A CHOICE OF GUIDES

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Because of the universal service of the motor vehicle in the every-day pattern of living for all of us, and its essential relation to our economy, the effective maintenance of the highway plant has become a highly important function of government. It seems paradoxical that many of the national-scale industries, privately financed and managed by organizations that command high respect by their performance, particularly their progress through research, are dependent for their continuing markets and economic health upon progressive highway policies and efficient operation of the highway departments. The initiation by these industries of a number of programs to stimulate interest in, and information about, our public highways, reflects their deep awareness of this vital inter-relation.

The problems, both quantitative and qualitative, confronting highway officials, have grown to current dimensions in a period so short, there has been no opportunity for general public analysis and understanding. These are now required. Only the compelling authority exerted by an informed public opinion will activate coordinated efforts by all of the official representatives of the public, - the legislative, the judicial, the executive agencies throughout the reaches of local, state and federal government. The validity of our form of government is dependent upon the action of those who are delegated by the public to represent them in the making of laws which must set in motion any public undertaking. On the

record of the past we have faith that if information of the character and integrity essential to a clear understanding of the current highway problems is placed before our legislative bodies, their action will be responsive. To supply our law-makers with full data from continuous engineering and economic surveys and studies is the most important single duty we have as highway officials. We now have methods to serve the purpose, refined by actual use, upon which firm reliance may be placed as supports for unassailable conclusions.

The search for truth is old - it characterizes man's efforts to advance. As long ago as the latter half of the second century A.D., the philosopher Lucian is reported thus:

> "Then***this choice of roads and guides is quite a serious matter; we can by no means just follow our noses; we shall be discovering that we are well on the way to Babylon instead of to Corinth. Nor is it advisable to toss up, either, on the chance that we may hit upon the right way if we start upon any one at a venture. *** I cannot think we ought to gamble recklessly with such high stakes, nor commit our hopes to a frail craft, like the wise men who went to sea in a bowl; **** And as to the perils of blundering into one of the wrong roads instead of the right one, mis-led by a belief in the discretion of Fortune, - it is no easy matter to turn back and get safe into port when you have once cast loose your moorings and committed yourself to the breeze; ***** Your mistake was at the beginning; before leaving, you should have gone up to some high point, and observed whether the wind was in the right quarter, and of the right strength for a crossing to Corinth, not neglecting, by the way, to secure the very best pilot obtainable, and a seaworthy craft equal to so high a sea."

It is important before deciding upon the guides to follow in determining our recommendations for legislation or new administrative policies, to review the factual and research data from the studies of the State Highway Departments and the Bureau of Public Roads which will provide a sound foundation for public understanding of our critical highway situation and clear some of the foggy ideas now prevalent.

Increase in required highway facilities is not reflected accurately by the numerical increase in vehicles.

The increase in the total number of motor vehicles in use has been so astonishingly rapid, particularly since the war, that the increase in numbers is quite erroneously given as the major cause of current highway inadequacies and deficiencies.

Were this true and had a simple straight-line relation persisted through the years between highway facilities and vehicle numbers, the highway problem would now be perhaps less than one-third its present dimensions, physically or financially.

It is with the nature of the "multi-elemented" problem that this discussion is concerned, with the hope a more accurately informed public opinion will result.

The number of registered vehicles in the United States now or at any other time does not represent a true picture of the constantly increasing load placed upon highways to provide acceptable transportation services. During the period from 1921 to 1930 inclusive, when the highways were being classified into systems and when large mileages of roads, many of which are yet in use, were receiving all-weather surfaces, there was an average of 19.92 million registered vehicles. In 1952, there are 53.36 million registered vehicles. This represents an increase of 167.9 per cent over the 1921 - 1930 average. This increase of 167.9 per cent in the number of registered vehicles represents but a fraction of the total increase in highway facilities necessary to satisfy the demands of traffic. (Refer to tables 1, 2 and 3 attached.)

Increase in numbers of vehicles.

The increase in the numbers of vehicles on a percentage basis, using the average number of vehicles during the period 1921 - 1930 as 100 per cent, has been as follows:

	Per cent
Increase to 1940	62.9
Total 1940	162.9
Increase 1940 to 1950	83.9
Total 1950	246.8
Increase 1950 to 1952	21.1
Total	267.9

Busses and trucks as passenger car equivalents.

Busses and trucks, especially those with dual tires, occupy more road space than a passenger car. Since busses and trucks have increased at a faster rate than passenger vehicles, the need for improved highway facilities has increased at a faster rate than the increase in the numbers of vehicles indicates. A dual-tired vehicle in a highway capacity sense, is equivalent to two passenger cars in a level terrain, to four passenger cars in rolling terrain, and to somewhere between five and nineteen passenger cars in mountainous terrain, depending on particular conditions. As a conservative average, each truck, including both those with dual and single rear tires, is equivalent to three passenger cars. Relating the increase in numbers of vehicles to an equivalent number of passenger cars, the following increases have taken place during the past years, assuming the average traffic for the period 1921 - 1930 as 100 per cent:

	Per cent
Increase to 1940	68.7
Total 1940	168.7
Increase 1940 to 1950	97.0
Total 1950	265.7
Increase 1950 to 1952	21.8
Total 1952	287.5

Increase in average travel per year.

The average vehicle registered in 1940 traveled 42 per cent more miles per year than the average number of miles traveled by the vehicles registered during the base period. There was a forced reduction in average travel during the war but in 1946 average travel exceeded that of 1940 and has remained above the 1940 level each year.

Equivalent 1921 - 1930 vehicle miles.

With the average equivalent passenger-car miles during the period 1921 - 1930 as 100 per cent, the increases in equivalent passenger-car miles due to increased travel, increased percentage of trucks and busses, and the increased numbers of vehicles, are as follows:

	Per cent
Increase to 1940	140.1
Total	240.1
Increase 1940 - 1950	138.3
Total 1950	378.4
Increase 1950 - 1952	32.1
Total	410.6

Thus, rather than an increase of only 167.9 per cent in the total highway load as indicated by the number of registered vehicles, the actual increase has been 310.6 per cent, i.e. the increase from these factors only in the highway load has been approximately twice as great as the increase in the numbers of vehicles.

Other factors affecting highway capacity and design.

This still does not reflect the extent of the problem. The possible speeds of vehicles have increased with the result that the speeds at which they are driven on the highway system have also increased, making improved geometric design standards necessary to meet the demands of traffic without sacrifice of safety and convenience. (Refer to Table 2)

The vehicle-miles of travel have increased from 131,091 million, an average for the 1921 - 1930 period, to 524,769 million vehicle-miles in 1952. This is an increase of 300 per cent.

The gasoline consumption for highway use during 1952 was 432 per cent of the average gasoline consumption per year during the period 1921 - 1930, or an increase of 332 per cent.

There was a marked increase in the top speeds of American stock cars up until 1940. Most of this increase took place during the period from 1930 to 1935.

During the period 1921 - 1930, the average speed on main rural highways was 26 miles per hour and 90 per cent of the drivers observed did not exceed 40 miles per hour. At the present time, the average speed is 50 miles per hour and 90 per cent of the drivers observed do not exceed 62 miles per hour. These increases in the speeds at which vehicles are driven have made necessary much higher standards of highway design to meet the accepted safe-use requirements.

Necessary lane width.

During the base period 1921 - 1930, a hard surface width of 18 feet for a 2-lane road was reasonably adequate for the numbers of vehicles and the speeds at which they were driven. The new roads

with 9- and 10-foot traffic lanes offered services considered adequate. Today, traffic lanes at least 11 feet wide are necessary on roads carrying only passenger-car traffic, and lanes 12 feet wide are needed for roads having a mixed traffic of passenger cars, trucks and busses. In exceptional cases, lanes 12 feet in width are being constructed for passenger-car traffic and lanes wider than 12 feet are being constructed for mixed traffic.

Safe horizontal curvature.

During the period 1921 - 1930, 7-degree curves with a radius of 819 feet were adequate for the speeds at which vehicles were operated. Today, curvatures of slightly less than three degrees are necessary.

Sight-distance requirements.

The increase in speeds on rural highways has resulted in an increase in sight distance requirements. If all vehicles during the period 1920 - 1930 had been equipped with four-wheel brakes of modern design, a continuous sight distance of about 275 feet would have been adequate for the speeds at which the vehicles were being operated. Actually, vehicles were equipped with two-wheel mechanical brakes during this period, which made stopping sight distances of about 400 feet necessary for safe operation. This is about the same as the necessary stopping sight distance in 1935 when most vehicles were being equipped with four-wheel mechanical or hydraulic brakes. Some manufacturers started equipping their vehicles with four-wheel brakes in 1924. For safe stopping, at present-day speeds, a continuous sight distance of at least 500 feet is necessary on all types of rural highways.

To provide opportunities for passing slower-moving vehicles, passing sight distances must be provided at frequent intervals on a two-lane road. During the period 1921 - 1930, a passing sight distance of 1,100 feet was adequate. The corresponding sight distance for today's traffic is 2,500 feet. The increase in traffic volume on our rural highways has also increased the frequency with which these passing sight distances must be provided to meet the demands of traffic.

Percentage of highway on which critical sight distance for passing is required.

Although a passing sight distance of 2,500 feet is necessary to permit the higher speed vehicles of present traffic to pass vehicles going somewhat slower, the critical sight distance is 1,500 feet to permit passings occurring at a high frequency. The corresponding figure during the period 1921 - 1930 was 750 feet. Due to the increase in traffic volumes, however, a passing sight distance of 1,500 feet must be provided more frequently than was necessary for the 750-foot sight distance during the base period. For example, a highway with an average peak-hour volume of 200 vehicles during the period 1921 - 1930 only needed a passing sight distance of 750 feet at one or two places in each mile. If the traffic volume on this same highway increased in the same proportion as the total traffic throughout the country, its 1940 traffic required one or two places with a 1,500-foot sight distance, the 1950 traffic required a 1,500-foot sight distance over 50 per cent of its length, and the 1952 traffic a 1,500-foot sight distance over 80 per cent of its length. The sight-distance requirements for different years if the traffic volume during the base period 1921 - 1930 was 400 vehicles during the peak hour are as follows

1921 - 1930 average - One or two places per mile with a 750-foot sight distance.

1930 - 25 per cent of highway with 1,100-foot sight distance.

1940 - 100 per cent of highway with 1,500-foot sight distance.

1950 - A 4-lane highway desirable.

1952 - A 4-lane highway required.

To amplify further the change in the type of highway and geometric requirements occasioned by traffic-volume increases which have taken place, the changes of requirements for a highway which accommodated an average of 800 vehicles during the peak hours for the period 1921 - 1930 are as follows:

1921 - 1930 average - 60 per cent of highway with 750-foot sight distance.

1930 - 2-lane highway no longer adequate.

1940 - A 4-lane highway desirable.

1950 - 4 lanes required.

1952 - 6 lanes required.

Increased Frequency of Heavy Axle Loads.

Prior to 1930 there were five or less axle loads of 18,000 pounds or more for each 1000 trucks in the traffic flow. High accuracy is not claimed for this figure, but the fact is certain that the number of heavy axle loads was insignificant.

For the period 1948-51, the frequency of heavy axles had jumped to an average of 90 per 1000 trucks moving over the main highways.

Increased frequency of heavy gross loads.

In the base period the gross loads of 30,000 pounds and above imposed by trucks were very few indeed. In the pre-war years the loads reaching the 30,000-pound and above classification were limited to about 42 per 1000 of the total trucks in the traffic flow. For the two years 1950 and 1951, the annual average reached 190, and we can expect in 1952 a further increase to over 200 gross loads of 30,000 pounds and above in each 1000 total trucks and truck combinations.

This statement needs to be emphasized by repeating. In the current year there will be not less than 200 gross loads of 30,000 pounds and above in each 1000 trucks and truck combinations moving over our principal highway routes.

Prevailing design standards.

No highway department has ever been provided with the necessary funds or been permitted to build roads with margins of numerical capacity or structural strength for the future. The standards of design have been rigidly held to the minimum for the current traffic - more miles for the available dollars has been and still is the constant public pressure on the highway department. As noted, a large mileage of the roads in service today were built for the existing traffic of the base period 1921 - 1930.

The same standards were carried well beyond 1930 because of the depression years with their accent on maximum on-the-job labor and the minimum use of materials and equipment. About three quarters of the mileage of our present State highway systems, and substantially all of the primary Federal-aid system were improved prior to 1935. The paved surfaces were designed with reasonable uniformity, which means that by

far the major mileage of principal routes are for today's traffic seriously deficient in volume capacity, and substantially all of the mileage has a structural capacity limited to 18,000-pound axle loads and less.

The Maryland and the Idaho full scale research projects, together with other accumulated knowledge, will provide the information needed to appraise the effect on existing roads of heavier axle loads and to forecast the disastrous results that inevitably follow overloading. From the results of the Maryland test the conclusion may be drawn that the earlier technical work, such as the Bates road test in Illinois in 1922-23, was sound and stands up remarkably well in the light of the most recent research results.

Moreover, it is certain now that the factor of repetitive loading at short intervals has a serious deteriorating effect. This factor enters with the multiplication of the numbers of heavier trucks.

The Impact of Radically Changed Conditions.

The preceding applies particularly to rural routes; the selection of arterial systems to serve urban areas, with only a few notable exceptions, did not come into existence until after 1944.

The increasing demands on our highways of certain of these changes may be measured statistically including the numbers of registered vehicles, the increased annual miles of use by the individual vehicle, and the growth in numbers of the larger vehicles. These alone in 1952 impose an increased service load on our highways since the base period in the ratio of 1 to 4.

The effect of other changes in road use, largely reflected in the sharp upward trend of road design requirements, both geometric and structural, can be accurately measured if applied to specific routes and

specific conditions. The cumulative effect of too narrow lanes, too sharp curves, too short sight distances, and a variety of structural deficiencies, conservatively estimated, adds an equal increment to the unsatisfied service demand ratio produced by the factors related to the numerical increases.

From these two groups of causes, then, there results a combined service demand ratio of 1.0 to 8.0 for today's conditions when measured by assuming reasonable adequacy for the existing traffic of the very large mileage improved from 1920 to 1935. Without insistence that all these elements of change are precisely measured, there is ample evidence that highways today are only fractionally as adequate for today's traffic demands as they were two decades ago.

For the period of 11 years, 1930-1940 inclusive, with construction expenditures adjusted to take into account changes in purchasing power the average annual State - Federal-aid work put in place was substantially more than the annual average for the 12-year period 1941-1952 inclusive. Even excluding the 1941-1946 period, the annual average expenditure for the units of work put in place exceeded the annual average for 1930-1940 by only $234 million when adjusted to the same price base. The increased prices for highway construction have seriously limited the production possible with the available funds. The actual costs of the items included in Federal-aid contracts from January 1946 to September 1952 have taken $710 million of Federal funds in excess of the amount the same items would have cost at 1945 unit prices. The cost of increased prices in the past six and three quarter years has absorbed the equivalent of nearly one and one half years of Federal highway authorization. There has been an equivalent shrinkage of all State and local funds.

Highway needs studies.

The problem of highway deficiencies has been attacked by many States through comprehensive 'needs studies'. The plan of organization has not followed a fixed pattern for all the undertakings, but they have all been directed toward the same objectives and are thus reasonably comparable.

The reports for fourteen States have been summarized to obtain the relation between the estimated required annual expenditure program to meet highway needs within 15 years (12 years for two States) and the actual program. The studies are made within the five-year period since 1947, but the amounts used are adjusted to 1951 prices. (See Tables 4, 5 and 6)

For these fourteen States the ratio of the estimated required capital outlay to actual expenditures, 1951 prices (Table 5), is 100 to 50 for the State highway systems. There is a wide variation among the individual States. The lowest was 28 per cent of the required with a substantial increase assured, and the highest 108 per cent (with a drop to 53 per cent in prospect). It should be accented that were the comparison made for 1952, there would be a material difference in the reports for the individual States, but the average ratio of estimated required capital investment to actual outlay would probably not be materially changed.

The best approximations we have indicate an annual actual rate of outlay for the Federal-aid systems currently at less than 60 per cent of the required.

Nearly all the State-by-State estimates of required capital outlay have accepted a 15-year period of sustained effort to secure an adequate highway net, including city arterials. They have generally excluded

provision for essential terminal facilities. If the actual rate of outlay approximates 50 per cent of the estimated required rate, then the period is not 15 years but 30 years for our highways to approach adequacy. The incongruity of attempting to foresee our highway needs for a third of a century into the future must be apparent to everyone.

A Reliable Guide for the Future.

We must recognize the all too apparent fact, we are face to face with a whole series of highly intricate, highly dynamic problems - none are static. Involved are the use of the highways by destructive loads; need of financing far in excess of current income; fair distribution of costs among users and among units of government; necessary annual rates for capital improvements; the application of proven technical knowledge to design and construction; revision of our inadequate legal structure, the need for a multiple variety of economic data including the service life of roads and the real costs of transport related to the sizes and weights of vehicles used.

The determination of the uttermost potentials of maintenance deserves high priority for we are now and will be dependent for a long time upon the efficiency of the maintenance operations to keep the highway plant as a whole in service.

If there has been the error of concept that a 'needs study' might be valid for a period of some years, that error is now completely liquidated. The dynamic quality of the year-by-year planning and expenditure program which can only be guided properly by the basic factual and economic data is now fully recognized. A logical pattern is evolving in California which has the validity that only experience can give. The experience there confirms the rapidly changing qualities of the problem. In bare outline, the State Legislature in 1947 established a Study Committee composed of its own members to survey the highway problem on a State-wide basis. The Committee called on the Automotive Safety Foundation to provide a technical staff. In close

collaboration with the State Highway Department and some technical personnel from the Bureau of Public Roads, a comprehensive report was developed which provided a sound foundation for the recommendations of the Committee to the Legislature, and for the highly important subsequent action of the Legislature. The Highway Department, the counties and the cities were given a new highway improvement charter and authority for coordinated action.

The demands for highway service increased rapidly, other conditions such as prices changed, so the State this year called back the Automotive Safety Foundation to study the increase in needs, but limited to the State highway system. The report now completed discloses that in the short intervening period the estimated needs have reached new and unexpected dimensions.

A new study is now urged, with special reference to the cities and urban areas. A logical fourth study is the secondary or farm-to-market road requirements. After these, there is the continuing need to review annually the whole inventory as the only reliable guide for program planning.

There is no new or unproven method involved. The idea has been urged since 1934 when the first outline of the highway inventory was circulated by Public Roads for the planning surveys. The President and the Secretary of this Association sent urgent recommendations to all the States in August, 1951, to undertake an inventory of road needs. The Executive Committee and the Association itself have approved the idea. The States have responded with data that have been used by the Association in support of Federal-aid highway legislation before the Congress, but the studies have not been uniform or continuous and thus do not carry the weight of conviction they should.

The characteristics of the studies that should become standard practice are these:

A uniform procedure to assemble and keep current the data that experience dictates, and this Association agrees, should be included;

An annual "highway engineering needs" study with ancillary economic data;

An adequate "planning survey" unit in the State highway department administrative organization. The operations are so important that it should be rated as coordinate with the design, construction and maintenance functions of the department. For the larger metropolitan areas a continuing survey group with a representative from the highway staff of each unit of government is necessary.

There should be maintained in each State a unit to produce an annual report on highway needs. The Automotive Safety Foundation, whose staff has been responsible for many of the best State reports, should continue this activity and also be requested to help develop a standard manual on procedure and content of the "needs studies and reports". The Foundation can render most important services in a consulting capacity on request of any State. The reports which have been prepared in collaboration with a number of States, have pioneered the development of an essential administrative tool which now should be accepted and used continuously.

The planning surveys, with all the units of the highway organization necessarily participating in the final report, become automatically a coordinating force.

There are many new, or at least greatly changed conditions for evaluation by the surveys. For example, the interests of the Federal Government are of much larger scale because of the expanding significance of roads to serve the national defense, the growth of interstate commerce and increased use for carrying the mails.

Continuous factual studies of highway needs are essential to provide the information for all types of financing for both roads and bridges. In this connection it is germane that one-half our total traffic is within

urban limits which produces our most acute traffic congestions.

There is the need also in cooperation with the Directors of Civil Defense to select a State-wide network of emergency routes for mobile support and evacuation. The results of the highway planning surveys conducted over a period of years and the knowledge and experience of the staffs of the State highway departments in all matters pertaining to the highway systems, and particularly the studies which they made of defense requirements for operations during World War II, will prove invaluable to the Civil Defense officials responsible for the selection of a network of emergency routes for mobile support and evacuation and aiding in the development of a plan for regulating and controlling traffic on the emergency network during periods of disaster.

The use of continuing surveys and analysis as a basis for determination of annual programs and financial policies, is relied upon heavily by all successful corporations. An announcement of an expansion in plant always reflects competent market analysis and other research by expert organizations. This approach can be modified and used by each State highway department through a competent planning survey division.

The highway departments are being forced into transportation activities far beyond the traditional functions of road building and maintenance. There is no way to avoid these new responsibilities and yet retain the authority and prestige which the highway departments have acquired by meritorious performance.

The many uncertainties and the many attempts to exploit our highways and highway traffic can be withstood by the power that lies in an informed public opinion. The highway officials, - local, state and federal, - must supply the information in full measure through the continuing surveys which alone can provide a sound guide for the future.

Table 1.--Increase in highway load due to number, type, and use of vehicles

	Calendar year	Average 1921-1930	1930	1940	1950	1952
1.	Number of vehicles - millions					
	Passenger cars	17.306	23.035	27.466	40.334	43.894
	Busses	.018	.041	.101	.224	
	Trucks	2.596	3.675	4.886	8.604	9.469
	Total vehicles	19.920	26.750	32.453	49.162	53.363
2.	Passenger car equivalents - millions of passenger cars					
	Passenger cars	17.306	23.035	27.466	40.334	43.894
	Busses (Factor of 3 to 1)	0.054	.123	.303	.672	28.407
	Trucks (Factor of 3 to 1)	7.788	11.025	14.658	25.812	
	Total equivalent passenger cars	25.148	34.183	42.427	66.818	72.301
3.	Average travel per year - miles					
	Passenger cars	-	-	9,079	9,041	9,180
	Busses	-	-	18,562	20,910	20,820
	Trucks	-	-	10,624	10,696	10,170
	Average miles per year	6,581	7,713	9,346	9,373	9,398
4.	Equivalent 1921-1930 vehicles (Including correction for miles traveled)	25.148	40.062	60.388	95.149	103.246

Table 2.--Factors related to increase in traffic volumes

	Calendar year	Average 1921-1930	1930	1940	1950	1952
A.	Total vehicle miles-million	131,091	206,320	302,143	458,422	524,769
B.	Gasoline for highway use-millions of gallons	9,375	14,754	22,001	35,653	40,500
C.	Passenger car mileage when scrapped-thousands of miles	20	40	82	115	120
D.	Top speed of stock cars-miles per hour					
	High priced cars	63	73	91	91	91
	Medium priced cars	55	70	87	87	87
	Low priced cars	47	62	81	81	81
E.	Road speed on main rural highways-miles per hour					
	Average	26	35	47	47	50
	90 percentile[1/]	40	47	58	58	62

1/ The speed that is not exceeded by 90 percent of drivers.

Table 3.--Effect of number, type, and use of vehicles on roadway width and alinement

Calendar year	Average 1921-1930	1930	1940	1950	1952
5. Necessary lane width - feet (for numbers and speed combined)					
For passenger cars	9	10	11	11	11
For trucks and cars	9	11	12	12	12
6. Safe horizontal curvature (for 90-percentile speeds)					
Degrees	7	5	3+	3+	3-
Radii-feet	819	1,146	1,910-	1,910-	1,910+
7. Sight distance requirements (for 90-percentile speed - AASHO)					
For stopping - feet	275	325	450	450	500
For passing - feet	1,100	1,450	2,200	2,200	2,500
8. Percentage of highway on which critical sight distance for passing is required					
A. Critical sight distance-feet	750	1,100	1,500	1,500	1,500
B. Percentage of 2-lane highway on which sight distance must be as great as the critical sight distance if average 1921-1930 peak hour was:					
a. 200 vehicles	(one or two places per mile)			50%	80%
b. 400 vehicles	(one or two places per mile)	25%	100%	4 lanes	4 lanes required
c. 800 vehicles	60%	4 lanes	4 lanes	4 lanes required	6 lanes required
Volumes used for:					
a.	200	324	480	756	820
b.	400	648	960	1,522	1,640
c.	800	1,296	1,920	3,024	3,280

Table 4.--Estimated requirements of 15-year program (12 years for Maryland and Michigan) and current program of State highway systems

	State	Year of study	Annual total for capital outlay, maintenance, and administration		Percent, actual of required
			Required (1951 price level) ($1,000,000)	Actual, 1951 ($1,000,000)	
1.	California	1952	269.2	157.7	59
2.	Colorado	1949	36.0	26.9	75
3.	Illinois	1947	199.0	66.9	34
4.	Kansas	1948	60.6	30.7	51
5.	Maine	1948	16.5	11.5	70
6.	Maryland	1952	57.1	59.8	105 1/
7.	Michigan	1947	113.9	56.5	50
8.	Mississippi	1949	23.7	21.8	92
9.	Nebraska	1948	30.0	22.5	75
10.	New Hampshire	1948	8.5	7.2	85
11.	North Dakota	1952	21.9	13.5	62
12.	Ohio	1950	173.3	95.0	55
13.	Oregon	1948	51.7	32.1	62
14.	Washington	1948	56.2	39.1	70
			1,117.6	641.2	57

1/ Result of bond issue financing. Borrowed funds will soon be exhausted and rate will drop to 53 per cent.

Table 5.---Estimated requirements of 15-year program (12 years for Maryland and Michigan) and current program for capital outlay on State highway systems

	State	Year of study	Annual capital outlay: Required (1951 price level) ($1,000,000)	Annual capital outlay: Actual, 1951 ($1,000,000)	Percent, actual of required
1.	California	1952	219.0	122.7	56
2.	Colorado	1949	30.3	21.8	72
3.	Illinois	1947	166.4	46.8	28
4.	Kansas	1948	48.7	18.9	39
5.	Maine	1948	11.7	5.9	50
6.	Maryland	1952	47.4	51.3	108 1/
7.	Michigan	1947	98.6	36.6	37
8.	Mississippi	1949	16.8	16.6	99
9.	Nebraska	1948	23.3	14.1	60
10.	New Hampshire	1948	4.8	3.6	75
11.	North Dakota	1952	16.2	9.7	60
12.	Ohio	1950	135.4	54.8	40
13.	Oregon	1948	39.9	19.0	48
14.	Washington	1948	45.1	27.3	60
			903.6	449.1	50

1/ Result of bond issue financing. Borrowed funds will soon be exhausted and rate will drop to 53 per cent.

Table 6.--Estimated requirements and current program for maintenance and administration of State highway systems

	State	Year of study	Annual maintenance[1/] Required (1951 price level) ($1,000,000)	Annual maintenance[1/] Actual, 1951 ($1,000,000)	Percent, actual of required
1.	California	1952	50.2	35.0	70
2.	Colorado	1949	5.7	5.1	90
3.	Illinois	1947	32.6	20.1	62
4.	Kansas	1948	11.9	11.8	99
5.	Maine	1948	4.8	5.6	117
6.	Maryland	1952	9.7	8.5	88
7.	Michigan	1947	15.3	19.9	130
8.	Mississippi	1949	6.9	5.2	75
9.	Nebraska	1948	6.7	8.4	125
10.	New Hampshire	1948	3.7	3.6	97
11.	North Dakota	1952	5.7	3.8	67
12.	Ohio	1950	37.9	40.2	106
13.	Oregon	1948	11.8	13.1	111
14.	Washington	1948	11.1	11.8	106
			214.0	192.1	90

1/ Includes administration.