	1, 223	1. 2	358
Iowa	101, 525	235	. 2	0
Kansas	128, 198	301	. 2	9
Missouri	116, 893	522	. 4	282
Montana	65, 730	12	. 0	0
Ohio	82, 469	1, 517	1. 8	374
Utah	21, 493	82	. 4	22
West Virginia	32, 598	298	. 9	21
Wyoming	24, 725	0	. 0	0
Total	766, 314	4, 651	. 6	1, 155

However, as suggested by the traffic volume profile on plate 56, it is probable that this entire mileage is located within a relatively short distance of the cities of the 12 States. The profile shows uniformly a rapid drop in the traffic with increasing distance from the cities, and generally quite moderate traffic volumes beyond the immediate environs of the cities.

Not only do the findings of the planning surveys show that beyond the vicinity of the cities there is no great mileage of the existing main rural highways that requires increase in the number of its lanes, but they also show the existence of a number of other conditions on a considerable part of the mileage that urgently require correction. Plate 56 shows graphically the nature and prevalence of these unsatisfactory conditions on the existing highway from Philadelphia to San Francisco.

Distances along the highways are represented in this graph to a greatly condensed horizontal scale. The character of the highway pavement or surface at all points is represented by the shading or hatching within the broad bands extending across the diagram; and information concerning nine other important conditions in relation to each mile of the highway is presented by various plottings to six conveniently enlarged vertical scales.

The width of the pavement or surface on each mile is represented to the indicated scale by the width of the hatched lower band. To the same scale the distance between the horizontal lines immediately adjacent to the hatched bands represents the width of right-of-way at all points.

In the first row of plottings above the pavement and right-of-way bands the height of the narrow black vertical bars, each of a width corresponding to a distance of 1 mile to the horizontal distance scale, represents to the indicated scale the number of curves in each mile of the highway that in 1937 were sharper than certain indicated desirable standards, generally 6° in nonmountainous areas and 14° in mountainous areas.

In the next higher row, the narrow vertical bars represent to the indicated scale, the number of grades, longer than 500 feet, in each mile exceeding 5 percent in nonmountainous areas and 8 percent in mountainous areas, considered generally as desirable maximum limits.

Similarly, the height of the vertical bands in the next row represents to scale the number of sight distances in each mile shorter than desirable limits of 1,000 feet and 650 feet in nonmountainous and mountainous areas, respectively; and those in the next row in like manner represent the number of fatal highway accidents occurring on each mile during the year 1937.

At the top of the diagram the average daily volume of traffic on each mile of the highway is shown by three profiles, the highest representing the total vehicular traffic and the two lower ones, respectively; the traffic of motor trucks and busses and the so-called "foreign" traffic which, in each State, consists of all vehicles bearing license tags of other States.

Vertical lines extending through all of the data rows of the diagram, show to the horizontal scale the sequential location of the corporate limits of cities and State borders.

Examination of this highway condition diagram shows instances in which variations in the width or type of pavement or both are inconsistent with corresponding variations in the average daily traffic and a number of sections on which pavements of two-lane width are provided for traffic exceeding an average daily volume of 2,000 vehicles.

The existing rights-of-way are shown to be in the main quite narrow, generally less than 100 feet in width; and there is a marked absence of either uniformity or consistency in the widths provided. Wide pavements are confined within relatively narrow rights-of-way and narrow pavements in other places are laid on relatively wide rights-of-way. In some places the available right-of-way will be observed to constitute a definite impediment to desirable widening of the pavement.

Unsatisfactory conditions in respect to sight distance, grade, and curvature are shown to be of common occurrence; and on some sections the conjunction of such unsatisfactory physical conditions of the highway with a bad accident record suggests the possibility that the highway conditions may be in some measure responsible for the fatal accidents that have occurred. In other instances the record of highway physical conditions, including the width of pavement, appears to clear the highway of responsibility for accidents that have occurred.

The diagram reproduced in plate 56 is typical of others that have been drawn for nearly 27,000 miles of important main highways in the United States; and the conditions shown on this diagram are fairly indicative of those that exist generally on all the main highways of the country. There is no doubt that, as measured by the standards of the diagrammatic record, unsatisfactory conditions with respect to sight distance, curvature, and gradient are common. There is no doubt also, as indicated by the diagram, that acquired rights-of-way are inadequate. As further indicated, there is generally a reasonable accord between traffic volume and the number of pavement lanes provided and also between the amount and character of the traffic and the class of pavement or surface in place. A slightly inadequate width of the pavement lanes appears on a considerable mileage, usually near cities.

The unsatisfactory conditions found on the main roads of the country and indicated typically in plate 56, are the natural consequences of circumstances surrounding their construction. The roads, as they exist at present, are the product of construction operations carried on over a period of more than 20 years. It is estimated that at least 11,000 miles of road surface on the State primary systems, constructed prior to 1921, is still in service, widened perhaps, but still on its original alinement and still unchanged in basic design. This mileage represents 14 percent of the surfaced mileage in existence prior to 1921. A large part of the existing improved mileage was built during the twenties and still conforms to the standards then considered adequate.

One of the handicaps under which roadbuilders have labored during the period of development of the motor vehicle is that they must expect the roads they build to outlast the vehicles that exist at the time of their building. There is a substantial mileage of road pavement still in use that was built 25 years ago or longer, serving today kinds of vehicles that were undreamed of when they were built. Small wonder if such pavements, designed to be used by vehicles capable of a top speed of 30 miles an hour, are found somewhat inadequate for the service of vehicles that may be, and are frequently driven at speeds above 60 miles an hour.

When the oldest of still existing pavements were built there were only 2 or 3 million primitive motor vehicles, but there was already a strong demand for improved roads, and especially for roads connecting the larger cities, in which the great majority of the vehicles were owned. The recognized superior need for such roads resulted in their inclusion in State highway systems and, in 1921, the Federal-aid highway system, and the enactment of laws limiting expenditure of State and Federal funds largely to the improvement of these systems.

In the beginning nearly all of the mileage included in these systems had no improvement worthy of the name. The need of improvement in some degree was coextensive with the system; and the primary need was for the laying of surfaces which—to use the popular phrase—would "get the traffic out of the mud."

In general, the improvement began near each city and larger town and proceeded outward from these to eventual junction of the extending arms. While unimproved gaps remained there was constant pressure to close them as rapidly as possible in order to "get the traffic through." The full value of the improved sections was unrealized so long as at one or both ends they delivered their traffic to a road still unimproved. Residents along the unimproved sections naturally wanted to see their sections improved also, but they were scarcely more vigorous in pressing their claims than were those already served with pieces of improved highways that failed to take them where they wanted to go.

The pressure thus generated, impelling toward prompt interconnection of all the designated routes, forced a decision between two possible courses of action toward an eventual complete improvement. One of these would have involved the piecemeal completion of improvements regarded as fully adequate on each successive section of the system before undertaking any improvement whatever on other sections. The other course and the one adopted, described as stage construction, attempted to spread some degree of improvement as rapidly as possible over the whole system, and to build on this initial accomplishment by subsequent stages of improvement.

This was one of the expedients adopted to "get the traffic through" as quickly as possible over the entire main highway system. It was a proper expedient, and it resulted, as it was intended to result, in the giving of the greatest possible measure of service to the fast-growing and widespreading highway traffic in the shortest possible time. In accordance with this stage construction policy surfaces of low type were built as initial improvements wherever they could reasonably be expected to satisfy the minimum requirements of the existing traffic. Where high-type surfaces were required by the developed traffic they were commonly given the least width that would afford a substantial service. The funds thus saved were employed to extend surfacing to other sections.

The stage construction policy did not encourage any form of temporary improvement that would not acceptably serve as a basis for the further improvement contemplated. On the contrary, it insisted that the first stage improvements made, such as grading and drainage, and the cheaper types of surfacing, should be capable of incorporation without substantial loss as bases for subsequent pavements of higher type and greater width. Present inadequacies in the highway system that result from application of the stage construction policy consist mainly of surfaces a little narrow and somewhat weak for the traffic that moves over them. But these are defects that can be corrected by addition, with the almost complete salvage of the previous investment.

The more serious defects of the present roads—those that will involve in their correction a considerable loss of invested value, and that already have been responsible for a heavy obsolescence of the roads built—are consequences of another expedient adopted to hasten the extension of improvement in the pioneer period. That expedient was the acceptance of the existing rights-of-way of the preautomobile roads as the limits within which to place the new improvements. The sharp curvature and indirect alinement resulting from this policy are the causes of by far the greater part of the recognized present obsolescence of the main highway system.

In retrospect it appears that another course might have been followed but there was no question of the wisdom of the action at the time. It must be remembered that during the greater part of the period when the defective roads were built the motor vehicle had not yet become the abundant revenue producer it now is. The property tax was still relied upon in considerable measure to pay the costs of the roads built, and that form of tax was little easier to collect then than now. Annual road revenues were, therefore, relatively small in relation to need; and the most pressing need, as already remarked, was the extension of surfacing. There appeared to be very good reason to avoid, so far as possible, any expenditure for new right-of-way and apply the money instead to the construction of the much desired surfaces.

If the need for better alignment and more adequate right-of-way had been felt, and funds had been held available for the purpose, actual obtainment of the rights-of-way would have been a difficult and slow process because of the objections and obstruction that would have been offered by individual landowners all along the projected routes.

But more decisive than either of these circumstances in accounting for the adherence to old rights-of-way, was the fact that there seemed to be no great need to depart from them. Long distance travel by road had not developed and was not foreseen. For the local movements from one town to its immediate neighbors the indirection of the old roads was not a disadvantage, but an advantage. Motor vehicles were incapable of high speed and were legally restricted to very low speeds. The desire for the present high speed had not been born in a populace still tied to its home places and regarding 30 miles an hour as a breakneck pace. The improved curvature obtainable by slightly cutting the corners of the existing rights-of-way was all that was believed to be needed, and all that could reasonably be foreseen as required in the future.

It was not until the early years of the present decade that a change occurred. Then, rather suddenly, the speed capacity of motor vehicles was increased and new standards of highway design, particularly in relation to curvature, gradient, and surfaced width became necessary. By that time a large part of the present improved mileage had been constructed, and much of this earlier construction is now in some degree obsolescent, mainly because its curvature is too sharp. To correct its defects new right-of-way is needed in large acreage.

Moreover, there are other conditions that point to the same need, the need of additional right-of-way—mainly in the form of greater width. These are conditions associated with the private use of the land bordering the narrow strips within which the public highways are confined. Collectively such uses are described as "ribbon development." They include an unneeded number of unsightly stands and other minor and temporary retail establishments catering inefficiently and with little profit to the purchasing power of Americans awheel; a multiplication of roadside residences and more substantial business places, crowded close to the roadway; the private opening of innumerable accesses to the highways, many so blind as to be positive menaces; and the erection of billboards in such numbers on the more heavily traveled roads as virtually to obscure the natural scene.

The mere presence of these numerous, close-crowding objects and establishments is a distraction to drivers of vehicles. Some of them, by every conceivable device, endeavor to attract the attention of drivers of vehicles from their primary responsibility; most of them contribute largely to the hazards of unexpected stopping, turning, and emergence upon the highways of both vehicles and pedestrians. All are positive menaces and must be controlled, and the only probability of material improvement lies in a general and substantial widening of the rights-of-way of the more important roads, together with effective border control. On such roads the availability of wider publicly controlled margins will permit employment of various measures designed to abate the menace; among them roadside planting to obscure unwanted billboards, the prevention of parking on the traveled way, and control of the conditions of egress from and ingress to the highway at all bordering properties.

The need for such additional right-of-way width is not so great on the less frequented highways, because most of the developments complained of are only attracted by and associated with the denser traffic flows.

The need of modernizing improvements here suggested—improvements made necessary by the changes that have occurred in the speed and volume of traffic, and most of them involving important new right-of-way requirements—is present today on a large mileage of existing main highways in the State and Federal-aid systems, and on other roads of comparable importance, generally in the vicinity of cities. Specifically, the needed improvements include the reduction of excessive curvature; the flattening of heavy grades; an opening of longer sight distances; a general widening of pavement lanes; a construction of additional lanes and separation of opposing traffic where increased volume requires, and possibly also for the accommodation of slow vehicles on the heavier grades; the separation of grades at many railroad and highway intersections, and installation of protective cross traffic controls at others; the abatement of dangerous roadside conditions of all sorts; and a substantial improvement in the general directness of alinement between important objectives of the principal routes serving movements of the longer ranges.

All of these named improvements, except one, can be accomplished generally by local correction of, and addition to, the existing highways after acquisition of the new rights-of-way almost invariably required. The exception—the provision of more direct routes for long distance, interregional movements—will involve the construction of considerable lengths of new and more direct highways to be used in place of existing indirect roads by the through traffic. Usually the existing facility will remain in use for the service of the local traffic it was located originally to serve.

The abundance of information supplied by the State highway-planning surveys now makes it possible to decide upon the lines for such direct highways most useful for the accommodation of the ordinary peacetime movements. In consideration of this information and a knowledge of the general needs of the national defense received from previous advices of the War Department, a tentative selection of routes has been made, which, comprising a 26,700-mile system, is shown on the map reproduced as plate 57.

After further study, in which there should be a close cooperation with the Bureau of Public Roads by various agencies, particularly the War Department and the several State highway departments, it is now advisable by law to establish this or a closely similar system as the Primary Highway System of the United States.

The system tentatively selected is believed to include substantially every major line of interregional travel in the country. As shown on plate 58, it joins the populous cities of the United States, almost without exception, and one of its routes follows practically every one of the lines along which the population of the country has moved to its present settlement and along which it is still obviously thickest both in city and country.

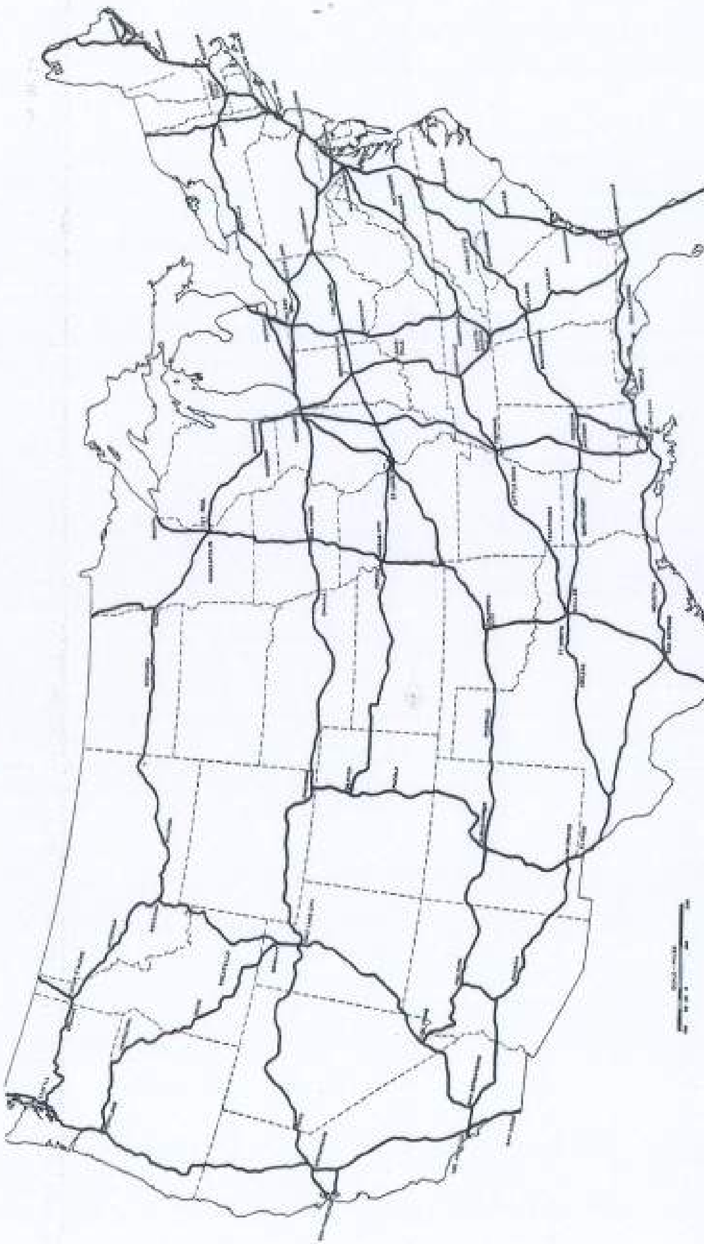

PLATE 57.—Location of existing routes tentatively selected as approximating the lines of a proposed interregional highway system.

The existing routes which would be improved by the proposed system are shown by the traffic map, plate 59, to be in each locality the most heavily traveled, as a whole, of all routes in the numbered United States Highway System.

Compared with the selected toll road system, conforming to the congressional definition, this suggested Primary Highway System of the United States, is nearly twice as large, made so by the essential inclusion of all routes of primary importance and interregional utility, not possible within the limits set by the act.

Improved as a system of public roads along lines chosen to facilitate the important traffic awaiting its service, it will attract traffic and generate new activity, in contradistinction to the traffic-repelling tendency of the proposed toll-road system.

With the aid of all State highway departments the significant conditions of all present highways approximating the lines of the direct system, including the average daily volume of traffic in 1937 on all such highways, have been ascertained and diagrammatically recorded for further study on straight-line diagrams, of which that reproduced in plate 56 is a typical sample. No such precise and acceptance-compelling information has ever before been available or possible of assembly with reference to a projected highway plan of comparable magnitude. Either already compiled or quickly available, there are ascertained facts to answer whatever questions may be asked as to the need for, and manner of making, the important improvements suggested.

The existing routes most nearly conforming to the direct routes suggested now serve somewhat less than 10 percent of the total vehicle-mileage on all rural highways. The suggested more direct routes would lose little of this traffic, and attract from other highways considerably more than they would lose, besides generating a large amount of new movement. Although in mileage they would represent as a system less than 1 percent of the total rural highway mileage of the country, they would unquestionably accommodate at least 12.5 percent of the total rural vehicle-mileage. This may be compared with the utilization estimated for the selected toll-road system which amounts to about 1.2 percent of the total rural vehicle-mileage.

These roads would directly substitute for substantially all of the most heavily traveled of present rural routes and would subtract heavily from lesser traffic streams now following other roads. By providing ample capacity and every safety device known to modern highway engineering, the construction of these roads would effect a greater reduction in the highway accident rate than could be made by an equivalent sum spent for highways in any other way.

Wherever it may be done, consistent with the purpose of direct routing and other essential considerations, the suggested routes should follow the alinement of, and incorporate the improvement of, existing highways. Reasonably direct connection between the major cities along their general lines should be the controlling thought in choosing revised location. Deviation from such direct lines should not go far for any purpose, and should be accepted in limited degree only to pick up the largest intermediate towns.

The routes should enter and traverse all large cities by means of facilities adequately designed to promote free movement of traffic to and through the center of the city. At large cities, wherever

U. S. GOVERNMENT PRINTING OFFICE : [illegible] (Face p. 110)

PLATE 58.—A comparison of population density and average daily traffic on existing routes

necessary, limited-access belt lines should also be provided; and all small communities should be bypassed—not entered. In general alinement the routes should be directed toward the center of large cities and past the sides of small towns, the line between large and small communities being drawn in each section between cities of such size as to contribute either (1) the larger or (2) the smaller part of the expected traffic on the route at their boundaries.

The standards of grade and curvature should be substantially the same as previously considered for the proposed toll-road system, varied slightly in concession to the more difficult or expensive locations.

All railroad grade crossings should be eliminated and all highway intersections should either be separated, closed, or positively protected according to the importance of the intersecting roads.

Lane widths should be the same as those proposed for the toll highways, and pavements more than two lanes wide should be provided where traffic exceeds 2,000 vehicles per average day. Wherever it is probable that an original two-lane pavement may have to be increased in width, the original pavement should be laid off-center of the right-of-way.

The right to limit access should be acquired at all points and should be exercised wherever and whenever the amount of entering vehicles is likely to endanger appreciably, or interfere materially, with the freedom of movement of the main stream of traffic. Approaching large cities and elsewhere, if necessary, bordering local-service roads should be provided.

Right-of-way width in rural areas generally should be not less than 300 feet, in urban areas not less than 160 feet. And here, it may be observed again, as in respect to the various classes of city and city-vicinal facilities previously discussed, lies the crux and the initial and greatest difficulty of effecting the type of direct rural facility proposed.

SECONDARY AND FEEDER ROADS

The great preponderance of highway traffic in the United States is served by the rural roads included in the Federal-aid and State highway systems and by city streets. Local rural roads administered by county and lesser governmental units, although they comprise the large percentage of the total rural highway mileage, serve a relatively small percentage of the total vehicle-mileage.

As shown graphically in plate 60, it is estimated on the basis of results obtained by the highway planning surveys of 17 typical States that the main highways, comprising the Federal-aid and State highway systems and their transcity connections, serve approximately 57 percent of the total vehicle mileage on all roads and streets, although these systems constitute only 11 percent of the total mileage. The local streets of cities, constituting only 6 percent of the total road and street mileage, serve approximately 30 percent of the total traffic expressed in vehicle-miles.

Contrasting with these more heavily traveled highway and street facilities, the county and other local rural roads, which constitute approximately 83 percent of the total road and street mileage of the country serve only about 13 percent of the total traffic.

As these relative percentages indicate, problems incident to the service of large volumes of traffic are found almost exclusively on the Federal-aid and State highway systems and on the streets of cities.

Improvement of these more heavily traveled facilities, comprising in the aggregate about 17 percent of the total street and highway mileage, benefits all but a very small part (13 percent, as shown by the diagram) of the movements that in sum represent the country's highway transportation.

But, while the improvement of heavy traffic arteries is thus indicated to be a first necessity, and of greatest value to the largest proportion of highway usage, the State highway planning surveys are also establishing other facts that merit careful consideration. These facts show that it is probable that the Federal-aid and State highways in the average State give direct access to about one-fourth of the total number of rural homes, and places of business, social and religious gatherings.

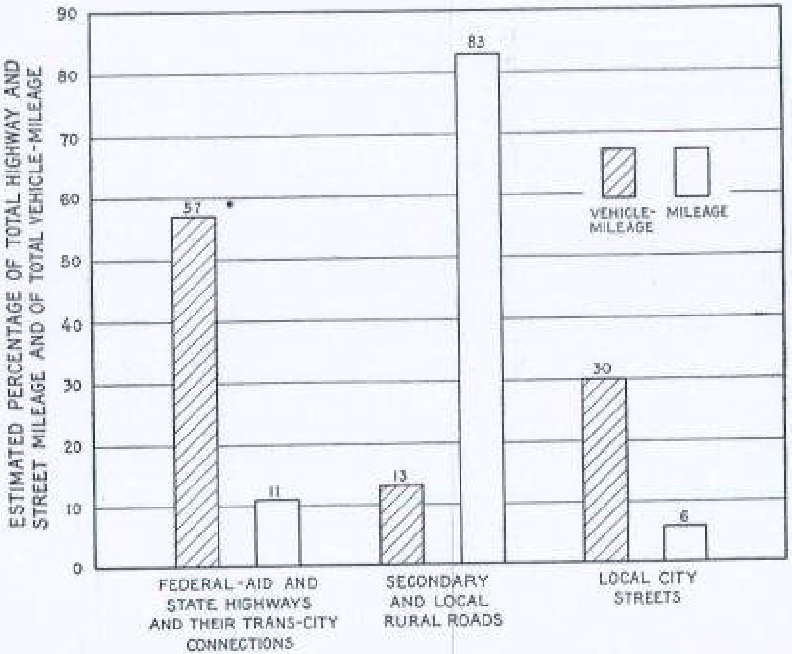

PLATE 60.—Estimated distribution by systems of total rural highways in the United States and city street mileage and corresponding distribution of total vehicle-mileage.

In Oregon, for example, the State highway system, comprising approximately 13.7 percent of the total rural-road mileage serves directly 23.6 percent of all farms, rural homes, and rural commercial, social, and religious establishments.

In Florida, the State-maintained highway system, including 22.4 percent of the total rural-road mileage serves directly 29.2 percent of the farm houses, homes and other rural buildings previously described.

In Vermont, the State highway system, which includes 12.7 percent of the total mileage of rural roads, serves directly 22.5 percent of the total number of rural homes and other establishments.

In Utah, the State highway system, comprising 21.6 percent of the total rural-road system, serves directly 30.7 percent of the rural homes and other establishments.

There is every reason to believe that the similar relationships in other States conform approximately to the pattern established in the States cited, and it is probable that for the country as a whole the Federal-aid and State highway systems, as at present designated, give direct service to about 25 percent of the total number of farmhouses, homes, churches, schools, stores, and other commercial establishments in strictly rural territory.

It is apparent then that the improvement of highway mileage outside of the Federal-aid and State systems must rest, not upon the value of a resultant substantial gain in vehicle-mileage accommodated, but rather upon the desirability of giving direct improved-road access to a greater percentage of rural homes and places of business and other congregation.

Outside of the Federal-aid and primary State highway systems there are in rural territory some 2,618,000 miles of road.[2] Even to reach directly all of the farmhouses, homes, and other establishments, it would not be necessary to improve all of this large residual mileage, because there is a considerable part of the existing mileage that serves neither occupied property nor measurable traffic. Moreover the highway planning surveys are indicating that an improvement of a substantially smaller mileage will bring direct service to a large percentage of the rural population.

For example, in Florida 57 percent of all rural dwellings are located within 1 mile of the State-maintained system; in Utah nearly 70 percent are within a like distance of the State system, and within the same distance of the State roads in Vermont are nearly 55 percent of all rural dwellings. What additional feeder road mileage, if any, it would be necessary to improve to give direct service to these or larger percentages of the rural population cannot be indicated. On this point the facts are not yet sufficiently analyzed to warrant a more definite statement. It is known, however, that conditions vary among the States and regions of the country.

It is apparent, however, that the improvement of roads outside of the Federal-aid and State highway systems calls for careful selection, to accomplish the greatest benefit with the least expenditure from two points of view: (1) Improved service to a still larger percentage of the total traffic; and (2) direct access to a greater percentage of rural homes and establishments.

In administering the appropriations recently made by Congress for the improvement of secondary and feeder roads, the Secretary of Agriculture has interpreted the language of the acts as applying to roads not included in the Federal-aid highway system, but possibly included in the State highway systems. Pending the availability of facts to be supplied by the State highway planning surveys as indicative of the relative importance of portions of the large mileage comprised under the definition, sections of road for improvement are being selected on the basis of the best available information. As soon as the planning survey information will permit, the States will select for approval by the Secretary of Agriculture a group or system of roads,

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[2] This total includes secondary State highways and county roads under State control.

conforming to the definition and including roads of high relative usefulness, not exceeding at the outset an aggregate mileage equivalent to 10 percent of the total mileage of rural roads in each State.

The selection will be materially influenced by the purpose of promoting desirable future uses of rural land as well as by evidence of existing settlement and usage; and to this end the highway authorities of the States are being asked to cooperate closely with committees that are being formed in each State and each county to develop programs of most effective land utilization.

It is obvious that the further improvement of secondary and feeder roads should be consistent with the probable future use of the lands served by them. That, to a certain extent, the selection of roads for improvement may be the means, over a long period, of fostering a desirable movement from less to more favorable lands is also seen as a possibility. Governed in this way, the improvement of secondary and feeder roads, by widening the margin of advantage between the less and the more favorable lands, may become a useful instrument for inducing an economically and socially beneficial resettlement of the rural population by a gradual and natural process.

Extended in the light of such investigations of need and usefulness as are here mentioned, the further improvement of secondary and feeder roads is desirable and necessary. It should be realized, however, that the construction of roads of this class approaches a margin, below which the benefits, measured by any standard, must appear as less than the costs. Therefore, in providing for improvements of any roads forming part of the 2,618,000-mile total that serves only 13 percent of the total traffic, a careful selection is necessary.

NATURE OF THE RIGHT-OF-WAY PROBLEM

There can be no question of the need for the various classes of highway and street improvements described. In many instances they are already too long delayed, and with the growth in use and economic significance of highway transportation still continuing, the need for revision of facilities which were designed to serve a far less exacting and voluminous traffic will continue to grow.

The most influential causes of the delay in effecting the needed changes hitherto have been the inadequacy of available funds and the overpowering legal obstacles and inhibitions that stand in the way of obtaining essential rights-of-way; and these will continue to retard action and eventually build up a formidable burden of deferred construction expenditure unless early provision is made to deal adequately with this problem.

Thus far, the Government of the United States generally has been unwilling to assume any part of the cost of obtaining rights-of-way. In all work under the Federal Highway Act the responsibility to provide the right-of-way and to satisfy damage claims is placed solely upon the States. The Government has assumed a part of the right-of-way expense in other recent public works of various classes in which it has participated, but it generally has refrained from lending any assistance to the States and local governments in overcoming the difficult legal and procedural obstacles encountered. Undoubtedly these right-of-way difficulties have been the primary cause of delay in dispatching many of the most worth-while projects undertaken in the various emergency programs to deal with the condition of unemployment.

As previously suggested, the States, in their highway operations, have never had at their disposal funds in sufficient amount to meet the costs of a desirably prompt construction program and a simultaneous heavy expense of land acquisition. The same condition has generally affected the various operations of the municipal and county governments. In consequence, the character of the improvements undertaken too often has been governed by the limited possibilities of land acquisition.

When, as in the recent emergency programs, there is added to the normal difficulties of this problem an urgent demand for speed of action, a situation already bad is made much worse. It is believed to be beyond question that a proper handling of the acquisition of land for public purposes requires reasonably long anticipation and careful and coordinated planning of all the public purposes that may be affected by every proposed purchase. When, as is now well-nigh universally the case, the obtainment of land is postponed until the very moment its possession becomes imperative for the provision of an announced and urgently required facility, every condition conduces to precipitate ill-advised, uneconomical, and generally unsatisfactory action.

This condition comes about, in large measure, from the legislative practice, so general in the States, of appropriating or providing for land acquisition in the same acts that supply funds for the construction of public works. This practice inevitably postpones to the last and the most inconvenient and inappropriate moment a provision that should be the subject of far-sighted planning and accomplishment well in advance of the actual need. This observation is especcially true with respect to highways, because of the principle of growth that lies in them, but which far too often is not recognized in the action of the authorities of all branches of government, the judicial as well as the executive and legislative.

A typical example may serve to illustrate the way in which this growth principle is disregarded in the improvement of highways, and the expensive and embarrassing consequences that ensue. A road hitherto lightly traveled is about to be improved. It occupies an ancient right-of-way of a width consistent with its use many years ago. The legislature, as the appropriating body, has made available for the improvement of that particular road and many others certain public funds from which must be met not only the costs of constructing the roads but also whatever costs there may be for the acquisition of the lands on which such roads may be built. Because they see not only the necessity for improvement on the particular road but also the many competing needs of other roads, and have at their disposal and in view only a certain total sum that they feel must be made to go as far as possible in meeting all needs, the highway authorities construct the road on the existing admittedly restricted right-of-way. The principle of growth asserts itself. New traffic, drawn and generated by the improvement, appears on the road. The road as built soon becomes inadequate to accommodate the greater traffic. The surface must be widened, but to do so an additional width of right-of-way is required and sought of the owners of abutting land. If this additional width had been obtained in advance of the original improvement it might have been acquired at a relatively moderate cost. The owners then may be presumed to have been eager for the improvement of the road for their own use; and the land at that time being served by an inadequate highway facility stood at a lower level of value. But, at the time, even this moderate cost appeared too great; and such inevitable delays as might have been encountered appeared too long, for the time of improvement was at hand, the demand of the public was insistent, and the appropriated funds awaited expenditure in the treasury.

When further widening is thus forced the needed additional land has risen in value. There are more owners or occupants to deal with and many of the new ones occupy the very margins of the road where they conduct various sorts of traffic-serving business. To some of the owners the additional widening, required mainly for the accommodation of an increased volume of passing traffic, is of little interest and in their view will confer no new or greatly desired benefits. To others, the widening proposed means the destruction of their property. So the owners ask a higher price.

Forced to act, the highway authorities decide to acquire an additional strip of land. As they must buy the front of the properties affected, a price well above the average acreage value of the neighboring lands is demanded. And, because of the higher price and a continuing competing demand of other needed improvements far exceeding in cost all the funds of which they are assured, they decide to acquire only the narrowest strip that will physically accommodate the widening to be made immediately. If they should attempt to pursue the more farsighted policy of acquiring sufficient width to provide not only for the immediately projected improvement but also for probable future widening, such excess acquisition, if resisted by the landowners, could be accomplished only by exercise of the power of eminent domain. In the latter case, the general attitude of the courts that private property taken under the power of eminent domain may not exceed that needed for public use would have an important bearing, as many instances are of record where attempted takings by condemnation in excess of that actually necessary for the physical location and construction of definitely contemplated improvements have been held unconstitutional by the courts. This obstacle, however, is not encountered in cases of excess taking that are accomplished by agreement with the landowners without resort to the power of eminent domain.

Two other major situations frequently arise further to complicate the right-of-way problem, particularly when it is found desirable to establish a new highway alinement by cutting across existing property lines. Such instances usually encounter not only a strong resistance to the change by those who may be inconvenienced thereby, but also generally involve, (1) the problem of remnants, i. e., small parcels that are separated by the road improvement from the main body of land to which they were originally attached, and the value of which to the owner is alleged to be destroyed or definitely impaired; and (2) the question of denial of access from adjacent lands to so-called freeways, i. e., highways to which access is permitted only at certain selected points as a measure for dealing with heavy streams of extra-local traffic.

The remnant problem is an especially serious one in cities. Whether a street improvement involves only simple widening or the opening of a new alinement, a neat acquirement of precisely the lands required for the improvement may leave the abutting owners in possession of remnants, often narrow and irregular in shape, for which there is no really desirable use. Often their only possible use is for the erection of sign boards, shanties, or some types of stand developments that are usually unsightly and detrimental to the neighborhood. Such areas, moreover, unable to support a useful building, cut off property which otherwise would have street frontage. They thus not only have no great value in themselves, but prevent benefits which otherwise would accrue to nearby properties.

The remnants created by the construction of rural highways generally involve the cutting off from farms of areas that are too narrow, small, or irregular for convenient and economical tillage. In the case of heavily traveled roads, even quite large parcels separated from the main body of farms may take on the aspect of remnants, particularly where the lands affected are devoted to livestock purposes, unless underpasses are constructed to afford safe access to the parcels so cut off. And, in some cases, the value of the land to the owner may be substantially destroyed by the penetration of a highway, so that two remnants are formed, one on each side of the highway.

The problem with respect to freeways will arise with increasing frequency in the future, in connection with efforts to restrict or deny the right of access to highways from abutting lands. This is a common-law right in both England and the United States. The occasion for such roads of limited access has been previously explained in this report.

It appears to be a principle upon which the courts generally agree that if the right of access to a street or highway from abutting land is wholly denied the result may be equivalent to a taking of the property itself and may entitle the owner to compensation accordingly. Where complete denial of access is not involved, impairment may be considered a proper element of damages. Therefore, it may be taken as a fact that the cutting off of abutting owners from access to a highway or street must either be accompanied by a payment of damages or by the construction of service roads that will furnish access at other reasonably convenient points.

While this condition would seem to be reasonable with respect to premises served by an existing road that is incorporated into a freeway or road of limited access, if the public buys a right-of-way for such a road in a new location where highway service has not previously existed it would seem illogical to permit the abutting lands to claim damages because of the denial of access thereto. Yet, unless there is a change in existing law and a reversal of judicial opinion in many States, the abutting properties will possess the same right of access to new roads as to old ones.

While there is no question that public authorities may close access from abutting land to a street or highway with the consent of the owner and upon payment of compensation or damages, there is, even in the face of specific statutory authority, some question as to the power of public agencies to deny the right of access without such consent. Such power is specifically conferred by a freeway law enacted in Rhode Island in 1937 (Public Laws of 1937, ch. 2537). The text of this act, which is the first law of this kind enacted in this country, is given in appendix A, attached to this report. The English Restriction of Ribbon Development Act of 1935 has similar provisions relative to access, in its sections 13–16, inclusive, which are reproduced in appendix B.

Another situation, already of more frequent occurrence than in the past and sure to occur frequently in the future, is that which arises when it is desirable to acquire possession for the public of a strip of land on each side of a highway, which is not required for the present accommodation of the physical structure of the highway, but which may become necessary for such purpose in the future and is needed immediately for the purpose of regulating and controlling the use of the land bordering upon the highway.

This may be desirable for aesthetic reasons. It unquestionably is the best available measure for disposing of unsightly billboards. Or, it may be desirable as a measure of safety, intended to control, or at least to set back from the trafficway, those bordering developments, such as roadside stands, filling stations, taverns, dance halls, tourist camps, and used-car lots, that, by causing the sudden stopping, turning, or emergence of vehicles upon the highway, are such prolific sources of dangerous accidents.

An anticipated new situation may arise through efforts by governmental agencies to recoup all or part of the cost of highway and street improvements by the resale or other disposal of benefited lands in excess of the need for the highways or streets acquired in advance of their improvement. This may be referred to as "recoupment taking." In support of the theory underlying such excess taking, there is usually cited the successful use of the practice in England, in Canada, in some European countries, and at least one early experience in the United States. A decision by the United States Supreme Court respecting resort to such taking in the case of *Cincinnati* v. *Vester* (281 U. S. 439), indicates that its use is subject to definite limitations in order to avoid infringement of rights guaranteed by the United States Constitution. A digest of this decision, a brief statement of the terms of constitutional provisions in eight States pertaining to this subject, and a summary of several outstanding examples of recoupment operations are given in appendix C, attached to this report.

The foregoing discussion is designed to set forth briefly the difficulties in the proper planning of highway and street improvements encountered by governmental agencies because of the right-of-way problem. These same difficulties have an equally retarding effect upon other public improvements, such as parks, recreational facilities, slum clearance, low-cost housing, and the reclamation of marginal and submarginal areas adjacent to highways and streets. Land availability, more than any other single consideration determines the character and frequently the success of such projects. It is obvious that the acquisition of land has not been given proper weight in planning for public improvements by either the legislative, judicial, or administrative branches of the Government.

Highway authorities in many States, both State and local, operate under rather definite statutory restrictions as to the maximum width of right-of-way that may be acquired for highway or street improvement purposes. These statutory widths were adopted in some instances many years ago and have been allowed to remain in the statutes without change. Where such restriction is found in the statutes of a State it is difficult for the highway authorities to acquire rights-of-way in excess thereof, regardless of what the traffic conditions to be met may require. The laws of practically all of our States pertaining to rights-of-way for highway and street improvements are archaic. They are based in almost all cases on provisions that were written into the statutes before the days of the automobile. They definitely are inadequate insofar as the authority which they confer upon the public officials charged with the duty and responsibility of providing highway and street facilities for present day needs is concerned.

It is easy to understand why changes in these laws have not kept pace with the expanding needs for greater highway facilities due to the development of the automobile and the phenomenal increase in volume of motor-vehicle traffic upon the highways. History demonstrates that legislative changes come about rather slowly. The same is true with respect to the attitude of the judiciary, where precedent is relied on to such a great extent. When we consider that the highway widths provided for in these statutes were adequate for all practical purposes less than 25 years ago, it is not difficult to understand why we now find the right-of-way problem one of the most difficult with which we have to deal. It is believed, therefore, that this will be corrected. In fact, the legislatures of a few States already have made very marked changes in the laws on this subject in the last few years, and it is reasonable to assume that legislatures of other States will do likewise. When the first Federal-aid road act became a law on July 11, 1916, a number of States had no highway department, and as late as 1920 there were some States that had highway departments in name only, all highway work actually being in the hands of county and other local officials. However, this has since been corrected.

It is believed also that the courts will take a more liberal attitude with respect to the taking of lands necessary for highway and street improvements on a basis that will be recognized by them as including within the term "public use" such additional areas as may be necessary for future widening, safety, parks, recreational, and sanitary facilities, preservation of scenic values, and the elimination of unsightly developments, such as billboards. In fact, while the courts have uniformly held that the question of what constitutes a public use is a judicial and not a legislative one, they nevertheless have sustained the taking of wider widths of rights-of-way than were required for the actual physical location of the traffic facility, and it is only reasonable to assume that they will be more and more responsive to the growth of traffic volume and the obvious necessity for expansion of the highway facilities to accommodate that traffic. It even may be that a few years hence we may find a disposition on the part of the courts to take judicial notice of traffic volume, traffic congestion, and the public need for expanding existing traffic facilities. In the case of *City of East Cleveland* v. *Nau et al.* (124 Ohio State 433, 179 N. E. 187), the Supreme Court of Ohio said:

> We would not disturb the reasonable discretion exercised by municipal authorities in the appropriation of excess lands adjoining a street improvement when necessary for the furtherance of that improvement; but we cannot sanction an

arbitrary and unreasonable taking of excess private property for the contemplated use, under the guise that it is necessary for the improvement, where the weight of the evidence shows it to be otherwise.

The right-of-way problem could be greatly simplified and in a large measure eliminated with respect to major highways and streets if there were some central agency with sufficient funds and authority of law to acquire the lands necessary for the improvement of such highways and streets at a period substantially in advance of the time when the improvements actually would be made. If this were done, then the right-of-way previously acquired could be made available to the highway authorities charged with the duty of making the improvements, either on a rental basis or at the price paid by the acquiring agency, plus the costs of such acquisition and any interest charges paid thereon to the date of the use of the lands. Acquisitions by such agency should include all areas, the need for which reasonably might be anticipated for the physical construction of the improvement and for necessary roadside development, including probable future expansions of the transportation facility itself. Such an agency would have to be created by the Congress in order that its jurisdiction and authority might be general throughout all of the States, and that its operations could be on such a basis that it would be in whole or in substantial part self-liquidating. This suggestion is discussed more in detail in another part of this report.

Obviously, the right-of-way problem is rendered much more complex and difficult because of the various reasons mentioned herein and will continue to be so until such time as the changes necessary to meet these difficulties shall have been made in the statutes relating to the subject. To meet the problem fully will require legislative changes in all of the States, together with some legislation on the part of Congress, and it is believed that such legislation should be designed along the following lines:

1. The statutes of each State should be carefully examined and revised by its legislative assembly so that they will serve present needs. Such revision should eliminate maximum widths which may be acquired, and, if any specific limit is prescribed it should be the minimum and not the maximum. The authorities charged with the duty of providing for highway and street improvements should be definitely authorized and directed to acquire all necessary land in advance of the time for the physical construction of the improvements, and should be provided sufficient funds for that purpose, or, if necessary, should be authorized to meet the cost by some form of deferred payment plan, or by long-term leasing arrangement with right of purchase. Such authorities should be given the right to enter upon the lands to be taken and to begin construction, and to leave the compensation or damages to be paid for later determination by the courts, similar to provision now in the statutes of North Carolina and a few other States.

2. The powers conferred upon the authorities in each State charged with the duty and responsibility of highway and street construction, improvement, and maintenance should include discretionary power on the part of such officials to determine the width of right-of-way to be acquired for any improvement to be undertaken, with specific authority for such right-of-way to include such lands in excess of those which may be actually needed for the physical location of the traffic facility as will provide for safety, for reasonable roadside development, recreational, sanitary, and other facilities, and for future expansion of the transportation facility to meet the prospective future needs of traffic.

3. Consideration might be given by the Congress to the setting up of a Federal agency for the purpose of acquiring necessary lands in advance of highway and street improvements, as outlined more in detail elsewhere in this report. Such agency should have authority, under proper restrictions, to make such lands available to State and local highway and street authorities for rights-of-way and for development for recreational, tourist, and the other facilities for the accommodation of traffic, all on a basis which would render such agency either partly or wholly self-liquidating over a period of years.

FEDERAL ACTION DESIRABLE

Considering the needs in respect to highway and street improvements described in detail in this report, it is believed that the Federal Government can most helpfully contribute to the important improvements required in the following ways:

1. By facilitating the acquisition of adequate rights-of-way. To a great degree the early obsolescence of the rural highways previously built is due to the restrictions imposed upon their design by inadequate rights-of-way. In cities, archaic street plans are in need of major revision to permit the free flow of modern traffic. Far-sighted improvements of both rural highways and city streets are everywhere blocked by the inability of the States and local governments unaided, to provide the rights-of-way required; and there is danger that expedient measures forced by the irresistible pressure of traffic, will result in heavy new investment destined for early obsolescence.

The obtainment of proper rights-of-way-for the several kinds of needed new facilities will involve a heavy present investment, but a virtually permanent one, and one that will pay large dividends in the avoidance of future expenditures in larger amounts.

The aid of the Federal Government can be practically extended by supplying capital for investment in highway and street rights-of-way on a scale sufficient to protect the facilities and provide amply for their expected growth.

Such rights-of-way acquired with Federal funds at the request of a State highway department, and in accordance with State and Federal laws, could remain the property of the Federal Government subject to lease by the State over a period of 50 years on terms that would in that period amortize the initial cost. Representative State highway officials with whom this suggestion has been discussed are unanimously of the opinion that such a provision would not only be helpful toward a solution of the difficult right-of-way problem, but would also be welcomed and utilized by the State governments.

Effectively to administer such a provision would probably require the creation of a Federal Land Authority, having corporate status with adequate capitalization and authority to issue obligations within prescribed limits, which would be empowered to acquire, hold, sell, and lease lands for stated purposes.

Problems of land acquisition similar to those described as affecting highways are also encountered in connection with public works of other categories carried out by the Federal Government, independently and in cooperation with States and their subdivisions; and in such connections their proper solution is equally basic to successful administration and correspondingly difficult. In connection with such other public works the aid of the proposed Federal Land Authority, if created would be similarly useful and desirable. Moreover, since the establishment of a proper relation between all such public works projects in their uses of land is highly desirable, the common association of all with the proposed Land Authority might supply very effective means for promoting a reasonable coordination. Through the control exercisable by the proposed Federal Land Authority, for example, many such conflicts as that indicated as possible in Baltimore between the location of Federal slum-clearance projects and Federal-aid street improvements might conceivably be avoided (see p. 99).

In this connection it may be pointed out that the proposed aid of the Federal Government could not be effectively employed in any State in the absence of constitutional authority for the acquisition of lands in sufficient amount to provide for anticipated future developments and the most desirable use of, and protection of, the public works investment, whatever its nature.

2. By providing, in cooperation with the States and the War Department, for detailed investigations leading to the designation of a system of reasonably direct interregional highways, with appropriate connections through and around cities, similar to the system tentatively selected and described in this report, and limited in total extent to not more than 1 percent of the total mileage of rural highways in the United States, without specific limitation in each State. In view of the predominant national importance of such a system, the Federal Government could reasonably contribute to its construction in a proportion materially larger than that in which it contributes under the Federal Highway Act, but the administration should remain under the Secretary of Agriculture through the agency of the Bureau of Public Roads and the several State highway departments.

3. By continuance of cooperation with the States in the improvement of the Federal-aid highway system and the elimination of hazards at railroad grade crossings, with annual authorizations commensurate with those previously provided.

4. By continuance of the program of secondary and feeder road construction, with appropriations equal to, or larger than those authorized for the fiscal years 1940 and 1941, to be expended in such way as to give effect to the principles enunciated in this report.

APPENDIXES

APPENDIX A. RHODE ISLAND FREEWAY LAW

AN ACT Relative to the Construction, Maintenance, and Improvement of Freeways

[Rhode Island Public Laws, 1937 (January Session), C. 2537]

It is enacted by the General Assembly as follows:

SECTION 1. A freeway is a way especially designed for through traffic over which abutters have no easement or right of light, air, or access by reason of the fact that their property abuts upon such way.

SEC. 2. The director of public works and the division of roads and bridges shall have full power and authority to lay out, establish, acquire, open, construct, improve, maintain, discontinue, and regulate the use of freeways within this state in the same manner or manners in which said director and said division, respectively, may now lay out, establish, acquire, open, construct, improve, maintain, discontinue, and regulate the use of highways within the state. Said director and division shall also have any and all other additional authority and power relative to such freeways as they now respectively possess relative to highways, including the authority and power to acquire or accept title to the lands or right-of-way needed for the same.

SEC. 3. Where an existing highway has been designated as or included within a freeway by the said director or division, existing easements of access, light, or air may be extinguished by purchase or by taking under eminent domain, in accordance with any existing method now exercised by said director or said division in purchasing or taking land for highway purposes. Access to such freeway from any existing highway, road, or street may be regulated and restricted by the said director or said division of roads and bridges. Access to any such freeway from any new highway, road, or street shall be subject to the consent and approval of said director and said division.

SEC. 4. This act shall take effect upon its passage, and the passage of this act shall be considered supplementary and in addition to any and all other powers now exercised by the director of public works and the division of roads and bridges

APPENDIX B. RESTRICTION OF RIBBON DEVELOPMENT ACT, 1935, GREAT BRITAIN

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ACQUISITION OF LAND

13. (1) Any highway authority may acquire any land within two hundred and twenty yards from the middle of any road the acquisition of which is, in their opinion, necessary for the purposes of the construction or improvement of the road or of preventing the erection of buildings detrimental to the view from the road and, if they are unable to do so by agreement on terms which are in their opinion reasonable, they may purchase the land compulsorily by means of an order (in this Act referred to as a "compulsory purchase order") made by them and confirmed by the Minister and the provisions of sections one hundred and sixty-one and one hundred and sixty-two, one hundred and seventy-four and one hundred and seventy-five of the Local Government Act, 1933, and of paragraph (a) of section one hundred and seventy-nine of that Act, shall apply with respect to any such order in like manner as they apply to orders to be confirmed by the Minister of Health under that Act:

Provided that the Lands Clauses Acts and the Acquisition of Land (Assessment of Compensation) Act, 1919, as incorporated in the order, shall be subject to the following modifications, that is to say, in determining the amount of any compensation—

(a) the arbitrator shall have regard to the extent to which the remaining contiguous lands belonging to the same person may be benefited by the purpose for which the land is authorized to be acquired, and in particular (without prejudice to the generality of the foregoing provisions of this paragraph) shall, in the case of land authorized to be acquired for the widening of any road, set off against the value of the land to be acquired any increase in the value of other land belonging to the same person which will accrue by reason of the creation of a frontage to the road as widened; and

(b) the arbitrator shall take into account and embody in his award any undertaking given by the highway authority as to the use to which the land, or any part thereof, will be put.

(2) Any highway authority may acquire by agreement any land in the neighbourhood of any road being land which they consider it desirable to acquire for the purposes of preserving the amenities of the locality in which it is situated (including the purpose of preventing the erection of buildings detrimental to the view from the road).

(3) The following provisions shall have effect with respect to the acquisition of land under the powers conferred by this section, and with respect to land acquired under those powers—

(a) except for the purposes of the construction or improvement of a road, a highway authority shall not, under the said powers, acquire compulsorily any land which is required to be retained as part of a park, garden, pleasure ground, or home farm attached to and usually occupied with a mansion house, or is otherwise required for the amenity or convenience of any dwelling house existing when the compulsory purchase order is made, or which is for the time being subject to conditions restricting the planning, development, or use thereof imposed by any agreement enforceable under section thirty-four of the Town and Country Planning Act, 1932;

(b) whenever land is acquired by a highway authority under the said powers, the authority shall furnish to the Minister, in a form approved by him, sufficient particulars of the purposes for which the land is acquired and of the manner in which it is intended to be used for those purposes and the said particulars shall be so furnished in the case of land to be acquired by means of a compulsory purchase order by specifying them in the order submitted to the Minister, and in any other case in such manner as the Minister may direct;

(c) a highway authority shall not have power to use in any manner other than that specified in the particulars furnished under the last foregoing paragraph or to let, sell, or exchange any land which has been acquired by them under the said powers for the purposes of preventing the erection of buildings detrimental to the view from a road or for any of the purposes specified in subsection (2) of this section unless they are authorized to do so by an order made by the Minister of Health, and, except in the case of an order authorizing the letting of such land for a term not exceeding seven years for purposes specified in the order, being purposes which, in the opinion of the Minister of Health, are consistent with the preservation of the amenities of the locality, any such order shall be provisional only and shall not have effect unless and until it is confirmed by Parliament.

(4) The powers conferred upon highway authorities by section one of the Roads Improvement Act, 1925 (which relates to the planting of trees and shrubs and the laying out of grass margins), may be exercised upon any land acquired by a highway authority under this section notwithstanding that the land does not form part of the highway.

(5) Where any highway authority are authorised by an order confirmed under this section to purchase land compulsorily, then, at any time after notice to treat has been served, the authority may, after giving to the owner and to the occupier of the land not less than fourteen days' notice, enter on and take possession of the land or such part thereof as is specified in the notice, without previous consent or compliance with sections eighty-four to ninety of the Lands Clauses Consolidation Act, 1845, but subject to the payment of the like compensation for the land of which possession is taken, and interest on the compensation awarded, as would have been payable if those provisions had been complied with.

(6) Save as is provided in the section of this Act next following, nothing in this section shall authorise the compulsory acquisition of any land which is the property of any local authority (including any drainage board) or has been acquired by any statutory undertakers for the purposes of their undertaking.

14. (1) Subject to the provisions of this section, a compulsory purchase order under the last foregoing section may authorise a highway authority to acquire compulsorily, subject to such conditions (including conditions as to the persons by whom any works are to be constructed or maintained) as may be imposed by the order, a right upon, under, or over any land which is the property of any local authority (including any drainage board), or has been acquired by statutory undertakers for the purpose of their undertaking, if the acquisition is—

(a) for the purposes of the construction of any bridge (not including the reconstruction or alteration of an existing bridge) upon, under, or over such land or of the approaches to any such bridge; or

(b) for the purposes of any system of road drainage.

(2) A compulsory purchase order for the acquisition of any right for the purposes specified in the last foregoing subsection shall be made subject to such conditions as the Minister, after consultation with the local authority or statutory undertakers from whom the right is to be acquired, considers necessary for securing that the bridge and approaches or the drainage system, as the case may be, to be constructed will be so designed, constructed, and placed as to avoid unreasonable interference with the functions and future development of the local authority or statutory undertakers and shall provide for the bridge and approaches or the drainage system, as the case may be, being constructed and maintained, except so far as may be otherwise agreed, at the expense of the highway authority;

Provided, that in the case of any such order authorizing a highway authority to acquire a right for the purpose of substituting a bridge for any level crossing over a railway, the provisions of sections six and seven of the Bridges Act, 1929, shall, as set out with modifications in the Fourth Schedule of this Act, apply with respect to the apportionment of the expenses of the construction and maintenance thereof.

(3) Where by means of a compulsory purchase order a highway authority has acquired from any local authority or statutory undertakers a right for any of the purposes specified in subsection (1) of this section, any additional expense which is thereafter, in consequence of the construction of the bridge or approaches or of the drainage system, as the case may be, incurred by the local authority or statutory undertakers in connection with the widening or alteration upon land which was vested in them before the confirmation of the order of any railway, canal, inland navigation, dock, harbor, works, or apparatus belonging to them, shall be defrayed by the highway authority, and any question whether such additional expense has been so incurred or as to the amount thereof shall, in default of agreement, be determined by arbitration.

(4) A compulsory purchase order for the acquisition of any right for the purposes specified in paragraph (b) of subsection (1) of this section shall be made, subject to such conditions as the Minister considers necessary for securing that no road shall be drained into any watercourse under the control of a drainage board without the consent of that board or into any reservoir, river, canal, dock, harbor, basin, or other work which belongs to or is under the jurisdiction of any local authority or statutory undertakers without their consent.

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15. Where land subject to restrictions in force under section one or section two of this Act is acquired by a highway authority by means of an order made under this or any other Act authorizing compulsory purchases of the land, any compensation payable in respect of any estate or interest in the land shall be assessed as if the restrictions were not in force if compensation in respect of injury to that estate or interest occasioned by the restrictions has been paid under this Act neither to the person having that estate or interest nor to any of his predecessors in title.

PARKING PLACES AND MEANS OF ACCESS

16. (1) The powers of a local authority under section sixty-eight of the Public Health Act, 1925 (which relates to the provision of parking places for the purpose of relieving or preventing congestion of traffic) shall include power to provide and maintain buildings for use as parking places, and to provide and maintain underground parking places for the like purpose and also to provide and maintain cloakrooms and other conveniences for use in connection with parking places, and in that section the expression "parking place" shall be construed accordingly as including such buildings, underground parking places, cloakrooms and other conveniences, so, however, that for the purposes of that section an underground

parking place shall not be deemed to be part of a street by reason only of its being situated under a street.

(2) The powers of a local authority under the said section sixty-eight to acquire, utilise, and adapt land shall include powers to acquire, utilise, and adapt land (including any right in, over, or under land) for the purpose of providing means of entrance to and egress from any parking place and, notwithstanding anything in subsection (4) of the said section, the said power to adapt land shall include power to adapt land being part of a street for the purpose aforesaid with the consent of the authority or person responsible for the maintenance of the street.

(3) The powers of a local authority under the said section sixty-eight shall include powers to let for use as a parking place any parking place provided by them not being part of a street.

(4) Subsection (6) of the said section sixty-eight (which relates to the power of a local authority to make regulations as to the matters therein specified) shall have effect as if for the word "regulations" there were therein substituted, in all places where that word occurs, the word "byelaws" and in relation to any byelaws made under the said subsection references in section two hundred and fifty of the Local Government Act, 1933, to "the confirming authority" shall be construed as references to the Minister of Health.

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APPENDIX C. EXCESS CONDEMNATION FOR PURPOSE OF RECOUPMENT

SUPREME COURT DECISION, STATE CONSTITUTIONAL PROVISIONS, AND EXPERIENCE IN PRACTICE

Following is a digest of the decision of the Supreme Court of the United States in the case of *Cincinnati* v. *Vester* (281 U. S. 439 (1929)):

* * * * * * *

These three cases were heard together. The suits were brought by owners of land in the city of Cincinnati to restrain the appropriation of their property by the city, upon the grounds that the taking was not in accordance with the applicable provisions of the constitution and statutes of Ohio and would constitute a deprivation of property without due process of law in violation of the fourteenth amendment, it being alleged that the appropriation was not for a public use. Under the law of Ohio these questions could be raised only by injunction proceedings. *P. C. C. & St. L. Railway Co.* v. *Greenville* (69 O. S. 487, 496); *Sargent* v. *Cincinnati* (110 O. S. 444). Decrees in favor of plaintiffs for a permanent injunction were entered in the district court and were affirmed by the circuit court of appeals (33 F. (2d) 242). This court granted writs of certiorari, 280 U. S. 545.

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The controversy relates to what is known as "excess condemnation," that is, the taking of more land than is needed to be occupied by the improvement directly in contemplation. The constitution of Ohio provides (art. XVIII, sec. 10):

"A municipality appropriating or otherwise acquiring property for public use may in furtherance of such public use appropriate or acquire an excess over that actually to be occupied by the improvement, and may sell such excess with such restrictions as shall be appropriate to preserve the improvement made. Bonds may be issued to supply the funds in whole or in part to pay for the excess property so appropriated or otherwise acquired, but said bonds shall be a lien only against the property so acquired for the improvement and excess, and they shall not be a liability of the municipality nor be included in any limitation of the bonded indebtedness of such municipality prescribed by law."

* * * * * * *

Among the statutory provisions of Ohio relating to the condemnation of property by municipal corporations is the following with respect to the declaration of the purpose of the appropriation (General Code of Ohio, sec. 3679):

"SEC. 3679. Resolution shall be passed. When it is deemed necessary to appropriate property, council shall pass a resolution, declaring such intent, defining

the purpose of the appropriation, setting forth a pertinent description of the land, and the estate or interest therein desired to be appropriated. For waterworks purposes and for the purpose of creating reservoirs to provide for a supply of water, the council may appropriate such property as it may determine to be necessary."

The excess condemnation of the properties in question is proposed by the resolution adopted by the city council, but the purpose of the appropriation is stated in the resolution only in the most general terms as being "in furtherance of the said widening of Fifth Street" and "necessary for the complete enjoyment and preservation of said public use." The ordinance providing for the excess appropriation was not more specific, declaring simply that it is "in furtherance of the public use," described as the widening of Fifth Street, and "for the more complete enjoyment and preservation of the benefits to accrue from said public use." In what way the excess condemnation of these properties was in furtherance of the widening of the street, and why it was necessary for the complete enjoyment and preservation of the public use of the widened street are not stated and are thus left to surmise.

The plaintiffs alleged in their bills of complaint that the excess condemnation is "a mere speculation upon an anticipated increase in the value of the properties adjacent to said improvement," and that the properties were taken "with the design of reselling the same at a profit to private individuals to be used for private purposes, and no use of said property by or for the public is intended or contemplated." The answers of the city denied these allegations and summed up the position of the city by saying that the application of the principle of excess condemnation in these cases would enable the city (1) "to further the appropriate development of the south side of Fifth Street" by using or disposing of the excess properties in tracts "with such size and with such restrictions as will inure to the public advantage," and (2) that the increase in value of the properties in question which may accrue by reason of the improvement contemplated by the city "will pay in part the very heavy expense to which the city will be put in effecting the improvement."

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The city argues that in resorting to excess condemnation legislative bodies generally have had in view the following three purposes (1) the avoidance of remnant lots, (2) the preservation and amplification of the improvement, and (3) the recoupment of expense from increased values. Both the district court and the circuit court of appeals concluded that the theory of remnants, and of the protection and preservation of the improvement, were not applicable to the present cases. Both courts considered that the sole purpose of the city was the recoupment by the resale of the properties in question of a large part of the expense of the street widening. In this view, both courts held that the excess condemnation was in violation of the constitutional rights of the plaintiffs upon the ground that it was not a taking for a public use "within the meaning of that term as it heretofore has been held to justify the taking of private property." The circuit court of appeals added that the provision of the Constitution of Ohio relating to excess condemnation, supra, "would seem to mean in furtherance of the normal use to which the property that is occupied by the improvement is devoted—here the use and preservation of the street for the purposes of travel," and the court held that if the provision means that property may be taken "for the purpose of selling it at a profit and paying for the improvement it is clearly invalid."

In this court, the city challenges the propriety of the assumption upon which these rulings below were based, that is, that the city was proceeding on the theory of the recoupment of expense by resale of the properties. While contending that this would be a valid purpose under the constitution of Ohio, and would constitute a taking for public use and therefore would be consistent with the fourteenth amendment, the city insists that its purpose in the present cases cannot thus be delimited. The city calls attention to the general statements in the resolution and ordinance adopted by the city council and declares that these broad declarations constitute "practically all the evidence which directly shows the purpose of the city." While reference is made to what is said in its pleadings with respect to its position, the argument for the city adds that "obviously an impersonality such as a city cannot very well testify as to what its plans and hopes are." The court is asked to take judicial notice of certain desirable objects which the city might have in view. The city urges that, when the improvement is completed, the city council will doubtless be in a position to determine what sized tracts and what kinds of restriction will be best suited for the harmonious development of the

> south side of Fifth Street. But the city also insists that it may never resell the excess; that it is not compelled to do so by the constitution; that the question is one to be determined in the future; that recoupment can come only from a sale, and that until by some act the city evidences an intent to sell it cannot be said to be proceeding only on a theory of recoupment. The city says that it may preserve the public use in many ways, and that sale with restrictions is one that may hereafter be chosen, but that there is no warrant upon this record for discarding every possible use in favor of a use by sale that may, among other things, result in a possible recoupment.
>
> We are thus asked to sustain the excess appropriation in these cases upon the bare statements of the resolution and ordinance of the city council, by considering hypothetically every possible, but undefined, use to which the city may put these properties, and by determining that such use will not be repugnant to the rights secured to the property owners by the fourteenth amendment. We are thus either to assume that whatever the city, entirely uncontrolled by any specific statement of its purpose, may decide to do with the properties appropriated, will be valid under both the State and Federal Constitutions, or to set up some hypothesis as to use and decide for or against the taking accordingly, although the assumption may be found to be foreign to the actual purpose of the appropriation as ultimately disclosed and the appropriation may thus be sustained or defeated through a misconception of fact.
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> It is well established that in considering the application of the fourteenth amendment to cases of expropriation of private property, the question what is a public use is a judicial one. In deciding such a question, the court has appropriate regard to the diversity of local conditions and considers with great respect legislative declarations and in particular the judgments of State courts as to the uses considered to be public in the light of local exigencies. But the question remains a judicial one which this court must decide in performing its duty of enforcing the provisions of the Federal Constitution. In the present instance, we have no legislative declaration, apart from the statement of the city council, and no judgment of the State court as to the particular matter before us. Under the provision of the constitution of Ohio for excess condemnation when a city acquires property for public use, it would seem to be clear that a mere statement by the council that the excess condemnation is in furtherance of such use would not be conclusive. Otherwise, the taking of any land in excess condemnation, although in reality wholly unrelated to the immediate improvement, would be sustained on a bare recital. This would be to treat the constitutional provision as giving such a sweeping authority to municipalities as to make nugatory the express condition upon which the authority is granted.
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> * * * It is an established principle governing the exercise of the jurisdiction of this court, that it will not decide important constitutional questions unnecessarily or hypothetically. *Liverpool, New York & Philadelphia Steamship Company* v. *Commissioners of Emigration*, (113 U. S. 33, 39); *Siler* v. *Louisville & Nashville Railroad Company* (213 U. S. 175, 191, 193); *United States* v. *Delaware & Hudson Company* (213 U. S. 366, 407). The present cases call for the application of this principle. Questions relating to the constitutional validity of an excess condemnation should not be determined upon conjecture as to the contemplated purpose, the object of the excess appropriation not being set forth as required by the local law.
>
> We conclude that the proceedings for excess condemnation of the properties involved in these suits were not taken in conformity with the applicable law of the State, and in affirming the decrees below upon this ground we refrain from expressing an opinion upon the other questions that have been argued.

STATE CONSTITUTIONAL AMENDMENTS

The decision of the Supreme Court came after the adoption of amendments of the constitutions of seven States, which specifically authorize the excess taking of land and its resale under certain conditions; and it was followed by an amendment of the constitution of Pennsylvania to the same effect.

The first of the State constitutions to be amended was that of Massachusetts in 1911. This was followed in 1912 by Ohio and Wisconsin, in 1913 by New York, in 1916 by Rhode Island, in 1928 by Michigan and California, and in 1933 by Pennsylvania.

In California, Massachusetts, New York, Pennsylvania, and Rhode Island the acquisition of land outside the boundaries of a highway is limited. California authorizes the State or any of its cities or counties to condemn land "in and about and along and leading to public works within 150 feet of the public work or improvement, provided that when parcels lie only partially within the 150 feet such portions may be acquired which do not exceed 200 feet from the closest boundary."

Massachusetts provides that more land may be taken by the commonwealth, county, or city than is needed for the actual construction, provided that no more land is to be taken than is needed for suitable building lots on both sides of the street.

New York authorizes cities and counties to take more land than is needed for actual construction provided that no more land shall be taken than is needed to form suitable building sites.

Pennsylvania authorizes cities to take more land than is needed for actual construction and also restricts the taking to land not more than sufficient for suitable building sites. It further restricts the authority to streets connecting with bridges crossing, and tunnels under, streams which form State boundaries, and to a point not more than 3 miles from the approach to any such bridge or tunnel.

Rhode Island authorizes the State, city, and town to acquire more land than is needed for public purposes, but confines the taking to lands sufficient for suitable building sites.

Ohio authorizes municipalities to take for public use property in excess of that actually occupied by the improvement. The surplus may be sold with appropriate restriction to protect the improvement.

Wisconsin authorizes the State or its cities to condemn lands in and about and along and leading to public works, and after the completion of the improvement, to sell the remainder with restrictions protecting the improvement.

Michigan provides that municipalities may take land adjacent to an improvement which is appropriate for securing the greatest public advantage from the improvement. The surplus may be sold with or without restriction. Thus, Michigan provides constitutional sanction of recoupment condemnation with less restriction than any other State.

Thus the object of the constitutional amendments in California, Massachusetts, New York, Pennsylvania, and Rhode Island, apparently is to prevent the formation of unusable remnants along a street improvement. In Ohio and Wisconsin, in addition, restrictions can be imposed on the future use of real estate, while in Michigan these objectives and recoupment as well seem to be permissible.

Although there are these contitutional provisions in eight States, and statutory provisions in seven others (Delaware, Illinois, Indiana, Maryland, Nebraska, Oregon, and Virginia), the right to acquire marginal land in connection with highway development is still very limited. The right to resell a surplus of land taken is still more circumscribed; and the right to condemn private property solely for the purpose of recouping the cost of a public-works improvement is left open to question on the point of constitutionality by decision of the highest court. Even to prevent the creation of land remnants and to protect improvements by use of the power of eminent domain, in most States will require constitutional amendments.

OUTSTANDING INSTANCES OF RECOUPMENT TAKINGS

The English experience.—The first attempt of excess condemnation for recoupment purposes was made by the Metropolitan Board of Works, which had charge of public improvements in London from 1857 to 1889. This organization applied directly to Parliament for authority to condemn land in each instance. During this period, the board widened 14.13 miles of streets in London, condemning land worth $58,859,000; it recovered $26,608,000 from the sale of surplus land, which was 43.5 percent of the construction cost.

Northumberland Avenue improvement.—This is the only street opening or improvement in London where it has thus far been possible to recoup the entire cost of the project. Northumberland Avenue was opened through a section of rather low economic development between Trafalgar Square and the Embankment. Expensive properties and established businesses were not involved; the property was therefore acquired at a reasonable cost. The avenue created new economic utilities in its neighborhood and it was thereby possible to dispose of frontages at good prices. The project was completed in 1875 at a cost of £711,911 including the price of the land. The recovery from the land was £831,310. The profit to the public was about £120,000 or $600,000.

The Kingsway improvement.—The Kingsway is a wide thoroughfare connecting Holborn and the Strand. The improvement was proposed in 1836 but was a matter of controversy until, in 1899, when the serious opposition to the project was finally eliminated and the empowering law enacted.[1]

The law gave the London County Council power to condemn more land than was actually needed. This land could be taken specifically to recoup the cost of the undertaking, to protect the improvement, and to secure sites for necessary housing. The excess land could be sold or leased at any time within 60 years, and was subject to designated protective restrictions.

The street itself was about three-fourths of a mile in length and 100 feet wide. About 600 estates were acquired and demolished, entailing the freeholds, leaseholds, or trade interests of about 1,500 persons. Over 6,000 persons of the working class were displaced and had to be rehoused. The area directly affected comprised 28 acres, of which 15¾ acres constituted the surplus to be leased or sold as building sites. From these lands the London County Council is understood to receive about £143,000 annually in ground rents and the buildings erected on the lands have cost approximately £5,000,000. A sum of £966 a year is received by the council in respect of betterment charges.

A total of £735,507 has been received from the sale of sites and other sites valued at £225,191 were transferred in settlement of claims on a reinstatement basis. The total debt charges incurred for the improvement to March 31, 1936 (£5,209,563), plus the net debt outstanding at that date £3,208,607), amounted to £8,418,170. Against this the aggregate rents received, plus the value of the leased sites, amounted to £6,009,931. The difference (£2,408,239) may therefore be said to represent the net cost to the taxpayer up to March 31, 1936.

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[1] London County Council Act, 1897, 60 and 61 Victoria, cap. 242.

Paris, France.—The decree of 1852 gave to the city of Paris the power to use excess condemnation in its improvements. It is not only provided that fragments of land, unsuitable for development, were to be condemned, but also that land outside the lines of an improvement could be taken where needed to replat these remnants. Between 1852 and 1869, among others, Baron Hausmann, as prefect of the Seine, executed improvements which left the city of Paris indebted to the extent of some $193,200,000, 56.25 miles of new streets being constructed with an average width of about 80 feet. The city condemned land worth $259,400,000. In 1869, the city had sold part of the land which it did not need for $51,800,000 and had on hand 728,000 square yards valued at $14,400,000, 390,000 square yards of surplus land having been acquired by the discontinuance of old streets which had cost the city nothing. Therefore, in the building of 56.25 miles of streets, the city had recovered about one-fourth of what it had paid originally for the land.

Brussels, Belgium.—In 1867, a law was passed in Belgium granting cities the right to condemn land, not only needed for public improvements, but also for a surrounding zone to improve sanitary conditions or to protect public improvements. To relieve the congested city of Brussels, the statute facilitated the construction of a through highway. The work, commenced in 1868, was completed in the late seventies and forms the present new or inner boulevards. Many of the loans which were advanced by the city to encourage development of adjacent properties were never repaid, the public being forced to take over half-finished buildings and complete them. As a net result, a public debt of some $50,000,000 accrued. In 1904, the city had title to about 400 buildings with a net debt of $6,400,000, about a million dollars in excess of a resale price. Several similar undertakings in the early eighties resulted in a like financial loss.

Montreal, Canada.—The city of Montreal, Canada, has carried out three excess condemnation projects.

The first of these improvements was the extension of St. Lawrence Boulevard from Notre Dame Street to the river front. This new highway covered an area 67 feet wide and about 650 feet long. In 1912 the city condemned all land lying between the north line of this highway and the next parallel street for an average depth of about 75 feet. A similar zone was taken on the south side of the new thoroughfare. The purchase price was $690,850 for 102,002 square feet of condemned land. Of this 49,258 square feet were used for street purposes, the surplus being sold at public auction for $722,194; the cost of sale amounted to $6,344; the city therefore, made a profit of $25,000 which could be applied to construction costs.

The area of land taken in the two other projects was somewhat larger than in the St. Lawrence Boulevard instance, but the profit accruing was small, being $12,817 for one sale and $16,780 for the other.

In 1913, Montreal embarked upon a fourth project, in the opening of the St. Joseph Boulevard Improvement. About 794,000 square feet of land were acquired at a cost of about $2,500,000. The surplus land constituted an area of about 100,556 square feet.

The Massachusetts Back Bay Flats reclamation project.—Over 60 years ago, the State of Massachusetts reclaimed the so-called Back Bay Flats, which were lowlands washed by tides from Boston Harbor.

The lands were absolutely unusable; in fact, their existence prevented the efficient use and development of the harbor. The State condemned the area, drained it, and provided proper protection with the result that usable land was created. A large portion was sold at a profit to the State. In a test case the court of Massachusetts upheld the project as constitutional.

Philadelphia, Pa.—An effort to take marginal land for the protection of an improvement began in Philadelphia in 1903. In 1907, Fairmount Parkway was begun, and the legislature passed a law giving the city the right to take property within 200 feet of the boundaries of the improvement. In 1912, the city condemned certain areas abutting on the parkway. Such land-taking was declared illegal in 1913 in the case of the *Pennsylvania Mutual Life Insurance Co.* v. *City of Philadelphia* (22 Pa. Dist. Reports, 195). However, the city continued the work by purchasing without condemnation all the land possible, and by 1916 had acquired all but about 160 of the 1,000 parcels desired. After this unfavorable decision, the attempt to obtain legal sanction for marginal condemnation was continued, and in 1933 Pennsylvania adopted a constitutional amendment permitting the extended use of the power of eminent domain.

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