

Annual Meeting, American Association of State Highway Officials,  
Pittsburgh, Pennsylvania -- November 17, 1930.

THE PRACTICAL APPLICATION OF HIGHWAY  
TRANSPORT SURVEYS TO A STATE HIGHWAY SYSTEM

by

Thos. H. MacDonald  
Chief, U.S. Bureau of Public Roads

The earlier highway transport studies consisted almost wholly of counting the traffic at arbitrarily selected points during an arbitrarily fixed time period, frequently very limited. These counts are continued in some states but the principal value of the data now accumulated over a number of years is to indicate the changing trends in the amount and character of highway use. They have little dependable utility for the planner of a state highway system.

The modern transport survey includes the gathering and the analysis of the data defining all of the elements, physical and financial, which enter into the planning of a highway system, structurally sound, and the setting up of a budget sufficient to carry the indicated expenditures. These elements include a division of the state into districts or areas, homogeneous in character, and so defined that the traffic flow in each area may be secured from counts taken at a

minimum number of stations; a study of population and motor vehicle registration trends in reasonably small units for each area; the gathering of the amount, weights, and characteristics of passenger and cargo traffic flow over a sufficient time period to reflect all of the peak and seasonal variations, preferably not less than one year; the analyses of the individual movements of motor vehicles by origin and destination; a thorough condition survey of existing highways; the determination of the relative use by urban and rural vehicles; a forecast of the effect of possible unusual industrial or natural resource developments; and a very careful study of the sources and amounts of the highway income. Such a series of studies requires an extensive field and office organization working under competent and experienced direction, and governed by sound statistical methods. It must be accented that the State highway departments as a whole are operating an annual business approximating one billion dollars of expenditure. The need for detailed economic studies grows constantly more necessary to keep the highway systems in balance as the improvement of the most important roads is accomplished.

The element of insecurity and loss attendant upon incomplete or incorrect methods and unsound traffic forecasting is well illustrated in the income breakdown of many private toll bridges which have been financed on the expected earnings of predicted traffic greatly in excess of that which has actually developed. And, it may be added, greatly in excess of the traffic possible within any reasonable period.

The consideration of a highway system fundamentally as a structure is sound. The proper planning of the highway mesh requires the main members to be so placed and so designed as to be capable of carrying present traffic and also of being enlarged and strengthened to carry the indicated increments of increase as additional loads are thrown upon them by the improvement of the lesser and more remote traffic lines.

Highway Planning is a Large Element in Proper State Planning. - The successful planning of a highway system goes far beyond the building of the roadways to the planning of the state itself. That is, to foreseeing the logical and probable development and land utilization that proper planning and control may be exercised. The highways must provide

traffic service to all sections of the state, but they have also an important relationship, which in the past has not been accorded the intelligent consideration merited, to the cities and their various areas of commercial, industrial and residential character; to the development and utilization of scenic and recreational areas; to the multiplication of parks, roadside planting and improvement; and to provision for the services of electricity, sewerage, gas, water and telephone lines. In short, for most of the facilities which are essential to the development of an area for the most satisfactory living conditions the highway lines provide the only available locations and opportunities. A highway survey covering this scope of information is self indicative of its application to the planning of the highway system structure, and in the surveys which have been made, important principles have been developed which may be applied with some success in other states without the painstaking efforts to gather and to analyze the great mass of data which must be brought together for an adequate State survey. But the evidence all proves the great desirability of undertaking complete transport surveys in each state as a foundation for the continuity of sound administration, and in the aggregate to strengthen and enlarge the administrative

control of the State highway departments as a vital factor in the building and operation of an adequate system of highways for the nation.

The State Highway Departments are Today Dependent for Their Existence Upon the Income from the Road User Taxes. -

Considered on the national scale, the State highway departments are today dependent for their income upon the revenues from the road user, i. e., the gas tax and the motor vehicle license fees. The tendency of the legislation of the latest general assemblies has been to increase the revenues collected from the road users, and to divert these increases from the control of the State highway departments. The attempts, successful in many states, to divert road user revenues from the State highway departments, are for two principal purposes; first, for roads outside the State highway systems in the rural communities; and second, for use upon city streets. There are other demands for the diversion of these funds to be used for general revenue purposes, or for specific purposes, wholly unconnected with highway improvement. The diverting of road user funds from the State highway system is relatively of less importance than their removal from the control of the State highway departments. Admittedly, the State

road systems have been set up in a more or less arbitrary manner, and no one will suggest that the systems may not be modified reasonably as time passes to include other roads which are needed for the general use of the public, whether they lie in the rural communities or within the city boundaries. In fact, they are being greatly modified by additions in some cases far beyond the revenues available for their improvement and maintenance. The essential point is the control of these user revenues by the State highway departments because of the demonstrated capacity of these organizations as a whole to expend the funds properly, and because our highway systems must be built on a State-wide basis. This is an outstanding fact developed by the highway transport surveys.

The Federal Government is a Cooperating and Coordinating Agency. - The Federal Government through Federal aid may, and we believe does, occupy an important and essential position in correlating the major systems between the states and in assisting to build at a reasonable rate a coordinated national system of highways. The local communities such as the counties and the cities each have a highly important function. Within the metropolitan districts there is the necessity for, and there

are being developed, auxiliary systems of major importance. The counties are similarly engaged. But the key to the whole administrative structure, considering highways from the basis of a national system, lies in the State highway departments. The jurisdiction over road revenues in a major sense must remain lodged with these departments. Otherwise the nation will suffer a breakdown in the administration of the highways of major importance.

Political Changes in Highway Departments Constantly

Menace Efficient Administration. - In addition to the influences mentioned tending to break down control of these funds by the State highway departments are the political changes which so materially affect the personnel of the departments. Possibly, at the moment, there are not less than 20 per cent of our highway departments which may suffer a change in administrative personnel with the attendant disruption of momentum and organization at a time when the country is calling most loudly upon these departments to extend and hasten their work to provide the fullest measure of employment possible. Here, indeed, is one public effort in which an economic problem can be met in no small degree with an economic answer.

The Support of the Highest Executive Officers of the State is Essential to the Continuity of Highway Programs. -

There is a quotation from the message on highways of Governor Young of California to the General Assembly in March 1929, which deserves to be repeated here and to be broadcast. He says:

"No governor should be asked or expected to sign a bill providing for the extension of the State highway system, except upon recommendation of the Department of Public Works - a recommendation in its turn based upon a careful study of traffic requirements and highway use, in line with the broad general policy of long-time planning. Any other plan will break down our program of highway construction and will savor of political expediency rather than of safe and business-like procedure. Whatever policy may be adopted must be based on traffic and not political pressure."

Further - "I think we would agree that before a road is added a traffic and economic study should determine its necessity, and a survey as to rights of way, grades, economy of construction, and the like, should determine its location.

"I think we would also agree that new roads should not be added more rapidly than they can be adequately cared for."

In fact the whole of this message is an ideal approach to this perplexing question of the planning and particularly the extension of the State highway systems.

In the preceding are recorded some of the problems and the adverse influences at work to break down an efficient ad-



ministration of the highways of general public use. Governor Young in his message adequately meets one of these chief problems by recommending a careful survey of the State system and the need for, and relationship of, any proposed additional roads to the system as a whole. He proposes as a basic principle that the State system, together with those immediately necessary additions of secondary roads, shall all be financed from the anticipated revenues within a reasonable time. There are presented as the essential elements a careful study of the whole system and the establishment of an adequate covering budget for a period of years which for the State of California has been fixed at ten years.

Highway Transport Surveys have Demonstrated their Value in Efficient Administration. - While highway economic studies have been carried on for many years by the Bureau of Public Roads, the first cooperative survey including all of the elements which have been here listed as attributes of the modern transport survey, was made by the State highway department of Connecticut and the Bureau in 1922. This was followed by similar surveys in Maine, Vermont, New Hampshire, Pennsylvania, Ohio, and the metropolitan districts of Cuyahoga County, Ohio, and Cook County, Illinois.

Mr. Macdonald, State Highway Commissioner of Connecticut,

states:

"At the same time that we made the transportation survey, we made what I term a condition survey; that is, we predicted the probable life of each section of highway which we had. The reconstruction program since about 1925 has been based solely upon these two surveys. Our new construction program has been based on a transportation survey as a relief to traffic. I do not see how it would be possible for any State highway department to approach intelligently the question of reconstruction and consider types and locations without knowing first what the probable trend of traffic would be over the highway in question."

Mr. Everett, Highway Commissioner of New Hampshire, says:

"While the legislature did not approve his recommendation (i.e., the recommendation of the Governor to increase the revenue for putting into effect the recommendations of the survey) they did make available added revenue by the passage of a bond issue which increased the revenue one million and a half a year for the last two years; the added revenue to be used exclusively for reconstruction with a hard surface, agreeable to the plan laid down in the survey. While we have not been able to proceed as fast as our program called for, all the work that we are doing is being carried out strictly according to the survey. There is no doubt that we would not have had the bond issue if this survey had not been made, and further there is no doubt but what a considerable amount of our regular highway fund would have been diverted for other purposes. We therefore consider that the transport survey was of inestimable value to the State for this reason alone."

Mr. Quinlan, Superintendent of Highways, Cook County,

Illinois, states:

"It is my belief that highway transport or traffic surveys are of immeasurable value and use in planning and administering any highway program, whether it be county, state or federal. They pay for themselves many times over; first, as a guide in the proper allocation and design of highway improvements, and second, as a powerful weapon against well-meaning but inadequately informed citizens or others who believe that certain improvements are necessary or endeavor to get them constructed. It is my experience that an improvement program extending several years into the future is very necessary in order to properly carry on highway construction in a metropolitan area like Chicago. A highway traffic survey showing present traffic conditions, points of greatest congestion, and probable future conditions, is very necessary if a sound highway program is to be laid out several years in advance. Adequate funds to take care of future construction are always easier to get if a traffic survey shows the need for such construction."

Mr. Sargent, Commissioner of Vermont, states:

"Highway transport survey has been of inestimable value in planning and administering State construction program. Practically all of our work has followed its recommendations. It has been the major and sometimes the sole guide in laying out our work."

Mr. Eckels, Chief Engineer of the Department of Highways of Pennsylvania, in a paper presented before the Engineering Teachers at Yale University on July 16 of this year, says:

"The same basic, economic and engineering principles of management that control business should govern the public business of production in the highway field. Applied to the public

business of the State which is responsible for developing a connected system of highway improvements to facilitate transportation, the first principle of production management is that various sections of a highway system should be based upon present and anticipated traffic demands. The second basic principle is the familiar one of the budget, upon which all financially sound industries operate. From facts developed by the survey it is possible to forecast accurately traffic conditions on any section of the highway system for many years in the future, and this study is the basis upon which the Department selects the character and type of pavement to be constructed and the logical location upon which to undertake construction. In planning highway construction on these several systems the establishment of a highway budget is essential as it involves the determination of the amount of funds necessary to scientifically improve the road systems over a definite period of years, the annual funds required and an equitable distribution of the cost of the improvement program among the sources of highway income."

During the past year the State highway departments of eleven of the western States have cooperated with the Bureau in a transport survey which has covered a vast area and for which the data for the movement of nearly one million motor vehicles are being tabulated and analyzed, as a foundation on which to determine the present and to predict the future flow of traffic in this area, and to determine the types of roads, the budgets and the development of the systems most necessary.

A comprehensive survey is also under way in Michigan through cooperation between the State Highway Department and

the Bureau. In this study it has been found desirable to include more than 1100 stations to obtain the data on which to evaluate not only the State roads but also a State-wide system of secondary roads.

Important Principles Underlying Highway Transport have been Established by the Transport Surveys Completed. - By the eight transport surveys which have been made, covering states having quite diverse conditions, the following principles are reasonably indicated:

(1) Highway traffic universally tends to concentration considered either on a State-wide or smaller area basis.

In Connecticut seven roads can be picked from the entire State system as being outstanding carriers of the total State traffic. In Ohio 13 per cent of the State highway system carried 58 per cent of all traffic. In Pennsylvania 11 per cent of the State system carried 68.3 per cent of all traffic. In New Hampshire 11.3 per cent carried 69.4 per cent of all traffic.

(2) The planning of an adequate and continuous State system automatically puts a greater portion of mileage in the areas less densely populated and thus insures proportionately greater recognition of the rural sections.

Because roads adequate and necessary to serve concentrated population must cross and recross areas of less population we find the following conditions:

In Connecticut, in 1900, 1910 and 1920, we find the population in those areas where the density was from zero to 63 per square mile to have been 10.4 per cent, 8.4 per cent and 6.3 per cent, respectively, and in 1925, the developed State aid and State highway system had 40 per cent and 43.8 per cent of the total mileage in the same areas. In Connecticut again, the area which in 1900 had a population density of from 64 to 127 contained 7.2 per cent of the total State population, but the same area has 19.3 per cent of the total State aid road and 17.7 per cent of the total trunk line road. On the other hand, the area which in 1920 had a population density of from 640 to 1279 and contained a population of 17.6 per cent of the total State population had only 6.7 per cent of the State aid mileage and 4.8 per cent of the trunk line mileage. We find the same condition prevailing in Ohio. The area in Section 1, according to the classification of area adopted by the report, had 44.0 per cent of the population and 25.6 per cent of the total State highway mileage. Section 2, with 16.5 per cent of the population, had 6.7 per cent of mileage. Section 3, with 8.7 per cent of population, had 11.7 per cent of mileage. Section 4, with 18.8 per cent of population, had 30.9 per cent of mileage, and Section 5, with 12.0 per cent of population, had 25.1 per cent of mileage.

The principle is exemplified also in New Hampshire. This data may also be used to confirm the principle of the concentration of traffic on a relatively small mileage.

(3) Population follows the improved road.

Between 1910 and 1920 in Connecticut the average increase in population was 23.9 per cent for all towns (township). The increase for all towns not on main routes in that period was 4.7 per cent. There are 168 towns in Connecticut; of these 60 are crossed

by main routes, and 108 are not crossed by main routes.

Between 1910 and 1920, 52 of the 60 towns crossed by main routes showed an increase of population, and 8 a decrease.

In the same period, of the 108 other towns, 46 showed an increase and 62 showed a decrease.

This principle also might be used as a deliberate means to accomplish a desired redistribution of population.

(4) Traffic volume is largely proportional to population, and a rational outline plan of a system may be secured by laying out the major State roads between and in the order of population centers in cases where other data are lacking. Such a plan does not offer the desirable refinements or accuracy, and is only to be recommended as a temporary expedient until a State-wide study can be made.

(5) Highway utilization (vehicle miles, total tonnage) varies with highway classification, with regional characteristics (agricultural, industrial, urban, suburban, etc.) and with distribution of population.

(6) The major traffic flow is between and adjacent to large centers of population.

(7) The relative types of improvement are indicated, and the definite class of improvements may be determined, to the extent accurate knowledge is had of the traffic capacity of the

various types under the existing soil and climatic conditions.

At this point, engineering and economic data must be used in combination.

(8) Heavy hauling (truck operation) is generally limited to short distances. The percentage of long hauls is negligible.

This indicates the nature and limited extent of metropolitan areas.

(9) Foreign traffic is generally a small part of the total and is confined largely to the main routes, but on particular main routes often becomes a large percentage of the total traffic.

(10) Truck loadings, travel radii, commodity types, and miscellaneous characteristics representing traffic are all determinable adequately by the statistical field methods developed in transport surveys.

Wherever subsequent surveys are being made they are checking previous results closely enough to indicate the use of satisfactory methods.

(11) Highway utilization is increasing absolutely. That is, car mileage of travel is increasing at a faster rate than registration.

(12) The order of priority of construction is indicated.

(13) Statistical methods, utilizing adequate field data,



can be used to forecast traffic in ways satisfactory for planning highway programs.

Upon such a foundation can be built the annual construction, reconstruction and maintenance program and the required budget of expenditure. A period of at least five and preferably ten years should be covered. Then and not until then is the State ready to make a decision as to amounts and ways and means of financing. The use or non-use of bonds ought to be decided upon such evidence.

(14) Transport surveys may be used to determine an equitable allocation of gross user revenues to the various classes of highways of the State.

(15) An intelligent assignment of funds based on present and potential traffic requirements can be made covering a period coordinated with the actual physical performance of the work necessary.

(16) On a conservative basis of cost for service rendered, the major road systems of the States amortize themselves in a remarkably short time.

Assigning to truck traffic three cents per vehicle-mile and to passenger car traffic 1 cent per vehicle-mile for highway service, the entire cost of the Connecticut system to 1923 would be amortized in approximately nine years. The cost of the Ohio system to 1925 would be amortized in about 4-1/2 years, and the cost of the Pennsylvania system would be amortized in about 10 years.

The Objective sought is a Stabilized Satisfactory Traffic Service Improvement of the System as a whole. - There are other principles which may be taken from the analyses of the survey data, but these are sufficient to indicate the practical application of such surveys to the highway program. In summing up the use of such surveys to arrive at a consistent program, one other definition is needed. There has been a great deal of talk of various types of construction and much urging of the merits of various kinds of materials. Our experience, however, - and it has now been extensive, - points to the necessity for intelligent and scientific approach to the selection and use of both types and materials according to the traffic needs, and there is a higher premium on highly developed and sound engineering practice now than ever before, each problem requiring a specific rather than a general solution.

There has also been much talk revolving about such words as "permanent" - "durable" - "low-cost" - "high-type" - and other similar terms. We must accept the fact that the building of a system of roads involves continuous consideration of the system as a whole, and the adoption of methods of construction and maintenance which will offer within the possible expenditure the most satisfactory traffic service constantly.

Types of construction are in a state of constant change, and we are seeking to provide for a system of major highways a stabilized satisfactory traffic type of improvement, which means that the type of construction is such that it will offer satisfactory traffic service over a reasonable length of time without a progressive increase in the annual maintenance cost. We do not delude ourselves with the idea of an intangible and unobtainable permanency of construction but rather accept as the practical and sound objective the providing of improvements that will render satisfactory traffic service economically if diligently maintained. This idea accepts a program of betterment and reconstruction as well as new construction to maintain a stabilized condition of the system.

The traffic survey gives the information on which to predicate this condition, and, including as an item the condition survey, indicates the annual expenditure necessary to bring the system as a whole to this stabilized traffic condition. It accepts the fact that stabilization in this sense looks to the character of the traffic service and to the maintenance costs as the standards of value rather than to particular types of construction.

Based on this definition of the objective, it is evident that the traffic survey sets up data on which to budget necessary expenditures covering a reasonable period, not less than 5 years and preferably 10 years. It provides also for a growth in the system itself from the secondary roads and within the city areas.

A Long Time Program and Budget are the only and the Greatest Protection against the Unwarranted Dissipation of Road User Taxes from Control of the State Highway Departments. -

The growth of the user funds, as stated elsewhere, has been so spectacular as to attract demands for major diversions and dissipation.

A long-time budget set up to meet a definite plan of operations over a long period, indicating the extent to which all such income will be necessary, is the only possible defense against such dissipation. It is the only possible argument sufficient to maintain these funds under the control of the State highway departments, which in turn means an effective, honest, national administration of our highways. No over-emphasis can be placed upon the necessity for the long-time budget based on adequate studies as herein indicated, since the principles

defined are in themselves proof of the asserted efficiency and adequacy of this procedure.

The Bureau has been for years engaged in these surveys with the State highway departments, and as each survey has matured the worth while results have been more apparent. As a future policy the Bureau stands ready to cooperate with the States to the limit of its support funds and available personnel, believing as we do that not only is the progress in administration dependent upon such studies, but that the very existence and strengthening of the State highway departments are largely dependent upon such adequate and comprehensive knowledge of every condition within the State affecting highway development. We have sufficient examples now of States that are utilizing such surveys that their virtue has passed far beyond the theoretical or debatable stage.

The Department of Public Works of California will submit to the legislature this winter a ten-year budget, the value of which can not be over-estimated as typifying that efficiency of administration which is now demanded of the State highway departments. When these long-time budgets shall be established in all the States we will be able to face attacks upon the

funds or upon the layout of the highway systems with much greater composure and greater assurance of holding to a long-time program, which means certain progress in building adequate roads for the nation.

In such a program lies no denial of the rights of the public to greater highway service, but rather assurance that through such a plan the public will secure that greatly desired extension of service.