ECONOMIC FACTORS IN THE LOW COST ROAD PROGRAM

A paper delivered by Thos. H. MacDonald,
Chief, U. S. Bureau of Public Roads,
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As a prologue, I desire to quote from the closing paragraph of the paper delivered before the 6th Annual Asphalt Paving Conference held at Atlanta in 1927:

> "This article has been prepared upon the general premise that the physical dimensions of the highway problem in this country are so enormous that we must, through the development of new processes and new methods, give adequate service over greater mileages than we are doing now."

In the Atlanta paper I placed emphasis upon the opportunity insistently knocking at the door to use bituminous materials for the surface treatment of the very large mileage of the existing low-type roadways to improve the service, and particularly the safety, of these roads which were dusty in dry weather, muddy in wet weather, and at best unsatisfactory. I also endorsed the widely increased use of easily maintainable low-cost bituminous surfaces on unimproved sections of the State highway systems and on the more important local roads.

In the five years since, there has been remarkable progress in both of these fields, with components of advance in the theory of design, and in the technique of equipment and workmanship, far

beyond our expectations. In this short period it has become accepted in most States that bituminous treatments of gravel, sand-clay and other low-type surfaces are necessary to protect the investment and to give adequate service on roads carrying only moderate traffic. It has become a fixed policy of the Federal-aid procedure in approving projects to require bituminous treatments for low-cost construction. There has been a notable activity in the development of materials, methods and special equipment for the construction of all types of the low-cost bituminous surfaces. There has been a greater development of new processes and specialized equipment for this general type of construction than has appeared in connection with the bituminous industry during any similar period and probably in the entire history of the industry.

As might be expected of a development that has taken place so rapidly, in which so many individuals and agencies have participated, there has been a wide diversity of methods and specifications. The situation generated individualism which had to be standardized within limits before low costs and mass production of a reliable character could result. One of the most effective examples of this coordination has been in the project for the standardization of bituminous specifications to reduce to the

lowest possible number the kinds of road oils and other bituminous products which the manufacturers were called upon to produce to satisfy State specifications. The progress which is being made through the regional meetings participated in by representatives of the State highway departments, the industry and the Bureau of Public Roads, is a highly gratifying demonstration of effective cooperation toward simplifying industry and reducing costs by focusing upon the problems the organized strength of the chemical and engineering forces of the highway building industry and the asphalt industry. The results which have been and will be reached are an illuminating instance of the elimination of waste that can be secured through cooperation and interchange of ideas.

I wish to take this opportunity to point out to the States and to the industry that the good reasons for reducing all unnecessary costs of production and eliminating all unnecessary divergence in bituminous specifications, which existed when this work was undertaken, are better reasons now because of the necessity for making the road dollar reach farther. One of the series of regional meetings will be held coincident with this gathering. I urge the great desirability of continuing this activity as a major undertaking and pledge the full interest and support of the Bureau.

From the title of this paper it might be inferred that a theoretical discussion of so-called factors of economics is indicated. I prefer to believe that we have long since passed the abstract discussion stage and can more profitably devote the time to the applied economics possible within the range of known facts, technical information and positive results which are now of sufficient age to justify conclusions. These are the only sound foundation on which to base a program offering any possibility of permanent success. The inevitable sequence of economic forces holds us on a charted course regardless of the tackings back and forth across the line brought about by the politician and the opportunist. These tackings back and forth only delay arrival by the direct line, which is and must always remain the shortest distance between two points. In other words, a program which either under or over-accents the lesser important roads is doomed to failure over a relatively short period.

It is my purpose, therefore, to examine some of the economic factors which should determine no one particular part of the highway improvement program, but the program as a whole. These fall naturally into three general lines, - administration, financial and technical.

The most important factor of administration is the planning of the road system as a whole and obtaining the legislative acceptance of the plan. By the expression, a planning of the system as a whole, I am endeavoring to break away from any narrow conception of highways as legally classified, and to consider them from the standpoint of traffic requirements, present or potential. This distinction possibly can be best explained by use of the recent traffic survey in Michigan. This survey brings out the following facts:

1. That the existing State highway system of 7,691 miles (exclusive of sections within city limits) serves an average daily traffic of 1,144 vehicles.

2. That the existing county roads totaling 17,175 miles serve an average daily traffic of 190 vehicles; and

3. That the existing township roads which make up the balance of 60,214 miles serve an average of only 22 vehicles daily.

This classification is the existing order based upon legal and administrative control, and is subject to large revision upon the basis of the traffic importance of the individual roads within these three groups. Some roads of Classes 2 and 3 would be lifted to Class I and interchanged between these two classes. When this is done, from the record of their use each individual road would be properly placed in its class, but probably the total mileages

of each class would not be materially altered. This means that in the two upper groups there are approximately 25,000 to 30,000 miles whose use justifies improvement with a surfacing adequate for the travel to be carried, and that can be provided within the earnings of these roads as a whole. But there remain 50,000 to 60,000 miles of roads which average not more than 22 vehicles per day, and an adjustment as suggested above of the classification would reduce this average. It is not necessary to figure minutely the earnings from serving vehicular travel of these roads carrying 20 vehicles per day. It may be indicated by assuming a gas tax of 4 cents and 10 miles per gallon. Each mile would then earn about 8 cents per day, or $29 annually.

We will trip over our own feet in trying to draw sound conclusions based on the present classes of roads as legally defined. No one will seriously question the care and improvement, through the earnings of vehicular travel, of Classes 1 and 2 when revised for Michigan, to the extent possible within the limits of the income. The maximum total income will limit the taxation imposed upon the individual motor vehicle through the law of diminishing returns. But there is a very definite line between these roads of general motor use which in the case of Michigan amount to a total of 29 per cent of the total road mileage and those whose purpose is purely local.

Farm-to-market roads are coincident with the lines of general community use.

Following these facts through, we find they are reasonably representative, and based on a careful survey of other States in which a similar division has been worked out, the indicated general classification for all existing public roads might be as follows:

	Miles	
A. Federal and state highway systems: to include all routes where traffic is heavy and where terminal-to terminal traffic predominates	330,000	11.0%
B. County highways: including all important farm-to-market roads where through traffic is lighter and where highway service to adjacent property or to roads of Class C is more than the through traffic	600,000	20.0%
C. Local roads: comprising all other local roads and those whose use is closely related to crop production and disposal. These are, in general, short roads, tributary to Classes A and B	2,070,000	69.0%
	3,000,000	100.0%

Please do not understand that I am setting up a final classification for our existing roads, or these precise percentages for any particular State. 1/ Rather, this classification indicates a top limit now for our general-use roads at from 30 to 35% of our public road mileage, or roughly, a division in Classes A and B of one-third, and in Class C, two-thirds. What this means in terms of service to the agricultural population is indicated by the fact that a strip one mile wide on either side of a mileage so extensive as 35% of our public road mileage in Classes A and B, would include over 2,000,000 square miles out of a total area of 3,026,789 square miles for the Continental United States. 2/

There is no doubt that the time has come now for those States that have not already adopted such a program to make a study and classification of roads here included under Classes A and B. A considerable number of the States have already adopted such a plan and are devoting a portion of the income from the motor

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1/ Such a classification obviously will rest upon the area, density and distribution of population, topography, types of development, age, etc., since these determine highway usage. Thus the sparsely settled States of the West would vary widely from the percentages given here but the principle would apply. In these States the percentages in Classes A and B would be much larger.

2/ This is subject to correction for the limited mileages where the roads of Classes A and B would be less than two miles apart.

vehicles to improving the roads either through State operation or through assistance to the counties under general State direction.3/

To make reasonable provision from road user taxes for Classes A and B is not, in general, impossible. Class C roads, or those carrying we will say an average of about 20 vehicles per day, which make up the big percentage of our road mileage, but consist essentially of short sections of very local roads tributary to those of general use certainly can not in fairness be supported from the road user revenues. Since we are here contemplating a mileage of general use roads so extensive that two-thirds of the whole land surface is directly served, that is, within a maximum distance of one mile, these would include not only all the main State and inter-county roads, but all of those which could by any stretch of the imagination be called the

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3/ From the gasoline taxes for the first half of 1932, California, Illinois, North Carolina, Ohio, Iowa, Massachusetts, Pennsylvania, Wisconsin, have each allotted by law from about two millions to nearly six millions each to local roads. Twenty-seven States have allotted a total of forty-six millions to such roads from this source of revenue. This is not indicative, however, of the full participation of local roads in the motor vehicle taxes. In 1931 a total of more than one hundred eighty-nine millions was allocated to local roads and city streets from these taxes. In a majority of States these allotments are made without provision for direct or general State control of the expenditure. Notable exceptions to this rule are Connecticut, Pennsylvania, Illinois, Iowa, Missouri.

real farm-to-market roads. This Class C mileage is not therefore discussed further in this paper.4/

The above classifications for A and B roads total 930,000 miles, a figure that seems almost fantastic perhaps, yet according to our best estimates we have now a grand total of 720,000 miles of surfaced roads, leaving a difference of 210,000 miles yet to be improved with surface if the reported improvements were all on the roads that would fall in Classes A and B. This would be by no means an impossible task within a reasonable period in the future had these improvements been so systematized.

We have for the past several years recorded an annual increase in surfaced roads up to a total of about 30,000 miles. At this rate there is ahead, theoretically, only say ten years, even at the considerably reduced rate which we now face. This, however, is simply a fantasy which we wish were true, since a very large part of the mileage reported as surfaced is not located upon roads of Classes A or B, or improved to a degree consistent with either traffic requirements or minimum maintenance costs.

4/ While Class C roads will be improved by low-cost methods, this is primarily a discussion of the use of bituminous materials. It will be accepted that for an average traffic of 20 vehicles per day, more or less, the use of bituminous materials under any of our present methods would not be considered or the expense justified.

Here are more nearly the real facts:

The State highway systems, which I have called Class A highways, comprise 330,000 miles. There remain of these approximately 100,000 miles yet to be surfaced. Of the county road systems placed above at a maximum of 600,000 miles, we may estimate 325,000 miles surfaced, leaving 275,000 miles yet to be surfaced. This leaves of the total reported surfacing, 165,000 miles to be distributed back to the Class C roads of 2,000,000 plus miles.

I do not intend to represent these figures as accurate but they are reasonably indicative of the road surfacing status at the present time. Under this traffic classification of the roads which should be surfaced, there are in these groups which I have termed (A) and (B) a total of at least 375,000 miles yet to be improved with some type of all-year usable surfaces. To this total must be added a considerable mileage of streets within municipalities which is logically a part of the general use system and which involves, in general, improvements of a more extensive character. It is thus evident that our highway improvement program indicates an indefinite time to carry it to even a reasonably stable status. By which I mean a physical condition

throughout the two groups that provides the most economical service.5/

These are sufficient facts upon which to base the principle that we must plan our annual highway improvement program as a continuous activity and not one that will be finished in a definite or near foreseen time.6/ The administrative program, therefore, for any State, should not depart too widely from the following considerations:

(1) The definite classification of the roads based on traffic, present and prospective, and

(2) The setting up of a budget providing for fixed charges, maintenance, reconstruction and new construction.

It is my judgment that priority should at this time be given to these items in the order mentioned, but subject to the following explanations:

The conditions do vary so widely between the States that to make this more general, perhaps, the reconstruction and new construction items could be considered together to cover

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5/ The cost of service must include, both the road and the vehicle. Items of capital investment, interest, maintenance, etc., are accepted for the road. Items of depreciation, fuel, tires, etc., for the vehicle are not so commonly associated in the public mind with the varying types and degrees of road improvement. These latter however comprise much the greater percentage of the annual cost of highway transportation.

6/ It is evident the total funds available for road improvement over the next several years will be greatly decreased from the average of the past five-year period.

the reconditioning of such types as the older gravel and macadam roads, and the lifting of the unstable surface types to a higher type, as well as the extension of construction to a new mileage.

From studies which we have made recently in States where existing debts claim a large percentage of the revenues arising from imposts upon the motor vehicle, we have placed, as of next importance after routine maintenance, the completion of relatively short gaps in the major highway system, and the reconditioning and lifting of unstable existing surfaces to stable types, above the extension of new construction. Such a policy has for its support the protection of the capital investment already made, perhaps yet unpaid, and the greater use with resulting increased income to meet the menace of a now decreasing income from motor vehicle imposts. Needless to say, after fixed debts are met, first priority goes to adequate road maintenance.

In the broad future program there is a wide use of bituminous materials and types indicated. Referring back to the first principle of the administrative program, it being assumed that the unsurfaced mileage yet existing on the State highway systems is the most important from the traffic standpoint, this mileage should receive first consideration for improvement at least to the stage of a graded and drained type with a low-cost

surface which may vary from a light oil surface treatment to one of the more durable low-cost types.

We have now to meet a very different condition than during normal times. The problem of unemployment enters as an economic factor as certainly and more acutely than other factors, so that it is a justifiable policy to give greater consideration to the extension of mileage of the low-cost types provided these operations are based always upon the traffic requirements in the order of their importance. Also that the types of improvement selected can be maintained with economy relative to the traffic.

In this connection I feel it desirable to point out a situation that is perhaps generally misunderstood as to the working out of the policies which have been applied to the administration of the Federal aid highway funds. There is attached a schedule showing the type classification of roads to which Federal aid funds have been applied in the 16-year period from the beginning of Federal aid appropriations, 1916 to July 1, 1932.

In this time, 101,000 miles have been included in Federal aid projects. Dividing the low-cost types on the line between the low-cost bituminous mixtures and the bituminous macadams, Federal funds have been used on 57,000 plus miles of low-type against 43,000 miles of the higher type surfacings. The ratio

of original Federal aid projects is 57.2 per cent low type to 42.8 per cent high type. The States by additional construction of surfacings on this original Federal aid project mileage have changed the status until we have now the ratio of 52.9 per cent low type to 47.1 per cent high type.

Of the original project total low-cost or stage-type mileage there was untreated with bituminous materials 90.5 per cent, treated 9.5 per cent. The States have changed this situation by additional construction and application of bituminous materials to a present status of 68.5 per cent untreated and 31.5 per cent treated. These figures indicate that the stage or progressive construction policy adopted many years ago was sound, and has greatly increased the usable mileage of roads which are being rapidly raised to improvement types more nearly meeting the traffic requirements by the States almost wholly with funds provided through the road user income.

The use of Federal aid funds has not only been a major factor in providing a large mileage of the higher type roads needed to carry the heaviest traffic, but has been an equally large factor in the mileage extension of the low-cost types. The engineering adequacy with which the pioneer work of grading and drainage, of providing structures and improved location has been done on these projects, is a tremendous factor in the ability shown by the low-cost bituminous surfaces subsequently added to carry heavier traffic than was possible a few years ago.

There are two other factors of importance in this now demonstrated capacity of the low-cost types to carry heavier traffic:

1. The remarkable transition which has taken place in tire equipment in the universal substitution of the pneumatic tire for other types, and
2. The more perfect maintenance organizations and methods developed generally by the State highway departments.

One other item in the administration of Federal aid funds is of importance. In the Federal Highway Act of 1921 provision was made for the addition of roads to the first selected seven per cent system when all of this original mileage was completed to a degree adequate for present traffic requirements. The emergency legislation of July, 1932, considerably liberalized this requirement by the provision that when 90 per cent of the original seven per cent

system is completed to a condition adequate for present traffic requirements, an additional one per cent might be added. At this time fourteen States have taken advantage of these legal provisions and have increased the mileage of their original Federal aid system.

Reasonable revisions of the original systems have been made from time to time by various States in agreement with the Bureau, so that it may be assumed that generally the uncompleted mileage of the Federal aid system includes the most important roads from the traffic standpoint.

The legislation above mentioned permits, therefore, the application of available Federal aid funds continuously to the unimproved roads of greatest importance in the State. This, taken in connection with the policy of the Bureau to operate with the States on the stage construction basis, with reasonable regard for the traffic requirements, removes all obstructions to the use of the Federal aid funds for the types of roads which would give the most direct employment on the job at the present time. It may be stated that in recent operations we have experienced more difficulty in obtaining the desirable maximum of first stage and low-cost types of improvement in a number of States than in securing the higher type projects.

Taking the mileage of inadequate road surfaces and the unimproved mileage for Classes A and B estimated at more than

375,000 miles, we reach a rough approximation of more than 200,000 miles as a measure of the extent to which the low-cost types of surfacing are the only possible character of improvement within any reasonable period, even under normal economic conditions.

In this discussion I have had in mind principally the use in the future of the funds which have for their source the motor vehicle license and gas taxes with such other revenues as come from the use of the roads rather than tax return from real and personal property.

It need not be emphasized in a meeting composed of informed men, that the State highway departments are almost wholly dependent upon these funds for their activities even for their very existence. But it is against these funds that the most vigorous attacks are likely to be made this winter, notwithstanding that through the devotion of these funds, without diversion, to road improvement, lies the only hope of lowering taxes upon other property such as real estate, and the railroads, for these same purposes. Their use for road purposes provides a maximum redistribution to labor and provides a most practical and morale sustaining employment.

The matter of highway finances can not be adequately covered here without prolonging to undue lengths this discussion. In the studies which we have made in cooperation with the University of Wisconsin, in the States of Illinois, Wisconsin and Michigan, we have been impressed with the rate of taxation upon property which

now exists in the larger cities. These studies also indicate that a major part of the income which is being used for State highway improvement comes from urban owners of motor vehicles. These vehicular license and fuel imposts have been used and rightly so upon the principal rural highways. Our transport surveys have continuously indicated that the necessity for their improvement, particularly with the higher types, in a major sense results from their use by the urban population.

In this field generalizations are highly dangerous, but I would interpret the results of these financial studies to mean that where the State highway systems have been improved to the point that new mileages may be added, first consideration should be given to those city streets which constitute the extensions of these systems through the municipalities. I know of specific instances where the use of such funds would be of more importance to the traffic into, through, and around the metropolitan areas, than any possible extension of rural mileage and would provide facilities which I can not see possible of attainment through further urban taxation under present conditions.

Such improvements would in many cases include the use of bituminous materials, but would not be satisfied by the low-cost types.

The proponents of the placing of all rural road care and improvement wholly upon the motor vehicle must consider also the

inadequate roads and very heavy taxation in the metropolitan areas. The facilitating of traffic in these areas will help to sustain the road income and to prevent a revolt of the urban motor vehicle user through fair provision for the traffic facilities which he requires.

In conclusion, I have endeavored to give a rather definite line of demarkation between the roads which should be considered for improvement now and those whose improvement can not be justified as a facility provided on account of and for the use of the motor vehicle.

I do not insist upon the particular point or line of division. I do insist that already shrinking revenues if spread too thin over either rural roads or urban streets will only accelerate their rate of diminishing.

We have to face the facts that under present conditions all road revenues from local to Federal will be very materially reduced. I do not know to what extent but I do know it will be very serious, - so serious that the result will be to endanger both our very large capital investment in highway construction and the experienced and competent technical organizations of our highway departments. I have referred to the great utility which lies in the various available bituminous materials and types of use for the preservation of the capital already invested and for the extension of adequate road service. But just as certainly as this utility exists

with, it will vanish without the technical organizations of the highway departments which are so largely responsible for the development and profitable use of bituminous materials and types, particularly those included in the lower cost range.

This is not a defense or a plea for the Highway Departments. It is a matter of the public's interest. Our whole improved road mileage is absolutely dependent for its existence upon day to day highly organized maintenance operations under efficient technical supervision and control. Because of this expert timely care, the public generally has no conception of the fragile character (measured by time durability) of perhaps 75% of our surface mileage, or the potential rapidity of its depreciation without continuous maintenance. This is the national concern. The hazard to the low cost road program of any breakdown of adequate maintenance and technical control by the highway departments is impossible to over-stress.

I propose therefore as a sound national program based on the economic factors involved; first, road classification, to include in addition to the State highway system, the county and municipal roads and streets on the basis of general traffic use, into classes as herein defined, and the selection of types consistent with the use which will be required; second, the placing of all motor vehicle imposts under the administration and the direct or general control of the State highway department; third, that fixed debts

and maintenance be made the first priorities followed by reconditioning, reconstruction and then new construction; fourth, that an amount equal or even greater than is proposed for diversion to other purposes or to other divisions of government such as the counties or cities be set aside for the roads and streets of these divisions which are included in the above classification as general use highways under direct or general control of the State highway department; fifth, that taxes on real or personal property within the counties or cities be reduced by an amount equal to the sums provided from the motor vehicle imposts. Or, if these amounts are needed to balance the budget for other purposes, that they be taken to the extent necessary from the property taxes now used for road purposes which would be met under this proposal by allotments from the motor vehicle imposts.

Such a program offers the best defense in the present situation -- a constructive attack. It would assure traffic service and maintain income. It would protect credit and capital investment. It would insure continuance of the competent control of expenditures and engineering operations of the State highway departments. In them we have a national asset that no nation is wealthy enough to sacrifice.

Type classification of Federal-aid roads as improved with Federal aid, and as modified by subsequent improvements by the States without Federal aid, June 30, 1932

Type	Federal-aid improvements by types		Actual existing mileage by types due to further improvements by the States	
	Mileage	Per cent of total	Mileage	Per cent of total
Graded and drained	12,222.4	12.1	4,516.5	4.5
Sand-clay and top-soil, untreated	7,395.8	7.3	6,681.8	6.6
Sand-clay and top-soil, treated	36.0	----	829.4	.8
Gravel, untreated	30,545.9	30.2	24,417.1	24.2
Gravel, treated	862.8	.9	8,084.6	8.0
Macadam, untreated	1,983.5	2.0	777.2	.7
Macadam, treated	916.4	.9	2,191.0	2.2
Low-cost bituminous mixtures	3,582.2	3.6	5,673.0	5.6
Bituminous macadam	4,468.2	4.4	4,752.2	4.7
Bituminous concrete	3,841.6	3.8	4,689.2	4.6
Concrete	33,671.6	33.3	36,851.9	36.5
Block	1,021.5	1.0	1,084.0	1.1
Bridges and approaches	484.2	.5	484.2	.5
Total	101,032.1	100.0	101,032.1	100.0