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HIGHWAY POLICIES

A paper delivered by Mr. Thos. H. MacDonald,
Chief of the Bureau of Public Roads,
before the
Thirteenth Annual Meeting of the American Association
of State Highway Officials, held at Denver, Colo.,
from
October 3 to 6, 1927.

The highway situation is constantly changing in detail and in its broad trends. As the opportunity has come each year to me to address this conferenoe of the American Association of State Highway Officials, it has been approached with the thought of placing before the highway executives of the nation a definite, forward looking, but not radical expression, upon some of the matters which appear at the moment to be of major importance both for the present, and for the future, which, notwithstanding changing conditions, will be so materially influenced by what we do now. Even more it has been approached with the hope of correctly interpreting the Bureau of Public Roads to you that the present cordial relationships may be guarded against misunderstandings. Perhaps this is too meagerly phrased to indicate the full significance to highway progress of harmonious and concentrated effort by the State and Federal highway forces. Highways are characterized by, and inseparable from, their community interests. Whether considered from the State, national, international or local viewpoint, whether from that of the road builder or the road user, the common interests must first be served, since, together, they are the most important. To me, this "community of interests" aspect of highways contains a constantly growing appeal as not only their direct, but even more, their indirect, influences become more and more apparent. Through these influences we enjoy the real opportunity to lift the dead level of the day's work toward the higher objective of progress in government and thus contribute, each one as he is able, to the common good. This general thought may be more clearly expressed by reference to more specific matters.

THE PROPOSED 1930 INTERNATIONAL CONFERENCE.

This year there has been a notable increase of officials and students from foreign countries to study and to examine critically our highways and highway policies. They are not the first to come for like purposes from other lands. Prior years have brought

INDIVIDUALS, BUT NOT UNTIL THE LAST YEAR OR TWO HAVE WE BEEN ABLE TO VISUALIZE BY THEIR NUMBER, THEIR FAR DISTANT JOURNEYINGS AND THEIR INTIMATE DESCRIPTIONS OF HOME CONDITIONS, THAT THIS PROBLEM OF HIGHWAYS AND HIGHWAY TRANSPORT, WITH WHICH WE ARE CONFRONTED, IS AN ACUTE WORLD PROBLEM AND THAT THE UNITED STATES HAS BECOME THE PROPONENT OF METHODS AND POLICIES OF NEW CONCEPT AND, MORE IMPORTANT, A LEADER IN THEIR EFFECTIVE USE. WITHIN THE TWELVE-MONTH PERIOD, GOVERNMENTAL OFFICIALS, ENGINEERS, BUSINESSMEN AND STUDENTS FROM CHINA, JAPAN, AUSTRALIA, INDIA, MEXICO, NORWAY, SWEDEN, CHILE, ARGENTINE, BRAZIL, COLOMBIA, ECUADOR, VENEZUELA, BOLIVIA AND PERU HAVE SPENT FROM A FEW DAYS TO AN EXTENDED PERIOD INSPECTING AND GATHERING DATA FOR THE DIRECT PURPOSE OF TRANSPLANTING TO THEIR OWN COUNTRIES SUCH OF OUR HIGHWAY EXPERIENCES AS THEY FIND APPLICABLE. THE WIDE VARIATIONS TO BE FOUND HERE IN CLIMATE, TOPOGRAPHY, TRAFFIC, POPULATION DENSITY, SOILS AND MATERIALS OFFER SOMEWHERE CONDITIONS CLOSELY PARALLEL AND PROBLEMS QUITE TYPICAL OF THEIR OWN COUNTRIES. SOME HAVE BEEN CHIEFLY INTERESTED IN TECHNICAL DETAIL. OTHERS HAVE SOUGHT GOVERNMENTAL AND ADMINISTRATIVE POLICIES. WHETHER THE ONE OR THE OTHER, THERE HAS BEEN UNANIMITY OF AGREEMENT IN THEIR EXPRESSED APPRECIATION OF THE COURTESIES AND INFORMATION FURNISHED BY THE STATE AND FEDERAL HIGHWAY OFFICIALS.

THIS OUTSIDE VIEWPOINT OF WHAT THE UNITED STATES IS DOING WITH HER HIGHWAYS AND HIGHWAY TRANSPORT FOUND A MOST ENCOURAGING AND COMPLIMENTARY EXPRESSION IN JUNE OF THIS YEAR WHEN THE EXECUTIVE COMMITTEE OF THE INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES VOTED TO HOLD, IN 1930, THE NEXT INTERNATIONAL ASSEMBLY IN THIS COUNTRY IF AN OFFICIAL INVITATION IS FORTHCOMING. SUCH AN INVITATION CAN ONLY BE ISSUED BY THE UNITED STATES CONGRESS. THIS OPPORTUNITY TO BRING TOGETHER IN THE UNITED STATES THE FOREMOST HIGHWAY OFFICIALS AND BEST QUALIFIED ENGINEERS OF ALL THE NATIONS OF THE WORLD WILL NOT COME AGAIN FOR MANY YEARS. THE FAR-REACHING NATIONAL AND INTERNATIONAL INFLUENCES OF, AND THROUGH, SUCH AN EVENT ARE NOT EASILY EXAGGERATED AND MUST NOT BE LOST TO US. THIS ASSOCIATION OF STATE HIGHWAY OFFICIALS WOULD BE A RANKING HOST TO THESE WORLD REPRESENTATIVE GUESTS.

THIS COUNTRY DOES HAVE MUCH THAT MAY BE OF THE GREATEST VALUE TO OTHER NATIONS IN THE DEVELOPMENT OF HIGHWAY TRANSPORT WITH ITS MANY, AS YET, NEW PROBLEMS. A VERY WRONG IMPRESSION EXISTS THAT IN THE UNITED STATES, HIGHWAYS ARE NOT ADVANCED TO STANDARDS OF SERVICE COMMENSURATE WITH THOSE OF OTHER COUNTRIES.

Statistics are not comparable. Perhaps the real picture may be visioned, but not well, by sketching in a detail or two.

The largest concentration of population abroad is in the London metropolitan area. When the right of way was secured about 1920 for the new radial trunk roads, the cost of good agricultural land within six or seven miles of the very heart of the city was less than the acre price of farm land in the Mississippi Valley well away from even a large town. Compare this fact with the per acre price of suburban acreage in any metropolitan district in this country to realize only a little of the more extended use here of highway transport in just this one field. Or read what Col. Bressey, Chief Engineer of the Ministry of Transport has written, 1923, of highway conditions as they have existed and to a large extent still exist in the London district in which there is such very heavy highway traffic.

In some other country then? Ing. Puricelli, of Milan, built the Autostrade, the highway exclusively for motor traffic, from Milan to the Italian lakes, in all a length of about fifty miles. The design incorporates the best of modern standards. Its actual accomplishment is an even greater achievement. His authority and experience in this field are unquestioned. What is his testimony as to the adequacy of the roads of Italy - these highways whose forebears were the Roman roads of antiquity? He and his associates, in cooperation with the Ministry of Public Works and the Italian Touring Club, have undertaken to prepare a comprehensive scheme for the general overhaul of the first class roads of the country. His preliminary estimates based on as yet incomplete data indicate a needed expenditure of roughly 14,000,000 dollars for about 13,000 miles to bring these main roads to a condition adequate for the traffic. In the area of the heaviest traffic, his estimate of unit costs ranges from about 12,800 to 23,000 dollars per mile. The number of passenger cars and motorcycles registered in 1926 is 197,970. To the highway group these facts need no interpretation. They illuminate Italy's road problem as well as their condition.

HIGHWAY POLICIES DEVELOPED IN THE UNITED STATES

Surely this nation does have much of valuable experience in highway matters to share with other countries and we should. As a nation we have profited much from the experiences of the older nations. How much of our present cultural, social, religious, educational fabric has been woven from threads spun out of the experiences, sacrifices and advancements of those who as individuals or as nations built painstakingly and slowly through the centuries the enduring and worthwhile concepts we call civilization. Language, religion, architecture, art, music, literature, medicine, laws, where in the whole list can we find one in which we have in the past surpassed all others in the elements we believe to be enduring. But the United States has madeher great contributions to civilization. In form of government? In the political field, yes. We believe and hope it is so. But the time element is to be considered. Other forms of government are older. Our nation is yet young. At least the point is debatable by those who demand more centuries of successful demonstration.

In what field, then? The only one which will be easily conceded is that of engineering achievement. Not engineering in fine detail. Other countries produce fine engineers, highly trained. The measure of the achievement is not that of the personal equation. Rather it is the engineering achievement of organization and mass production. Availability is made possible by the combination of cheap transportation, mechanical power and equipment, and great engineering vision of consumption. This is the great contribution the United States has made to civilization, measured by standards of living.

This general idea is both proved and illustrated by the services of transportation, of communication and of sanitation. Each has large and intricate requirements of far-spread planning and operating organizations, of financial support, of research of constantly changing devices and improved processes. Yet with all these and many others, these typical services upon which depend in so large a degree the every-day-living standards of our people, are made available throughout the nation and for a relatively low cost to the individual.

What is commonplace and possible of enjoyment to those with very moderate incomes here are frequently luxuries or impossible to secure elsewhere. So, by this reasoning, we reach some fundamental conceptions:

> First, there is no nation today which has highways adequate to its present, much less its future rapidly developing highway transport needs,
>
> Second, that the same principles of engineering organization and quantity production which have been so successfully demonstrated in the United States must be applied universally to produce adequate mileages of serviceable highways at the lowest cost,
>
> Third, that the most important progress has been made in processes and methods which have made possible increased production.

For example, consider the stage construction policy. In highway building the time element is important in the first stages of improvement, where, as in many States, there has necessarily been much relocation and realignment. Delays are inevitable with loss of time and there has been frequent criticism of the progress made toward an adequate major-highway system in those States which have shown a large percentage of first-stage construction only. Yet the real progress has probably been as great as in those States where less attention was given to the fundamentals of location, drainage structures and grading. As funds are now becoming available in larger amounts in a number of these States, their progress in surfacing will be rapid. It is true that the service for the past several years has not been first class by any means, but the policy of laying the foundation when funds for the completed improvement were not available, has justified itself a thousand-fold.

There are other outstanding examples of this principle of quantity production at the lowest consistent cost. State highway maintenance, the use of power equipment for grading, the use of mechanical equipment throughout for building concrete roads, the fine crushed rock surfaces of the West, the bituminous processing of these and the reclaiming of the old macadams of the East, are all of this order. Measured by the

important standards of the time gained in making the roads available, their cost and the quality of their service, it is evident that these newer principles of administration define the only possible approach to a meeting of the demand for highway service not only at home but abroad as well. So in the development of sound principles of engineering and financial administration this country has much to contribute and should place greater emphasis on their future development, making engineering detail and technique the servant, and not the master of these principles. If it becomes the good fortune of this nation to have as its guests in 1930, the leading engineers and officials of all the other countries of the world, we, speaking particularly for the State and Federal administrative officials, must be in a position to justify the principles of administration upon which we are relying, by the results produced. A sacrifice of sound technique or quality of product is not a necessary companion of quantity production. This it will be possible to demonstrate through a critical examination of the results and a generous cooperation to remedy defects.

PROGRESS IN FEDERAL-AID HIGHWAY CONSTRUCTION.

For the fiscal year ending June 30 under the Federal-aid program, 9,683 miles of projects were completed. Eight thousand, three hundred and seven miles were new construction, and 1,376 miles additional construction of projects on which preliminary work had already been done, that is, that were additional stages of construction. While 2,537 miles of graded and drained roads were built as original construction during the year, the mileage in this stage increased by only 1,145 miles. This was the result of the further improvement of previously graded roads as stage construction. This is a decided advance which indicates the turning toward the more adequate improvement.

Three thousand, two hundred and ninety-nine miles of gravel were built, a decrease of 862 miles below the previous year, and 2,971 miles of pavements of bituminous and cement concrete, a decrease of 518 miles below the preceding year.

In these figures the evidence is clear that the Federal highway funds accumulated during the war and immediately following have been largely used and we are approaching the annual production that will be possible with the current authorization.

The total of Federal-aid projects completed, under construction, or approved for construction as of July 1, was 76,708 miles, divided as follows:

1.	Stage construction, graded and drained	15,500 miles
2.	Sand clay and gravel	34,474 "
3.	Waterbound macadam	1,431 "
4.	Bituminous macadam	4,307 "
5.	Cement concrete	18,009 "
6.	Brick	832 "
7.	Bituminous concrete and asphalt	1,923 "
8.	Bridges	232 "

STAGE CONSTRUCTION.

There has been in the minds of many, chiefly those not directly connected with highway improvement, the question as to the use of Federal funds for the lower types of construction, particularly the first stage of graded and drained earth roads. This year we have the answer to these critics. A material advance has been made in the application of the surfacing or second stage of improvement to a considerable mileage, and this will continue at an accelerated rate. The policy is one of the most valuable tenets of administration that can be recommended to other countries in the early stages of their highway development.

As a matter of fact, to a large extent all highway construction must be stage construction, and there can be no just criticism of whatever is undertaken if it be undertaken intelligently with a well defined conception of the future development and if the execution of the idea is efficient.

NATIONAL HIGHWAYS AND METROPOLITAN AREA ROADS.

As little as five years ago it was thought that the national highway problem lay in the necessity for the building of transcontinental routes. Our knowledge of traffic flow and highway utilization has changed materially in that time, and today transcontinental traffic is far better provided for than is the weekly peak traffic, particularly in metropolitan areas. This is not boasting about transcontinental routes. A great deal remains to be done, and now that we have agreed upon a system of interstate routes we need to demonstrate that the principle of cooperation between the States and the nation when assisted by Federal-aid funds, can expedite the improvement up to an adequate utility standard of each major national traffic route from east to west and from north to south. Weak links in the east-to-west transcontinental highways lie largely between the 90th and 117th meridians or, roughly, between the Mississippi River and the eastern boundaries of California, Oregon and Washington. North to south there is a potential traffic between the Great Lakes and the Gulf Coast which is now held back by weak links on the U. S. system, largely south of the Ohio River.

Transcontinental traffic has been thought about from the earliest days in terms of east-to-west traffic. There is a potential north-to-south traffic that will develop quickly into now unguessed dimensions following the completion of adequate routes. Why not agree between ourselves upon a policy of using at least 50 per cent of the Federal-aid allotments in the closing up of the gaps in these main thoroughfares, and realize within the next two or three years a consummation of the representations that have been continually made by both the Bureau of Public Roads and the States that it is possible under the present plan to secure an adequate national system of highways more quickly than in any other way.

As highway officials we do not want to confess at the close of another year that we do not have as yet a completely improved highway route across the country. By a recognition on the part of only a few States that they do have an obligation to their sister States and to the national plan of highways, such confession will not be necessary. Political differences ought to be adjusted in a few States so the highway situation would not be in continual jeopardy from improper administration. How each State administers its own funds and

internal affairs is very much its own affair, but how any State administers the Federal highway funds is quite a different matter. The Bureau is now prepared, failing to obtain cooperation for the completion of these important thoroughfares, to insist upon a recognition of the requirements of the law which provides for expediting the completion of these routes. The Attorney General of the United States has ruled with special reference to the reconstruction of the interstate bridge at Memphis that in order to expedite the completion of interstate routes, the Secretary of Agriculture has full authority to withhold his approval of other projects.

In connection with the interpretation and enforcement of the Federal highway legislation, the thought is continually before the Bureau of the community of interests between the States which are tied together by their highways. Thus, in insisting upon the completion of gaps, the Bureau is endeavoring to bring about in full measure a compliance with the community interests. It requires no boldness to assert that a twisted perspective of States' rights exists. The rights in this instance are all with the States which have met the needs of the public service and all against the tardy and reluctant States. There can be no rights which are wrongs to the majority of the whole community.

The greatest problem in the highway field is the number and character of the roads required in the metropolitan areas. Both the States and the Federal Bureau are less able to contribute in a major way to the solution of this problem than elsewhere. Here the routes of the State system, or the Federal highway system, constitute the main traffic arteries, but within a 50-mile radius there are many other routes which may for local traffic be almost of equal importance.

What may be called the city gateway problem, falls upon the shoulders partly of the State, but largely upon the counties and smaller subdivisions. It is a problem largely resulting from multiple and interfering jurisdictions. Highway traffic in quantity has very similar characteristics to the flow of liquids. It has been possible in the laboratory to determine the laws governing the flow of liquids. The great decrease in the flow of liquids caused by obstructions or abrupt change of direction is known and determinable by mathematical computation. We will determine these rules for highway traffic, even though it is a long and tedious process. But the technical knowledge of what to do is far in advance

of the probability of its being done, due to the multiplicity of conflicting and overlapping jurisdictions. In Cook County, in the Chicago metropolitan area, the transport survey quickly developed the fact that within a radius of 30 miles there were 89 civil jurisdictions controlling sections of the traffic routes and, with the exception of the State and county, these different units were largely working independently or not at all. As the survey proceeded, it became apparent that the greatest obstruction to traffic existed in this multiplication of overlapping jurisdictions.

There are two methods that may be used for handling the highway problem in these metropolitan areas: first, the plan of securing legislation which sets up a board with super authority over all established authorities; and second, the plan of securing voluntary cooperation between the existing authorities. It is not possible to discuss the relative merits and demerits of these two methods, since up to the present time neither plan has been in operation long enough to determine whether it will succeed or fail. It is certain, however, that the first plan will always meet with hostility which may become so vigorous as to delay action for a long period. The second plan contains the valuable element of being at once available and, at worst, it can only partially fail to succeed.

It is my judgment that the plan of cooperation can be made to work. On the request of the Board of County Commissioners of Cuyahoga County, Ohio, the Bureau has undertaken in cooperation with that Board, a survey in the metropolitan area of Cleveland to include a radius of upwards of 50 miles - a similar study to that in Cook County. However, in this instance, before agreeing to participate in the survey which has for its purpose the formation of a plan of highways for the whole metropolitan district, all of the communities interested were invited to attend a conference at which the purposes were explained and a request made that the various jurisdictions join to formulate a plan and to carry into effect their parts of the plan when it was made. So, before the survey started, all of the jurisdictions, whether city, county or township, had signed a definite agreement to make the plan to be agreed upon, effective. Not much faith is necessary to believe that this document will become a historical one, because the agreement on the part of the various governing bodies within the metropolitan areas, first, to plan, and second, to build according to plan,

WILL PROBABLY BECOME THE MOST EFFECTIVE METHOD OF HANDLING THE HIGHWAY PROBLEM IN THE METROPOLITAN AREAS. IT MAY MEAN, OF COURSE, THE TRANSFER OF JURISDICTION OR THE BROADENING OR RELINQUISHING OF JURISDICTION, IN ORDER TO ACCOMPLISH THE PURPOSE. WHEN IT COMES TO THE FINANCING, UNDOUBTEDLY RELIEF MUST COME TO THE SMALLER UNITS FROM THE LARGER ONES. THE PLAN OF FINANCE IS EQUALLY IMPORTANT WITH THE PHYSICAL PLAN. THE BIG POINT IS THAT THE OFFICIALS POSSESSING THE LEGAL AUTHORITY TO ACT HAVE AGREED TO WORK TOGETHER. IN SIMILAR MOVEMENTS, THE STATE AND PERHAPS, TO A CERTAIN EXTENT, THE FEDERAL BUREAU OF ROADS, CAN BE OF CONSIDERABLE HELP AND THIS IS A PART OF THE RESPONSIBILITY WHICH THEY MUST UNDERTAKE.

BALANCING HIGHWAY BUDGETS WITH HIGHWAY NEEDS.

IT HAS BECOME MORE AND MORE APPARENT, PARTICULARLY AS THE DISCUSSION OF ANNUAL BUDGETS HAS BECOME COMMON, THAT THERE ARE TWO KINDS OF BUDGETING; THE BUDGET THAT IS PREPARED WITH REFERENCE TO THE EXPECTED INCOME, AND THE BUDGET THAT IS PREPARED WITH REFERENCE TO THE PHYSICAL CONDITION AND NECESSITIES OF THE HIGHWAYS. THEY MIGHT BE TERMED, THE FISCAL BUDGET AND THE PHYSICAL BUDGET. THE FIRST TYPE OF BUDGET IS OPEN TO A GREAT DEAL OF MISMANAGEMENT NO MATTER HOW CORRECT THE FISCAL INFORMATION. THE SECOND TYPE OF BUDGET IS THE ONLY PLAN THAT EVENTUALLY WILL WORK FOR ECONOMY. IT IS APPARENT THAT A GREAT MANY STATE HIGHWAY DEPARTMENTS DO NOT HAVE THE INFORMATION IN SUFFICIENTLY ACCURATE FORM, RELATIVE TO THE PHYSICAL CONDITION AND NECESSITIES OF THE HIGHWAYS, TO PREPARE THE KIND OF A BUDGET THAT WILL EVENTUALLY LEAD TO A SYSTEM OF ROADS UNIFORM WITH THE NECESSITIES OF TRAFFIC. THIS LACK OF INFORMATION IS EVIDENT IN BUDGETS IMPROPERLY BALANCED BETWEEN RECONSTRUCTION AND NEW CONSTRUCTION ON EXTENSIONS. IT WILL ALWAYS BE A TEMPTATION TO ADD TO THE MILEAGE OF STATE ROUTES. DURING THE YEAR 1926, 13,000 MILES OF ROAD WERE ADDED TO THE STATE SYSTEMS, AND IT IS THIS TENDENCY THAT DEFINITELY POINTED OUT TO THE BUREAU THE NECESSITY FOR REQUESTING THAT THE FIRST STAGE-CONSTRUCTION PROJECTS BE LIFTED TO A HIGHER DEGREE OF IMPROVEMENT AT A RATE TO WIPE OUT THE ROADS OF THIS CLASS WITHIN A VERY FEW YEARS. THE POLICY OF APPROVING STAGE-CONSTRUCTION PROJECTS WILL BE LIMITED IN THE FUTURE TO A DEFINITE PERIOD, AND MORE FOR THE PURPOSE OF HANDLING THE FIRST STAGE OF CONSTRUCTION EFFICIENTLY THAN FOR THE PURPOSE OF DEFERRING THE GREATER EXPENDITURE NECESSARY TO PROVIDE A UTILITY SURFACE.

MOTOR TRUCK AND BUS REGULATION.

One of the most peculiar and unintelligent reactions to a progressive policy of weight regulation was manifest in the consideration accorded legislation proposed last year to permit the use of 6-wheel trucks. Only two States adopted legislation providing for such use, and it was definitely turned down in other States, in one or two cases on the recommendation of the highway officials. All of the available information indicates that the way to approach the handling of the heavier loads on the highways is by multiplying the wheels and limiting the concentration of load per wheel. This principle will undoubtedly be accepted eventually, but it is a principle that should find vigorous support from the highway officials where so far it has failed to receive justifiable support. The question of what wheel concentration should be permitted is, of course, debatable, but there is no room for questioning the principle of increase of wheels and decrease of wheel concentration. By this is meant, not so much the matter of wheel concentration legally permitted, as the actual concentration which exists. Whether national legislation to regulate the motor bus and truck will be seriously urged before the next session of Congress is not now indicated. Both of these services have very quickly found their respective fields of usefulness because they have been left largely free from artificial restriction. This has resulted in a more complete operation of economic regulation which is the to-be-desired status. It now seems well proven that the physical regulation is certainly a function of the States which must maintain the highways, and the intrastate service, to the extent legislative regulation is necessary to protect the public, is likewise a State function. This leaves only the interstate service of common carriers for possible national legislation. But this interstate service is in fact so small a part of the whole and so intimately connected with intrastate operation that it seems most desirable to permit this also to be administered by the States, with uniformity assured. The constitutional method to accomplish this is believed to be available.

HIGHWAY SAFETY.

The problem of highway safety is one that can only be met by cooperation. There is much over-working of the word, and a greater disregard of its meaning. The lack of correlation between the traffic officers and those responsible for street and highway improvements, particularly within the city areas is distressing in the extent to which it exists. Also

THE GROWTH IN THE INSTALLATION OF AUTOMATIC STOP LIGHTS IS A TRIBUTE TO SALESMANSHIP RATHER THAN TO ENGINEERING INTELLIGENCE. THERE ARE LIMITED AREAS IN CITIES WHERE TRAFFIC IS EQUAL AND CONSTANT, WHERE THERE IS A LARGE AMOUNT OF PEDESTRIAN AS WELL AS VEHICULAR TRAFFIC, AND WHERE THE STOP-AND-GO CONTROL IS NECESSARY AND, SO FAR, THE ONLY DEVELOPED MEANS OF MEETING THE SITUATION. IT IS CERTAIN THAT A LARGE AMOUNT OF FUNDAMENTAL RESEARCH AND INVESTIGATION, AND PROBABLY TRIAL PLANS, MUST BE UNDERTAKEN IN ORDER TO PREVENT THE LOSS OF PERHAPS THE MOST VALUABLE ELEMENT WHICH THE MOTOR VEHICLE HAS BROUGHT; THAT IS, THE SAVING OF TIME TO THE INDIVIDUAL.

ENGINEERING PERSONNEL

THE DEMAND UPON THE HIGHWAY FIELD FOR ENGINEERS WHO HAVE HAD TRAINING AND EXPERIENCE CONTINUES TO POINT TO THE NECESSITY FOR THE SPECIAL TRAINING OF YOUNG ENGINEERS WHO HAVE ATTENDED THE TECHNICAL SCHOOLS. IT IS ALSO EVIDENT THAT THE UNITED STATES IS TO BECOME THE MECCA OF A GREAT MANY FOREIGN STUDENTS SEEKING EXPERIENCE AND KNOWLEDGE IN THIS FIELD. RECENT COMMUNICATIONS IN WHICH THE POSSIBILITY OF THE USE OF A FEW FOREIGN STUDENTS WAS BROUGHT TO THE ATTENTION OF THE STATE HIGHWAY DEPARTMENTS HAVE ELICITED A WONDERFUL RESPONSE. IT WOULD AFFORD ME GREAT PLEASURE TO READ BEFORE THIS ASSOCIATION THE REPLIES RECEIVED FROM THE STATE HIGHWAY DEPARTMENTS UPON THIS SUBJECT. IT IS MY OPINION, BASED ON OBSERVATION IN MANY FOREIGN LANDS, THAT THROUGH THE INTERCHANGE OF OPINIONS AND EXPERIENCE AND THE PERSONAL CONTACTS BETWEEN THOSE CONNECTED WITH THE HIGHWAYS IN THIS COUNTRY AND THOSE IN OTHER LANDS, THAT A SOUND COMMUNITY OF INTEREST CAN BE BUILT THAT WILL HELP INTERPRET THE UNITED STATES TO OTHERS AND HELP US TO UNDERSTAND THEM. A FEW DAYS AGO, ONE OF THE FOREIGN ATTACHES OF THE DEPARTMENT OF COMMERCE MADE THE AMAZING STATEMENT IN MY OFFICE, THAT DUE TO THE CONDITIONS OF TRANSPORTATION IN TURKEY IT WAS ACTUALLY POSSIBLE TO LAY DOWN FLOUR MILLED IN THE UNITED STATES, FROM WHEAT GROWN IN MINNESOTA AND OUR NORTHWEST, AT SAMSUN ON THE BLACK SEA, 6000 OR 7000 MILES AWAY, AT A LESS COST THAN FLOUR MILLED FROM WHEAT GROWN IN THE INTERIOR OF TURKEY, PERHAPS 250 MILES AWAY. COUNTRIES WHICH HAVE LONG GONE WITHOUT ANYTHING LIKE ADEQUATE TRANSPORTATION BECAUSE OF THEIR INABILITY TO FINANCE RAILROAD CONSTRUCTION, CAN FIND IN MOTOR TRANSPORTATION EITHER THE FINAL SOLUTION OF THEIR TRANSPORTATION PROBLEM OR A DEFINITE STEP TOWARD THE POSSIBLE COMBINATION OF

HIGHWAY AND RAILWAY TRANSPORT THAT WILL ADEQUATELY SERVE THEIR NEEDS. THE EXPRESSION OF THE INTEREST OF THE HIGHWAY DEPARTMENTS IS ONE OF THE MOST CONVINCING EVIDENCES THAT I HAVE RECEIVED OF THE BROADMINDED OUTLOOK AND PUBLIC SPIRIT OF THE MEN WHO ARE AT THE HEAD OF THE HIGHWAY WORK THROUGHOUT THE UNITED STATES. THERE IS A SINCERE FEELING OF APPRECIATION THROUGHOUT THE VARIOUS FEDERAL AGENCIES, SUCH AS THE DEPARTMENT OF STATE, THE DEPARTMENT OF COMMERCE, THE PAN AMERICAN UNION AND THE DEPARTMENT OF AGRICULTURE, FOR THE COURTESIES, HELPFULNESS AND ATTENTION THAT HAVE BEEN EXTENDED TO THOSE FROM OTHER COUNTRIES SO GENEROUSLY BY THE STATE HIGHWAY DEPARTMENTS WHENEVER THEY HAVE HAD THE OPPORTUNITY. THE FACT THAT THERE WILL APPARENTLY BE CONSTANT DEMANDS IN THE FUTURE, AND UNDOUBTEDLY GROWING DEMANDS OF THE SAME CHARACTER, LEADS ME TO EXPRESS THE HOPE THAT WHEN SUCH REQUESTS ARE MADE THEY WILL BE MET IN THE SAME SPIRIT AS IN THE PAST. THEY ARE ONLY MADE BY THIS BUREAU, AND ANY OTHER AGENCY OF THE GOVERNMENT, IN THE BELIEF THAT, WHENEVER IT IS POSSIBLE TO GIVE THE OPPORTUNITY TO THOSE FROM THE OUTSIDE TO UNDERSTAND AND SEE THE UNITED STATES AND TO OBTAIN INFORMATION OF VALUE, IT IS A REAL ADVANTAGE TO THE UNITED STATES.

HIGHWAY RESEARCH.

THE PROBLEMS OF DESIGN AND CONSTRUCTION ARE PERHAPS BECOMING MORE SIMPLIFIED AND THEIR PROPER HANDLING BETTER UNDERSTOOD BY THE RESEARCH AND INVESTIGATION WHICH GO FORWARD CONSTANTLY. IT IS DOUBTFUL IF THERE IS A SUFFICIENTLY RAPID ASSIMILATION OF THE RESULTS OF RESEARCH IN ACTUAL DESIGN AND CONSTRUCTION. AT LEAST IT SEEMS WORTHWHILE TO CALL TO THE ATTENTION OF THE HIGHWAY OFFICIALS THE DESIRABILITY OF CHANGING OR MODIFYING PRACTICES ALONG THE LINES WHICH APPEAR TO BE SOUND TECHNICALLY AND SUPPORTED BY REAL EVIDENCE. THE PROBLEM OF THE SECONDARY HIGHWAY IS ACUTE AND MUST BE MET IN A GREATER DEGREE THAN NOW. SO THE FIELD AHEAD FOR THIS ORGANIZATION AND ITS MEMBERS IS GROWING LARGER RATHER THAN SMALLER. UNQUESTIONABLY THE STATE HIGHWAY ORGANIZATIONS COULD NOW BE OF THE GREATEST BENEFIT BY EXERCISING AT LEAST GENERAL ADMINISTRATIVE AND ENGINEERING DIRECTION OVER THE MORE IMPORTANT LOCAL ROADS, BUT WE MUST FIND THROUGH RESEARCH AND EXPERIMENT MORE EFFECTIVE METHODS AND PROCESSES THAN HAVE YET BEEN DEVELOPED. IN THE NECESSITY FOR THE IMPROVEMENT OF THE SECONDARY ROADS EXISTS AN ALMOST

LIMITLESS FIELD FOR EXTENDING THE USEFULNESS OF THE STATE HIGHWAY DEPARTMENTS.

IN CLOSING MAY I EXPRESS THE THOUGHT THAT IN MY CONTACTS WITH THE STATE HIGHWAY OFFICIALS I AM CONSTANTLY IMPRESSED WITH THE FINE ATTITUDE TAKEN TOWARD THIS GREAT PUBLIC WORK AND THE MAGNITUDE OF THE YEAR-AFTER-YEAR ACCOMPLISHMENT.

United States Department of Agriculture
Bureau of Public Roads

S.P.R.-F.A.-A-1
M-September 1927 - A-1

STATUS OF CURRENT FEDERAL AID ROAD WORK

FOR THE FISCAL YEAR ENDING JUNE 30, 1928

AS OF SEPTEMBER 30, 1927.

STATES	BALANCE OF FEDERAL AID FUND AVAILABLE FOR NEW PROJECTS	* UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			AMOUNT PAID STATES DURING FISCAL YEAR	COMPLETED AND PAID DURING FISCAL YEAR			AGREEMENTS NOW IN FORCE			P. S. & E. RECOMMENDED FOR APPROVAL BY DISTRICT ENGINEER			STATES
		Federal Aid	Mileage		Federal Aid	Mileage			Federal Aid	Mileage		Federal Aid	Mileage		Federal Aid	Mileage		
			Original	Stage		Original	Stage			Original	Stage		Original	Stage		Original	Stage	
ALABAMA	2,852,514.96	3,369,691.51	409.8	1.9	19,644.62	0.2		339,248.45	40,723.98	0.2		3,158,447.69	391.9	1.9	219,888.44	18.1		ALABAMA
ARIZONA	2,928,204.24	1,088,686.44	67.8	4.4	17,264.44			163,741.13	192,919.61	14.1		1,088,686.44	67.7	4.4	17,264.44			ARIZONA
ARKANSAS	1,292,591.25	1,880,893.63	223.9		158,899.73	7.3		18,654.41	26,122.64	0.1		1,622,004.09	229.4		417,789.27	1.8		ARKANSAS
CALIFORNIA	3,677,315.86	3,463,363.06	150.1	0.4	18,941.01	0.1		550,642.79	429,604.26	29.8		3,048,811.27	126.9	0.4	433,492.80	23.3		CALIFORNIA
COLORADO	2,677,646.95	3,121,842.16	280.3	9.1	20,057.34	2.9		256,313.64	48,486.64	0.9		2,965,729.13	262.7	9.1	176,170.37	20.5		COLORADO
CONNECTICUT	384,572.62	1,522,693.35	60.6		251,363.49	13.8		78,337.30	203,730.00	13.6		1,553,781.05	63.4		210,181.79	11.0		CONNECTICUT
DELAWARE	7,919.18	188,470.46	16.7	2.1	176,900.72	15.4		120,820.22	120,820.22	14.6		164,633.46	15.7		200,837.72	15.4	2.1	DELAWARE
FLORIDA	844,788.07	3,507,767.54	176.2		269,730.00	18.0		474,783.97	734,206.79	32.7	24.7	3,241,414.63	170.0		636,063.01	24.2		FLORIDA
GEORGIA	339,508.56	3,668,582.92	286.5	89.0	188,028.26	0.1	12.1	747,573.84	1,113,809.87	86.1	38.4	3,190,042.92	260.9	79.4	665,568.25	25.7	21.7	GEORGIA
IDAHO	190,479.77	1,743,761.70	187.9	43.1	397,052.97	36.3	39.7	452,710.33	87,998.40	24.2		1,575,809.90	175.8	23.6	565,004.77	48.4	59.2	IDAHO
ILLINOIS	1,930,460.64	7,016,546.35	605.6		1,268,103.41	86.7	2.3	259,928.20				5,788,455.46	428.4		2,486,193.30	163.9	2.3	ILLINOIS
INDIANA	252,983.14	8,076,101.26	507.8		373,205.37	43.1	0.6	927,173.57	191,269.03	13.3		7,676,318.41	487.6		771,988.22	63.3	0.6	INDIANA
IOWA	11,942.82	6,680,555.96	549.3	235.4	98,386.66	15.2	2.6	1,118,284.39	344,072.82	53.8	3.6	6,575,948.61	554.9	225.8	202,994.00	9.6	12.2	IOWA
KANSAS	250,062.10	6,871,973.63	762.0	14.5	381,057.44	99.1		805,870.49	299,030.45	36.7		5,426,743.29	737.5	8.4	826,287.68	123.6	6.1	KANSAS
KENTUCKY	17,595.37	4,730,589.55	434.1	79.7	170,542.71	16.6	1.5	649,932.09	201,333.62	20.6		4,366,842.34	418.8	57.7	534,289.92	31.9	23.5	KENTUCKY
LOUISIANA	621,789.68	1,523,675.46	95.6	7.5	604,042.54	13.1		266,649.99	442,316.21	37.9		1,470,080.34	95.6	7.5	657,537.66	13.1		LOUISIANA
MAINE	1,027,234.95	918,131.24	64.0		195,499.27	19.9		98,809.68	146,303.87	17.3		954,866.23	67.6		158,764.28	16.3		MAINE
MARYLAND	8,362.09	569,083.64	53.4		457,800.00	61.2		44,919.56				637,485.64	59.1		389,400.00	45.6		MARYLAND
MASSACHUSETTS	1,921,158.22	1,738,239.63	105.7		18,675.00	1.3		93,825.00	93,825.00	6.3		1,510,485.69	90.9		246,428.94	16.1		MASSACHUSETTS
MICHIGAN	911,816.17	6,399,277.08	408.7	12.7	880,175.00	43.2	6.5	1,052,039.63	37,302.76	2.0		5,234,690.85	370.4	12.7	2,044,761.23	81.5	6.5	MICHIGAN
MINNESOTA	501,476.43	2,158,898.90	392.0	116.7	6,000.00	13.6		865,251.18				2,115,898.90	389.7	115.7	49,000.00	15.8		MINNESOTA
MISSISSIPPI	646,268.48	3,098,087.90	360.2	15.0	284,767.62	23.4	11.9	581,076.00	402,479.38	45.3		2,867,124.77	323.9	14.7	515,730.75	59.7	12.2	MISSISSIPPI
MISSOURI	671,696.51	3,840,278.04	274.2	45.0	267,955.91	30.4		647,087.34	730,654.06	57.1	2.5	3,533,301.43	278.9	34.8	574,932.52	25.6	10.2	MISSOURI
MONTANA	4,189,324.15	2,277,574.70	243.5	7.5	1,059,313.87	193.2		468,513.97	152,882.59	25.3	1.6	3,087,543.47	401.9	7.5	259,345.10	34.8		MONTANA
NEBRASKA	649,746.56	6,332,966.99	1,298.5	622.4	490,350.80	58.2	157.9	843,500.42	1,007,922.26	198.8	224.4	6,118,242.61	1,275.3	532.7	705,075.18	91.4	147.5	NEBRASKA
NEVADA	428,027.32	1,671,910.67	193.7	36.6	72,268.56	9.4		186,207.83	82,449.77	27.4		1,480,883.28	193.7	26.2	163,195.95	9.4	10.4	NEVADA
NEW HAMPSHIRE	2,752.08	631,427.86	41.1		77,846.01	6.3		22,226.97	44,163.01	3.7		650,966.37	42.6		58,307.49	4.8		NEW HAMPSHIRE
NEW JERSEY	2.96	1,601,398.56	104.7		28,095.00	1.9		277,170.00	277,170.00	18.5		1,481,323.56	96.7		149,170.00	9.9		NEW JERSEY
NEW MEXICO	1,621,103.88	2,500,113.06	234.7					502,753.90	100,334.00	18.3		2,460,215.15	234.7		39,897.91			NEW MEXICO
NEW YORK	3,632,540 06	10,090,878.95	622.0		1,817,612.50	117.3	8.6	1,382,023.07	545,424.84	37.5		11,333,383.95	704.6		575,107.50	34.7	8.6	NEW YORK
NORTH CAROLINA	715,652.37	1,482,854.57	80.4	26.2	363,253.75	26.3	9.7	445,380.39	349,898.15	28.6		1,356,515.52	75.5	19.1	489,592.80	31.2	16.8	NORTH CAROLINA
NORTH DAKOTA	135,200.56	2,814,778.56	894.5	368.1	516,579.76	210.6	140.0	494,605.36	730,757.44	49.5		2,852,575.38	964.1	410.2	478,782.94	141.0	97.9	NORTH DAKOTA
OHIO	2,748,794.27	4,410,653.90	326.6	4.2	1,761,215.00	84 1		652,960.66	251,965.07	16.9		4,172,938.90	313.2	4.2	1,988,930.00	96.5		OHIO
OKLAHOMA	692,260.63	1,803,363.89	301.9	9.9	818,709.28	86.6	15.2	348,404.72	379,754.99	9.6	17.9	1,605,202.32	269.5	20.7	1,016,870.85	119.1	4.4	OKLAHOMA
OREGON	523,474.31	1,277,261.67	72.8	36.8	126,976.58	6.1		194,731.31	92,383.50	0.2		1,131,836.51	67.3	35.8	252,401.74	11.6		OREGON
PENNSYLVANIA	1,427,152.72	5,695,826.02	370.7	3.0	951,388.84	43.8	3.2	1,067,090.75	282,528.10	22.9		5,795,918.72	361.7		861,296.14	52.8	6.2	PENNSYLVANIA
RHODE ISLAND	425,512.53	480,563.74	31.1		128,638.67	7.6		32,175.00				491,393.74	31.8		117,808.67	6.9		RHODE ISLAND
SOUTH CAROLINA	224,386.22	2,407,723.43	257.5	81.6	9,000.00		2.5	401,657.06	688,413.55	39.3		2,169,585.73	199.6	30.7	247,137.70	58.0	53.4	SOUTH CAROLINA
SOUTH DAKOTA	128,636.31	2,420,862.36	747.6	79.3	272,003.80	68.1	111.8	205,121.13	57,825.99	29.1		2,318,319.96	751.3	119.7	374,546.20	64.3	72.4	SOUTH DAKOTA
TENNESSEE	1,000,942.45	3,243,456.92	217.1	33.7	466,756.41	41.9		474,450.90	632,743.67	24.6	26.6	2,783,880.34	178.4	26.2	926,332.99	80.6	7.5	TENNESSEE
TEXAS	4,249,773.71	6,515,476.66	497.3	213.3	1,216,404.43	100.2	67.6	963,583.54	1,555 087.85	124.6	45.5	5,547,902.64	402.6	197.3	2,183,978.45	194.9	83.5	TEXAS
UTAH	173,364.21	2,005,007.34	186.8	3.4	422,096.66	37.0	11.1	267,244.03	298,136.86	35.9		1,767,940.26	168.4		659,163.73	54.4	14.5	UTAH
VERMONT	980.33	1,243,622.61	70.3					240,614.90	40,673.05	1.3		1,192,527.09	66.1		51,095.52	4.3		VERMONT
VIRGINIA	16,846.98	2,121,948.18	113.1	4.0	150,738.21	9.1		548,940.79	117,551.38	8.2		2,125,832.35	115.9	4.0	146,854.04	3.3		VIRGINIA
WASHINGTON	776,419.73	1,330,600.00	66.5		508,000.00	48.3		143,063.52	415,736.32	5.3		1,375,600.00	73.0		463,000.00	41.8		WASHINGTON
WEST VIRGINIA	26,189.72	2,929,734.05	238.2	12.0	617,475.22	48.8	7.1					2,841,704.96	237.1	12.0	705,504.31	49.9	7.1	WEST VIRGINIA
WISCONSIN	2,264,252.76	4,338,085.18	336.2	39.7	24,000.00	3.5		1,101,406.31	835,073.17	94.4	0.9	4,077,290.18	306.0	39.7	284,795.00	34.7		WISCONSIN
WYOMING	337,230.78	1,753,760.77	190.4	119.1	126,582.59	39.6		295,457.81	143,801.81	24.2		1,665,512.17	210.0	108.5	214,831.19	20.0	10.6	WYOMING
HAWAII	805,975.36	662,362.64	29.7					133,030.98				562,362.64	29.7					HAWAII
TOTALS	50,964,011.90	150,019,212.47	14,136.3	2,275.3	18,539,399.43	1,808.7	611.8	22,285,977.60	14,969,684.96	1,350.7	386.1	142,244,901.14	13,837.4	2,189.6	26,313,710.76	2,107.6	697.5	TOTALS

* Includes projects reported completed (final vouchers not yet paid) totaling - Federal aid $44,022,355.63 - Mileage, Original 4,214.9 - Stage 744.2

SNOW REMOVAL REPORT FOR THE WINTER OF 1926-27

Contributed by H. G. McKelvey of the Division of Construction

Compiled from data collected from the 36 State highway departments within the snow area

Snow-removal work was practiced more effectively and extensively by the State highway departments during the winter of 1926-27 than in any preceding year. As may be seen from Table I the mileage cleared on the State highway systems in the 36 States in the heavy-snowfall area (over 20 inches annually) increased by 50 per cent each year until the winter of 1926-27. At that time the increase dropped to 15 per cent indicating that the departments had extended their operations to practically all the principal roads on the systems and that henceforth the added mileage would be only the normal increase due to the gradual development of traffic. During the coming season the mileage that will be included in the program (estimated at 117,109 miles) is only 10 per cent above the mileage of last winter's program. A further study of Table I shows that during the four-year period beginning with 1922-23 the State highway departments have quadrupled the mileage of their snow-removal operations and the total expenditures during the same interval have increased sixfold. The average cost of snow removal per mile of road has increased 55 per cent as a result of the public demand for more complete clearing, and unobstructed winter travel. The small increase in the average cost per mile for 1926-27 as compared with 1925-26 - $43.50 against $40.38 - probably indicates the approach toward a satisfactory standard of service.

That these conclusions drawn from Table I are correct may be confirmed by an inspection of Table 2. In the winter of 1922-23 there were only 184 truck plows and 221 tractor plows in operation in the entire 36 snow States. In the next three-year period the total truck and tractor plows increased eightfold; the increase during the next year then dropped to 16 per cent. This would indicate that equipment to take care of the large mileage of roads was purchased as rapidly as funds were available until such a time as the main traveled roads of the State systems were brought under effective control by the snow-removal forces. It is interesting to note here that while in 1922-23 the relation between truck and

TABLE 1.- THE INCREASE IN THE SNOW-REMOVAL MILEAGES AND EXPENDITURES IN THE 36 HEAVY-SNOWFALL STATES OVER A FOUR-YEAR PERIOD BEGINNING WITH THE WINTER OF 1922-23.

WINTER	TOTAL ROADS WITH SNOW REMOVED	INCREASE OVER PRECEDING YEAR	TOTAL COST OF SNOW REMOVAL	INCREASE OVER PRECEDING YEAR	AVERAGE COST PER MILE
	MILES	PER CENT		PER CENT	
1922-23	27,096	--	$ 762,159	--	$28.12
1923-24	41,302	52	946,262	24	22.91
1924-25	62,167	50	1,826,813	93	29.39
1925-26	93,006	50	3,757,663	106	40.38
1926-27	106,721	15	4,641,037	24	43.50
1927-28	117,109*	10			

*ESTIMATED

TRACTOR PLOWS WAS IN THE RATIO OF 5:6, THAT FOUR YEARS LATER IN 1925-26 THAT RATIO HAD BEEN REVERSED TO 5:2. THIS IS IN KEEPING WITH THE GENERAL DEMAND FOR FAST-MOVING UNITS, CONTINUOUSLY OPERATED DURING SNOWFALLS, TO KEEP THE ROADS OPEN TO TRAFFIC AT ALL TIMES. THE EXISTING POLICY IS A DECIDED ADVANCE OVER THE ORIGINAL PROCEDURE WHEN IT WAS CONSIDERED NECESSARY ONLY TO BEGIN SNOW REMOVAL AFTER THE STORM HAD PASSED, THEREBY CAUSING A CONSIDERABLE LOSS TO TRANSPORTATION AGENCIES TEMPORARILY BLOCKADED WHILE THE SNOW WAS FALLING.

TABLE 2.- THE INCREASE IN THE AMOUNT OF EQUIPMENT USED IN SNOW-REMOVAL OPERATIONS IN THE 36 HEAVY-SNOWFALL STATES OVER A FOUR-YEAR PERIOD BEGINNING WITH THE WINTER OF 1922-23

WINTER	TRUCK PLOWS	INCREASE OVER PRECEDING YEAR	TRACTOR PLOWS	INCREASE OVER PRECEDING YEAR	TOTAL TRUCK AND TRACTOR PLOWS	INCREASE OVER PRECEDING YEAR	MISCELLANEOUS TRUCKS	MISCELLANEOUS TRACTORS
		PER CENT		PER CENT		PER CENT		
1922-23	184	--	221	--	405	--	--	--
1923-24	1,227	567	287	30	1,514	274	--	--
1924-25	1,456	19	446	55	1,902	26	--	--
1925-26	2,546	75	803	80	3,349	76	3,943	1,348
1926-27	2,827	11	1,069	33	3,896	16	4,365	1,600

SNOW-REMOVAL ORGANIZATIONS HAVE REACHED HIGH STATE OF DEVELOPMENT

THE SNOW-REMOVAL ORGANIZATION OF THE CONNECTICUT STATE HIGHWAY DEPARTMENT IS TYPICAL OF THE HIGHLY-DEVELOPED ORGANIZATIONS WHICH HAVE BEEN PERFECTED IN A NUMBER OF THE STATES DURING THE PAST FEW YEARS. THE SNOW-REMOVAL WORK IN THIS STATE IS CONTROLLED BY ELEVEN DISTRICT SUPERVISORS UNDER A SUPERINTENDENT OF MAINTENANCE. EACH DISTRICT ORGANIZATION IS COMPOSED OF THE NECESSARY FOREMEN, MEN, AND EQUIPMENT. THE HIGHLY EFFICIENT PERSONNEL HAS BEEN INSTRUCTED TO BEGIN SNOW REMOVAL AS SOON AS THE ROADS HAVE BECOME COVERED TO A DEPTH OF TWO INCHES. THIS AMOUNT OF SNOW STARTS THE ORGANIZATION TO WORK AUTOMATICALLY, WITHOUT ANY FURTHER INSTRUCTIONS FROM HEADQUARTERS. THE MEN ASSEMBLE, ACCORDING TO A PREDETERMINED PLAN, AT THE VARIOUS STORAGE SITES OF THE EQUIPMENT; AND IF ANY FAIL TO REPORT FOR DUTY ON TIME, IT MEANS THE LOSS OF THEIR POSITION WITH THE HIGHWAY DEPARTMENT, UNLESS THEY ARE ABLE TO GIVE A REASONABLE EXCUSE FOR THEIR ABSENCE.

The equipment consists of 183 trucks, of various models and makes, scattered over the State at strategic points. These trucks are equipped with straight-blade plows. The State also has 7 V-plows operated by tractors. The straight-blade plows are used for light work and the heavy V-plows for the removal of drifted snow.

The location of each outfit is recorded, with large flat-headed pins on a State map hung on the wall of the headquarters office. On each pin there is a number which indicates the make, power and condition of the truck, and the description of the plow attachment. The equipment allotted to the various districts is intended to be adequate for normal conditions, but it often happens that a heavy snowfall, which exceeds the capacity of the equipment, occurs in one district, while the surrounding regions are affected by little or no snowfall. In this case the personnel of the snow-free districts are directed by the superintendent to proceed to the assistance of the crews in the heavy-snowfall area. This help is not delayed until the overtaxed district is snowed in, but careful watch is maintained by the headquarters office, and the relief units from the surrounding districts are hurried to the scene before the local crews have lost control of the situation. As the various units are moved to their new temporary locations, the pins on the headquarters map are shifted accordingly.

Snow removal, in the States that have been actively engaged in this service on their main highways, requires no further promotion. Open roads for the winter traffic have been sold to the traveling public, and they look upon the cleared highway in the winter as a necessity and expect this service to continue with the same regularity as the maintenance of the surfaces during the remainder of the year. Once begun the size of the program is seldom curtailed from year to year unless it is reduced by open winters in isolated sections. Usually the only question raised is how much can the mileage of cleared roads be increased during the next winter with the available equipment and funds. One of the New England States, of relatively small area, but with a snow-removal program of 1,900 miles reports that in one winter the maintenance office received some 2,000 telephone inquiries as to whether certain roads were open or passable; but that no such calls were received last winter. The traveling public had come to expect the main roads to be open and serviceable and no doubt found them in that desirable condition.

Equipment While Improved Is Essentially the Same as Used During the Previous Winter

With the exception of such progressive improvements in snow plows as might be expected, this type of equipment remains essentially the same as formerly reported. Those engaged in the work appear to be giving their attention chiefly to the motive power employed, in order that wider roads may be opened and maintained with the greatest possible speed. The mold-board snow plow, the lighter and heavier types of V-plows, and the rotary plows, all continue popular; but the engineers in charge of their use have, through careful study and experiments, become able to specify, fairly accurately, the types most suitable for use under various conditions and with different types of motive power. While some localities still hold to opening the roads after the storm is over, the majority of snow fighters attack the snow at the commencement of its fall or shortly thereafter, and continue operations until the storm is past and the road cleared. When the latter method is used and the roads are kept open for constant traffic, mold-board plows or light V-type plows are invariably employed with high-speed trucks for the motive power. The plows used vary in design only in the height and cross section of the mold board, and shape and strength of the V-plow, but there appears to be some difference of opinion regarding the model and power of the trucks to be employed. An engineer in central New York (Onondaga County) with considerable snow to handle, after experimenting with various trucks, has adopted a truck of rather heavy build as best suited for his snow-removal work; while engineers of Michigan, after similar study, believe a lighter and less expensive truck is suitable for all preliminary clearing. The truck used in New York is shown in Figure 1. This view shows the mount equipped with a V-plow and wing widener. Figure 2 shows a similar chassis without the widener, but with a center scraper-blade attachment, and Figure 3 shows the same outfit with a straight-blade plow in place of the V-type.

The truck shown in Figures 2 and 3 is one of the four-wheel-drive type. It is geared for five forward speeds and the motors develop 80 to 100 horse power according to the model. The truck costs about $7,000 f.o.b. factory, exclusive of snow-removal attachments. This type of truck while clearing 974 miles of road in Onondaga County, New York, used 440 gallons of gasoline, 6 quarts of engine oil, and 5 pounds of grease. The engineer of this county considers this truck very efficient for snow-removal work. He states that, with a driver and one extra man, it can do the work of two or three ordinary trucks. He claims that it will clear 10 inches of snow, with a V-plow and wing-widener attachment, at the rate of

Figure 1. - Typical snow-removal equipment employed by Onondaga County, New York.

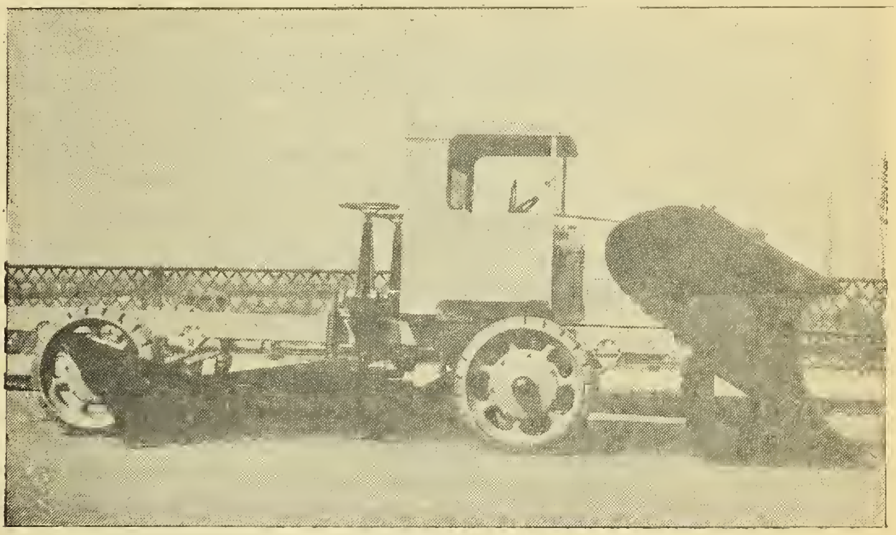


Figure 2. - Chassis of truck, with center scraper-blade attachment, used somewhat extensively in the State of New York.

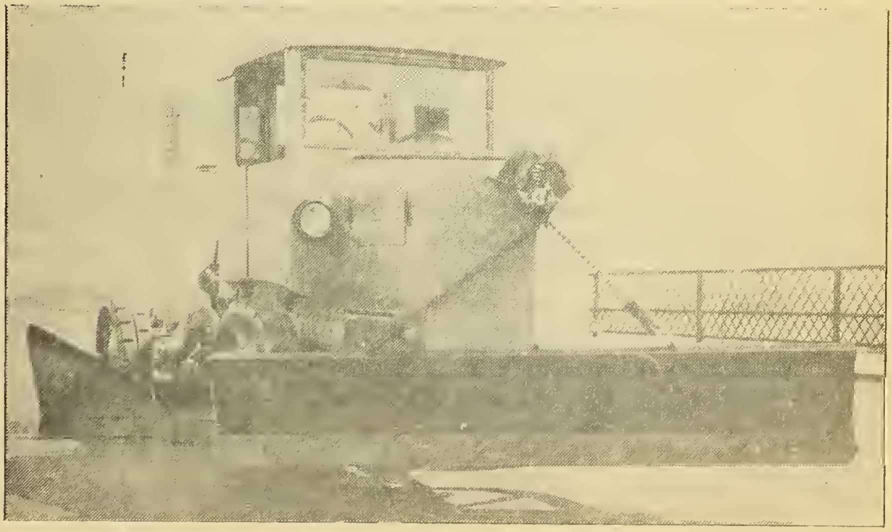


Figure 3. - The same chassis as in Figure 2 with a straight-blade in place of the V-plow.

35 miles per hour, and also that one of the outfits will keep a 35-mile section of highway open, in his locality, provided adequate drift prevention is maintained. When the outfit includes the straight-blade plow and center scraper, it is more efficient for widening a cut than the V-plow because only one-half of the blade of the latter is in use. The front blade employed is usually 10 feet wide by 20 inches high, while the center scraper is 12 feet wide and 18 inches high with side wings 36 inches high. Although this type of truck is particularly efficient for snow-removal work, its cost seems to be rather high for use in the general winter maintenance of rural roads. The outfit might, however, be employed economically for clearing heavy-traffic roads adjacent to large cities.

Figure 4 shows a truck equipped with a lateral-type rotary plow. Heretofore, rotaries generally have been mounted on tractors. While such equipment has been considered suitable for widening and heavy snow-removal work, it was found to be very slow in reaching the field of operation and in traveling between drifts. Such a rotary, suitable as a truck mount, with a truck efficient for such a plow, should be a valuable acquisition to snow-removal equipment. The outfit may be moved to the scene of work at high speed, and between drifts the plow may be lifted from the pavement and the intervening section traveled over rapidly.

The type of truck used extensively in Michigan is similar to the one described but is less expensive; the cost is reported at about $4,000. The engine has six cylinders and develops either 40 or 70 horsepower, in accordance with the model selected. Pneumatic tires are used because they are considered more suitable for snow-removal work by the Michigan engineers. The truck is equipped with a V or straight-blade plow, and often also carries an 8-foot by 10-inch center blade slung beneath its chassis. The center blade is used in summer maintenance for floating gravel.

Wide Cuts to Accommodate Snow from Subsequent Storms now Becoming General Practice

In localities with considerable seasonal snowfall and a general low temperature, which keeps the snow from melting during all or a part of the winter, the chief requirement appears to be to maintain wide cuts, where the topography will permit. While these wide cuts make useful roadways for traffic, their principal purpose, after a certain width adequate for traffic is cleared, is to provide room for the snow of future storms. Whichever model of truck is

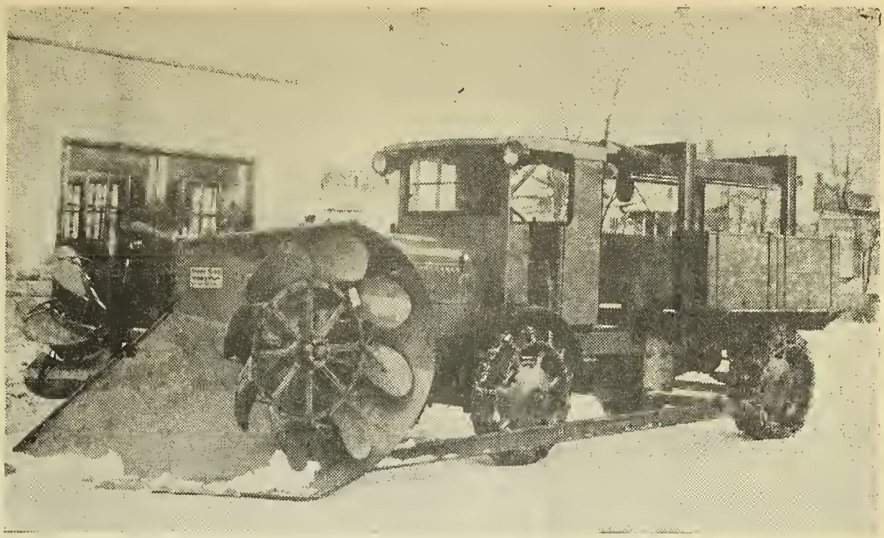


Figure 4. - A rotary plow, of the lateral type, suitable as a truck mount.

Figure 5. - An open road, in the State of Michigan, where the cleared way has been widened with truck-plow attachment.

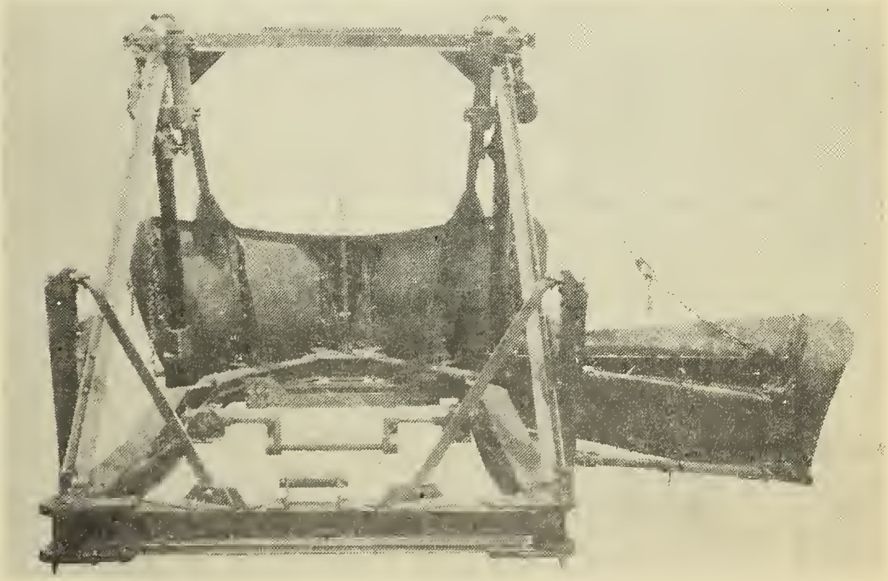


Figure 6. - Rear view of a V-shaped plow, with adjustable wing attachment suitable for bank leveling.

employed for the preliminary clearing, the cut must be widened as the season advances to make further displacement work possible. This widening work is done by numerous types of plows and motor equipment. During the early part of the season the widening is done over drift-protected sections by the straight-blade or V-plow mounted on trucks. After the roadway has been cleared for traffic, the trucks continue operations and push back the snow as far as is considered necessary. This is done as the season advances, as long as it is possible to do so, with trucks and light plows, without the aid of heavier plows and tractors. For economic work the tractor equipment is not brought into action until the trucks are no longer adequate. As soon as the tractor becomes absolutely necessary for widening operations, the cost of the work begins to run into money. As mentioned above, the travel of the tractor to the site of the work and between drifts is slow. It is also best to keep tractors off flexible pavements as much as possible. The flanges of the tractor indent the surface. These indentations will iron out of bituminous pavements during the warmer weather, but in the meantime they provide a means for water to enter the surface, with a possibility of injury. Consequently, the widening operations should be carried on by trucks, as the motive power, to the utmost limit of their capacity. However, in localities with low temperatures, and where the snow of successive storms remains throughout the winter, the wide cuts must be provided, in any event, for convenience of the work and economy in the cost of operation. Comparisons show that it is more costly to maintain a narrow path during severe winters than a wide one. In removing the snow of a succeeding storm from a narrow cut, the work must be done with tractor equipment, whereas the snow from a similar storm falling over a wide cleared path can be handled with trucks and light plows. Figure 5 shows a roadway widened with truck-plow equipment. As may be observed, the path was made as wide as the poles and trees would permit.

The widening of cuts to accommodate the snow of succeeding storms has now become a well established practice. Of course this is nothing really new, but the engineers in charge have begun to realize its importance. After the truck plow is no longer adequate, the widening of preliminary cuts through deep snow is accomplished with heavy displacement plows and rotaries of one type or another, both classes of plow being employed with tractors. The displacement plow is very serviceable for this work, but as it rolls the loosened snow to the top of the adjacent bank, it occasionally builds up a wedge-shaped formation which acts as a wind break and causes drifts in the traveled way. This is prevented, in some instances, by an

ADJUSTABLE WING ATTACHMENT IN CONNECTION WITH THE PLOW. THE WING IS ATTACHED TO A POST ON THE RIGHT HAND SIDE OF THE FRAME, IN SUCH A MANNER THAT IT CAN BE RAISED OR LOWERED TO A LEVEL WITH THE HEIGHT OF THE ADJACENT BANK, WITH THE CUTTING EDGE PARALLEL TO THE HORIZONTAL PLANE, AND THE WING SET AT ABOUT AN ANGLE OF 45 DEGREES TO THE AXIS OF THE CUT. THE WING IN THIS POSITION LEVELS THE TOP OF THE SNOW BANK SO THAT IT WILL NOT ACT AS A WIND BREAK. FIGURE 6 IS A REAR VIEW OF A DISPLACEMENT PLOW WITH WING ATTACHMENT SUITABLE FOR BANK LEVELING. IN THIS PICTURE THE PLOW IS DETACHED FROM ITS MOUNT, WITH THE ADJUSTABLE WING RAISED AT A SLIGHT ANGLE WITH THE HORIZONTAL PLANE.

WITH THE USE OF THE ROTARY PLOW IN WIDENING OPERATIONS, THE WEDGE-SHAPED TOP IS NOT FORMED, BUT A SHEER BANK WITH LEVEL TOP IS PROVIDED. FIGURE 7 SHOWS A WIDENED ROADWAY CLEARED WITH A ROTARY PLOW AND TRACTOR, AND FIGURE 8 SHOWS A ROTARY PLOW IN ACTION WIDENING A PRELIMINARY CUT.

IN SOME CASES WHEN THE SNOW HAS BECOME HARD OR THE BANK IS HIGHER THAN THE TOP OF THE ROTORS, THE ROTARY PLOW IS PROVIDED WITH AN AUXILIARY ATTACHMENT FOR CONVENIENCE IN THE WIDENING WORK. THE DEVICE IS ATTACHED TO THE REAR OF THE ROTARY PLOW AND LOOSENS THE SNOW, PERMITTING IT TO FALL TO THE ROAD SURFACE WHERE IT IS PICKED UP AND CAST INTO THE FIELDS ON THE RETURN TRIP OF THE PLOW. FIGURE 9 ILLUSTRATES THE DEVICE IN ACTION.

DRIFT PREVENTION CONTINUES AS GENERAL PRACTICE

DRIFT PREVENTION WITH SNOW FENCE OR BY OTHER MEANS CONTINUES TO BE POPULAR. AN ENGINEER IN CENTRAL NEW YORK REPORTS THAT OVER SOME SECTIONS OF HIS ROADS ROTARY PLOWS WERE NECESSARY FOR WIDENING THE CLEARED WAY BEFORE THEY HAD ERECTED SNOW FENCES. AFTER PLACING THE SNOW FENCE, AT STUDIED LOCATIONS, ALL WIDENING WAS ACCOMPLISHED WITH TRUCK-MOUNTED DISPLACEMENT PLOWS, WITH A SUBSTANTIAL SAVING IN OPERATING EXPENSES. ALTHOUGH SNOW FENCES OF VARIOUS TYPES AND DESIGN ARE BEING USED IN LARGE QUANTITIES OVER THE SNOW AREA, AT TIMES THE APPROPRIATIONS FOR THIS PURPOSE DO NOT KEEP UP WITH THE DEMAND, AND IN SUCH INSTANCES NUMEROUS MAKESHIFTS ARE RESORTED TO FOR OVERCOMING THE SHORTAGE. IN ONE LOCALITY, DISCARDED CALCIUM CHLORIDE BAGS WERE STRUNG ON WIRE ATTACHED TO POSTS. THESE WERE FOUND USEFUL FOR KEEPING THE DRIFTS FROM THE TRAVELED WAY. THE WIND RESISTANCE OF THE BOARDS OF WOODEN GUARD-RAIL IS OFTEN THE CAUSE OF DRIFTED ROADWAYS, AND THE SAME BOARDS AT TIMES INTERFERE WITH THE DISPLACEMENT OF SNOW. THE LOWER PLANK PREVENTS THE SNOW FROM BEING PUSHED LATERALLY BY THE PLOWS. IN SOME LOCALITIES, SECTIONS OF WOODEN GUARD-RAIL ARE DISMANTLED DURING THE WINTER AND THE PLANKS USED TOGETHER WITH CHLORIDE

Figure 7. - A vertical snow bank with level top. This cut was widened with a rotary plow.

Figure 8. - A rotary plow in action, widening a cut.

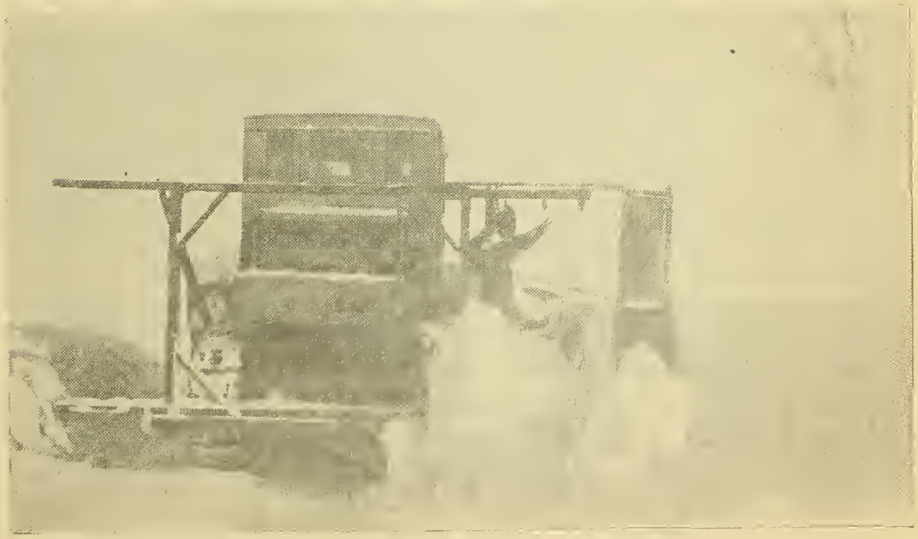


Figure 9. - The bank sloper for high banks attached to a rotary plow, being used in widening work.

bags for improvising snow fences. The boards are bound together in temporary frames and the bags tacked in place. At the close of the snow season the boards are replaced in the guard rail. Figure 10 is a view of the snow fence made of bags strung on wire, and Figure 11 shows a front view of the framed guard-rail snow fence. The drifts may be seen on the leeward side of the structure. The road, not shown in the picture, was free from drifts along sections thus protected.

Snow Traps Prevent Drifting in Some Localities

The formation of drifts in roadways is preventable to some extent, in territory with heavy snowfalls and low temperatures, by plowing a path in the snow in the fields on the windward side of the highway. The plowed paths are called "snow traps." The idea is not entirely new, as it was formerly used in timbered country for the protection of logging roads from drifted snow. The traps are plowed from 75 to 100 feet away from the road and are made from 12 to 15 feet wide. One or more traps are plowed according to the nature of the terrain adjacent to the road and the amount of snow in prospect. The theory is that the traps stop the snow to some extent and keep it from drifting into the road. After each storm the runways are replowed and the snow piles up in high banks which serve very well as wind breaks until the necessary quantities of regular fence can be financed and set. Figure 12 shows a series of the traps plowed along a road in northern Michigan.

Cost of Snow Removal Varies Over a Wide Range

Considerable attention has been given to the actual cost of snow-removal work in order to arrive, if possible, at some method of calculating precise cost data. In Connecticut officials contend that, through the savings made in another direction, the work in reality costs the taxpayers nothing. While this State controls many miles of concrete surfaces they also have a considerable mileage of flexible types of pavement to maintain and it is claimed that the money spent on snow removal is more than saved in the spring maintenance of their waterbound and bituminous surfaces. Before the days of snow removal, automobiles and trucks with armored tires often caused ruts for miles in the flexible pavements. This necessitated expensive spring repairs. Since snow removal has been adopted and perfected by Connecticut, the use of non-skid chains has become unnecessary, and this has resulted in a large saving in maintenance. Moreover it has been estimated that the gasoline tax paid for the operation of vehicles over the cleared roads during the heavy snow

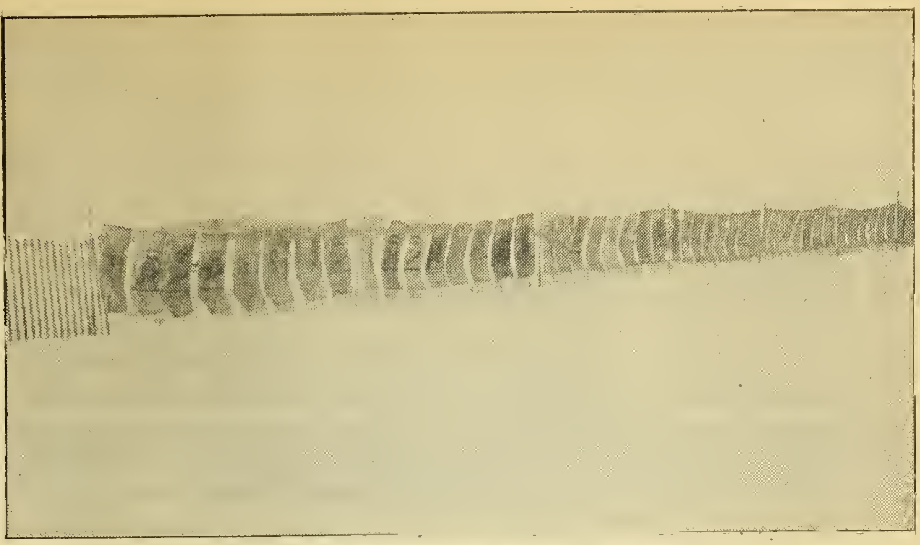


Figure 10. - A snow fence made from discarded calcium-chloride bags.

Figure 11. - A snow fence made from discarded bags and framed guard-rail timber.

Figure 12. - A series of snow traps. The snow cloud in the center of the picture is caused by a rotary plow engaged in widening work.

SEASON IS SUFFICIENT TO PAY APPROXIMATELY THE ENTIRE SNOW-REMOVAL BILL FOR THE SEASON. WITHOUT SNOW REMOVAL ANOTHER LOSS IN REVENUE COULD BE CHARGED TO THE FAILURE OF NUMEROUS CAR OWNERS TO PURCHASE THEIR LICENSE PLATES UNTIL APRIL 1 OF EACH YEAR, AND THEREBY CAUSE A CORRESPONDING REDUCTION IN THE TOTAL TAX. WITH 32 OF THE 36 SNOW STATES WITH GAS-TAX RATES RANGING FROM 2 CENTS TO 5 CENTS PER GALLON, AND FROM THE OTHER FACTS CITED, IT IS APPARENT THAT SNOW-REMOVAL WORK, GENERALLY, IS PAID FOR FULLY BY THE MOTOR VEHICLES ACTUALLY TRAVELING OVER THE CLEARED HIGHWAYS.

THE SUPERINTENDENT IN CHARGE OF THE SNOW-REMOVAL WORK FOR CONNECTICUT, WHO HAS UNDER HIS SUPERVISION THE EFFICIENT MAINTENANCE ORGANIZATION WHICH HAS BEEN PREVIOUSLY MENTIONED, BELIEVES THAT RELIABLE COST DATA ARE UNOBTAINABLE. HE CLAIMS THAT 12 INCHES OF SNOW, FALLING WITHOUT WIND, CAN BE MOVED AS CHEAPLY AS 5 INCHES, FALLING WITH WIND. CONSEQUENTLY, ANY EFFORT TO ARRIVE AT THE COST OF REMOVAL PER INCH OF FALL IS USELESS. IT IS REPORTED THAT NEWLY-FALLEN SNOW, WITHOUT WIND, CAN BE MOVED WITH A TRUCK, WHICH WITH ONE DRIVER IS RATED AT $25.00 PER DAY OF NINE HOURS. IN ORDER TO CLEAR A PATH 36 FEET WIDE WITH THIS OUTFIT, IT WOULD BE NECESSARY FOR THE TRUCK TO MAKE FOUR TRIPS OVER A SECTION OF 13 MILES, AND IN DOING SO MAINTAIN AN AVERAGE OF SIX MILES PER HOUR DURING THE NINE HOURS WORK. THIS WOULD BRING THE COST OF SNOW REMOVAL, UNDER SUCH CONDITIONS, TO A RATE OF $2.00 PER MILE PER STORM. SOME SUCH FIGURES MIGHT BE USED FOR COST DATA PER STORM, BUT THEY WOULD BE UNRELIABLE FOR THE REASON THAT SNOW SELDOM FALLS WITHOUT WIND, AND THEY COULD BE USED ONLY IF THE SNOW WAS LEFT UNDISTURBED UNTIL THE STORM WAS OVER. ORDINARILY SNOW REMOVAL IS BEGUN WHEN A DEPTH OF 2 INCHES OR MORE HAS BEEN REACHED, AND THE WORK IS CONTINUED UNTIL THE STORM IS OVER AND THE SECTION CLEARED. IN SUCH CASES, A TRUCK WOULD TRAVEL MUCH FASTER THAN SIX MILES PER HOUR, BUT IT WOULD BE NECESSARY TO MAKE MORE TRIPS IN ORDER TO KEEP THE SECTION CLEARED. SOME FIGURES MIGHT BE ARRIVED AT TO COVER THE COST PER MILE PER STORM UNDER THESE CONDITIONS BUT THEY WOULD VARY WITH THE DURATION AND INTENSITY OF THE STORM. THE SNOWFALL MAY LAST FOR NINE HOURS AND DEPOSIT 9 INCHES OF SNOW, OR IT MAY FALL INTERMITTENTLY OVER A PERIOD OF 24 HOURS WITH THE SAME RELATIVE DEPTH OF SNOW TO REMOVE. THE AVERAGE COST OF SNOW REMOVAL FOR A STATE OR LARGE TERRITORY IS UNRELIABLE, EITHER WHEN ESTIMATED FROM DEPTH FACTORS OR PER STORM. THE SNOWFALL FOR THE SEASON MAY VARY FROM 25 INCHES IN SOME SECTIONS TO 75 INCHES IN OTHERS, AND THESE DEPTHS VARY BY YEARS. THE NUMBER, DURATION, AND INTENSITY OF THE STORMS MAY VARY IN LIKE MANNER.

The engineer for a State in the Middle West believes that the cost of removing snow from the roads in one territory can be estimated from the cost of work over a similar section, provided the necessary records have been kept. A report compiled by one of the State highway engineers states that the average annual snowfall for the State varies from 30 inches at its southeast corner to 130 inches at its extreme northern limits. The State has a temperature varying from occasional zero weather in the southeast section to 50 degrees below zero at its northern limits. An extensive snow-removal program is maintained which covers practically all sections of the State, no part of which is mountainous, and a most careful and complete study has been given to snow-removal work. The studies included the preparation of a map of all the roads included in the snow-removal program. The map shows the nature of the surrounding topography as affecting the drifting of snow. Snow-removal work for the State is divided into five divisions and ten maintenance sections, each section being in charge of a maintenance supervisor who further subdivides his section into workable units. In some instances the work is parceled out to the counties, on a cost-plus basis, under contract to keep the State roads open. During the past winter, all division engineers, maintenance supervisors, and foremen were directed to keep accurate cost data of all snow-removal operations. The records are to be segregated into convenient sections with designated termini, and are to be compared with similar areas on the topographical map. The various organizations were instructed to note all cost data on snow-removal work; the records to include the equipment used and the hourly rental charges adopted; wages of men; estimated overhead; intensity and duration of storms; duration and estimated velocity of the wind; density of the snow; temperatures during the storm and while removal operations are in progress; in fact each and every item to be noted bearing on the work involved, that would be directly or remotely useful in securing cost data. When these figures have been classified, and compared as to sections with similar topography, they will make available for that State actual cost data covering small and large sections of territory, over a region with snow precipitation averaging between 30 and 130 inches per year. With this information, should the State highway department wish to estimate the cost to remove snow from any particular section, they may do so after a study of the topographical conditions and the local Weather Bureau records, followed by a comparison of the data with a previously studied section of similar territory.

Attached to this report is a table showing the mileages covered and the equipment used for the winter of 1926-27 in the 36 States lying within the heavy-snowfall area. The data were collected from the State highway departments, with one exception, where the counties were requested to furnish the information. Since the information was furnished by the States it should be understood that it covers principally the snow-removal work under the control of the State highway departments. It is not possible to secure accurate records of the work in the 36 heavy-snowfall States, which is being carried on by the counties, townships, local authorities, and private concerns.

The attached map shows the location of the main roads which are proposed to be kept clear of snow during the winter of 1927-28.

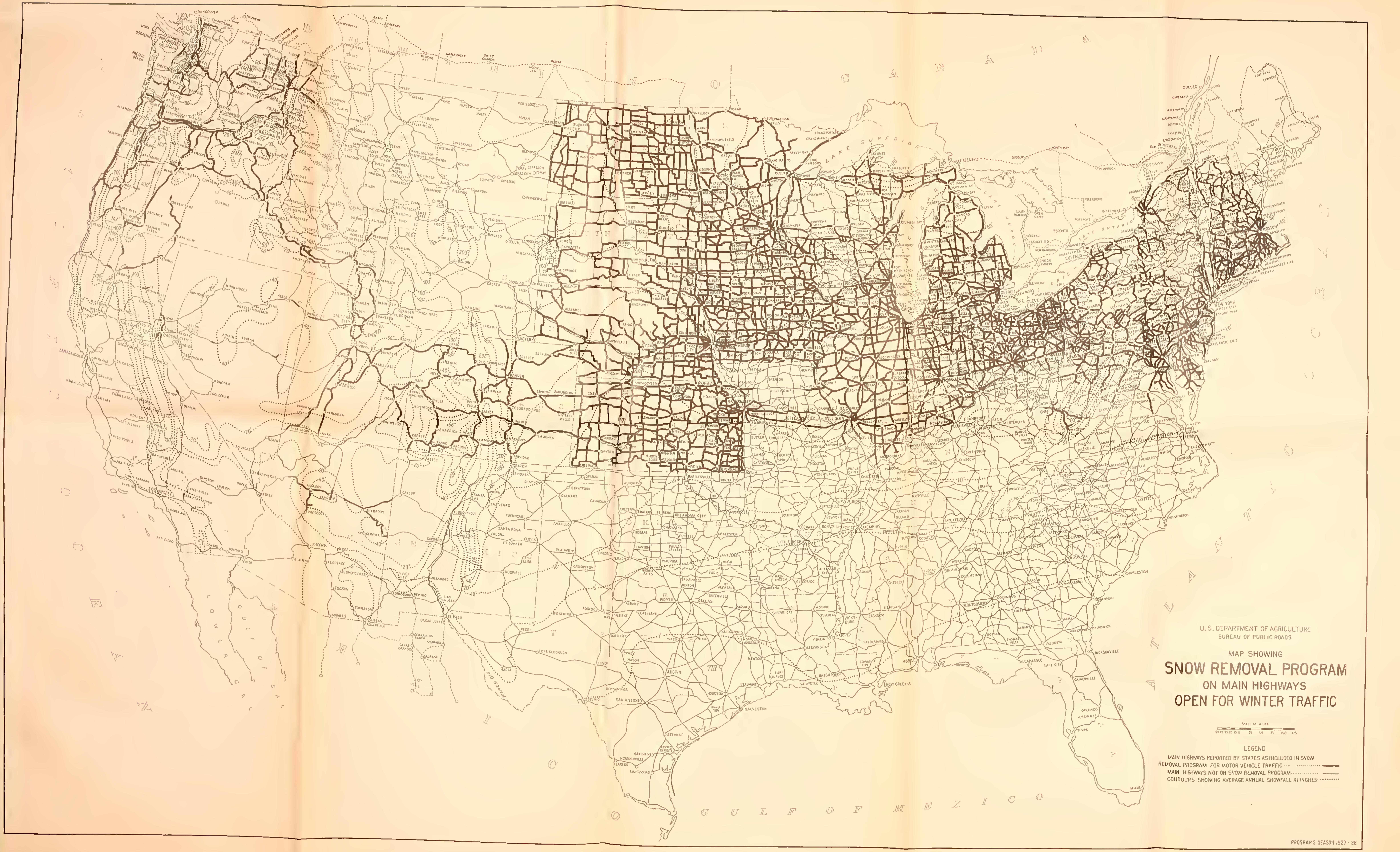
UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Public Roads - Division of Construction

SNOW REMOVAL DATA - WINTER 1926-27

	STATE	Total mileage State roads (including Fed. aid roads) surfaced with gravel or higher types of pavement as of Jan. 1, 1927	Min. and max. average annual snowfall recorded over a period of yrs. in different sections of State	Control of snow removal 1926-27	Snow Removal Equipment - Winter 1926-27: Truck Plows: Mold board type	Truck Plows: "V" type	Tractor Plows: Mold board type	Tractor Plows: "V" type	Tractor Plows: Rotary type	Miscellaneous Equipment: Trucks and tractors	Miscellaneous Equipment: Graders	Snow fence 1926-27	Snow Removal Winter 1926-27: Mileage of roads with snow removed	Snow Removal Winter 1926-27: Average seasonal snowfall from records in different sections of State	Total cost snow removal	Mileage on snow removal program for winter 1927-28	REMARKS
			Inches									Miles		Inches			
NORTH ATLANTIC STATES	Maine	1,302	74.4 to 131.9	Townships	*	*	*	*	*	*	*	*	250	94.2	*	*	Future snow removal activities to be in charge of State through legislative enactment.
	New Hampshire	1,963	65.1 to 94.0	State and Townships	18	12	8	68	-	28 Trucks 76 Tractors	4	8	**4,680	86.1	69,700	**4,800	Mileage of roads cleared include State and township. Total cost includes State work only*
	Vermont	2,139	63.8 to 110.6	Townships	22	15	35	10	1	40 Trucks 35 Tractors	32	3	1,627	73.4	**5,700	1,650	
	Massachusetts	1,651	45.4 to 61.5	Townships	142	*	18	*	*	142 Trucks 18 Tractors	*	*	1,800	56.3	10,000	1,800	State loans part equipment. Towns remove snow. No data available on the township work
	Rhode Island	452	24.1 to 47.0	State and Townships	**82	-	-	3	9	**62 Trucks 13 Tractors	*	-	**751	31.[illegible]	**52,[illegible]	**775	Total cost snow removal exclusive of equipment. Data for townships estimated
	Connecticut	1,819	40.3 to 75.6	State and Townships	183	-	-	7	-	183 Trucks 7 Tractors		20	1,900	41.1	174,[illegible]85	1,900	Equipment includes also 15 extra snow plows.
	New York	9,854	28.8 to 141.4	Counties & Townships	115	194	43	250	38	305 Trucks 211 Tractors	Numerous	[illegible]	**1[illegible],000	70.7	**936,000	**15,000	Snow removal data estimated from figures submitted by 37 counties.
	New Jersey	1,297	14.4 to 54.4	State and Counties	131	33	-	7	4	161 Trucks 11 Tractors	32	1	[illegible]	[illegible]1.0	16[illegible],1[illegible]	[illegible]	Total cost high due to all overhead included. County work data omitted.
	Pennsylvania	8,439	24.7 to 92.2	State	377	107	-	85	5	464 Trucks 96 Tractors	25	23	6,3[illegible]	[illegible]	[illegible]	**6,300	
S. ATLANTIC STATES	Delaware	591	16.7 to 22.9	State and County	5	7	-	5	-	23 Trucks 5 Tractors	10	2	600	[illegible].8	1[illegible],[illegible]00	650	One county only engaged in snow removal work.
	Maryland	2,420	13.9 to 69.4	State	88	-	-	-	3	88 Trucks 3 Tractors	[illegible]	18	2,[illegible]73	[illegible]	4[illegible]	2,730	
	Virginia	2,825	7.3 to 33.4	State and Counties	20	5	5	6	-	50 Trucks 50 Tractors	50	3	5,000	9.9	32,000	[illegible],200	The equipment also includes 50 horse-drawn V-plows.
	West Virginia	1,732	8.8 to 101.0	State and Counties	11	-	1	-	-	44 Trucks 16 Tractors	34	-	**422	25.6	**9,853	**422	Data for former winter used.
NORTH CENTRAL STATES	Ohio	9,591	16.8 to 34.8	State and Local	150	32	6	9	6	525 Trucks 131 Tractors	396	80	5,169	2[illegible].9	143,142	7,[illegible]	Data covers State work only.
	Indiana	4,153	13.6 to 61.3	State and Local	8	15	-	2	-	624 Trucks 49 Tractors	230	-	3,590	25.8	32,510	3,300	Equipment also includes 28 wooden plows. Data covers State work only
	Illinois	4,496	11.6 to 39.4	State and Counties	166	43	-	2	3	224 Trucks 55 Tractors	53	-	3,591	22.8	17[illegible],[illegible]74	3,8[illegible]	
	Michigan	6,229	33.5 to 121.4	State and Local	176	143	2	57	43	330 Trucks 108 Tractors	Numerous	169	5,705	56.2	283,562	6,612	
	Wisconsin	8,329	24.9 to 78.3	Counties & Townships	12	24	-	27	1	31 Trucks 21 Tractors	-	132	2,619	47.8	47,226	2,620	
	Minnesota	6,246	24.0 to 54.4	State and Local	10	63	18	56	5	107 Trucks 74 Tractors	4	284	5,000	43.5	664,[illegible]3	7,000	Data covers State work only.
	Iowa	3,470	21.2 to 38.1	State and Counties	14	103	-	13	6	245 Trucks 122 Tractors	1,026	345	6,650	25.2	[illegible]338	[illegible]50	Total cost includes cost of snow fence and large expenditures for equipment.
	Missouri	3,376	6.7 to 34.2	State	20	4	-	20	-	50 Trucks 40 Tractors	30	20	1,200	15.7	4,[illegible]	[illegible],200	Snow removal during winter 1926-27 was not a serious problem.
	North Dakota	1,335	25.0 to 45.2	State	-	-	-	3	1	3 Tractors	300	1[illegible]	2,500	37.4	20,000	3,[illegible]	Snow removal done generally with horse-drawn graders
	South Dakota	2,447	18.7 to 97.7	State and Counties	-	25	-	14	-	60 Trucks 50 Tractors	500	50	3,000	46.7	60,000	3,500	Snow removal work done by counties under State control.
	Nebraska	2,320	4.0 to 72.4	State	-	4	1	10	-	185 Trucks 127 Tractors	188	278	6,000	36.9	28,[illegible]	6,000	Total cost of snow removal work includes part of winter only.
	Kansas	1,002	8.8 to 29.2	State and Counties	15	25	60	25	-	30 Trucks 125 Tractors	1,200	125	9,190	14.3	**125,000	13,000	The equipment also includes 1[illegible] locally-made snow plows
WESTERN STATES	Montana	927	16.5 to 270.8	Counties	*	*	*	*	*	*	*	*	*	56.7	*	*	Snow removal work done by counties only, with data unavailable.
	Wyoming	929	9.2 to 219.7	State	-	1	-	1	-	10 Trucks 10 Tractors	-	5	100	73.4	13,662	**100	Definite program for season 1927-28 not formulated.
	Colorado	3,489	12.8 to 276.5	Counties	*	*	*	*	*	*	*	100	4,312	80.8	50,52[illegible]	4,4[illegible]0	
	New Mexico	1,685	5.3 to 138.4	State	*	*	*	*	*	*	*	-	*	27.6	*	*	Open winter, little snow removal work done. Maintenance equipment used
	Arizona	1,422	0.4 to 83.0	State	-	-	4	-	-	20 Trucks 4 Tractors	20	-	412	14.9	**6,000	412	
	Utah	1,190	5.0 to 155.1	State	14	8	6	1	1	12 Trucks 12 Tractors	-	11	1,250	51.2	4[illegible],000	1,350	
	Nevada	1,013	0.6 to 87.0	State and Local	-	2	-	-	3	4 Trucks 3 Tractors	3	2	361	31.4	1,9[illegible]	541	Data covers State work only
	Idaho	2,358	1.0 to 207.0	State and County	8	1	3	8	12	34 Trucks 12 Tractors	16	2	669	55.6	16,144	8[illegible]5	
	Washington	2,607	3.8 to 252.3	State and Counties	70	-	7	5	2	140 Trucks 14 Tractors	50	3	2,216	58.6	44,980	2,135	
	Oregon	3,220	1.4 to 338.6	State	44	-	16	1	5	90 Trucks 25 Tractors	50	9	1,133	46.7	130,000	1,[illegible]33	Local authorities cleared 3[illegible] miles of road not included in data.
	California	3,538	1.0 to 783.0	State and Local	7	-	8	-	2	14 Trucks 14 Tractors	14	1	316	[illegible]0.8	22,[illegible]5	3[illegible]	
	TOTAL	111,756			1,966	861	236	684	149	4,365 Trucks 1,600 Tractors	4,272	2,633	106,721		$4,641,037	117,109	

* Asterisk indicates information not available. ** Double asterisk indicates data estimated.

Note: The above data is compiled from reports by the States in answer to questionnaire submitted by the U. S. Bureau of Public Roads. Snowfall figures compiled from U. S. Weather Bureau records.



U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

MAP SHOWING
SNOW REMOVAL PROGRAM
ON MAIN HIGHWAYS
OPEN FOR WINTER TRAFFIC

LEGEND

MAIN HIGHWAYS REPORTED BY STATES AS INCLUDED IN SNOW REMOVAL PROGRAM FOR MOTOR VEHICLE TRAFFIC ━━
MAIN HIGHWAYS NOT ON SNOW REMOVAL PROGRAM ——
CONTOURS SHOWING AVERAGE ANNUAL SNOWFALL IN INCHES ⋯⋯

PROGRAMS SEASON 1927-28