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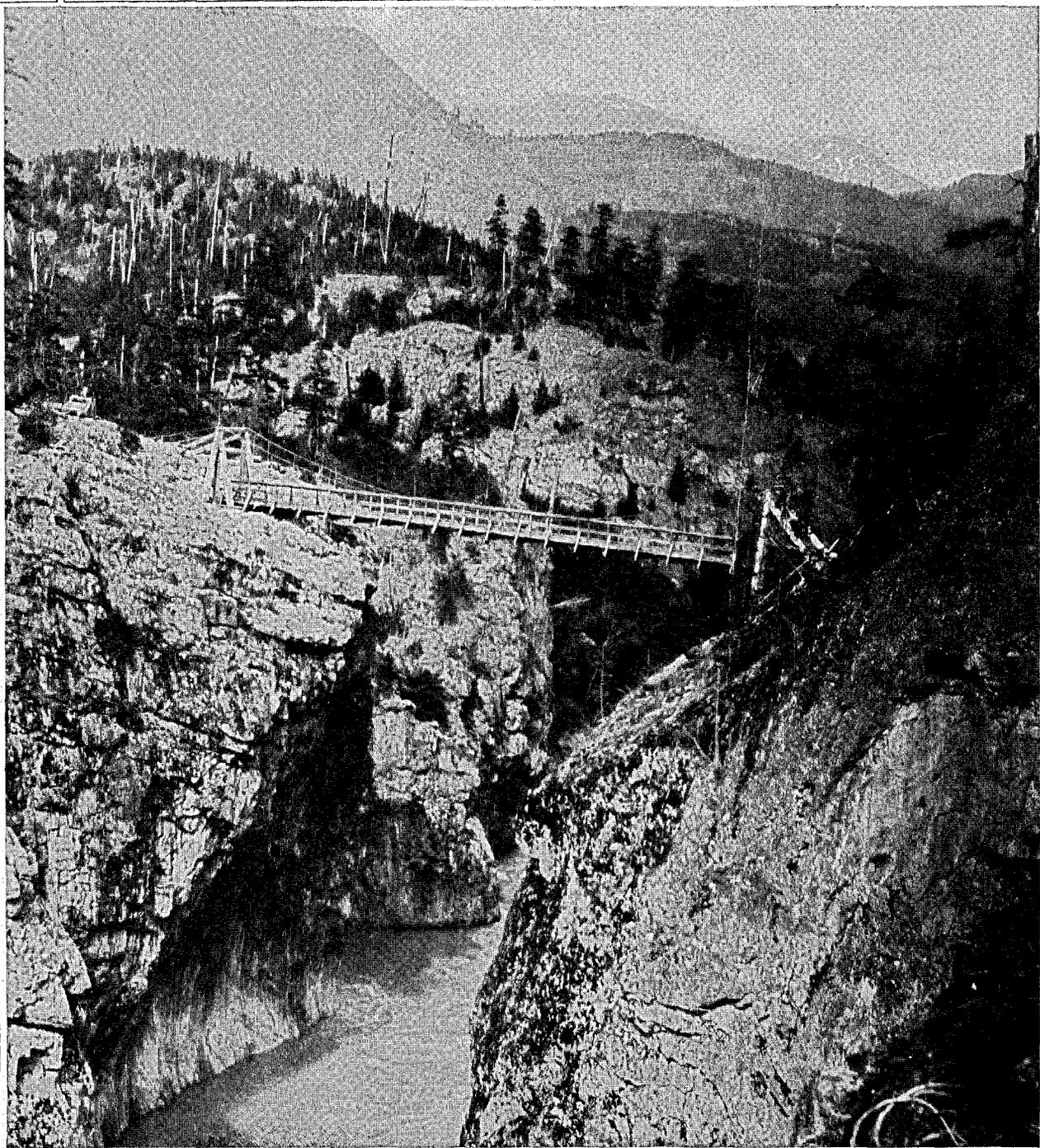
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS

Public Roads

VOL. 1, NO. 4

WASHINGTON, D. C.

AUGUST, 1918



SPANNING CANYON DIABLO, SKAGIT RIVER, WASHINGTON NATIONAL FOREST

Owing to the necessarily limited edition of this publication it will be impossible to distribute it free to any persons or institutions other than State and county officials actually engaged in the planning or construction of highways, instructors in highway engineering, periodicals upon an exchange basis, and Members of both houses of Congress. Others desiring to obtain PUBLIC ROADS can do so by sending 15 cents for each number or \$1.50 for annual subscription to the Superintendent of Documents, Government Printing Office, Washington, D. C.

It is the desire of the Bureau of Public Roads and the Government Printing Office to issue PUBLIC ROADS regularly each month, but it must be borne in mind by the readers that in these war times the tremendous volume of emergency printing takes precedence in the Printing Office and due allowance be made for numerous and unavoidable delays.

U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

PUBLIC ROADS

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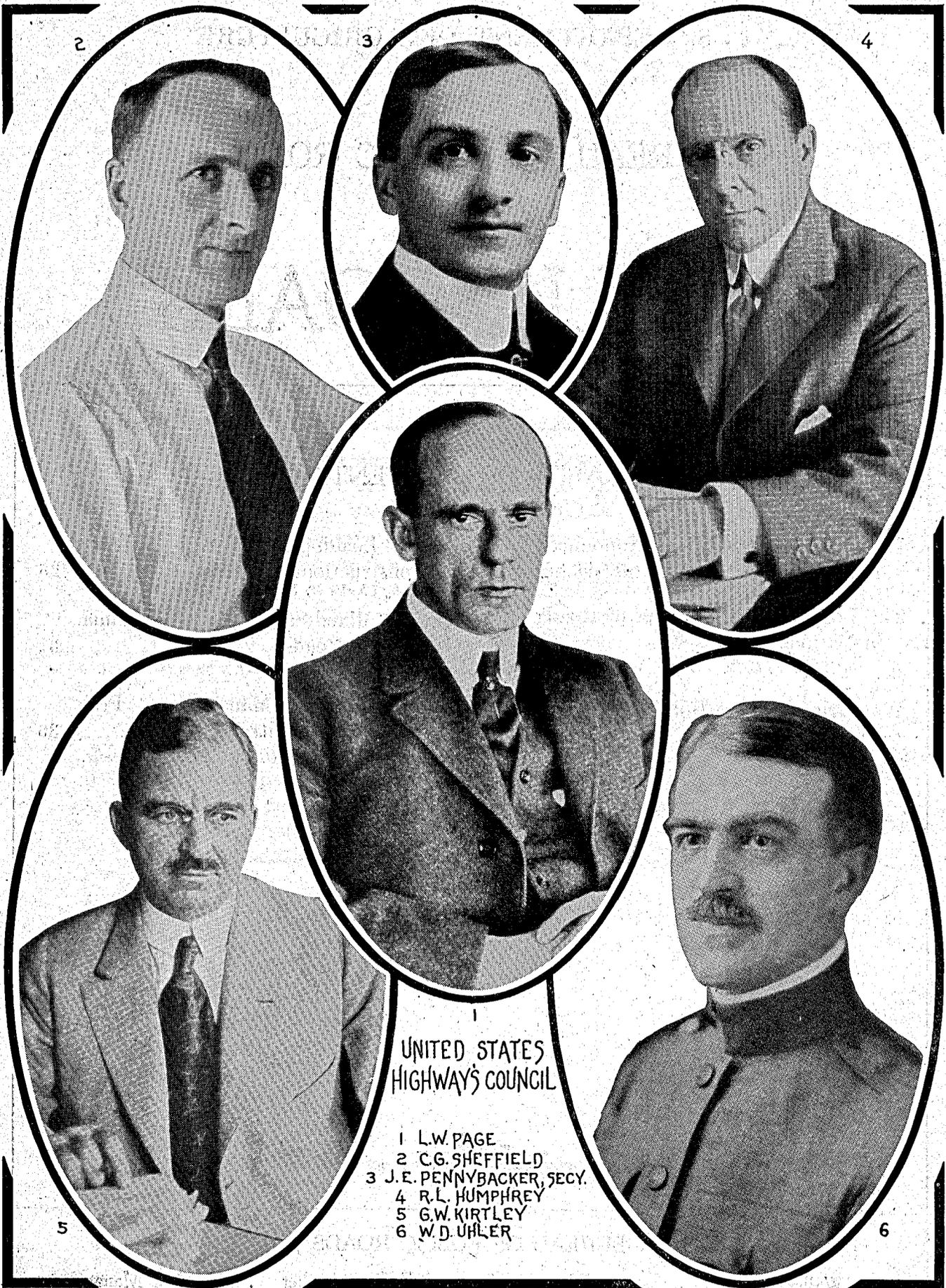
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WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

BUREAU OF PUBLIC ROADS

Logan Waller Page Director
P. St. J. Wilson Chief Engineer
J. E. Pennybacker Chief of Management
Jules L. Goldberg Editor



1
UNITED STATES
HIGHWAYS COUNCIL

- 1 L.W. PAGE
- 2 C.G. SHEFFIELD
- 3 J.E. PENNYBACKER, SECY.
- 4 R.L. HUMPHREY
- 5 G.W. KIRTLEY
- 6 W.D. UHLER

U. S. HIGHWAYS COUNCIL ANNOUNCES POLICIES COVERING ROAD PROJECTS

IN its Bulletin No. 1, just issued, The United States Highways Council announces its policy and procedure as to highway and street work in the country for the period of the war. The regulations therein stated become effective September 10. They make for the conservation of time, money, material, and man power throughout the country so far as highway work is concerned. They make possible the allocation of materials and the expenditure of resources to the greatest possible advantage and with a single purpose in view—to do all possible toward a victorious outcome of the struggle in which we are engaged.

All propositions relating to highway, street, culvert, or bridge construction, reconstruction, and maintenance in which are involved the issuance of bonds, the use of rail or water transportation, the use of coal or oil as fuel, or the use as highway material of cement, asphalt, oil, tar, steel, crushed stone or brick (and of sand and gravel where a shortage exists), must be submitted through the respective State highway departments for approval of the council.

It is realized that new construction, much curtailed in extent, will be found essential, and it will be the policy of the council to deal with this first from the standpoint of its military value and second from that of its national economic value. Reconstruction can receive favorable consideration only where it is evident that maintenance is no longer possible except at prohibitive cost.

In the policy of the council and the construction of a highway program the highway departments of the States can be of inestimable help to the council and the Nation. A careful and selective scrutiny of the projects submitted by the town, county, and municipal officials will eliminate those less essential and enable the council to give material aid in the projects approved.

The text of the bulletin follows:

UNITED STATES HIGHWAYS COUNCIL

BULLETIN NO. 1.

Effective September 10, 1918.

The United States highways council makes the following announcement with reference to policy and procedure as to highway and street work during the period of the war:

1. All proposed highway, street, culvert, and bridge construction, reconstruction, and maintenance involving: (a) The issuance of bonds; (b) the use of rail or water transportation; (c) the use of coal or oil as fuel; or, (d) the use of cement, brick, asphalt, oil, tar, crushed stone, or steel (also sand and gravel where shortage exists) as highway material, should first be submitted for approval to the United States highways council through the appropriate State highway department. Forms have been prepared for this purpose and a supply placed with each State highway department. No manufacturer will furnish any road building material until the project has been approved by the United States highways council.

2. The council again urges that new highway and street construction be confined to the most essential

needs. If this is done there will be a far greater probability that the work thus selected can be promptly and effectively carried through to completion than if an amount far in excess of the available facilities were to be undertaken.

The council in passing upon the projects which come before it will give first consideration to maintenance with a view to conserving all the highways already completed if possible.

Reconstruction will be favorably considered by the council only where it is clearly established that maintenance is no longer possible except at prohibitive cost.

New construction will be given consideration by the council in the following relative order of importance:

- (1) Highways and streets of military value.
- (2) Highways and streets of national economic value.
- (3) Unfinished contracts involving contractual obligations (incurred prior to April 5, 1918, where bond issue is involved) which may not be disturbed without serious consequences.

- (4) Streets and highways which although not of national economic importance are of such extreme local importance or the construction of which has progressed to such a point as to cause serious hardship if their construction or completion is postponed.

The council is hopeful that the selective consideration of new highway and street construction by the township, county, and municipal officials and in turn by the State highway departments, will so materially eliminate the less essential projects as to make it possible for the council to render active aid on the projects it approves. The aid contemplated will be in the form of such action by the other government agencies involved as will remove obstacles to the speedy completion of the projects.

3. By way of definition of highways of military and national economic value, the council offers the following:

(a) A highway of military value is one used regularly for the transportation of military supplies in considerable quantity; for the movement as an established practice of Army truck trains, or which is essential to the efficient operation of a military cantonment, post, or plant.

(b) A highway of national economic value is one which serves or will serve, if properly improved, directly to promote the welfare of the Nation and not merely the local welfare. As examples, it may be stated that in this class would be placed (1) highways which although not directly used for military purposes yet serve to help win the war by greatly facilitating the output or movement of war munitions and supplies; (2) highways which can clearly be shown to relieve congestion on railroad lines in a territory which is actually in need of such relief; (3) highways which give access to or promote the output of natural products needed by the Nation to a marked degree; (4) highways which further housing operations undertaken by the Federal Government or by other agencies with the approval of the Federal Government would justify at times this designation.

4. State highway departments are requested to give most careful consideration to each application on its merits in the light of the policy announced by the council and to exercise the power of disapproval freely. Only the projects approved by the State highway department will be considered by the council unless the department itself is in doubt and wishes a decision in the nature of a precedent.

5. The council will shortly begin, in cooperation with the Bureau of Public Roads of the Department of Agriculture and the State highway departments of the several States, the preparation of a program of road and street construction, reconstruction, and maintenance throughout the United States for the working season of 1919. The purpose of the program is to obtain an approximation of the character

and amount of street and highway work deemed essential in 1919, together with an approximation of the amount and character of financing required, the amount and character of the various materials entering into the work, the extent to which rail and water transportation will be involved, and the probable demands upon the labor supply. The preparation of the program in each State will be directed by the State highway department, and will cover all State, county, township, and municipal highway and street work.

6. For the information of the State highway departments as to procedure, forms are attached as follows:

Form H. C. 3, application to United States Highways Council for approval of project. This form should be filled out and signed by the public officials who are seeking approval of the project, and should then be filed with the State highway department. If the State highway department approves the application, it enters appropriate recommendation and certification on the last sheet of the form and transmits the application in duplicate to the United States Highways Council. The application is then given a serial number and its receipt acknowledged. It is then considered by the council and appropriate references made to the respective Government agencies interested. The applicant and the State highway department are duly advised as to action taken. Forms F. 1 and F. 2 comprise application for approval of delivery of bituminous materials and certification of the application by the State highway department. These forms have been superseded by Form H. C. 3, but may be used if so desired where only bituminous materials are required.

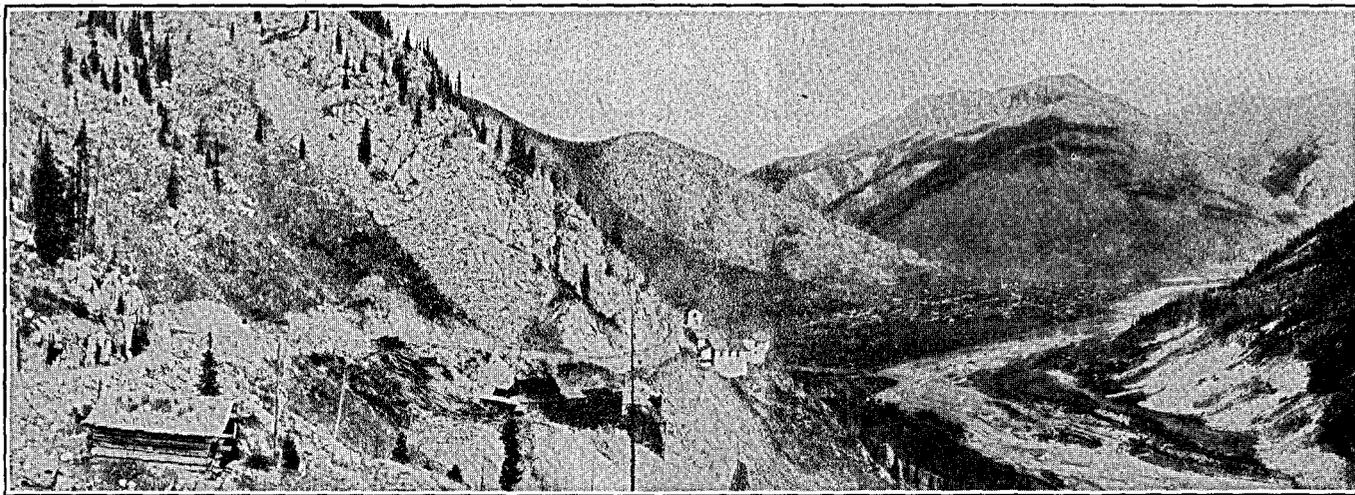
Form H. C. 4, schedule for use in submitting program of proposed highway and street work during the working season of 1919. This schedule is to be made up in four groups, namely: (1) State; (2) counties; (3) towns, townships, or districts; and (4) municipalities. For each of these groups three schedules, respectively, construction, reconstruction, and maintenance, are to be submitted. Definitions of construction, reconstruction, and maintenance, respectively, are given on form H. C. 4.

Announcement of June 20, 1918, a brief summary, giving organization, and purposes of the United States Highways Council, and showing the relation of various organizations represented on the council to highway work.

Circular No. C. S. 13, United States Railroad Administration, rules promulgated to govern car supply for stone, sand, and gravel, showing conditions under which open top cars may be supplied by railroads and providing for application to the Director of the Bureau of Public Roads, United States Department of Agriculture, where local car supply is insufficient. The representatives of the organizations mentioned in paragraph 5 of this circular comprise the United States Highways Council.

THE LOCATION AND BUILDING OF ROADS IN THE NATIONAL FORESTS.

By ARTHUR E. LODER, Assistant Chief Engineer, Bureau of Public Roads.



SILVERTON END OF THE DURANGO-SILVERTON ROAD, DURANGO NATIONAL FOREST, COLORADO, NOW UNDER CONSTRUCTION BY DAY LABOR.

THAT the national forests must play an important part in the road system of the United States becomes apparent when it is realized that the boundaries of the 147 national forests inclose a domain of 274,000 square miles, equivalent to the area of the States of California, Oregon, and one-fourth of Washington. This fact is driven home more forcibly when it is noted that instead of being grouped in one continuous area of regular proportions the forests are generally of an elongated, irregular shape covering the divides and rugged slopes of most of the mountain barriers which separate valley communities and stand in the way of interstate and transcontinental travel. As if to increase resistance the mountain ranges, and, therefore, the forest areas, generally lie along lines running north and south, while the larger portion of interstate travel passes in an east-and-west direction from its terminals at the seaboards.

Improved modern means of highway travel which make longer trips possible and the more intensive development of agriculture and all other resources of the valleys, create an ever-growing demand for roads through the forests on local as well as transcontinental routes. This demand will continue to increase at an accelerated rate.

In order to mold the current undertakings into a predetermined system, a list of projects giving the approximate location, length, and mileage of the principal roads considered by the Forest Service to be necessary for the present and future development of the national forests and contiguous territory has been prepared based upon estimates furnished by

the Bureau of Public Roads and any other available data. This is known as the "comprehensive road plan" and gives some idea of the work ahead if the forests are to be made reasonably accessible and provision made for through travel. The latest compilation of this constantly growing plan shows a total of 785 projects to be built, aggregating 17,000 miles of forest roads. Although estimates are not yet available on about 4,000 miles included in this total, it is apparent that the ultimate cost of the system will be not less than \$50,000,000 if built under normal conditions. This will require at least \$25,000,000 of Federal funds, provided 50 per cent cooperation is secured throughout, or \$15,000,000 more than the present act provides.

DEMAND FOR ROADS WILL INCREASE.

The undertaking appears large, but its ultimate accomplishment can not be doubted, since the demand for these roads will gather momentum rapidly as the present improvement gets under way.

The first "timberland reserve" was created by proclamation of President Harrison in 1891 and the Forest Service of the Department of Agriculture was created in 1905. No funds were provided, however, for systematic forest road work until 1912, when a beginning was made on road and trail construction under an act of Congress making available for that purpose 10 per cent of the funds derived from the sale of forest products. This is known as the "ten per cent fund."

Previous to this time the forest officials had appreciated keenly the need of trails and roads and

had done considerable work in a small way on isolated projects in order to extend or connect existing trails and bridge a few streams which could not be forded by pack trains. Some assistance was secured from local road officials, timbermen, and graziers. This work was at times very discouraging because of the difficulty of securing the funds needed for explosives and materials and the necessity for performing the work by the labor of forest rangers in the winter or off seasons.

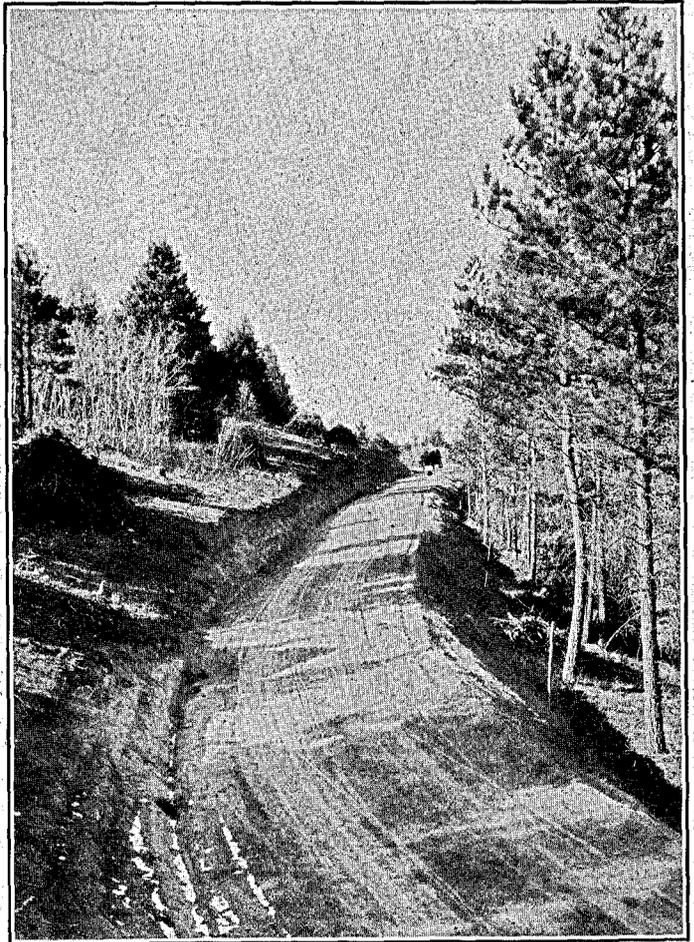
This small beginning, however, showed the necessity for work on a larger scale and resulted in the origin of numerous plans for the improvement of roads and trails in the forests. As early as 1906, at the request of the Forest Service, the Bureau of Public Roads assigned a highway engineer to cooperate in making a study of road and trail conditions in one of the national forests with a view to planning improvements. As funds were not available little was accomplished at that time except to show the need of funds and a vigorous prosecution of a road program in the national forests.

ROAD SYSTEM NECESSARY.

A system of roads was found to be as necessary for the national forests as for settled communities. They were required for the general administration of the forests; for fire protection and the rapid transportation of fire fighters; for the development of agricultural areas and mining camps within or adjacent to forest areas; for opening intercommunity or transcontinental routes of travel and the making of the forest areas available for the greatest possible recreational use; for the transportation of United States mails and to provide a means of defense in the event of military operations.

For the first two years after funds became available in 1912 the road and trail construction was carried on by engineers of the Forest Service. The money was allotted in small sums to many scattered projects and a large mileage of surveys was made, with the expectation of encouraging local road authorities to extend the short sections of improvements begun with Federal funds. Desired results were not being obtained and this policy was soon changed. The undertakings were cut down to a few of the more important pieces of improvement in each forest district in order to concentrate expenditures and secure earlier completion.

In 1914, upon the request of the Forest Service, an experienced highway engineer of the Bureau of Public Roads was assigned to five of the western forest districts to advise and assist the district foresters in road and bridge work and furnish the engineering supervision for the work within the district. Similar work in the Missoula Forest district was handled by a Forest Service road engineer. With further concentration on the more important proj-



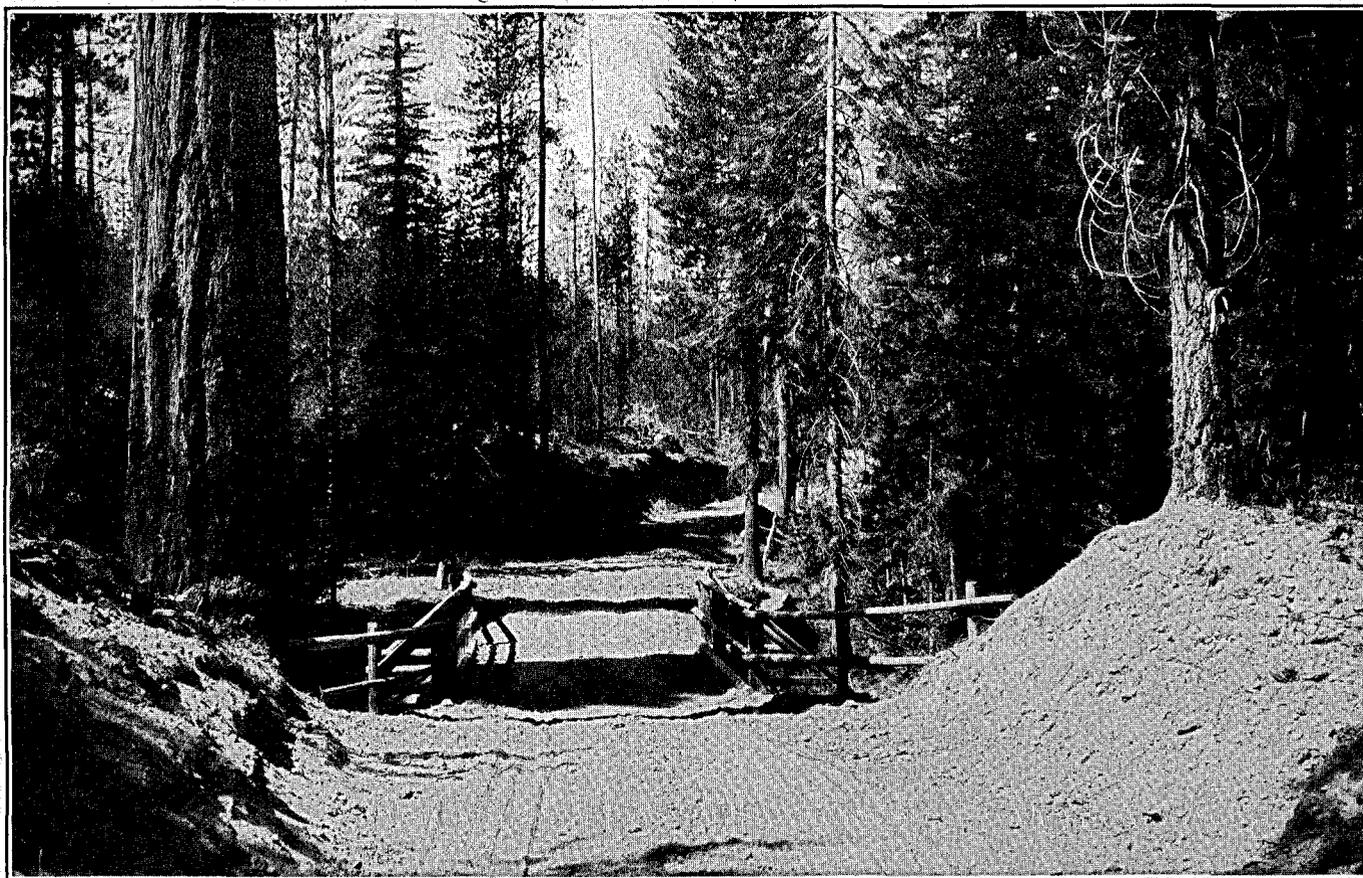
FIRST SECTION OF SEDALIA-DECKER SPRINGS ROAD, PIKE NATIONAL FOREST, COLORADO. WORK DONE ENTIRELY WITH ROAD GRADER.

ects a good beginning had been made on the construction program in each district at the close of 1916.

COOPERATION BRINGS RESULTS.

Under this system the mileage of reconnaissance and location surveys was extended and a considerable number of construction projects were carried on within the national forests. In the five districts to which representatives were assigned the surveys were made either by the highway engineer representing this office or under his direction. Construction work was carried on by the Forest Service forces under the supervision and guidance of the Bureau of Public Roads representatives. Notwithstanding the small funds available much good was accomplished by this cooperative arrangement. More satisfactory results have been obtained through an arrangement whereby the responsibility of each bureau is more definitely established, and through the better class of engineering supervision which the larger construction projects permit.

The Federal-aid road act was passed in 1916. Section 8 of the act makes available the sum of \$1,000,000 annually for the period of 10 years for



ROAD THROUGH THE CRATER NATIONAL FOREST, OREGON.

the survey, construction, and maintenance of roads, trails, and incidental bridges within or only partly within the national forests when necessary for the use and development of resources upon which communities within and adjacent to the national forests are dependent. The act provides that the work under these funds be carried on under cooperative agreements with local authorities on a basis equitable to both parties. The rules and regulations, promulgated by the Secretary of Agriculture for the carrying out of the work under the act, provide that the cooperator shall contribute for expenditure by the department at least 50 per cent of the cost of the work and also the entire cost of maintenance on roads constructed under the act, unless a satisfactory showing be made that such amount of cooperation is inequitable. This in effect makes available for the construction of so-called "section 8" national forest roads slightly more than \$2,000,000 annually and, in general, relieves the Government of the cost of maintenance of roads constructed under the act.

RESPONSIBILITIES FIXED.

The establishment of a complete Federal highway engineering organization throughout the country was made necessary by that portion of this act providing \$75,000,000 of Federal funds and at least an equal amount of State funds for post-road construction.

For this reason, and in order to concentrate Federal highway engineering activities, the Secretary of Agriculture placed with the Bureau of Public Roads the responsibility for all engineering and construction work on the national forest roads and cooperative forest roads to be built under section 8 of the act. At the same time he placed with the Forest Service the responsibility for the general administrative work necessary in selecting the roads to be constructed, securing cooperation and cooperative funds, arranging the allotment of funds and financing of projects and, in general, harmonizing the scheme of road construction with the requirements of the national forests.

Independent of the "section 8" funds there still becomes available to the Forest Service annually for road and trail construction located entirely within National Forest areas, the so-called "ten per cent" fund. This fund during the current year amounted to \$350,000, of which approximately 60 per cent is allotted by the Forest Service for expenditure by the Bureau of Public Roads on surveys and road construction work on major projects, which usually are financed by an equal amount from cooperators, but which may, if desired, be constructed entirely with Federal funds. The remainder is expended directly by the Forest Service on the construction of trails and on minor road construction and maintenance

projects carried on by the forest supervisors and their force of rangers under the direction of the district foresters.

WORK IS FACILITATED.

The reorganization of the forest road engineering and construction work along the lines above indicated went fully into effect January 1, 1917.

The procedure, so far as the Bureau of Public Roads is concerned, is practically the same on both the "ten per cent" and "section 8" work, except that all construction and engineering under the "section 8" work is handled by this office while in the case of "ten per cent" work the Forest Service carries on the construction of trail and minor projects, and allots to this bureau only that portion of the fund to be used on so-called major projects which require handling in the same manner as the larger "section 8" projects.

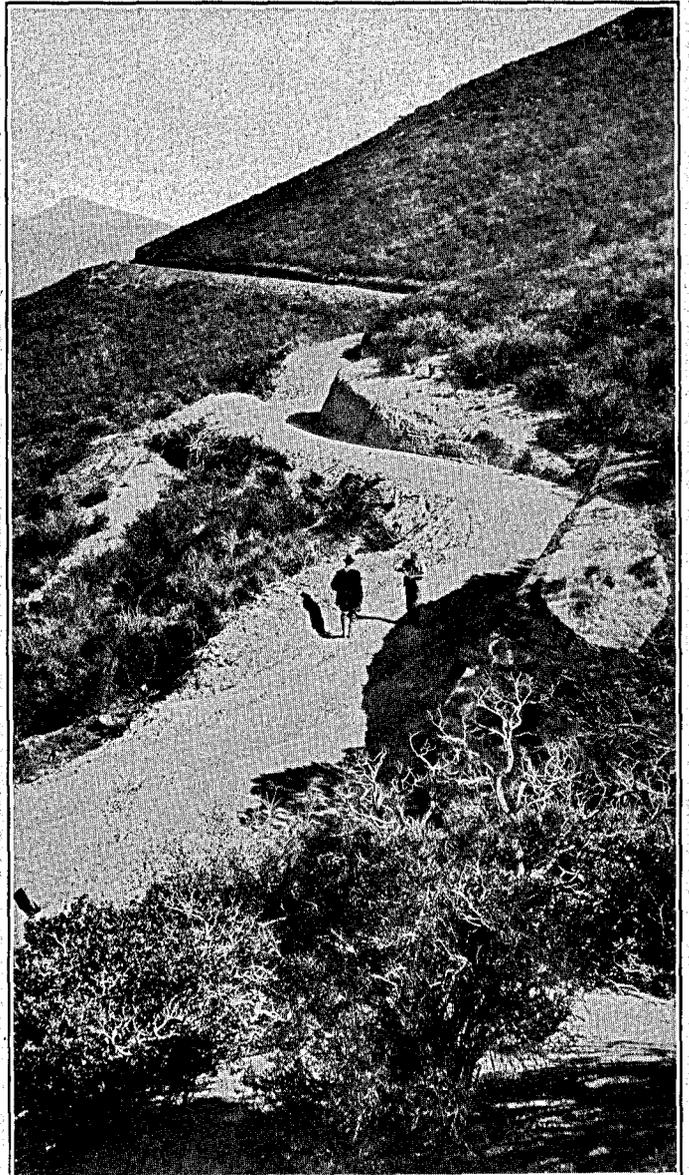
The boundaries of the road districts, so far as the handling of forest road work is concerned, have been made to conform with the boundaries of the forest districts regardless of State lines, in order that each district forester may deal with only one district engineer. The national forests are largely located in the Western Mountain States and Alaska.

The forest road work of the Bureau of Public Roads in the six western forest districts is in charge of three district engineers under the supervision of the Washington office. Each district engineer handles the work within two forest districts.

PREPARE "WORKING PLAN."

Under the procedure recently perfected, the Forest Service and the Bureau of Public Roads in close cooperation prepare by States and districts during January of each year, and issue to the various offices concerned, the annual "working plan," which sets forth definitely the work to be done during the calendar year, and shows the exact allotments of funds to be made to each project and to general administration, as well as contingent allotments to take care of unforeseen expenditures or increase in costs. This plan indicates the administrative decisions by the Forest Service concerning the work to be done based upon estimates and reports of the engineers of the Bureau of Public Roads, in which this bureau shows the results of its investigations as to the labor supply and the practicability of carrying on construction work or the other activities under consideration.

The "working plan" is prepared principally in the field offices during an inspection by supervising representatives of the two bureaus. It shows by projects the work to be done during the calendar year on preliminary investigations, reconnaissance surveys, location surveys, and construction. Allotments of funds in accordance with this plan are made



SECTION OF LAGUNA ROAD, CLEVELAND NATIONAL FOREST, CALIFORNIA. INEXPENSIVE TYPE OF CONTOUR ROAD.

directly to the individual projects in case of survey and construction work and to the road district for overhead work and the preliminary investigations and reconnaissance surveys. This plan and system of allotments prevents the undertaking of work in excess of funds available and makes possible a businesslike planning of the season's work, so that funds will not be lacking to carry it out and cover all liabilities to the end of the season. From the "working plan" district engineers may lay out the season's work economically and determine the order and locations of assignments for the units of their engineering and construction organizations.

WAR CONDITIONS GOVERN.

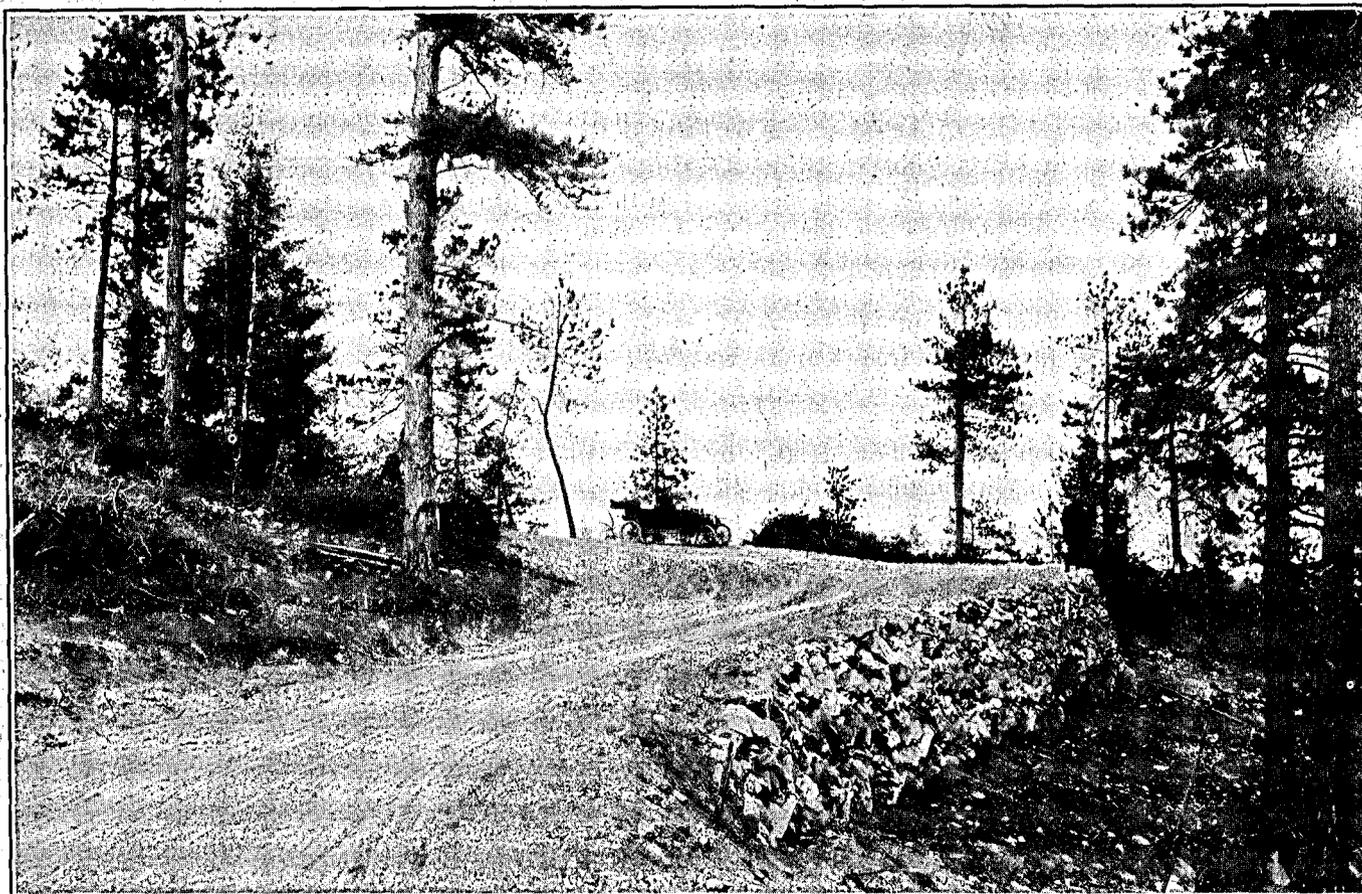
In preparing the plan for this year's work it became necessary to give first consideration to war conditions. This involved not only the effect which

the present abnormal financial and labor conditions would have upon the conduct of the work but the effect which the construction of each project might have on the winning of the war. These considerations caused the volume of construction for the season to be reduced to a minimum. At the same time they caused the postponement of some surveys. It was considered, however, that so long as men might be found available it would be good policy to advance surveys and plans, in order that a larger volume of work might be in readiness at the close of the war in the event it then should be found desirable

rich agricultural areas and increase food production. Construction work was postponed on each project unless it would contribute in some such manner to war activities or could be constructed with local labor between crop and fire-fighting seasons without interfering with labor on essential war industries.

ELIMINATING UNLIKELY PROJECTS.

Preliminary engineering examinations or reconnaissance surveys of proposed projects under section 8 funds are made before cooperative agreements are entered into with local authorities for complete



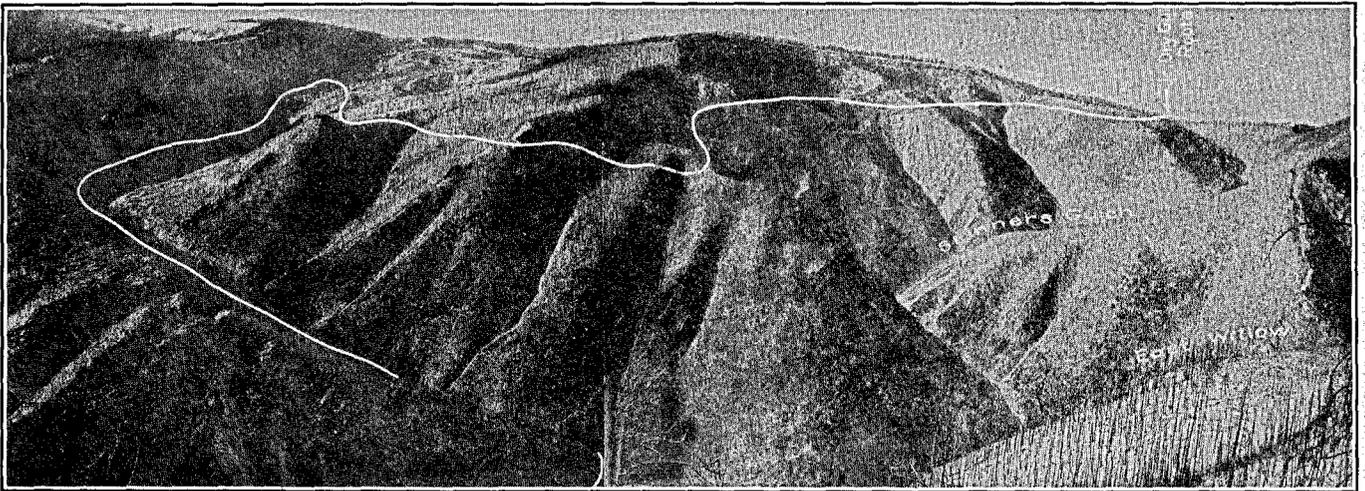
SWITCHBACK ON SECTION OF SEDALIA-DECKER SPRINGS ROAD, PIKE NATIONAL FOREST, COLORADO.

to increase public work and open up the forests and adjacent agricultural country during the period of readjustment which must follow.

It was found that some projects would open valuable tracts of spruce timber needed in aeroplane construction, while others would reach timber resources required for shipbuilding and other construction affecting war industries. Certain roads would make isolated but very essential mining activities accessible to railroad transportation. Others would make possible the distribution of local coal deposits or firewood needed by valley communities and near-by towns to relieve the fuel and transportation conditions. Some projects would immediately open up

location surveys or construction. This prevents squandering funds on location surveys of roads before it is determined finally that cooperative funds will be available for construction. Under this procedure the location survey follows the making of the cooperative agreement, and causes the cooperator to share in the expense of the survey. Similar procedure is now employed in connection with most of the Forest road projects under the 10 per cent funds.

Before the adoption of this method, hundreds of miles of location surveys had been made with the hope of securing cooperation, which in many cases has since vanished, leaving the work of slight value



SHOWING RECONNAISSANCE SURVEY OF THE ALTERNATE ROUTES FOR THE WHEELER NATIONAL MONUMENT TRAIL THROUGH THE BURNED-OVER REGION RIO GRANDE NATIONAL FOREST, COLORADO.

to the future. A preliminary engineering investigation or a relatively inexpensive reconnaissance survey can be extended without great expense over a large mileage of proposed projects. This exploration or pathfinding not only furnishes estimates and data necessary for the working out of the general Forest road plan and for any desired cooperative agreements preparatory to construction, but at the same time eliminates impossible locations and indicates the general location to be followed later by the locating party, which may begin its work with confidence that the desired location can be carried through to the end of the line without loss.

PRACTICAL EXPERIENCE ESSENTIAL.

In this preliminary engineering work the one important consideration is the practical experience of the field engineer performing the work and his ability to visually compare the quantities and construction difficulties with other similar projects on which he may have made location surveys or handled construction. It is found that the qualifications of the man have more to do with the accuracy of his report and estimate than instruments or other means employed by him on the work.

One of the principal difficulties experienced with all estimates has been the rapid increase in the cost of work and inability to forecast costs which are still soaring.

PRELIMINARY AND FINAL SURVEYS.

Only preliminary investigation by the field engineer is made where the prospect of further work appears remote, and it is also used for the review of old surveys or preliminary lines which have been made by private parties or local officials. Under the more favorable conditions the estimates from this type of work can be used in cooperative agreements without a further reconnaissance. As a rule, however, the preliminary investigation is not made

if the chances are good for a cooperative agreement in the near future.

Cooperative agreements are generally based upon so-called reconnaissance surveys, the work of which is more intensive than the preliminary investigations. An effort is made to secure an estimate within 25 per cent of final quantities. This may be done by the experienced man with comparatively little instrument work, while the estimates of less experienced men will more often fall outside of this limit regardless of elaborate observations, notes, plans, or computations.

After a cooperative agreement has been entered into and the project has been financed, location surveys are made in the usual manner.

In order to meet constantly rising costs and the serious shortage of men of experience it has been found necessary to reduce the survey and plan work to the simplest possible terms consistent with economical location and design and in keeping with the proposed construction expense. In some cases where construction is light and location conditions are easy the survey and plan work will resemble the so-called "preliminary survey" of railroad practice. The relative experience and efficiency of the locating engineer is found to affect the cost of the survey and plans by a large percentage. In some cases on less important roads and under favorable conditions it has been possible to construct from an intensive reconnaissance survey without further instrument work.

During the season of 1917, which was the first following the reorganization of forest road work in accordance with the new act, a considerable length of time was required in most districts for the negotiation and execution of desired cooperative agreements before the Bureau of Public Roads could be authorized to make surveys preparatory to construction. While a few location surveys could be

started early, the bureau was not in receipt of authorization to begin work on the majority of them until after the middle of the working season.

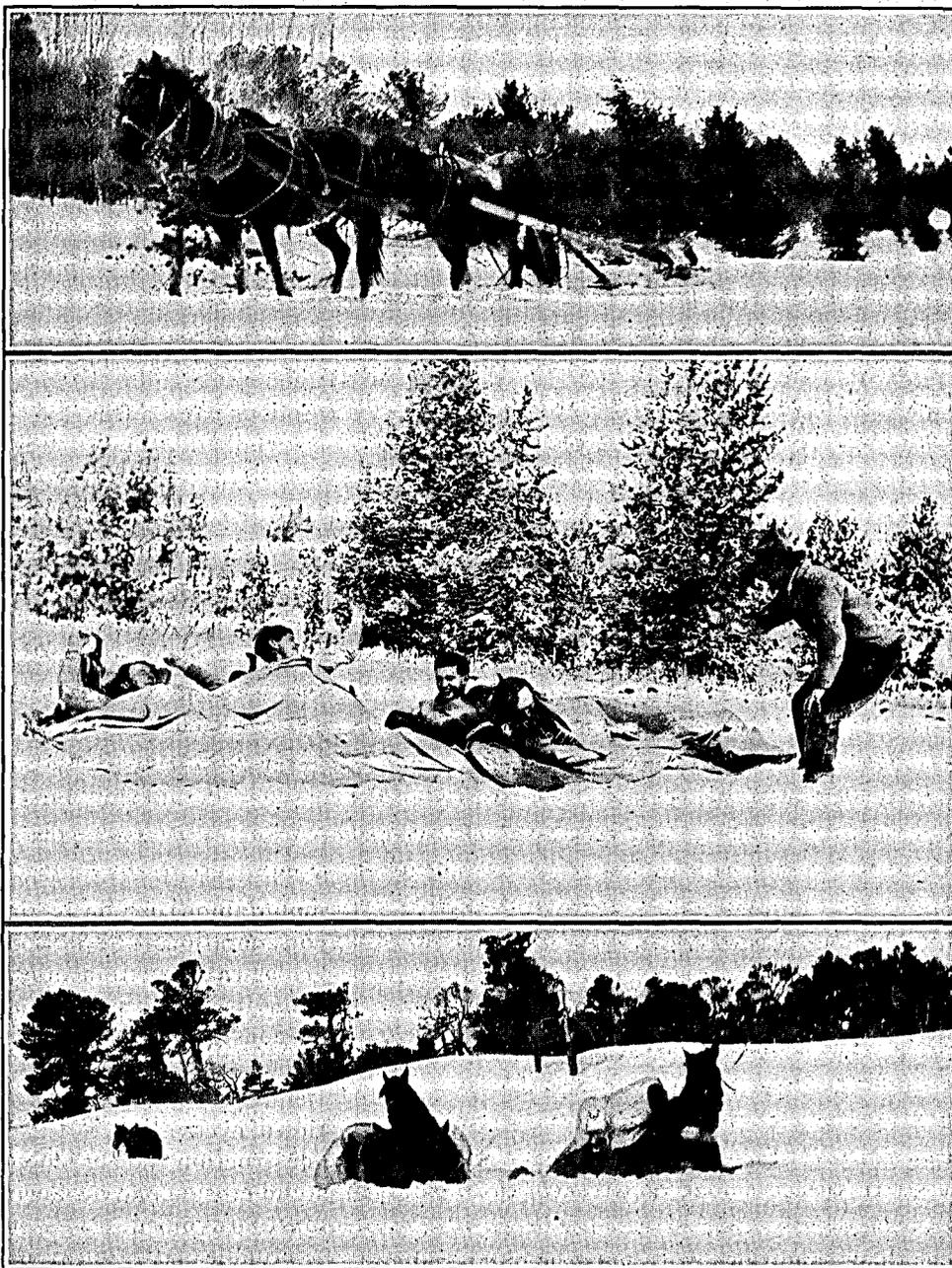
WAR CALLS THE ENGINEERS.

A large proportion of the experienced field engineers of the organization answered the first call of war and entered officers' training camps. Many of the younger men rolled their blankets and prepared to follow, making it necessary to recruit new survey parties as the work materialized. Available men with western mountain road experience became rare as soon as road building units began to be organized for overseas service. It was a high privilege to furnish road builders to become officers who are now taking active parts in building the "road to Berlin." It was, however, a task to organize and train temporary and relatively inexperienced survey and field men to be sent out on a few days' notice on mountain road surveys. As many men as possible with western experience were secured. It became necessary, however, to supply a considerable number from the east where road building organizations were suspending work.

Although no surveys on section 8 projects could be completed in time for beginning construction last year, good results were obtained considering conditions and the work is progressing this year in a more satisfactory manner as greater experience has been gained in the selection and placing of men who are not so likely to be called or accepted for military service.

FOREST ROAD SURVEY WORK.

During last season and until July 1 of this year, the following number of projects and mileage of forest roads had been surveyed by the office:

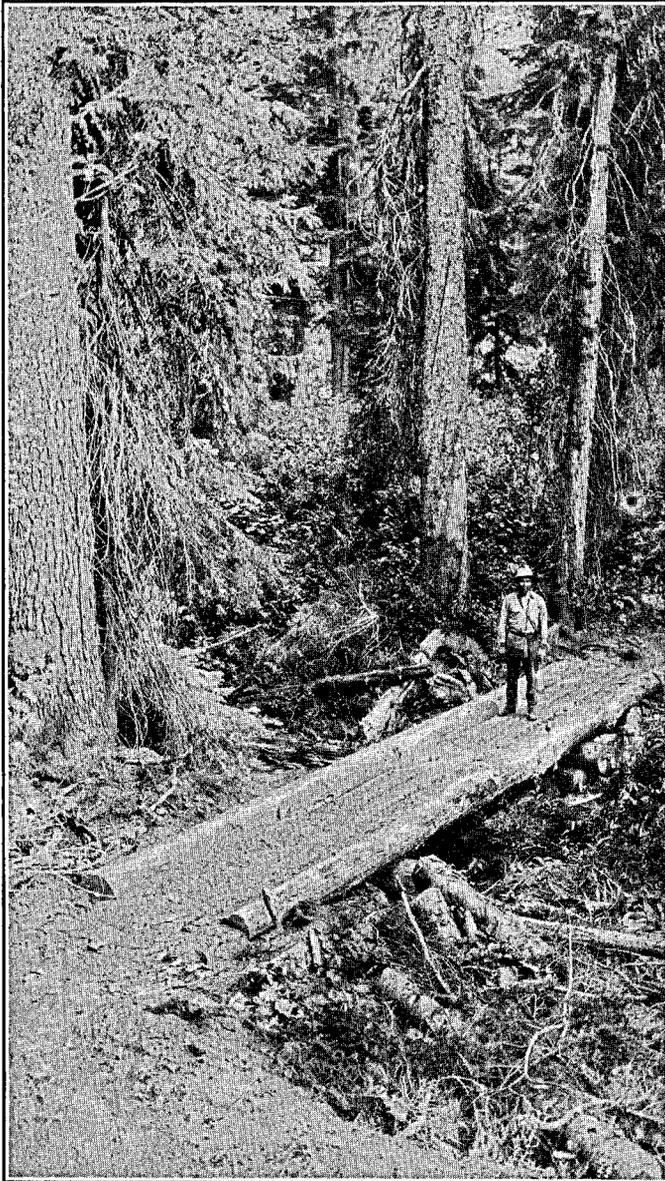


TOP AND BOTTOM—TRANSPORTING MAILS IN WINTER ALONG PROPOSED PROJECT, SHOSHONE NATIONAL FOREST, WYOMING. CENTER—OPEN-AIR LODGING FOR A SURVEYING PARTY.

	Miles.
Sixty-four preliminary investigation projects.....	1,574
Fifty-six reconnaissance survey projects.....	1,146
Thirty-nine location survey projects.....	795

Total mileage all classes survey..... 3,515

Much of the work is located at high altitudes where heavy snow remains until late in the spring. The streams carrying away the melting snow remain at flood stage making them difficult to ford until the last of June and in some cases even later. In such places the snow may begin to fall again in September and often stops field work before October. Although the work is located in every climate from the torrid desert, through regions of excessive rainfall and high timberline altitudes to the frozen forests of Alaska, the average season for efficient work is short.



TYPICAL SMALL TIMBER BRIDGE ON A FOREST ROAD PROJECT WHERE PERMANENT MATERIALS ARE NOT AVAILABLE.

Under these conditions work must be organized and rushed as fast as possible while conditions permit.

Although the locating engineer's work, with its interesting problems and the call of mountain and forest, is so fascinating that he is rarely content thereafter to live in the plains, his existence is a busy one and his hardships real. He soon learns to regard as a luxury his bed made by pounding the earth with an ax to remove the stones and roughest projections, and never has difficulty in sleeping without shelter unless the coyotes howl too much. He is also content with his morning bath in an icy stream and never complains of an all day and night hike to find camp, but the romance of the work gives way to the most serious problem of existence when, on a long lonesome reconnaissance a week's travel from base, he wakes in the morning to find that a

neighborly bear has visited camp, destroying his light grub pack and making away with the bacon upon which he had relied for subsistence on his return journey. If to this is added the sadness of finding that his horses have slipped their hobbles and disappeared completely, leaving him afoot, hungry, and four days from grub, his misery is complete. When a survey party sets forth with a standard camp, living conditions are usually good. The hardships are more often encountered on the long reconnaissance surveys when an attempt is made to travel with little equipment, depending upon game and good fortune for subsistence. Some sections can be traversed more easily by waiting for snowfall and using snowshoes or skis. In Alaska the dog train is useful. It is not an uncommon experience for the party to bunk in the snow without tent.

Occasionally the survey must be carried along the face of precipitous slopes and rocky cliffs where a misstep or a loosened rock would be disastrous. In such cases long ropes from above suspend the men or protect them from accident. In 1916 one member of a survey party on this work lost his life from a fall of several hundred feet on account of not taking such precaution.

LOCATING ROADS IN THE MOUNTAINS.

The selection of a location for forest roads in mountainous regions is influenced by a number of considerations in addition to line and grade. The geological formation may become a deciding factor, while it always has an important bearing upon cost of construction and maintenance as well as the safety of the road for traffic. A study of the formation is not only necessary in estimating the classification of excavation, but in order to so locate that after construction the cut slopes and fills will safely withstand erosion and displacement. Dangerous ground must be avoided.

Trouble may result from the sliding of unsupported rock strata on steeply inclined beds lubricated with talc or clay-like materials. Irresistible land slides of wet earth varying in size from very small areas to hundreds of acres in extent may carry away entire embankments or close cuts until their maintenance would become very discouraging, if not impossible. Such slides may carry the road out of position only a few feet in a year's time or may overnight carry away all trace of the road with the effect of an avalanche.

In one case a reconnaissance survey and study of the underlying formation showed that it would be considerably cheaper and result in a more satisfactory roadbed to adopt a location following a rugged canyon, where considerable quantities of rock excavation would be required in preference to an alternate



SURVEYORS' CAMP AMONG THE FERNS IN OLYMPIA NATIONAL FOREST, WASHINGTON.

route over easy rolling highlands where excavation quantities would be less. The easy appearing location was found to be the more expensive one due to the fact that the road would extend for miles over the immediate surface of a thick strata of tough sandstone requiring small excavation quantities, but unusually high unit costs because of the shallow cuts and the nature of the rock, while the canyon route passed generally through the rock débris slopes below limestone cliffs underlying the sandstone formation which appeared at the rim of the canyon. The last location, although requiring the excavation of larger quantities of rock, was found to be the less expensive due to the lower unit costs. The limestone also afforded an excellent road surface.

Preference is usually given to the slope which is most exposed to the sun. The rock formation on such an exposure is usually more disintegrated, and therefore weathered down to an easier slope which will require less expensive excavation. The warmer slope will usually be closed by snow for a shorter season and presents fewer subdrainage problems.

SINGLE-TRACK ROADS CONSTRUCTED.

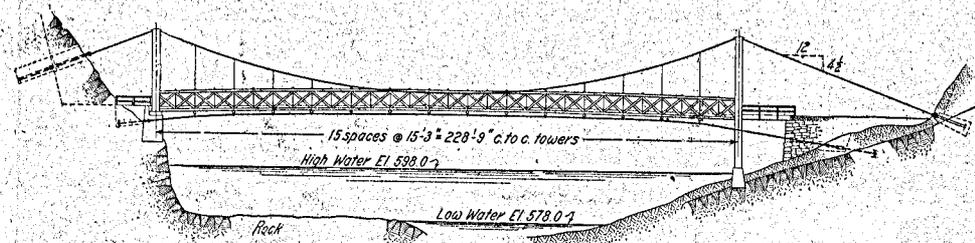
Because of the limited funds the building of forest roads frequently becomes a question of "getting through" and establishing communication with an

unsurfaced narrow road, which will open up the country and serve as a beginning for further construction as conditions make possible. This requires that the grades be laid out with a view to future development in order that it may be necessary only to widen the roadway and at the same operation improve the alignment at the sharp points.

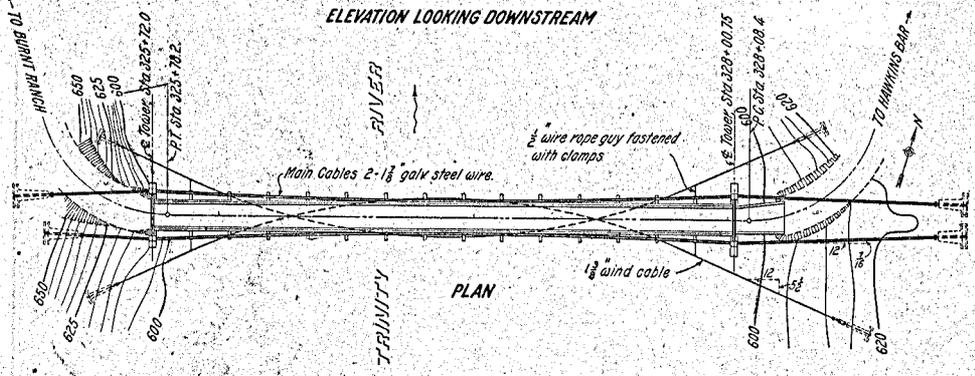
If a single-track road is used, frequent turnouts are provided at such points that approaching traffic may be seen after it leaves the first turnout ahead. These narrow roads are constructed on lateral routes or inter-community roads on which it is not expected that heavy travel may set in at once.

Even on a road which is to serve as a connecting link of an important through highway, insufficient funds occasionally make it necessary to construct a single-track road on short expensive sections. Such a road, well maintained, safeguarded, and provided with ample turnouts, can handle a relatively heavy mountain road traffic which is more uniformly distributed throughout the day than on roads near thickly settled communities.

On the more important routes double-track roads are built whenever possible. The widths depend upon the cost of excavating and the durability of the material, the safety of the road along the edge of fill, and the general difficulty of construction. It is economy to avoid the building of intermediate



ELEVATION LOOKING DOWNSTREAM



PLAN

GENERAL NOTES

Placing the cables. Concrete the cable anchors firmly into the solid rock walls of the canyon, taking care to place the rods in line with the cable, as shown. Allow concrete to set two weeks (temperature above 40°) before cables are swung into place. Sockets should be so located on cable that the elevation of the cable at the center of span under its own weight, will be 3" higher than that shown on the elevation, while the adjustable anchors are at mid position (so as to allow for future adjustment either way).

Housing of towers. Entire timber framework of towers to be housed for protection from the weather, by shakes, shingles, or 1" sheathing securely nailed to proper planking so as to allow a space of 1/4" between housing and plane of posts.

Wind load cables. Cables to be of 1 1/2" galv wire rope having ultimate strength of 150,000 lbs. Cables to be anchored firmly to walls of canyon same as main cables.

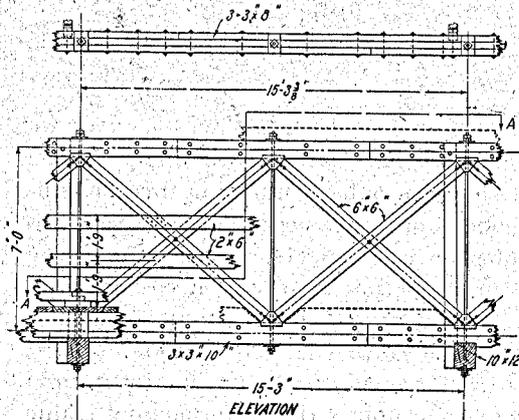
Stiffening trusses. Panel lengths specified for top and bottom chords should be strictly adhered to in order to provide the camber of 1-3", which camber (together with proper adjustment of hangers) will give the elevations of roadway at panel points as shown in general elevation.

East approach span. Use 20 ft. stringers supported at east end by masonry abutment or rock fill. Use 3x12 stringers @ 18" c.c. or 2x12 @ 13" c.c. Provide suitable guard rail of 4x6 posts and 2x6 rails. Widen roadway to 14'-0" at abutment end.

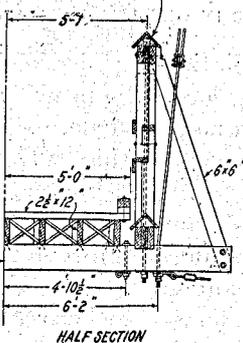
Timber (except hard wood blocks) to be fir, for which the following stresses are used:
 Bending, extreme fiber stress..... 1500 #/sq in.
 " longitudinal shear..... 100 "
 Compression, perpendicular to grain..... 200 "
 " " parallel to grain..... 1000 "
 " " values 10 to 30..... 1200 - 2000 "
 Tension..... 1500 "
 Hardwood blocks to be of good quality white oak or live oak.

Live loads: One typical 5-ton truck, or 50 lbs per sq ft uniform load.
 Impact allowance, 30% of live load.
 Dead load: 500 lbs per lin. ft. of bridge.
 Wind load = 30 #/sq ft on twice projected area.
 Max. stress in cable = 167000 lbs.
 All concrete 1-3-6 mixture.

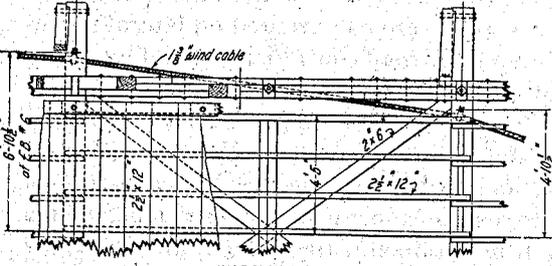
Note: After truss is in place, cover both top and bottom chords with 1" plank roof for protection from weather. Nailed securely to 2x5x10" blocks spaced 6'-0".



ELEVATION

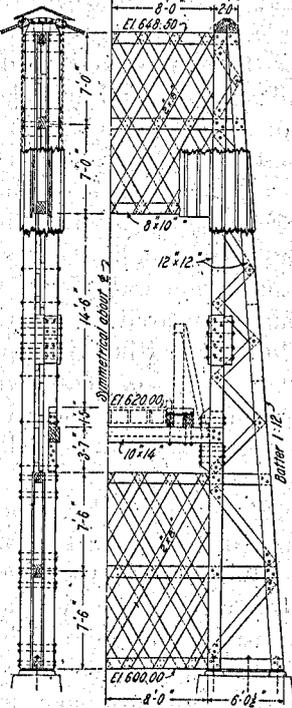


HALF SECTION



HALF PLAN A-A

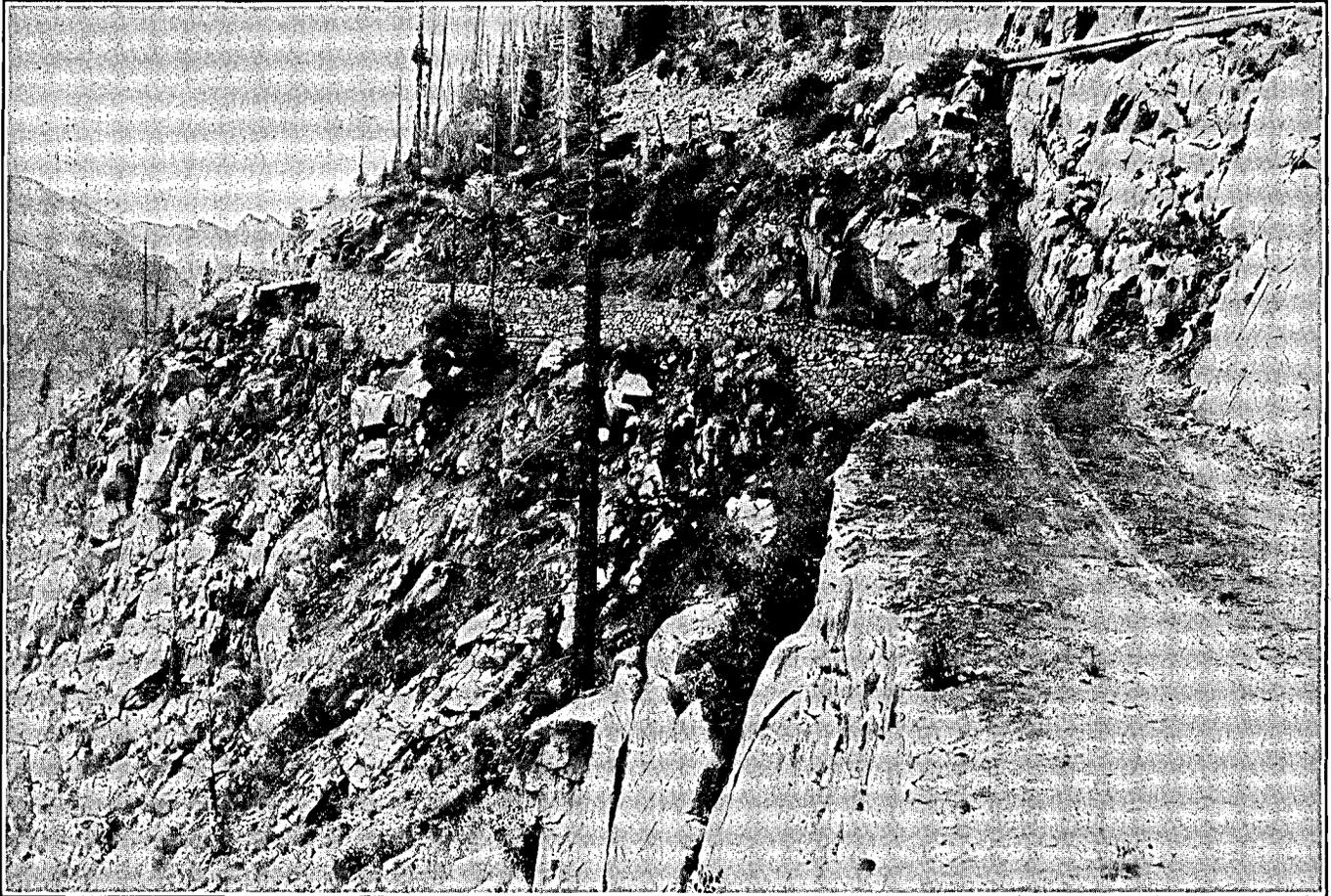
TYPICAL INTERIOR PANEL OF STIFFENING TRUSS



DETAIL OF EAST TOWER

BUREAU OF PUBLIC ROADS
 WASHINGTON, D. C.
LAYOUT AND PLAN
SUSPENSION BRIDGE
 OVER
TRINITY RIVER-HAWKINS BAR ROAD
 TRINITY NATIONAL FOREST
 TRINITY COUNTY
 CALIFORNIA
 1918

CORRECT *D. L. Ginn*
 BRIDGE ENGINEER
 APPROVED *D. J. Milward*
 CHIEF ENGINEER



TYPICAL SECTION DURANGO-SILVERTON ROAD, DURANGO NATIONAL FOREST, COLORADO, SHOWING RETAINING WALL.

widths which are wider than necessary for a single-track road and too narrow for double-track.

DRAINAGE AND STORM PROTECTION.

Rain and snow fall more heavily and for a longer period in the altitudes at which these roads are generally located than in the valley regions. This requires special attention to surface drainage and storm protection. The cross-section of gutter ditches is varied with the volume of water and the nature of the soil. When there is little water to be carried the gutter is decreased and so graded that it may serve as a portion of the roadway. This is possible when cutting through rock or durable materials which are not readily softened by the gutter water. Such variations of width result in considerable savings in excavations on expensive sections of road.

Notwithstanding the fact that pipe culverts are placed at frequent intervals to carry the gutter water across the road, it is necessary in many places to make the gutters wider and deeper than would be used on the average State highway. Deep snow drifts form along the cuts and in the gutters. When the snow melts the rate of run-off is very high and the gutters are obstructed by the drifts which tend to throw the water across the road where, if concentrated, serious damage may result. Wherever

practicable slope, ditches are used above the top of cuts to divert the water coming down the hillside into culverts. This relieves the road side gutters, facilitates the rapid removal of melting snow from the slopes above and often results in a saving of quantities by reason of the decreased width of road section which can be used in cuts.

After fills become settled the most dangerous points along the road are protected with a heavy rustic guardrail or rough stone wall.

Although primarily constructed for low-speed traffic, it is found that the maintenance of forest roads is decreased and traffic safeguarded by slightly superelevating curves sharper than 300 feet radius in order that approaching vehicles may keep to the proper side of the road with safety.

BRIDGE AND CULVERT WORK.

Permanent bridges and culverts of standard design are constructed when funds and materials are available. However, it frequently becomes necessary to use timber or such material as may be at hand. Under present conditions the use of steel is avoided as far as possible. The long distance from railroad generally makes concrete very expensive. In many cases part of the structures must be placed in advance of the grading and therefore

considerably in front of any available wagon road. The materials must then be carried on pack horses over steep trails unless local timber or stone is used. Under these conditions structures of the types shown in the accompanying illustrations are constructed of peeled logs up to clear spans of 70 feet!

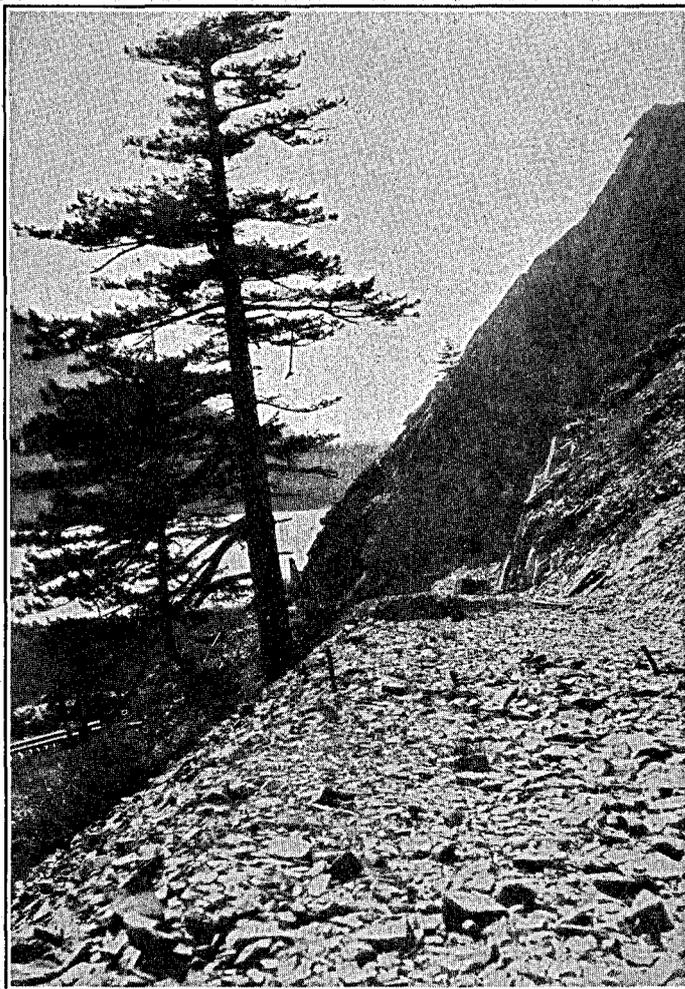
In a dry climate and when using species of timber selected for resistance to decay timber structures are found to have remarkable endurance and are believed to be more economical in some cases than permanent structures, notwithstanding their renewal and maintenance cost. This condition prevails, especially if the timber structure is so built that it can be renewed without seriously interrupting traffic and is located where danger from fire is small.

SUSPENSION BRIDGES OVER CANYONS.

Suspension bridges which can be constructed with the labor and equipment at hand are found to be economical and well adapted to some of the deep canyon crossings of rivers in the national forests. Many bridges of this type are found in or adjacent to forest areas ranging from the crudest home-made foot bridge of barrel staves woven into twisted fence wire or light cable, which gives the sensation of tight-rope walking, to the modern suspension bridge built after good engineering designs. Some unique old bridges of this type, built with inadequate stiffening trusses and poor wind anchorage, are found on old trails. In fact, the stiffening trusses are usually neglected to a considerable degree.

The accompanying drawing shows a suspension bridge being built this season by the Bureau of Public Roads over the Trinity River, Cal., on the Hawkins Bar project. It is on a spur road to reach limited forest products, and is of necessity a very light bridge. In fact the withdrawal of some of the allotted funds and difficulty in securing the required cable under war conditions made it necessary before beginning construction to decrease the loading from a 5-ton to a typical 3-ton truck. The stiffening trusses shown in this design should provide a rigid floor system under traffic. The bridge is secured against wind action by a pair of opposed wind cables placed below the floor and adjusted to secure lateral stiffness by pulling against each other throughout the length of the bridge, the wind stresses being carried to the shore anchors without affecting the towers.

Such bridges lend themselves to forest road and trail work from the fact that only the cable and a few rods must be imported. A long, heavy cable can be carried from the railroad for many miles over narrow trails on the backs of horses, forming a continuous pack train winding its way through the timber and along steep or crooked trails.



WIND MOUNTAIN SECTION, COOKS-COLLINS ROAD ALONG NORTH BANK OF COLUMBIA RIVER, WASHINGTON, SHOWING CONSTRUCTION AT BEGINNING OF THE SECTION WHERE HIGHWAY MUST BE BLASTED THROUGH ROCK CLIFFS OVERHANGING A HEAVY TRAFFIC RAILROAD, CONSTRUCTION NOW UNDER WAY BY DAY LABOR.

TWO ROADS ADD TO USE OF FOREST.

Comparatively little construction was financed and ready to be undertaken during last season, except work initiated under the old 10 per cent fund. The Laguna road, 14 miles in length, in the Cleveland National Forest, California, was constructed by the office from this fund, and its completion has opened up considerable forest resources, at the same time making this attractive forest available for the recreational use of the people living in the hot interior valleys. Visitors may now enjoy the refreshing breeze from the Pacific and at the same time obtain magnificent views of the country to the east in the vicinity of the Salton Sea and the Imperial Valley:

Construction has been completed this season on the last section of the Teton Pass road which connects the Jackson Hole in Western Wyoming with the outside world by way of Victor, Idaho. This will make possible the hauling of agricultural and

forest products over a road which has heretofore been a serious barrier to traffic.

The construction of a 5-mile section of the Trinity River road in the Trinity National Forest is being carried on by day labor, extending a road previously built by this office. It is also expected that some construction will be done this season on the Heber-Fruitland and Ephraim-Orangeville projects in Utah, if labor can be secured.

DIFFICULT PROJECTS UNDER WAY.

The Alberton project in Montana, along Clark's Fork of the Columbia River, with a length of 4½ miles, is now being constructed under contract, at a cost of approximately \$62,000. This project will complete the worst remaining section in the main transcontinental highway across the northern Rocky Mountains extending through Montana and westerly by way of Spokane. The accompanying photographs show the beginning of retaining wall construction which permits the carrying of this road on a very steep slope between the Northern Pacific Railroad and the river. It is typical of a number of important forest road projects where it becomes necessary to construct a highway along a narrow canyon or gorge already occupied by a river and one or more railroads. Construction under such condition becomes expensive and requires considerable engineering investigation and care. The difficulties in this particular case are less than in other cases where the road construction lies above the railroad. In such cases the blasting and rock excavation must be conducted with the greatest care and at much expense to prevent wrecks and the tie-up of railroad transportation.

A similar project is the Cooks-Collins road in the Columbia National Forest, State of Washington, located along the northern bank of the Columbia River about 60 miles above Portland. This project is now under construction by this bureau on a day labor basis. It is located along a difficult section of the North Shore road and must, in general, be blasted out of solid cliffs in a narrow space above the railroad. The cost is estimated at about \$96,000 for a length of 4½ miles. On the Wind Mountain section of this project. The work will cost at the rate of \$60,000 per mile. High and expensive dry rubble walls must be built to support the road. The completion of the project will extend a road up the Columbia Bank road which was previously constructed to this point by the State of Washington.

An effort was made to construct by contract this season the Quinault Lake road in the Olympic Peninsula in Washington in order to facilitate hauling spruce timber from the forest to the nearest railroad station. It was impossible to secure bids within reason and it is expected that the worst portion of the road will be constructed during the season by day labor if laborers can be secured.



"CEDAR BREAKS" ALONG THE CEDAR-DUCK LAKE ROUTE, SEVIER NATIONAL FOREST, UTAH. SCENERY SECOND ONLY TO THE GRAND CANYON.

The Flora-Enterprise road, 12 miles in length, in the Wallowa National Forest in northeastern Oregon is to be constructed during the season by day labor after failure to receive bids for the work.

FOURTH OF JULY CANYON PROJECT.

Construction under contract has been started this season on a 12-mile section of the Fourth of July Canyon project near Coeur d'Alene, Idaho. This section is estimated to cost \$140,000. It is, in part, located along the shore of Lake Coeur d'Alene and will open up for through travel probably the worst section remaining in Idaho on the northerly transcontinental route crossing the Rocky Mountains by way of Missoula and Spokane.

Following the travels of Lewis and Clark, the importance of this great northerly route across the Continental Divide caused Congress to appropriate \$10,000, with which Capt. Mullen, of the United

States Army, undertook the survey and construction of the first wagon trail across this region. On July 4, 1861, his survey had progressed as far as this project, where he blazed a tree, upon which he inscribed the date. From this incident he gave the canyon its present name. So far as known, this is the only original monument in existence on the Mullen trail, although granite monuments have recently been established at other points through Montana and Idaho to mark its location.

The cost of road building, as well as the requirements of traffic, have indeed changed since 1861, as shown by the fact that each mile of this part of the old Mullen trail now being completed costs more than the amount given to the pioneers for the entire route.

Bids have been requested for the construction of the Sheep Creek and Yaak projects, in Montana, and for the Canyonville-Galesville forest road, which forms a section of the Pacific highway, in Oregon. However, in the light of recent experience on other projects, it is doubtful if bids will be obtained, making it necessary to resort to construction by day labor wherever it appears necessary to proceed with work.

CONSTRUCTION BY DAY LABOR.

Construction by day labor is now under way on the Durango-Silverton road, Colorado. This project is 53 miles long and estimated to cost \$233,000. It appears to be one of the few projects where an ample supply of labor can be secured this season. The illustration on page 15 shows a typical section on one end of this road illustrating the character of construction which will be necessary on much of the work. This particular section was built under an earlier contract, but the road is to be widened at some of the worst points and the retaining walls reinforced as a part of the present project.

Construction is also to be carried on by day labor, provided sufficient forces can be obtained this season, on the three following forest roads in Colorado: Rabbit Ears Pass, length 9 miles, estimated to cost \$20,500; Monarch Pass project, length 27 miles, estimated to cost \$83,500; Sedalia-Decker Springs project, length 18½ miles, estimated to cost \$36,400.

A 16½-mile section of the Deadwood-Hot Springs road in the Black Hills National Forest, S. Dak., is

to be constructed this season at an estimated cost of \$57,500, if labor can be secured.

In New Mexico it has been planned to begin construction this season on the following four projects: Tijeras Canyon project in the Manzano National Forest; the Cimarron Taos project, in the Carson National Forest; the Hondo-Mescalero project, in the Lincoln National Forest; and the Glorieta-Panchuela project, in the Santa Fe National Forest. These projects aggregate 56 miles in length and cost approximately \$215,000. The present labor situation, however, makes it doubtful if much can be accomplished this season on these projects.

Construction has been completed this season on a timber trestle bridge across Cass Lake in the Minnesota National Forest, which will make possible a projected State highway route across Minnesota extending from Duluth on the lakes to a point on the Canadian line in the northwesterly part of the State.

Construction by day labor is now under way on the Ozark road in the Ozark National Forest, Ark., between Russellville and Pleasant Hill, at an estimated cost of \$60,000.

An effort has been made to arrange for the construction of a number of other forest road projects this season. The supply of labor, however, is a serious handicap, and it is apparent that the proposed work of the season will of necessity be greatly curtailed, except in certain localities, where unfavorable crop seasons or other unexpected conditions have resulted in an adequate supply of local labor which is seeking employment. Contracting conditions have been so unfavorable that very few bids have been received.

Because of these conditions it has been necessary to resort to construction by day labor on many projects which were urgently needed but where contractors could not afford to take chances on bidding. Under the day labor method it would be possible to close down at any time without serious loss should it be found inadvisable to continue work. The temporary suspension of work would serve only to delay the proposed improvements for the time being, since the Federal funds remain available until expended.

The force account or the cost plus system will not be employed on any of these forest projects, since the conditions do not appear to warrant undertaking work on such a basis.

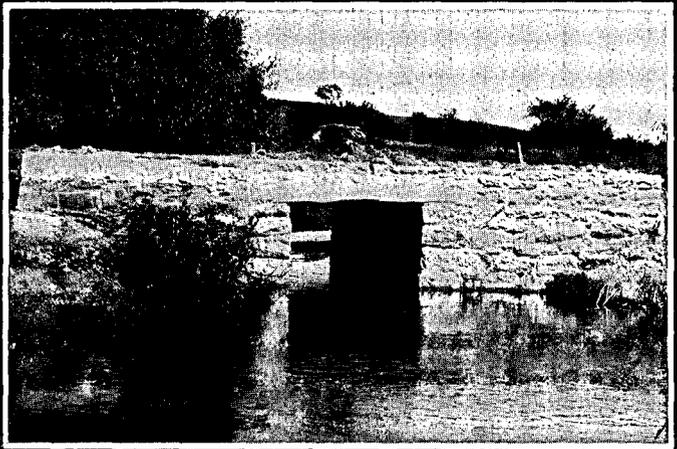
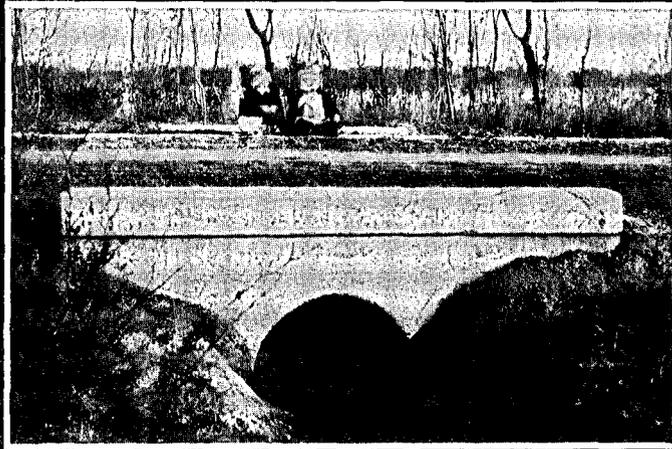
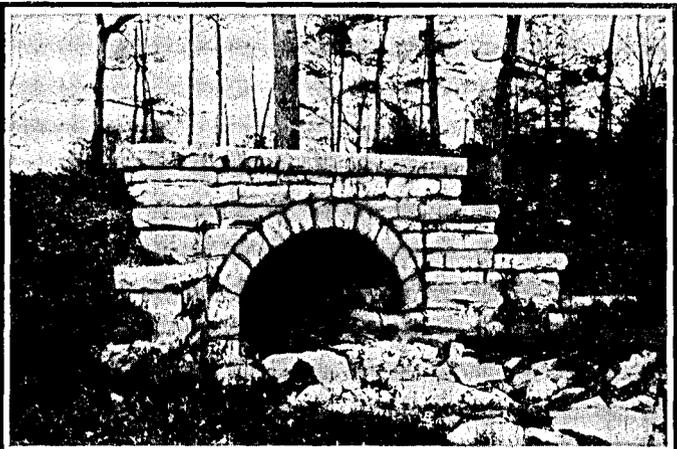
WAR BRINGS BRIDGE BUILDING BACK TO EARLY PRACTICES

By O. L. GROVER, Bridge Engineer, Bureau of Public Roads.

War conditions and necessities govern and must govern all our business and improvement activities. This will continue to be the fact until affairs are brought back to normal conditions after the close of the war. We can not get away from this.

Every road-building project, whether new construction or repair work, must be considered in its bearing on the war work of the country.

The elements affecting highway improvement under war conditions include the labor problem,



TOP, LEFT—BRIDGE AND CATTLE PASS, CALHOUN COUNTY, ALA., COST \$250. TOP, RIGHT—STONE CULVERT IN CHICKAMAUGA PARK, TENNESSEE. BOTTOM, LEFT—HALF ARCH CULVERT IN POTTAWATOMIE COUNTY, OKLA. BOTTOM, RIGHT—CULVERT WITH FLAT STONE TOP AT BRUNSWICK, MAINE.

existing because of the steadily growing scarcity of the country's man power and the increasing demand for that power in war industries, and the limitation in the supply of materials needed in construction, due to both transportation difficulties and to inability of the manufacturers to produce them.

Road building and road repair work must be limited to the essentially necessary work, the construction of only such new roadways as are indispensable in the country's war work and the repair work demanded to keep the highways in usable condition.

Some additional construction may be carried on where local supplies of materials are to be had without taxing the railroad service and where the situation is such that labor may properly be employed on the work.

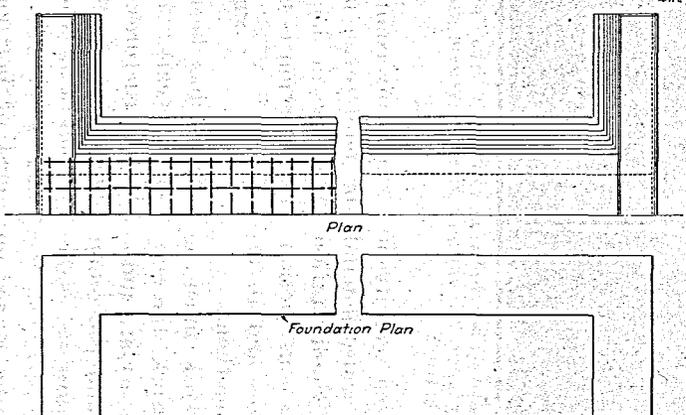
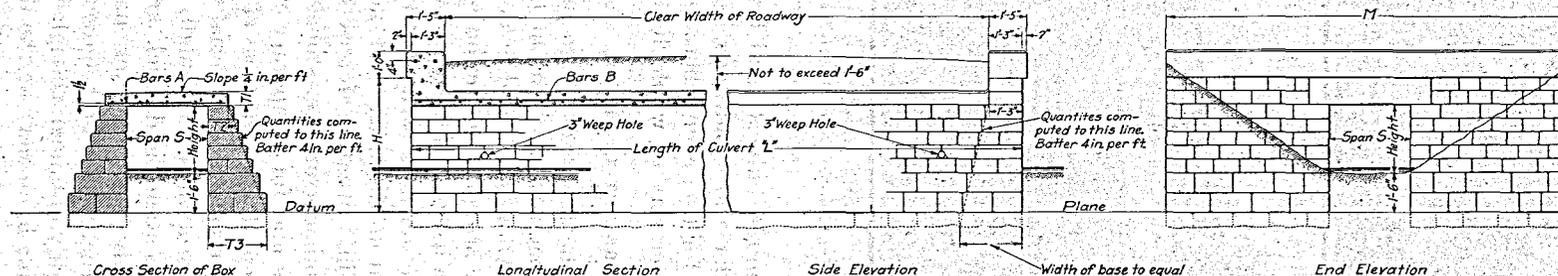
In highway construction attention is paid most often to the building of the road. Perhaps too little attention has been given to the building of bridges, a factor having an important part in the solving of the highway problem. In any construction work necessary under war conditions the bridge problem is likely to be equally if not more serious than that of the road making part.

In many communities culverts and bridges must be built, even under war conditions, to keep the highways in shape for use, even where no new road construction is under way or would be authorized.

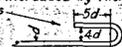
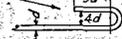
MUST REVERT TO TIMBER.

Steel has been the favorite bridge material for several years. It has been used for small as well as large structures. At present steel is not available in any quantity for bridge construction. It can not be had at all where its use can be avoided, while all large steel construction necessarily must be abandoned or postponed until peace and normal conditions return. This situation forces the use of other material—timber, concrete, stone, and brick.

For long bridges and for temporary work where the cost must be kept down regardless of high maintenance expenses, timber is the material which must be used for superstructures. In small, permanent structures concrete, stone, and brick are excellent materials, preferably in the order named. The character of the structure should be governed by the material most readily obtained, though in some instances the available labor may be the determining factor.



DESIGN DATA: Weight of Paving or Ballast, 180 lbs per sq ft
 Concentrated Load, 15-ton typical truck.
 Impact, 30 per cent of Live Load stresses.

GENERAL NOTES: Specifications, B.P.R. 1919.
 Reinforcing bars shown are deformed bars. Plain bars may be used provided lengths given are increased by twenty diameters of the bars and both ends hooked thus 
 All stone work to be uncoursed. All  "Cement Rubble Masonry", either coursed concrete 1-2-4 mix.

Exposed corners of concrete to be chamfered thus 
 Foundations to be carried to good firm material with a minimum depth below bed of stream of 1ft 6in unless on solid rock.
 Riprap and channel paving to be provided where necessary to prevent scour.
 Railings designed to suit local conditions are to be placed on culverts where required.
 Estimated quantities to be adjusted for length of culvert, footings below Datum Plane and for channel paving and riprap when used.
 Complete permanent records shall be made of each structure as built, showing footing depths and any modifications of this plan.

DIMENSIONS AND ESTIMATED QUANTITIES ABOVE DATUM PLANE

Span S Feet	Height	Area of Opening Sq Ft	Dimensions						Quantities								
			T1	T2	T3	H	M	Size and Spacing of Bars		Per Lineal Foot of Box		Two Curbs		2 End Walls		Total Quantities for Complete Culvert (L=22'-6")	
								A	B	Concrete Cu Yds	Steel Lbs	2 Rubble Side Walls Cu Yds	Total Concrete Cu Yds	Total Steel Lbs	Total Rubble Cu Yds	Concrete Cu Yds	Steel Lbs
2	1'-6"	3.0	6"	9"	1'-9"	4'-0"	11'-0"	1/2"-8c to c	0.06	7.6	0.28	1.3	3.7	3.7	2.7	208	9.4
	2'-0"	4.0	6"	9"	2'-0"	4'-6"	12'-6"	1/2"-8c to c	0.06	7.6	0.36	1.5	4.2	4.5	2.9	213	12.5
3	2'-0"	6.0	6"	9"	2'-0"	4'-6"	13'-6"	1/2"-8c to c	0.08	10.5	0.36	1.6	4.5	4.5	3.4	281	12.5
	2'-6"	7.5	6"	9"	2'-6"	5'-0"	15'-0"	1/2"-8c to c	0.08	10.5	0.44	1.8	5.0	6.0	3.6	286	16.0
4	3'-0"	9.0	6"	9"	2'-6"	5'-6"	16'-0"	1/2"-8c to c	0.11	14.3	0.54	1.9	5.5	7.8	3.7	291	20.0
	2'-0"	8.0	6"	10"	2'-0"	4'-6"	14'-6"	1/2"-8c to c	0.11	14.3	0.37	1.8	4.9	4.4	4.3	370	12.7
	2'-6"	10.0	6"	10"	2'-6"	5'-0"	16'-6"	1/2"-8c to c	0.11	14.3	0.46	1.9	5.4	5.9	4.4	376	16.2
	3'-0"	12.0	6"	10"	2'-6"	5'-6"	17'-6"	1/2"-8c to c	0.11	14.3	0.56	2.1	5.9	7.7	4.6	381	20.2
5	4'-0"	16.0	6"	10"	2'-9"	6'-8"	20'-6"	1/2"-8c to c	0.15	16.9	0.73	2.4	6.9	12.5	4.9	391	28.9
	2'-0"	10.0	7 1/2"	10"	2'-0"	4'-6"	15'-6"	1/2"-8c to c	0.15	16.9	0.37	1.9	5.2	4.4	5.3	432	12.7
	2'-6"	12.5	7 1/2"	10"	2'-6"	5'-0"	17'-0"	1/2"-8c to c	0.15	16.9	0.46	2.0	5.7	5.9	5.4	437	16.2
	3'-0"	15.0	7 1/2"	10"	2'-6"	5'-6"	18'-6"	1/2"-8c to c	0.15	16.9	0.56	2.2	6.2	7.7	5.6	442	20.2
5	4'-0"	20.0	7 1/2"	10"	2'-9"	6'-8"	21'-6"	1/2"-8c to c	0.15	16.9	0.73	2.5	7.2	12.5	5.9	452	28.9
	5'-0"	25.0	7 1/2"	10"	3'-3"	7'-6"	24'-6"	1/2"-8c to c	0.15	16.9	0.93	2.8	8.2	18.6	6.2	462	40.7

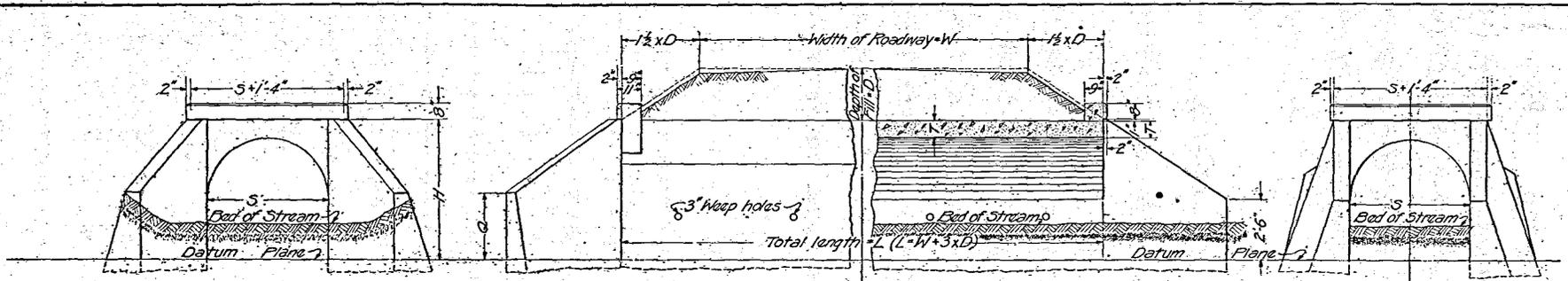
DESIGNED BY: [Name] DATE: [Date]
 CHECKED BY: [Name] DATE: [Date]
 TRACED BY: [Name] DATE: [Date]

BUREAU OF PUBLIC ROADS
 WASHINGTON, D.C.
STONE CULVERTS
 CONCRETE SLAB TOP
 SPANS 2 FT TO 5 FT
 JULY-1918

CORRECT: O. S. [Name]
 BRIDGE ENGINEER

APPROVED: [Signature]
 CHIEF ENGINEER

6-250

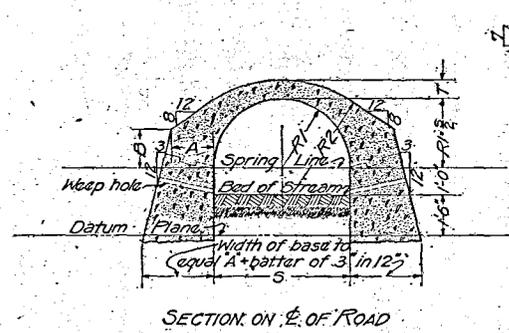


ELEVATION INLET END

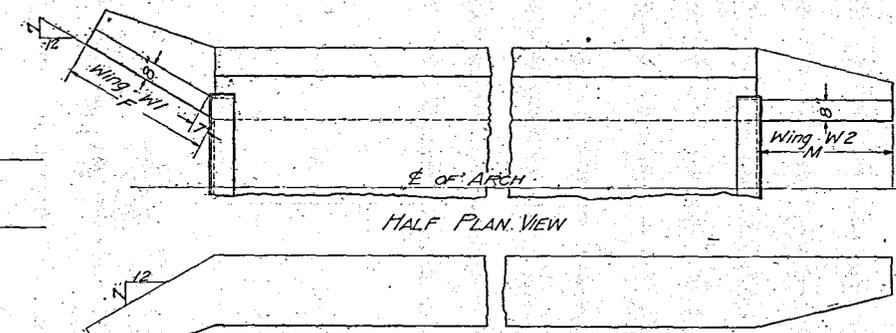
HALF ELEVATION (inlet End)

HALF SECTION ON E OF ARCH (Outlet End)

ELEVATION OUTLET END

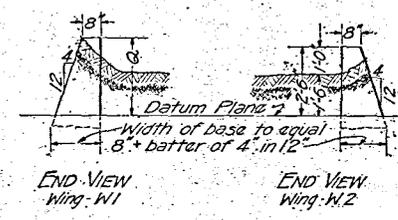


SECTION ON E OF ROAD



HALF PLAN VIEW

HALF FOUNDATION PLAN



END VIEW Wing W1

END VIEW Wing W2

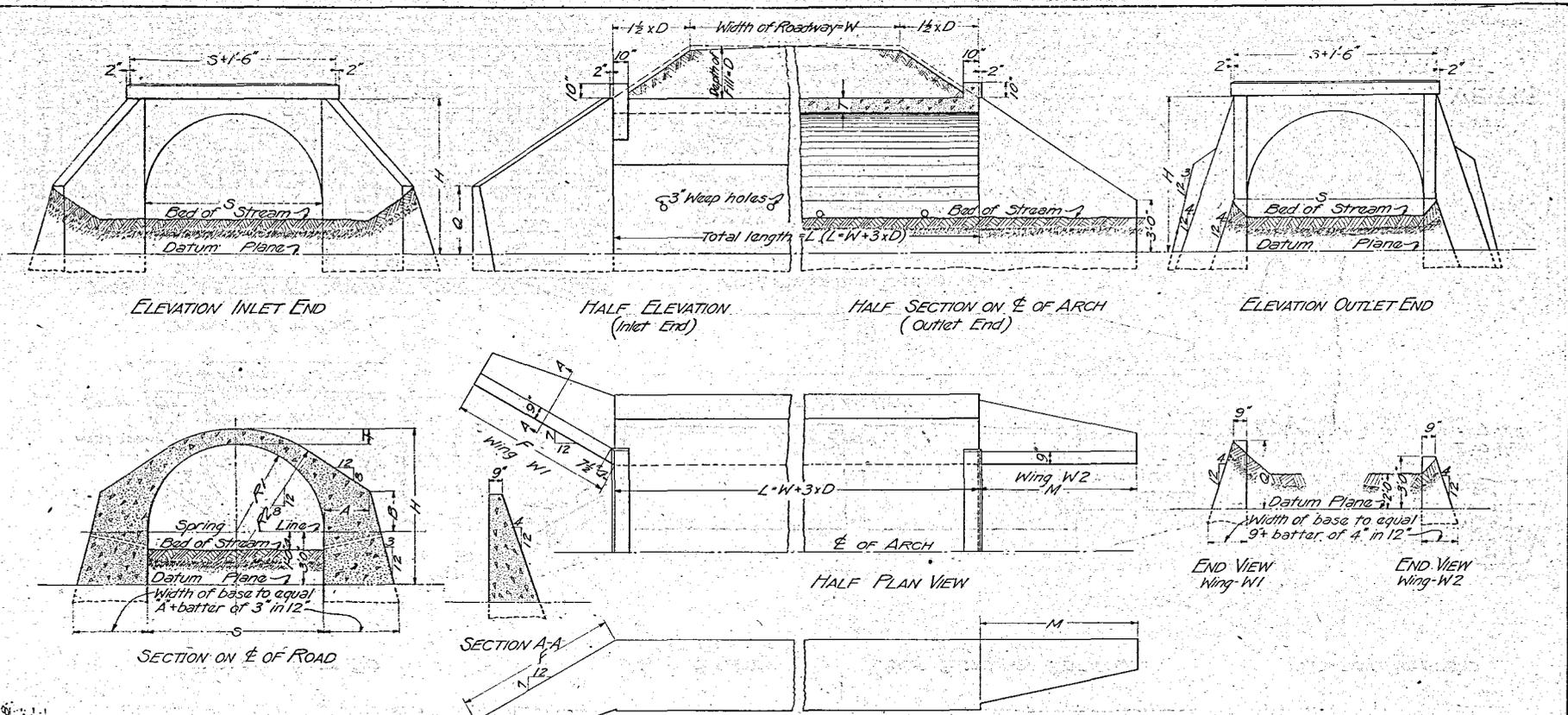
DIMENSIONS & ESTIMATED QUANTITIES ABOVE DATUM PLANE

S	Area of Water Span Ft.	Dimensions										Quantities above Datum Plane in Cu. Yds.				Total for Culvert (S*30')
		Arch										Two wings W1	Two wings W2	Two spandrel Walls	Arch per Lin. Ft.	
		R1	R2	T	A	B	F	Q	H	M	N					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
2	3.6	1-0	1-6	6	8	8	2-6	3-0	4-1	2-6	0.7	0.8	0.2	.30	10.7	
3	6.5	1-6	2-3	6	1-1	9	3-3	3-0	4-7	3-3	1.0	1.1	0.3	.46	16.2	
4	10.3	2-0	3-0	7	1-5	11	4-0	3-3	5-2	4-2	1.5	1.6	0.4	.63	22.4	
5	14.8	2-6	3-9	7 1/2	1-0	1-0	4-9	3-3	5-8 1/2	5-0	2.0	2.2	0.5	.83	29.6	
6	20.1	3-0	4-5	8	2 1/2	1-2	5-6	3-6	6-3	5-9	2.7	2.7	0.6	1.02	36.6	
7	26.2	3-6	5-3	8 1/2	2-4	1-5	6-3	3-6	6-9 1/2	6-7	3.4	3.6	0.7	1.23	44.6	

NOTE: Specifications B. & R. 1913.
 All concrete to be 1:2 1/2:5
 All corners to be chamfered thus: 
 Foundations to be carried to good firm material, with a minimum depth below bed of stream of 1'-6" unless on solid rock.
 Rip-rap and channel paving to be provided where necessary to prevent scour.
 Estimated quantities to be adjusted for length of culvert, foundation below datum plane, and for paving and rip-rap if used.
 Complete permanent records shall be made of each structure as built, showing footing depths and any modifications of this plan.

DESIGNED *J. J. S. Johnston* DATE *June 11, 1918*
 DRAWN *J. J. S. Johnston* DATE *July 3, 1918*
 TRACED *J. J. S. Johnston* DATE *July 3, 1918*
 CHECKED *J. J. S. Johnston* DATE *July 15, 1918*
 Total quantities above Datum Plane for any length of culvert equals L x quantity in column N° 15 plus quantities in column N° 12, 13 and 14.

BUREAU OF PUBLIC ROADS
 WASHINGTON, D. C.
ARCH CULVERTS
 PLAIN CONCRETE
 SPANS 2 TO 7 FEET
 JULY 1918
 CORRECT *O. K. Grover*
 CHIEF ENGINEER
 APPROVED *J. J. S. Johnston*
 CHIEF ENGINEER **G-248**



DIMENSIONS & ESTIMATED QUANTITIES ABOVE DATUM PLANE

S	Area Clear of Water Span Ft.	Dimensions										Quantities above Datum Plane in Cu. Yds.				Total for Culvert L=30'0"
		Arch					Wings					Two wings W1	Two wings W2	Two spandrel walls	Arch per Lin. Ft.	
		R1	R2	T	A	B	F	Q	H	M						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
8	33.1	4'-0"	6'-0"	9'	2'-6"	1'-7 1/2"	6'-9"	4'-5"	7'-9"	7'-3"	4.8	5.0	1.0	1.54	57.0	
9	40.8	4'-6"	6'-9"	9 1/2'	2'-7"	1'-11"	7'-6"	4'-4"	8'-4 1/2"	8'-1"	5.9	6.1	1.2	1.73	65.1	
10	49.3	5'-0"	7'-6"	10'	2'-8 1/2"	2'-2 1/2"	8'-3"	4'-5"	8'-10"	8'-11"	7.0	7.2	1.3	1.96	74.3	
12	68.6	6'-0"	9'-0"	11'	2'-9 1/2"	2'-10 1/2"	9'-9"	4'-8"	9'-11"	10'-6"	9.7	9.8	1.6	2.38	92.5	
14	91.0	7'-0"	10'-6"	12'	2'-11 1/2"	3'-6"	11'-3"	4'-10"	11'-0"	12'-2"	12.9	13.0	1.9	2.90	114.8	

Total quantities above Datum Plane for any length of culvert equals L x quantity in column N^o 15 plus quantities in column N^o 12, 13 and 14.

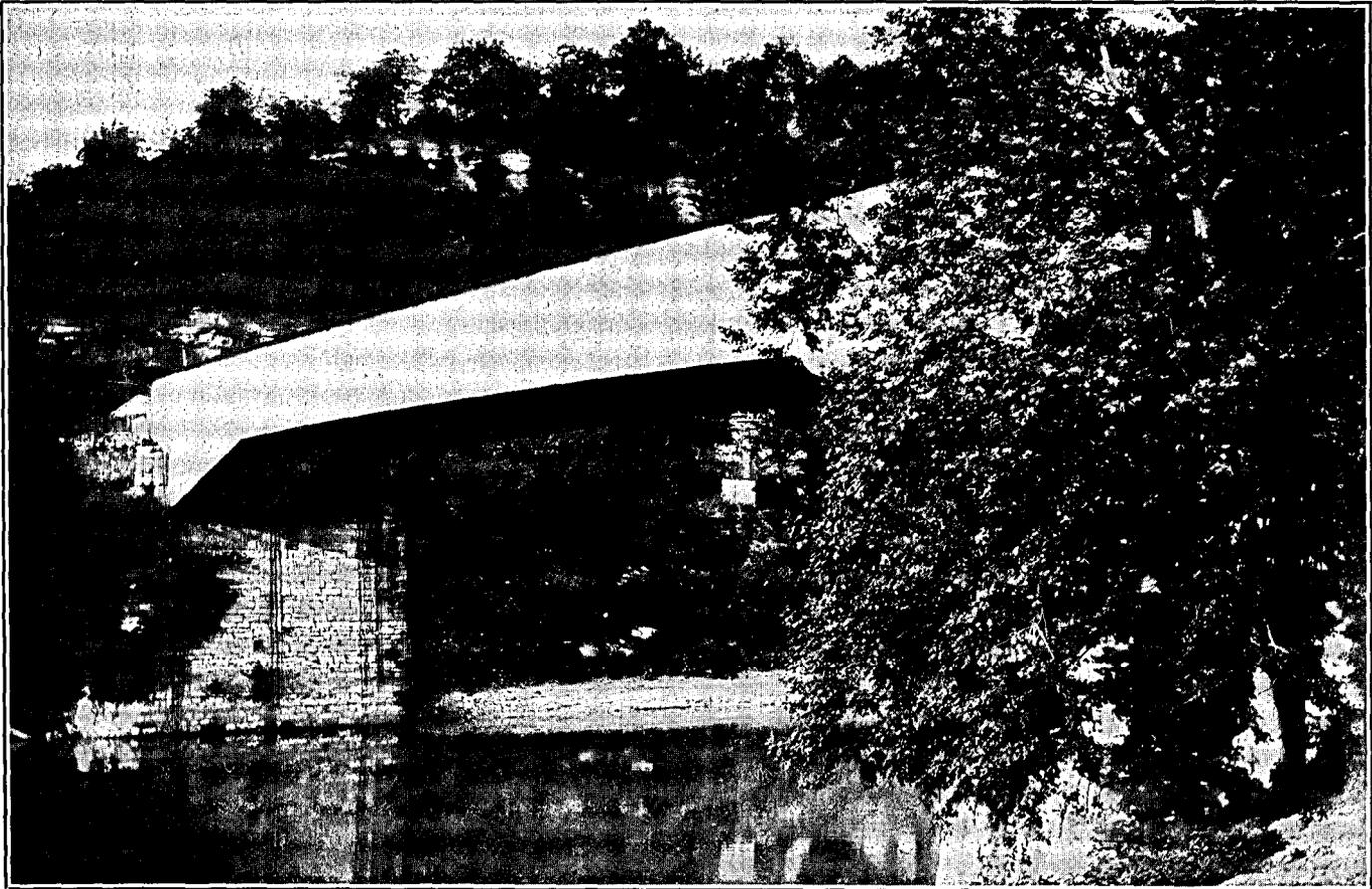
HALF FOUNDATION PLAN

NOTE:- Specifications B.P.R. 1918.
 All concrete to be 1-2 1/2-5
 All corners to be chamfered thus:-

Foundations to be carried to good firm material, with a minimum depth below bed of stream of 2'-0" unless on solid rock.
 Rip-rap and channel paving to be provided where necessary to prevent scour.
 Estimated quantities to be adjusted for length of culvert, foundation below datum plane, and for paving and rip-rap if used.
 Complete permanent records shall be made of each structure as built, showing footing depths and any modifications of this plan.

DESIGNED BY O. L. JONES, DATE JANUARY 1918.
 DRAWN BY E. J. CONNOR, DATE FEBRUARY 1918.
 CHECKED BY J. W. HARRIS, DATE FEBRUARY 1918.
 APPROVED BY O. L. JONES, DATE FEBRUARY 1918.

BUREAU OF PUBLIC ROADS
 WASHINGTON, D.C.
ARCH CULVERTS
 PLAIN CONCRETE
 SPANS 8 TO 14 FEET
 JULY 1918
 CORRECTED BY O. L. JONES, BRIDGE ENGINEER
 APPROVED BY E. J. CONNOR, BRIDGE ENGINEER
 G-249



OLD WOODEN BRIDGE ACROSS THE KENTUCKY RIVER IN JESSAMINE COUNTY, KY., BUILT OF HEWN TIMBER IN 1838.

With a view to help in solving the bridge problems which present themselves under the existing conditions there have been prepared designs for small work where concrete, stone, and brick can be used, and which will produce permanent structures, and for timber construction where long bridges are necessary. The plans have been made to meet the usual conditions found in any section of the country.

CULVERTS OF RUBBLE MASONRY.

Small structures, built even under the present war conditions, should be constructed with a view to permanence. Culverts with small spans can be built readily without the use of steel, and of the most substantial construction.

In locations where suitable stone can be procured culverts of rubble masonry with stone covers may be constructed where the spans do not exceed 4 feet. Such culverts will prove satisfactory and will last for a long time. An example is one built in Brunswick County, Mo. It is solid, of fine appearance, and gives perfect satisfaction. The construction is simple, and where suitable stone is found in the neighborhood within easy hauling distance the cost should be reasonable. In the selection of the stone the most durable should be used.

The following table gives the thickness and width of cover stones for culverts of 2, 3, and 4 foot spans:

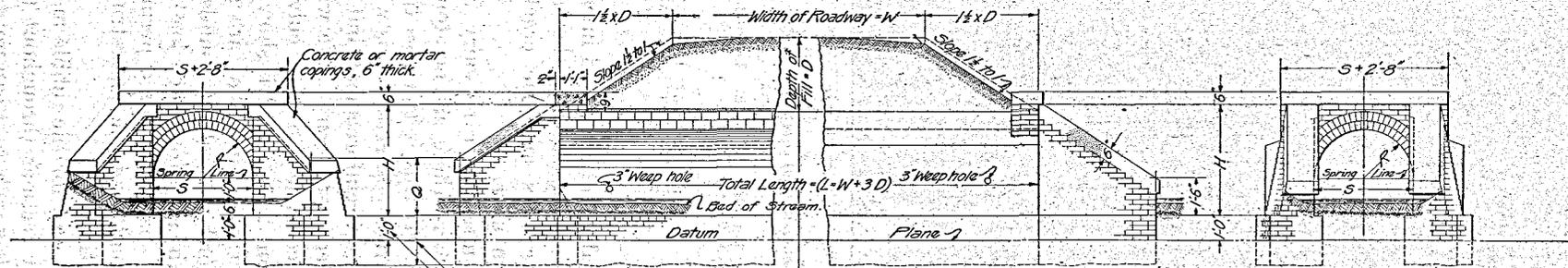
Dimensions of cover stones.

Span in feet.	Thickness in inches.	Width in inches.	Length in feet.
2	10	20	4
3	12	24	5
4	15	30	6

The masonry walls should be laid in cement mortar, and the stone slabs composing the cover should be laid in mortar beds and the cracks between stones filled with mortar.

Rubble stone suitable for masonry is found in many localities, where there are no stones suitable for the cover. Where this is the case the top may be made of reinforced concrete. This will require a small amount of steel reinforcement, but will permit the use of a longer span than is safe with the flat stone top. The construction of a culvert of this type of spans from 2 to 5 feet is shown herewith. This design and the specifications are made for a weight of paving or ballast of 180 pounds per square foot and to sustain a 15-ton truck load. Where a culvert of longer span is required permanent substructure can be built and the superstructure made temporarily with timber.

While suitable stone for the rubble masonry is to be found in many sections throughout the country there are many places where it can not be obtained.

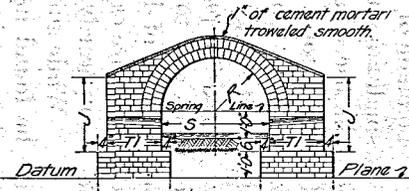


UPSTREAM ELEVATION

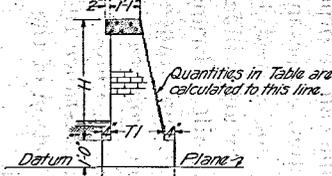
LONGITUDINAL SECTION

SIDE ELEVATION

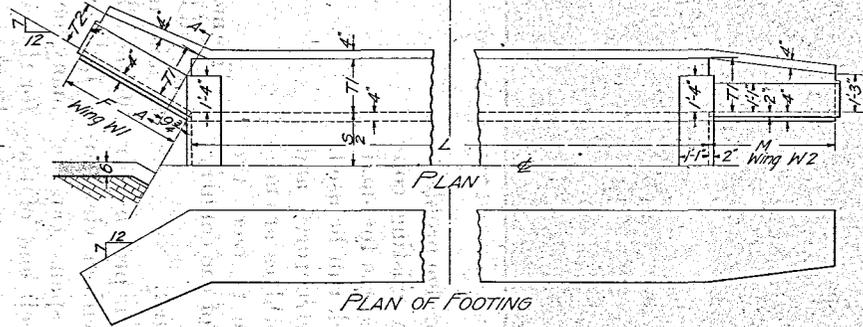
DOWNSTREAM ELEVATION



CROSS-SECTION OF BARREL



SECTION A-A



PLAN

PLAN OF FOOTING

Note-- Specifications, B.P.R. 1918.

Exposed corners to be chamfered thus--

Foundations to be carried to good firm material with a minimum depth below bed of stream of 1'-6" unless on solid rock. Rip-rap and channel paving to be provided where necessary to prevent scour.

Estimated quantities to be adjusted for length of culvert, footing below Datum Plane and for paving and rip-rap if used.

Complete permanent records shall be made of each structure as built showing footing depths and any modifications of this plan.

DIMENSIONS & ESTIMATED QUANTITIES

S	Area of Water Span, Wsq. Ft.	Dimensions							Quantities above Datum Plane in Cu. Yds.						Footings Cu. yds. per ft. of depth below Datum Plane				
		Arch			Wings				2 Wings W1 & Spandrel		2 Wings W2 & Spandrel		Arch per		Total for Culvert, L30°		2 Wings W1	2 Wings W2	2 Abut's per lin. ft.
		R	T1	J	F	Q	T2	H	M	Erick Coping	Erick Coping	lin. ft.	Erick Coping	lin. ft.	2 Wings W1	2 Wings W2	2 Abut's per lin. ft.		
2	3.6	1'-0"	1'-6"	2'-0"	3'-3"	2'-1"	1'-4"	3'-6"	3'-2"	1.2	0.3	1.2	0.3	0.50	17.4	0.6	0.4	0.5	0.16
3	6.5	1'-6"	1'-9"	2'-5"	3'-11"	2'-3"	1'-6"	4'-0"	3'-11"	1.7	0.3	1.7	0.4	0.66	23.2	0.7	0.6	0.6	0.18
4	10.3	2'-0"	2'-0"	2'-10"	4'-7"	2'-4"	1'-7"	4'-6"	4'-8"	2.3	0.4	2.4	0.5	0.84	29.9	0.9	0.7	0.8	0.20
5	14.8	2'-6"	2'-3"	3'-3"	5'-3"	2'-5"	1'-8"	5'-0"	5'-5"	2.9	0.5	2.9	0.6	1.03	36.7	1.1	0.9	1.0	0.22

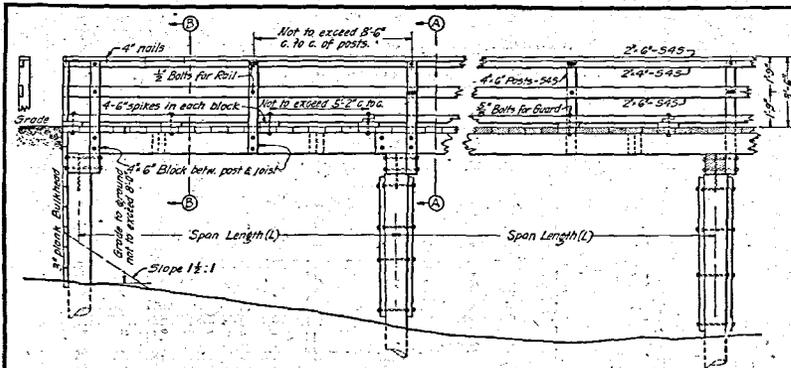
DESIGNED: James S. Gray DATE: July 1918
 DRAWN: J. H. [unclear] DATE: July 1918
 TRACED: J. H. [unclear] DATE: July 1918
 CHECKED: W. P. [unclear] DATE: July 1918

BUREAU OF PUBLIC ROADS
 WASHINGTON, D. C.
ARCH CULVERTS
 BRICK
 SPANS 2 to 5 FEET
 JULY 1918

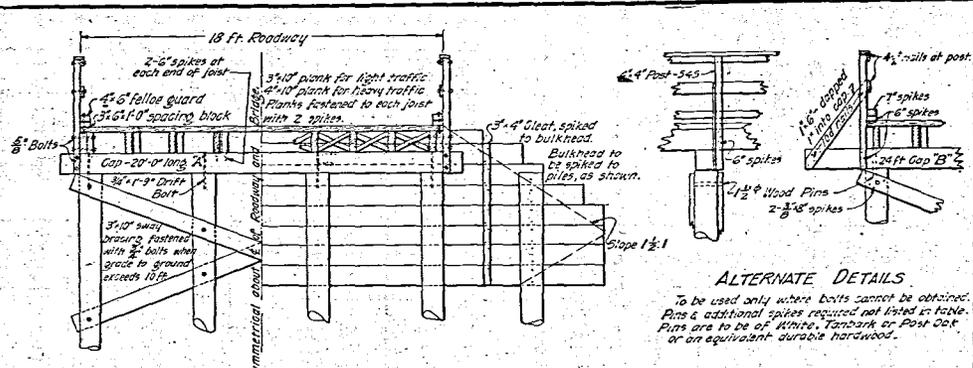
CORRECT: O. L. Grover
 BRIDGE ENGINEER
 APPROVED: R. S. McLean
 CIVIL ENGINEER

6-247

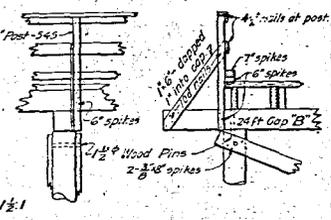
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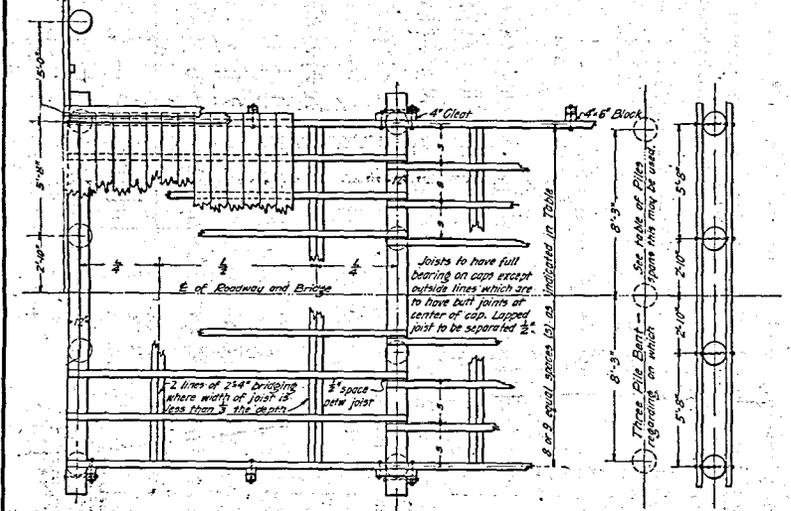
SIDE ELEVATION LONGITUDINAL SECTION



HALF SECTION A-A HALF SECTION B-B



ALTERNATE DETAILS
 To be used only where bolts cannot be obtained. Pins & additional spikes required not listed in table. Pins are to be of White Oak or Post Oak or an equivalent durable hardwood.



PART PLAN

NOTE:-
 Specifications: B.P.R. 1918.
 Live Load: 10 ton trucks or 80 lbs per sq. ft.
 Impact Allowance: 30 per cent.
 Three pile Bents may be substituted for 4 pile Bents as shown in table.
 Complete permanent records of each structure as built shall be made, showing pile lengths, penetration, pile driving data, and all modifications of these designs.

DESIGNED BY *[Signature]* DATE *[Date]*
 CHECKED BY *[Signature]* DATE *[Date]*
 TRACED BY *[Signature]* DATE *[Date]*
 ENGRAVED BY *[Signature]* DATE *[Date]*

DIMENSIONS & QUANTITIES

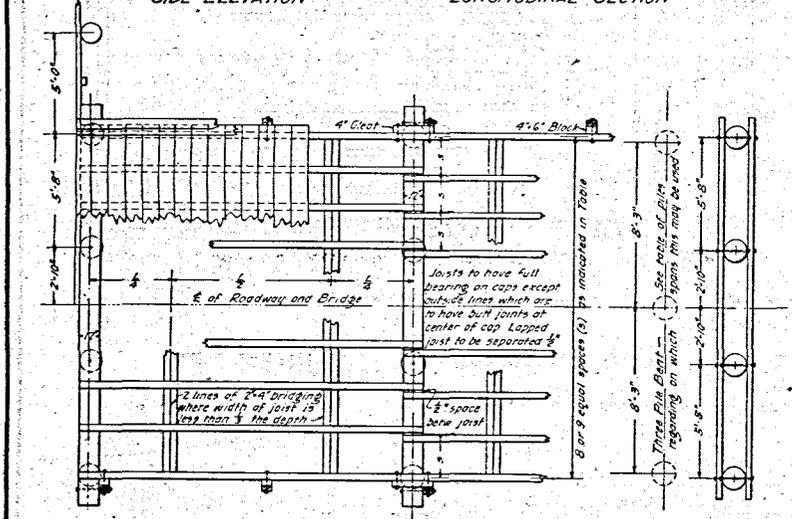
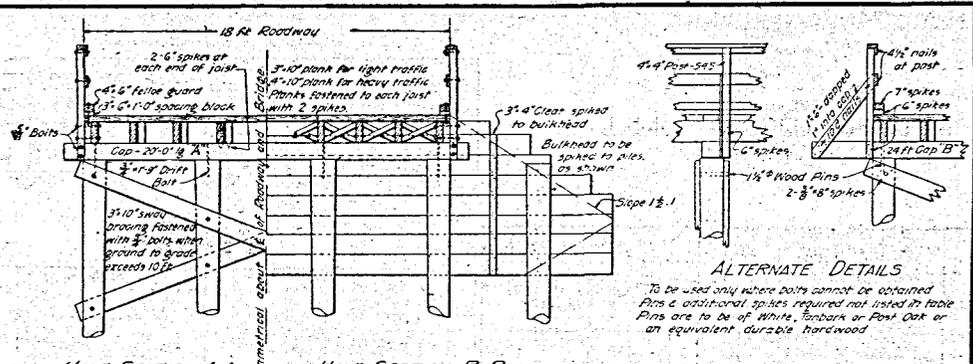
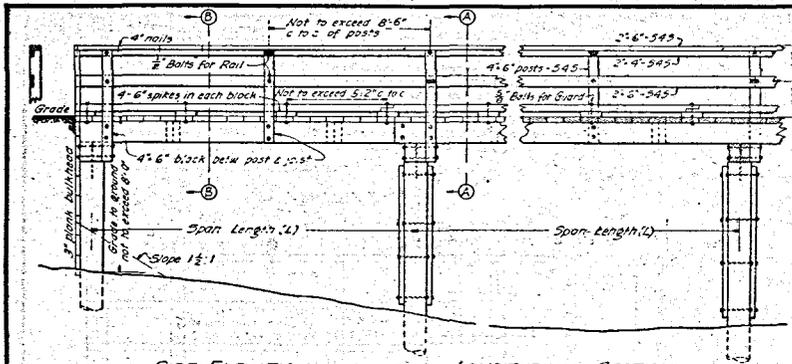
Table for Red Spruce, Chestnut and Cedar (western red).
 or equivalent (Bending Fiber Stress = 1000 pounds per square inch.)
 Table for Bald Cypress, Norway Pine and Hemlock
 or equivalent (Bending Fiber Stress = 1200 pounds per square inch.)

SPAN L	PILES	INTERMEDIATE PANEL				SPAN L	PILES	INTERMEDIATE PANEL				SPAN L	PILES	INTERMEDIATE PANEL										
		FLG	TOTL	FLG	TOTL			FLG	TOTL	FLG	TOTL			FLG	TOTL	FLG	TOTL	FLG	TOTL					
Feet	No.	Vol	Wt	Vol	Wt	Feet	No.	Vol	Wt	Vol	Wt	Feet	No.	Vol	Wt	Vol	Wt	Vol	Wt					
10	9	6x12	650	700	1350	16	9	8x14	1510	1630	2620	17	9	7x14	1320	1480	2320	18	9	6x12	1300	1420	2120	
	9	4x16	580	760	1940		9	6x16	1320	1090	2390		100	9	4x14	500	760		1260	9	6x16	1440	1310	2750
	10	4x16	550	760	1320		10	7x14	1470	1090	2560		10	8x16	1260	1190	2440		10	8x16	1440	1310	2750	
	10	3x16	480	760	1240		9	8x14	1510	1180	2890		9	8x14	1260	1190	2440		10	8x16	1440	1310	2750	
11	9	8x12	860	770	1630	17	9	6x16	1320	1180	2480	18	9	7x14	1470	1420	2890	19	9	6x12	1300	1420	2120	
	9	6x14	760	170	1530		9	7x14	1470	1180	2650		9	7x14	1470	1420	2890		9	8x16	1440	1310	2750	
	9	4x16	580	830	1410		9	7x16	1520	1240	3130		10	8x16	1440	1310	2750		10	7x16	1630	1310	2940	
	10	6x12	720	770	1490		9	8x16	1520	1240	2920		9	8x16	1440	1310	2750		10	8x16	1630	1310	2940	
12	9	8x12	1010	830	1840	18	9	8x16	1520	1310	3180	19	9	7x16	1680	1310	3290	20	9	7x16	1680	1310	3290	
	9	6x14	880	830	1710		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	9	4x16	670	820	1550		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	10	6x12	1010	960	1910		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
13	9	6x14	880	900	1780	19	9	8x16	1520	1310	3200	20	9	7x16	1680	1310	3290	21	9	7x16	1680	1310	3290	
	9	4x16	750	960	1710		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	9	6x12	1180	860	2140		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	10	6x12	1280	860	2280		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
14	10	6x14	1120	820	2080	20	9	8x16	1520	1310	3200	21	9	7x16	1680	1310	3290	22	9	7x16	1680	1310	3290	
	9	7x14	1160	1030	2210		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	9	6x12	1150	1030	2180		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	10	6x14	1120	1030	2210		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
15	9	6x12	1150	1030	2180	21	9	8x16	1520	1310	3200	22	9	7x16	1680	1310	3290	23	9	7x16	1680	1310	3290	
	9	4x16	850	1080	1930		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	9	6x14	1130	1230	2320		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	
	10	6x14	1120	1030	2210		9	8x16	1520	1310	3200		9	8x16	1520	1240	2840		9	8x16	1520	1240	2840	

FILES & CAPS				SWAY BRACING				BULKHEAD							
SPAN	FILES	SIZE	LUMBER	GROUND	SETS	INTERMEDIATE	BENT	GROUND	SETS	INTERMEDIATE	BENT	GROUND	SETS	INTERMEDIATE	BENT
Feet	No.	Vol	Wt	Feet	No.	Vol	Wt	Feet	No.	Vol	Wt	Feet	No.	Vol	Wt
10-17	3	12x12	240	288	10-14	1	22	10	45	4	330	10	4	330	10
18-23	4	12x18	200	240	15-18	1	24	120	45	5	430	10	6	540	10
					19-23	2	22	220	70	7	640	15	8	750	15

Caps and sway bracing shall be one of the kinds of Lumber listed above. Piles shall be Yellow Pine, Cypress, White Oak, or any species equally durable.

BUREAU OF PUBLIC ROADS
 WASHINGTON, D.C.
TYPICAL TIMBER TRESTLES
 18'-0" ROADWAY
 SPANS 10 to 23 FEET
 JULY 1918
 CORRECT
[Signature]
 APPROVED
[Signature]
 CHIEF ENGINEER
 G-251



DIMENSIONS & QUANTITIES
 Table for Pacific Post Oak, Western Larch and Tamarack or equivalent (Bending Fiber Stress = 1400 pounds per square inch.)
 Table for Longleaf Pine, White Oak and Douglas Fir (Pacific Coast) or equivalent (Bending Fiber Stress = 1600 pounds per square inch.)

SPAN (L)	JOIST	INTERMEDIATE PANEL					SPAN (L)	JOIST	INTERMEDIATE PANEL					SPAN (L)	JOIST	INTERMEDIATE PANEL					SPAN (L)	JOIST	INTERMEDIATE PANEL												
		FLOOR LUMBER	TOTAL BRGTS	BRGTS	SPICES	ETC			FLOOR LUMBER	TOTAL BRGTS	BRGTS	SPICES	ETC			FLOOR LUMBER	TOTAL BRGTS	BRGTS	SPICES	ETC			FLOOR LUMBER	TOTAL BRGTS	BRGTS	SPICES	ETC								
10	9 4x12	500	760	1260	80	18	9 6x16	1440	1240	2680	120	10	9 4x12	430	700	1130	80	18	9 8x12	1440	1240	2680	120	10	9 4x12	430	700	1130	80	18	9 6x16	1440	1240	2680	120
11	9 4x12	480	700	1180	80	19	9 6x16	1440	1240	2680	120	11	9 4x12	380	630	1010	80	19	9 8x12	1440	1240	2680	120	11	9 4x12	430	700	1130	80	19	9 6x16	1440	1240	2680	120
12	9 4x12	460	680	1160	90	20	9 6x16	1440	1240	2680	130	12	9 4x12	360	610	970	90	20	9 8x12	1440	1240	2680	130	12	9 4x12	410	680	1100	90	20	9 6x16	1440	1240	2680	130
13	9 4x12	440	660	1140	90	21	9 6x16	1440	1240	2680	130	13	9 4x12	340	590	930	90	21	9 8x12	1440	1240	2680	130	13	9 4x12	390	660	1060	90	21	9 6x16	1440	1240	2680	130
14	9 4x12	420	640	1120	90	22	9 6x16	1440	1240	2680	140	14	9 4x12	320	570	890	90	22	9 8x12	1440	1240	2680	140	14	9 4x12	370	640	1030	90	22	9 6x16	1440	1240	2680	140
15	9 4x12	400	620	1100	90	23	9 6x16	1440	1240	2680	140	15	9 4x12	300	550	850	90	23	9 8x12	1440	1240	2680	140	15	9 4x12	350	620	1000	90	23	9 6x16	1440	1240	2680	140
16	9 4x12	380	600	1080	90	24	9 6x16	1440	1240	2680	140	16	9 4x12	280	530	810	90	24	9 8x12	1440	1240	2680	140	16	9 4x12	330	600	970	90	24	9 6x16	1440	1240	2680	140
17	9 4x12	360	580	1060	90	25	9 6x16	1440	1240	2680	150	17	9 4x12	260	510	770	90	25	9 8x12	1440	1240	2680	150	17	9 4x12	310	580	940	90	25	9 6x16	1440	1240	2680	150

NOTE:-
 Specifications: B.P.R. 1318
 Live Load: 10 ton trucks or 80 lbs per sq ft
 Impact Allowance: 30 per cent
 Three pile bents may be substituted for 4 pile bents as shown in table
 Complete permanent records of each structure as built shall be made, showing pile lengths, penetration, pile driving data, and all modifications of these designs

PILES & CAPS		SWAY BRACING		BULKHEAD	
SPAN (L)	PILE BENT	PILES	CAPS	PILES	END BENT
10-12	4	12x12	200	2x4	4
12-24	4	12x12	200	2x4	4
12-24	4	12x12	200	2x4	4
12-24	4	12x12	200	2x4	4

BUREAU OF PUBLIC ROADS
 WASHINGTON, D.C.
TYPICAL TIMBER TRESTLES
 18'-0" ROADWAY
 SPANS 10 TO 25 FEET
 JULY 1918
 CORRECT *O. R. Johnson*
 BRIDGE ENGINEER
 APPROVED *D. M. Wood*
 CHIEF ENGINEER
 G-252

DESIGNED BY *D. M. Wood* DATE *June 22, 1918*
 DRAWN BY *W. J. Johnson* DATE *July 1, 1918*
 CHECKED BY *W. J. Johnson* DATE *July 1, 1918*
 REVISION BY *W. J. Johnson* DATE *July 1, 1918*

In some localities it may be desirable to substitute plain mass concrete in place of the rubble masonry, because of the difficulty in obtaining suitable stone.

THE CONSTRUCTION OF ARCHES.

Where it is necessary to make longer spans the arch is the only type of permanent structure that can be built without metal. The height needed and foundation conditions are the controlling features in this construction. The arch span will not prove substantial without a good solid foundation, either of cemented gravel, hardpan, or rock. So important is this in securing permanency that the arch should not be selected until after the most thorough examination of the location. In some streams the bed is of such a character that there will be no great difficulty in securing the proper foundation. In others all sorts of conditions may exist and make it difficult to provide one.

Where it is possible, the foundation should be on solid rock. Where this is not possible, it is often practicable to secure adequate foundations by carrying the footings deeper, by driving piles or sometimes by spreading the footing over a wider area. In all cases where solid rock is not found the problem should be submitted to an engineer for solution.

The three materials most used in arch construction are concrete, stone, and brick, preferable in the order named.

It is necessary to carry the foundations well below the bed of the stream. For the smaller spans this should not be less than 1 foot 6 inches and for the longer ones not less than 2 feet, unless they are laid on a bed of solid rock. Riprap and channel paving should be provided where it is necessary to prevent scour.

In building arches of stone or brick, the top of all masonry should be protected by copings of concrete or by copings of large, selected stone with grouted joints.

A road of any length usually will require many small culverts. Those built in accordance with the designs shown will prove satisfactory and durable. They are suitable for construction under present war conditions and will serve all requirements.

In the South, where the climate is not subject to hard freezing, common hard burned brick may be used in building arches, but should not be used where good rubble stone is to be had. In the colder sections of the country brick does not give as good results, because it absorbs moisture and disintegrates by freezing.

The foundations should be carried to good firm material, and have a minimum depth below the bed of the stream of 1½ feet unless on solid rock. The brick should be laid in cement mortar and be covered with 1 inch of cement mortar troweled smooth.

TIMBER TRESTLES AND BRIDGES.

Timber may be used with satisfactory results for both temporary and permanent structures, and to good advantage where brick, stone, and concrete are not easily secured. There is hardly any part of the country where good timber can not be obtained, and for spanning streams of considerable size the timber trestle or bridge is the usual type of construction under emergency conditions. It is often hard to draw the line as to just what is meant by temporary and permanent structures. Roads and bridge building is determined by the expected use, the necessity of early completion, probably most often by the available funds. At present the labor available must also be a controlling factor. Bridges will be built to last as long as they will perform the required service, though it may be expected to replace them with better and more permanent structures when additional funds are at hand or conditions warrant.

Timber deteriorates unless protected or treated for preservation, and for that reason is recommended only for temporary structures and where other materials are not available. The ordinary life of a timber trestle or bridge can be practically doubled by a good preservative treatment, and if the structure is expected to remain in use beyond the natural life of the wood it may be advisable, in order to keep down heavy maintenance expenses, to use a preservative treatment.

Bridges may be built of timber to serve any purpose required and will last many years. They can not be so economically maintained as bridges of reinforced concrete, but so long as it is not practical to make use of reinforced concrete the timber structure will be the one to build, but it must be borne in mind that it should rest on permanent foundations.

TIMBER BRIDGES STANDING 80 YEARS.

That the timber structure will prove durable when properly protected there is no doubt. A large number of wooden bridges are found in the Eastern and Southern States that have been in use from 40 to 60 years and are still in a good state of preservation. One example is the wooden bridge, with a span 280 feet long, over the North River, at Bridgewater, Va., which was built in 1866. The timbers are mostly hewn pine. Another bridge is in Jassamine County, Ky., over the Kentucky River, built in 1838. It also is of hewn timber, cut in the mountains and floated down the river to the site.

In timber construction the most durable timber should be used that can be obtained locally. The general type of temporary construction is the

trestle. Designs have been prepared for typical trestles, which are shown herewith. Tables are given, made up for extreme fiber stresses of 1,000, 1,200, 1,400, and 1,600 pounds per square inch, in order to provide for the use of the better species of timber to be obtained in the various parts of the country. These designs are based on concentrated loads of 10-ton trucks passing.

The more available timbers with a fiber stress of 1,600 pounds per square inch include long-leaf pine, white oak, and Douglas fir. In the 1,400-pound class is included Pacific post oak, Western larch and tamarack, in the 1,200-pound class bald cypress, Norway pine, and hemlock, and with a fiber stress of 1,000 pounds per square inch red spruce, chestnut, and red cedar. The tables are made up to include spans of from 10 to 25 feet. Piles used should be yellow pine, cypress, white oak, or some equally durable species.

CONSTRUCTION UNDER PRESENT CONDITIONS.

In meeting the present-day conditions limiting the construction of bridges local supplies of material and labor will be the determining factors. In general, the decision as to construction should be as follows:

Keep large structures in service by repair, whenever it is possible.

Put temporary spans on permanent substructures.

Put in temporary trestles where it can be done.

Small structures should be made permanent.

Where large structures are destroyed and must be replaced to keep the road open or where emergency use requires the building of a new crossing make temporary pile trestle structures if the nature of the stream does not make this type impracticable. Where temporary structures are not advisable timber structures may be protected so as to be more or less permanent.

DIRECT LOADING A SUCCESS IN CONCRETE CONSTRUCTION

By Charles M. Upham, Chief Engineer, Delaware State Highway Department.

WITH the present high costs of labor and materials it becomes increasingly necessary that labor saving devices and methods be used wherever possible in all construction. A few details generally are worked out on any particular piece of work, but probably no cost reducing method has been worked out any more thoroughly and successfully than direct loading on the recent construction of a 10-mile section of the Coleman Du Pont road in Sussex County, Del.

The line of the Du Pont Road is practically straight, there being only three curves in the 10-mile section. New location was followed with the exception of approximately two miles. The policy of locating the road just outside of the small towns, which was done in this case, seems to be gaining in favor with the people of the adjacent territory, for the road is available for use, and the small towns are not in any way troubled or subjected to the hazards of through auto traffic. The through auto traffic, on the other hand, is not obliged to slow down nor does it encounter the many cross streets that it would in passing through the villages or towns.

DRAINAGE PRACTICALLY PERFECT.

The grades on this section of the Du Pont Road are very light, in no case exceeding 3 per cent. On account of this flat nature of the country and of the numerous ditches, a complete drainage survey was made necessary and in some instances it was necessary to dig ditches nearly a mile distant from the

road to carry off the water. This drainage survey assured that the drainage on this section of road was practically perfect, and now no water can be seen alongside the road even after a heavy rain.

Grading was carried on as for any road, but considerable stress was laid on the necessity of securing uniform compaction of the subgrade.

The construction was standard concrete, with special care exercised as to the quality and cleanliness of the materials, considerable stress being laid on the inspection of construction.

The roadway is 14 feet wide, 7 inches deep in the center, and 5 inches on the sides. The concrete was mixed in the proportions of 1 part cement to 2 parts of fine aggregate and 4 parts of coarse aggregate.

The only ingredients obtained locally for the construction of the road was water, which was obtained from wells driven about a mile apart alongside the road and was connected with 2-inch pipe lines with taps at intervals of approximately 150 feet. In some instances a small elevated storage tank was used, but where there was a sufficient supply of water this was not necessary.

CONTRAST WITH OLD METHOD.

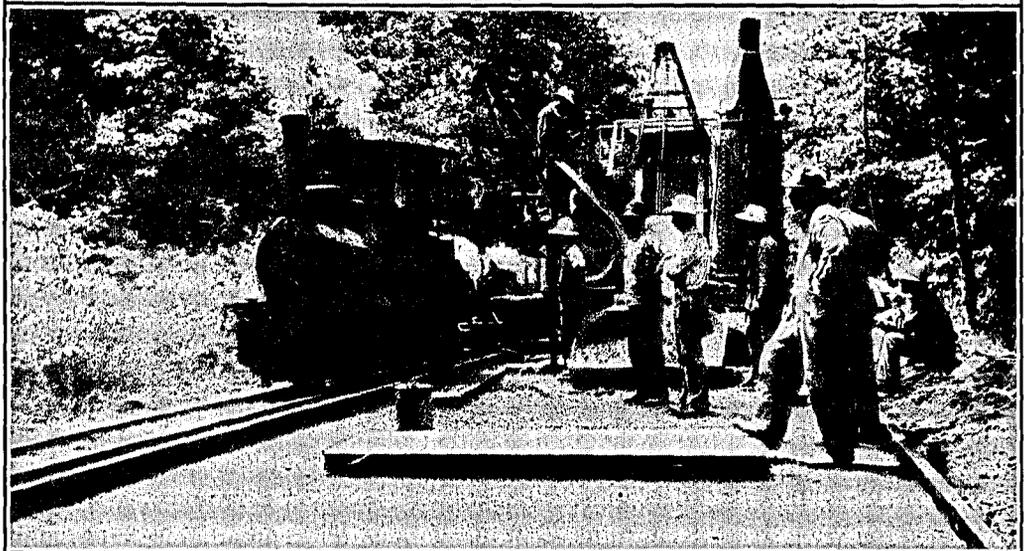
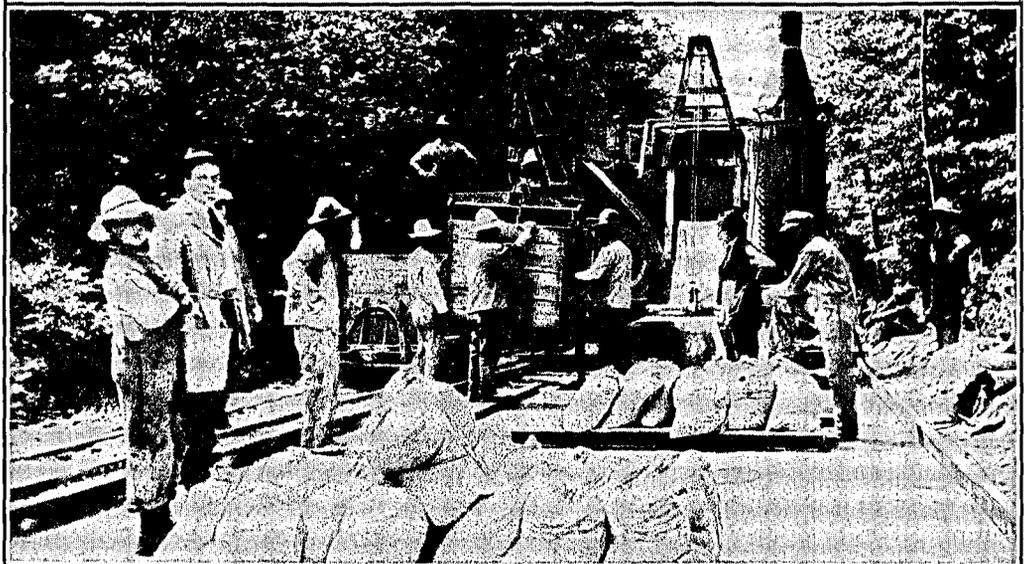
On account of the lack of suitable materials in the nearby vicinity, it was necessary that all materials be delivered by railroad.

The new feature on this particular construction was the direct loading and method of handling the materials in marked contrast to the old procedure

of storing the fine and coarse aggregates on the subgrade in front of the mixer and loading the mixer by means of wheelbarrows dumped into the skip. Many times under this old method it happened that the materials were not distributed uniformly on the subgrade, and quite often the wheelers had to push their wheelbarrows considerable distance, while at other times there would be too much material on the subgrade, making it necessary to remove enough to allow room for the wheelers to work.

Careful records kept of this method show that at least in one instance there was a loss of 10 per cent of the fine aggregate and of 8 per cent of the coarse aggregate.

With the material dumped on the subgrade there is always a chance that dirt will be picked up from the subgrade when the material is shoveled into the wheelbarrows. When the direct loading is used, this hazard of getting dirt from the subgrade mixed into the aggregates, as well as any loss of aggregate, is overcome entirely. Not only was the material kept clean and a great saving made



THE OLD METHOD AND THE NEW. DUMPING MATERIAL ON THE GRADE AND HANDLING BY DIRECT LOADING WITHOUT LOSS AND AT A SAVING IN TIME AND LABOR.

in eliminating the loss of aggregate materials, but one complete handling of the materials was eliminated and approximately 12 men were released from the mixer gang.

USE INDUSTRIAL RAILWAY.

Briefly, the direct loading method is described by stating that the materials to be used in the construction of the road are loaded directly from freight cars into box containers, in correct proportions, transported to the concrete mixer and dumped directly into the skip. For emergencies, stock piles of sand and stone were maintained at the freight station, but these were seldom used.

In this particular instance the containers which held sufficient aggregate for a three

bag batch were transported to the construction by means of an industrial railway, but there seems to be no reason why this same method could not be carried on by use of motor trucks. Two containers were placed on each car and a train load of 15 cars hauled to the mixer. Containers were lifted from the cars by means of a derrick attached to the concrete mixer. Three men were required to dump the container into the skip and one man was necessary on the derrick to lift the containers from the truck. After the container was lifted approximately 4 inches it would clear the body of the car.



TOP—SHOWING CONCRETE WITH A STEEL TEMPLATE. BELOW—SHOWING EARTH BLANKET WHICH IS KEPT ON FOR THIRTY DAYS.

The transporting of materials was carried on by three trains handled by an industrial engineer. While one train was being loaded at the freight station, the second train was being hauled to the concrete mixer, and the third train was being unloaded at the concrete mixer. This method worked out very satisfactorily up to a 4-mile maximum haul, and with proper equipment there should be no limit for the satisfactory working of this method. The cars holding the containers are moved at the concrete mixer by hand or by mule.

COMPLETE 600 FEET IN DAY.

It was necessary to have a siding for storing the empty cars near the mixer in order to allow the trains to pass. This siding was moved each day with very little trouble and at small expense.

The specifications required that all concrete should be mixed one and one-half minutes and there was no delay on account of the direct-loading method. Under favorable conditions, approximately 600 feet of 14-foot pavement was completed in one day, all the concrete having been mixed one and one-half minutes.

The completion of the concrete road was practically standard practice. After the subgrade was brought to the proper elevation and uniformly compacted it was thoroughly wet before the concrete was placed. The concrete was shaped with a steel template, approximately 8 inches wide, which left the surface comparatively smooth. After a short time the surface was finished with a belt, and the small places that were not smooth after the belt was used, were troweled. It is expected to try the roller method on the next section. Immediately

after finishing, sun covers were placed over the concrete to protect it from the sun and wind. These covers, constructed of wood frames covered with canvas or heavy cloth, were supported about 6 inches above the pavement. Experiments show that they are a great help in curing the concrete and preventing the small cracks due to quick drying of the surface.

ROAD COVERED 30 DAYS.

As soon as the concrete was sufficiently hard, an earth covering, practically 2 inches deep, was thrown on the roadway and thoroughly wet, in which condition it was kept for approximately 14 days. The earth covering was not cleared off for 30 days. This time of curing was possible, because the greater part of the road was located through new territory and very little traffic was encountered. After 30 days the roadway was cleared and the road thrown open to traffic.

Not only has the direct loading produced more uniform and better concrete, but it has increased the output of a plant and at the same time reduced the cost of construction.

NATURE MIXED SAND-CLAY FOR ALABAMA FEDERAL AID ROADS

By J. T. BULLEN, District Engineer, Bureau of Public Roads.

IN its first completed Federal aid project Alabama has contributed an example of nature-mixed sand clay construction. This road, in Pike County, is in the peanut-growing country. Another similar road is nearing completion in Dale County. The material for the surfacing, dark red in color, was taken already mixed from deposits found near the work. Each project forms a part of the Ozark, Troy, and Montgomery road, the project in Pike County being 9 miles in length, and the one in Dale County about 8½ miles.

The project agreement for Pike County was executed October 17, 1917, and work was begun with county convicts on October 26, 1917, and on July 10, 1918, the road was complete except the culvert headwalls. The project agreement estimate was for \$20,662, or \$2,268 per mile, and the amount of Federal aid requested was \$10,331, and the final estimate will not vary materially from these figures.

The Dale County project agreement was executed October 17, 1917, and work was begun with county forces on December 20, 1917, and it is now about 85 per cent completed. The estimated cost of this road was \$20,064, or \$2,300 per mile; and Federal aid was requested in the amount of \$10,032.

Excavation on both of these projects runs between

5,000 and 6,000 cubic yards per mile, and the natural sand-clay surfacing was spread 16 feet wide on the Dale County project, and from 24 to 30 feet wide on the Pike County project; and approximately 10 inches deep, loose, in both cases.

Little or no bridging was necessary on these projects, as the location of both follows ridge routes. Quite a number of double-strength vitrified culverts were necessary, however, and these were put in.

In the case of Dale County the width of the crown of the road is 24 feet and the surfacing of sand-clay 16 feet. On this work two out of four grade crossings were eliminated, and the road which was formerly of sand so deep that even walking was extremely difficult, has been converted to the conditions shown in the photographs.

The Pike County project also traversed a sandy character of soil and was for the most part deep sandy road before improving.

The people in these two counties are deeply interested in good roads and expect to give them the most careful maintenance. They have learned from past experience that the maintenance is just as necessary as was construction in the first instance.

As well as being the main highway between Troy, Ozark, and Montgomery, these projects form one

of the main highways from Montgomery into the Florida Peninsula. It passes through a country that has recently developed what has proven to be two of the foremost crops in this section, namely, the velvet bean and the peanut. A number of mills have sprung up in this section for crushing the nut, and various by-products are also developed. This is also known as the wire-grass section of Alabama, and is a great cattle and hog-raising country; in fact, on one day last winter in the small town of Ozark, having a population of about 3,000 people, \$18,000 worth of hogs were sold by local farmers.

On account of the fact that the peanut and velvet bean are cash crops, and the prices have been

so remunerative in the last year, the automobiles in use in the territory adjacent to this road have increased 100 per cent in number within a year.

The particular quality of sand and clay used in surfacing has in the past proved very satisfactory for roads having a medium amount of traffic; and on account of the proximity of the surfacing material; the expense of keeping this road in repair, even under medium heavy traffic, is only nominal. The surfacing serves equally well during dry weather and wet seasons.



THE OLD AND THE NEW. AT THE TOP TAKEN OPPOSITE THE POINT ILLUSTRATED BELOW IS SHOWN A LOOSE SAND ROAD IN DALE COUNTY, ALA., THE SAND BEING 10 INCHES DEEP AND THE ROAD LITTLE MORE THAN A CHANNEL FOR DRAINAGE. BELOW—THE NEW NATURE-MIXED SAND-CLAY HIGHWAY.

JUNE RECORD OF FEDERAL AID.

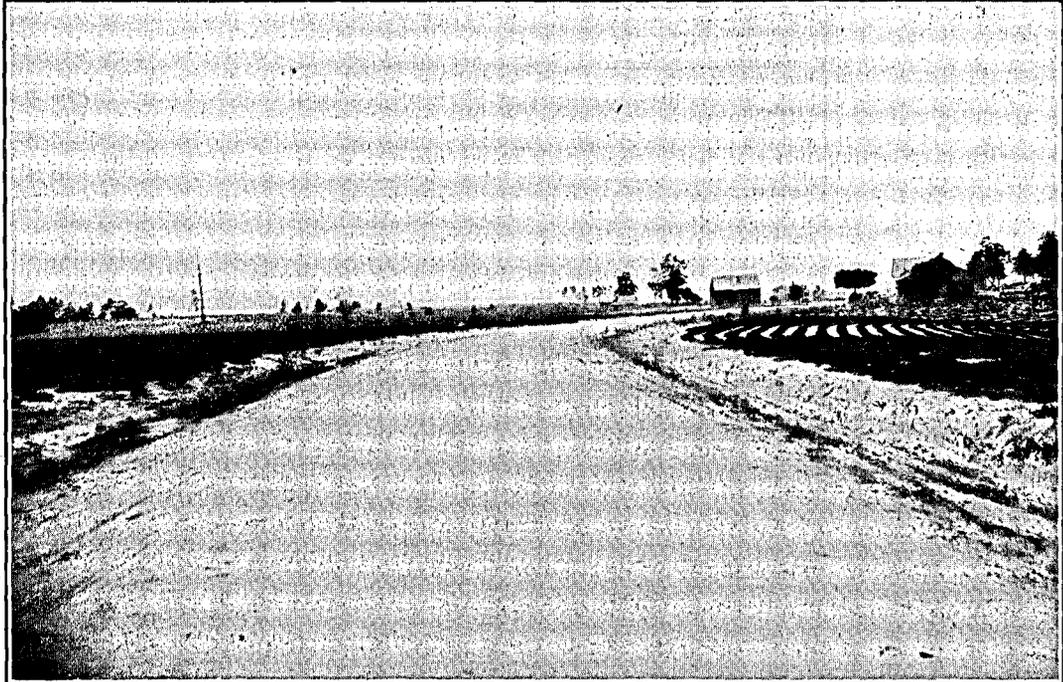
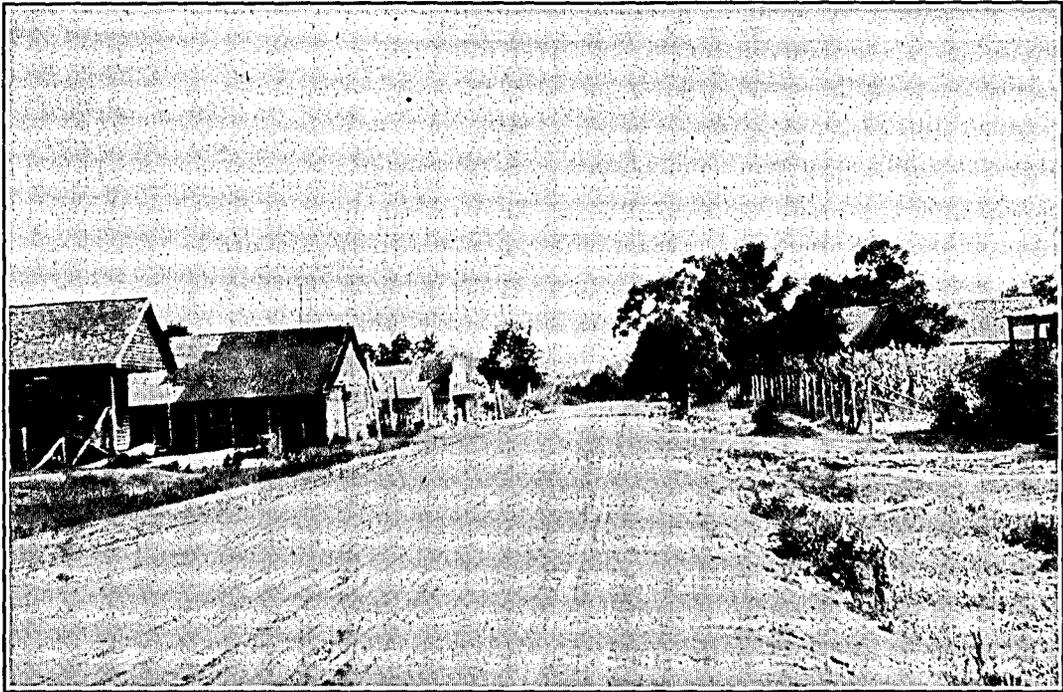
The month of June is distinguished by the unusually large amounts of money allowed for single projects, having 11 projects for which the sums to be spent by the States alone are in excess of \$200,000 each. In all 135 projects were submitted to the Secretary of Agriculture for consideration, of which 89 were executed in final agreement. These projects covered 1,448.601 miles of road and the estimated expenditures to cover construction are \$10,220,236.91 with Federal aid of \$4,215,640.74.

Wisconsin had the largest number of projects, 17, with a mileage of 65.92, State expenditure \$568,247.97, Federal aid allowed \$189,420.33. Nebraska, however, leads in the amount of mileage, having submitted seven projects covering 257.78 miles of road for which the State expects to spend \$469,395.91 and Federal aid to the extent of \$234,697.94 is asked.

Nebraska also submitted the longest single project, covering a sand-clay road 83.65 miles long through Kearney, Adams, Clay, and Nuckolls Counties, for which the State will pay \$138,683.09 and the Federal aid allotment is \$69,341.54. Nebraska has the second longest project of 57.37 miles with Illinois running a close second with two projects of 55.30 and 54.50 miles respectively.

The most expensive single project is \$904,700 for a stretch of 54.50 miles in Illinois of bituminous macadam and concrete construction for which Federal aid to the extent of \$407,115 was allowed. Illinois also has the largest total expenditure of any State, having only two projects with a total estimated expenditure by the State of \$1,385,040.92 while the Federal allowance is \$620,349.02.

In the five projects submitted by Idaho covering 99.36 miles of construction, an expenditure of \$701,577.04 is involved, with Federal aid allowance of \$271,000. Ohio has a single project of brick



ALABAMA'S FIRST COMPLETED FEDERAL AID PROJECT. NATURE-MIXED SAND-CLAY ROAD IN PIKE COUNTY. THE PEANUT CROP OF THIS COUNTY IN 1917 WAS WORTH \$2,000,000.

road construction, 16.20 miles long, on which it expects to spend \$761,117.50 and has asked \$165,000 of Federal aid.

California is going to spend \$210,668.48 of its money on an earth road, 15.94 miles long in Shasta County, and has been allotted \$105,334.24 from Federal aid funds.

Washington has planned a bridge in Lewis County which it expects will cost \$120,432.40 in addition to the allowance of \$60,000 Federal aid. The shortest shortest single project is of bituminous macadam construction in Rhode Island, being 1.15 miles to cost \$40,918.35 furnished by the State and \$11,500 from Federal aid funds.

FEDERAL AID IN DETAIL FOR JUNE.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
Alabama	15	Houston	4.3	Sand-clay		June 24	\$5,106.98	\$2,552.49
	18	Jefferson	6.0	Bituminous macadam		June 26	23,735.37	11,867.68
Arkansas	18	Benton	6.05	Gravel		June 7	13,537.98	6,768.99
California	7	Shasta	15.94	Earth		June 24	210,668.48	105,334.24
Colorado	3	Lake and Chaffee	8.94			June 27	62,614.42	31,307.21
	4	Garfield and Rio Blanco	21.00	Gravel or stone, and earth		June 29	78,831.43	39,415.71
	6	Prowers	3.13	Gravel and shale		June 27	23,838.36	11,919.18
Florida	4	De Soto	3.05	Brick or asphalt concrete	June 26		58,961.43	29,480.71
Georgia	3	Valdosta, Brooks, and Lowndes	6.80	Sand-clay	June 4		56,045.22	28,022.61
	18	Dooley	11.40	do	June 29		32,561.92	10,000.00
	20	Carroll	15.20	Topsoil	do		47,181.20	20,000.00
	22	Milton	10.80	do	do		36,080.00	12,500.00
	25	Candler	13.60	Sand-clay	do		18,574.87	8,500.00
	30	Cobb	17.90	Topsoil	do		35,579.50	15,000.00
Idaho	3	Custer	20.00	Earth		June 29	71,327.42	23,000.00
	4	do	1.36	do		do	8,088.87	2,000.00
	5	Lemhi	38.00	do		do	298,937.99	135,000.00
	6	Idaho	22.00	Macadam and earth	June 7		243,988.80	86,000.00
	7	Custer	18.00	Earth		June 29	79,233.96	25,000.00
Illinois	2	Will, Kankakee, and Iroquois	54.50	Bituminous macadam and concrete	June 5		904,700.00	407,115.00
Iowa	4	Cook and Lake	21.85	Concrete	June 10		481,340.92	213,234.02
	2	Woodbury	55.30	Earth		June 29	141,193.09	34,285.90
	3	Jefferson	20.53	do		do	65,719.72	16,830.55
	4	Delaware	14.65	Gravel		do	108,651.18	22,297.55
	5	Buchanan	15.52	do		do	83,785.41	22,141.35
	6	Ringgold	12.00	Earth		do	59,254.14	21,086.95
	7	Marion	18.00	do		do	77,465.90	22,531.85
Kansas	10	Geary	7.55	Concrete	June 10		152,702.06	22,905.31
Kentucky	1	Bond	8.11	Brick or concrete		June 24	214,193.31	76,944.89
	3	Rowan	8.085	Earth		June 27	48,400.00	24,200.00
	4	Carter	11.27	do		June 29	124,813.16	62,406.58
	6	Rockcastle	7.20	do		June 4	27,614.00	13,807.00
Louisiana	10	Richland	7.77	Gravel		June 4	90,612.62	41,743.00
Massachusetts	6	Barnstable	1,818	Bituminous concrete		June 25	21,356.04	10,678.02
Michigan	19	Washtenaw	2.89	Concrete or brick		June 3	90,838.00	28,900.00
	17	Chippewa and Mackinac	8.00	Gravel		June 22	68,921.39	34,210.69
	21	Kalamazoo	6.00	Concrete		June 24	127,509.36	60,000.00
	23	Berrien	3.43	Macadam		June 10	42,650.19	21,325.09
Minnesota	4	Crow Wing	20.57	Gravel		June 29	74,476.47	30,000.00
	5	Freeborn	15.41	do		June 17	57,987.62	23,100.00
	8	Winona	6.25	Earth		June 23	24,000.00	12,000.00
	18	Wabasha	7.72	do		June 17	39,557.88	15,000.00
Mississippi	33	Murray	29.10	Gravel		June 10	74,775.36	25,000.00
	1	Itawamba	23.65	do		June 25	129,458.84	60,000.00
	9	Kemper	5.57	do		June 27	27,696.80	12,000.00
	11	Amite	6.92	do		June 25	27,580.20	10,000.00
	13	Madison	4.27	Clay-gravel		do	20,967.43	8,000.00
	18	Rankin	3.83	Gravel		June 13	10,987.35	5,000.00
	27	Amite	5.80	do		June 14	25,201.00	10,000.00
Missouri	29	Union	6.00	Slag or gravel		June 13	33,564.96	15,000.00
	5	Scott	7.00	Gravel		June 5	39,353.50	9,813.37
	9	Jefferson	9.59	Gravel and macadam		June 26	47,630.05	23,815.02
Nebraska	2	Nemaha, Otoe, and Richardson	57.37	Gravel and earth		June 29	82,420.36	41,210.18
	3	Hall	32.25	Earth		June 22	39,848.16	19,924.08
	4	Cedar and Wayne	38.30	Sand-clay		June 26	89,044.91	44,522.45
	7	Kearney, Adams, Clay, and Nuckolls	83.65	do		June 29	138,683.09	69,341.54
	10	Lincoln	19.11	Earth		do	43,027.97	21,513.98
	12	Logan and McPherson	17.10	do		do	36,215.92	18,107.96
	17	Lancaster	10.00	do		do	40,153.50	20,077.75
Nevada	8	Lyon	7.00	do		June 3	65,915.30	32,957.65
New Hampshire	13	Grafton	1.61	Gravel		June 12	15,980.25	7,990.12
New Jersey	17	Rockingham	1.29	Bituminous gravel concrete		June 27	20,295.13	10,147.59
	1	Salem	9.694	Gravel, concrete, bituminous macadam		June 29	257,341.26	59,212.68
New Mexico	2	Mora	15.40	Crushed rock or gravel surface		do	108,067.61	54,033.80
	5	Quay	21.80	Macadam		June 22	89,101.68	44,550.84
New York	15	Dona Ana	2.59	Concrete		June 24	138,997.02	69,498.51
	2	Wyoming	2.59	Bituminous macadam		June 26	51,800.00	25,900.00
	3	Chenango	14.44	Bituminous macadam		June 26	223,800.00	111,900.00
	4	Chautauque	4.30	Concrete		do	88,000.00	43,000.00
	7	St. Lawrence	3.48	Bituminous macadam		do	66,572.11	33,286.05
	8	Wayne	3.21	Bituminous macadam or concrete		June 25	64,010.00	32,005.00
North Carolina	9	Fulton	1.06	Macadam, tar surface		June 26	21,192.00	10,596.00
	6	McDowell	7.69	Earth		June 14	40,921.43	15,000.00
	11	Lenoir	1,782	Concrete		do	35,973.04	10,000.00
	15	Guilford	14.55	Bituminous macadam		June 4	26,834.41	10,000.00
	19	Rockingham	8.21	Top soil		do	28,614.05	10,000.00
	22	Alamance	8.74	Bituminous macadam and concrete	June 4	June 25	74,258.92	25,000.00
North Dakota	9	Grand Forks	3.58	Gravel		June 17	11,403.21	5,701.61
	11	Cavalier	7.64	Earth		June 29	9,281.42	4,640.71
	12	Barnes	29.51	Earth and gravel		do	48,122.67	24,061.33
	13	Stutsman	7.92	Earth		do	14,714.02	7,357.01
	16	Grand Forks	6.90	Gravel		June 22	26,032.91	13,016.46
	17	Griggs	17.70	Earth		June 29	20,268.49	10,134.24
	26	Benson	6.00	do		June 26	7,128.00	3,564.00
Ohio	19	Summit	16.70	Brick		June 3	761,117.50	165,000.00
	21	Guernsey	1.25	Concrete		June 26	29,400.00	12,500.00
Oregon	7	Marion	18.00	Bituminous macadam		June 29	394,643.70	180,000.00
	8	Union	6.00	Earth		June 4	13,917.75	6,958.87
	9	Baker	4.90	Gravel		do	41,926.50	20,963.25
Rhode Island	3	Washington	1.15	Bituminous macadam		June 26	40,918.35	11,500.00
South Carolina	5	Chesterfield	2.14	Gravel		June 26	12,505.02	5,955.51
	6	Marion	3.51	Bridges		June 26	54,678.53	27,339.26
Tennessee	3	Franklin	10.66	Water-bound macadam		June 22	84,145.52	40,000.00
	4	Moore and Bedford	12.27	do		June 20	99,474.76	49,737.38
Texas	3	Wichita	8.81	Bituminous gravel		June 3	85,916.79	42,958.39
	4	Travis	6.00	do		June 17	37,568.10	18,784.05
	29	Val Verde	4.905	Gravel		June 29	25,801.15	12,843.95

¹ Increased estimate over amount previously approved.

FEDERAL AID IN DETAIL FOR JUNE—Continued.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
Texas	54	Walker	5.30	Gravel or macadam	June 7		\$14,341.80	\$87,170.00
	57	Willbarger	4.67	Concrete slab	June 5		97,137.05	46,353.45
	71	Grayson	1.77	Gravel	June 27		14,326.85	7,163.43
Utah	72	Nolan	2.75	do.	June 21		9,990.00	4,995.00
	1	Carbon and Duchesne	44.89	Earth		June 29	131,132.10	65,566.05
Vermont	4	Addison	1.44	Gravel		June 18	17,015.09	8,507.54
	8	Caicdonia	1.20	do.		June 18	15,656.44	7,828.22
Virginia	3	Elizabeth City	3.45	Concrete		June 22	77,412.27	34,500.00
	7	Albemarle	3.163	Macadam		June 24	35,504.66	17,752.33
	8	Lee	0.043	Bridge		June 22	17,574.04	8,787.02
Washington	9	Chesterfield	3.06	Concrete		June 21	69,017.39	30,600.00
	11	Leo	2.161	Water-bound macadam		June 24	42,103.70	21,051.85
	11	Lewis	0.35	Bridge		June 8	120,432.40	60,000.00
West Virginia	2	Taylor	2.01	Brick on concrete base		June 24	53,333.50	9,000.00
	5	Monongalia	2.54	Concrete		June 25	59,895.90	18,000.00
Wisconsin	7	Wetzol	1.29	do.		do.	23,900.00	8,645.00
	15	Jackson	1.00	do.		June 24	21,000.00	10,000.00
	2	Manitowoc	0.61	Concrete bridge		June 25	23,465.10	7,821.70
	3	Kenosha	1.50	Concrete		June 22	28,296.13	9,432.04
	5	Oconto and Marinette	6.58	Gravel		do.	32,240.35	10,746.82
	6	Oconto	3.01	do.		June 26	14,321.36	7,173.79
	7	Waikesha	3.65	Water-bound macadam		June 22	30,749.07	10,249.69
	8	Dane	3.41	Concrete		June 25	75,761.35	25,253.78
	12	do.	2.71	Water-bound macadam		do.	30,925.84	10,308.61
	20	Langlade	6.21	Gravel		June 22	39,083.51	13,027.83
	21	Brown	3.80	Concrete		do.	80,994.53	26,998.18
	23	Lincoln	4.15	Gravel		do.	29,379.97	9,793.32
	25	Marquette	4.16	Topsoil		do.	17,932.59	5,979.86
	26	Wood	2.82	Gravel		June 21	17,014.25	5,671.41
	27	Forest and Florence	6.29	Earth		June 22	22,012.32	7,337.44
30	Kenosha	1.44	Concrete		do.	27,875.93	9,291.98	
42	Rock	2.42	do.		June 26	51,183.27	17,061.09	
46	Waushara	10.3	Earth		June 25	23,841.40	7,947.13	
47	Vernon	2.86	do.		June 26	23,177.00	7,725.66	
Wyoming	4	Niobrara	6.61	do.		June 26	11,998.64	5,999.82
	10	Platte	1.21	Earth and 2 bridges		June 22	5,572.16	2,786.08
	19	Natrona	39.09	Earth, sand-clay, and bituminous concrete.		June 27	219,349.44	109,674.72
	21	Lincoln	6.59	Earth		June 26	20,004.38	10,002.19
Total	135		1,448.001				10,220,236.91	4,215,640.74

COST OF NEW JERSEY ROAD SYSTEM.

State Highway Commissioner Thompson, of New Jersey, states that the entire highway system, as proposed by the Edge Road act will cost fully \$30,000,000, and without taking into consideration the present war prices for labor and materials. He says that the \$15,000,000 supposed to become available at the end of five years for the entire 655 miles of State highways will be much below the amount needed. In the original estimate made in 1916 the cost was placed at \$16,000,000, with no allowance made for bridges, which were estimated at from \$5,000,000 to \$6,000,000. The legislature has since added two additional routes, increasing the cost \$4,000,000. Other items add to the cost. The cost of materials has increased from 50 to 100 per cent and labor from 40 to 70 per cent.

FOR HIGHWAY IN FOREST PRESERVE.

The New York constitution restricts the building of roads in the State forest preserve. Existing roads run along the easterly and westerly borders of the Adirondacks, but do not pass through the preserve. An amendment to the constitution will be voted on at the November election to remove the restriction so as to permit the building of a State highway from Saranac Lake to Long Lake and thence to Old Forge, by way of Blue Mountain and Lake Placid. The road will have to be provided for by the legislature if the amendment is adopted.

WORK ON MAIN CALIFORNIA ROADS.

The main highway from Vallejo to Napa, Cal., will be completed and open for traffic by November 1, according to a member of the California Highway Commission. The part of the road from Vallejo County line is a first-class oil-macadam road, and from the latter point to Suscol it is paved. The portion under construction is that from Suscol to Napa, a distance of 4 miles. Work on the Jamison Canyon road from Cordelia to Napa, which has been closed all summer, promises to be completed so the road will be open for traffic during the winter.

MICHIGAN MOTOR LINES SERVICE.

The Michigan highways committee, appointed by Governor Sleeper, is working out plans for the development of intercity trucking and rural motor express service. Surveys are being made to ascertain the localities available for trucking. The return loads system is included in the plans. Motor trucking was already started before the organization of the committee and was steadily developing.

TO LIMIT TRUCK LOADS.

A bill is to be introduced into the Pennsylvania legislature this coming winter to limit the weight of loads which trucks may haul over the improved roads of that State.

STATE HIGHWAY MANAGEMENT, CONTROL, AND PROCEDURE.

By M. O. ELDRIDGE, Assistant in Road Economics, G. G. CLARK and A. L. LUEDKE, Engineer Economist of the Bureau of Public Roads.

WITH an aggregate length of some 2,500,000 miles, a normal annual expenditure of \$300,000,000; a traffic which, expressed in horsepower, would probably exceed 125,000,000, the highways of the United States justify the most serious attention of the Nation in their construction, upkeep, and management. As each State looks after its own highways, there have developed 48 different varieties of highway management, and as in most of the States the task has been passed on down to the counties and even the townships, the development of highway management truly presents a "Joseph's coat" in the variation of method and design. It is manifest that among all these systems of management, varying as to intrinsic methods and defects and in the relative efficiency and inefficiency of their operation, much that is good has developed and much that is worthless may serve as a negative demonstration for future development.

In an endeavor to segregate the information which might prove useful in the further development of highway management, a very thorough investigation has been made during the past few years by the Bureau of Public Roads as to the organization, personnel, powers, and duties of the respective State and local highway management. The study has also included the classification of the highways and a study of the procedure followed in their construction and maintenance. The method of raising and expending funds for road purposes has also been prominently placed in the study.

A separate chapter has been prepared for each State in which the subjects are dealt with in the following order: Development and results of State participation and control of road work and the relation of State to local control; organization, personnel, duties, and powers of State and local road officials; classification of State and local roads with particular reference to control and basis of payment, including methods of selection, powers of State highway departments in granting aid, procedure in making surveys, letting contracts, and the control exercised by the State and local officials over construction and maintenance; sources of State and local funds, including bond issues, basis of allotment and apportionment of State funds, and the relation of State to local funds, and the amount available for road purposes during the latest calendar or fiscal year.

A chart accompanies each State chapter, visualizing the organization of highway departments, the personnel, duties and lines of responsibility and control over road affairs and the relation existing between the State and local forces.

Following the publication of State chapters and charts in "Public Roads," the results of the whole study will be presented in the form of tables, charts, and text so arranged and analyzed as to enable the reader to obtain a comprehensive knowledge of the subjects treated without reference to the State chapters except for details.

The chapters for the first 6 States are presented as follows:

ALABAMA.

DEVELOPMENT.

State participation in road improvement in Alabama consists of money aid to a State-wide system of State trunk roads and technical advice extended on request to local road officials, and is administered by the State highway department.

State interest in road improvement was first manifested in 1911 with the passage of a State-aid law which made the fund from the net earnings of State convicts available for distribution to the counties to aid in the construction of main thoroughfares. The State-wide system of trunk roads designated in 1915 by the State legislature and which comprises about 2,700 miles, or 5 per cent of the total road mileage of the State, now receives the aid extended by the State.

As this fund is limited in amount and the initiative in construction is taken by the county boards, the results so far with State aid comprise a series of systems of roads of local importance, instead of trunk roads connecting the various sections or important towns of the State.

About 1,400 miles of the State system have been improved of which 659 miles had at the close of 1916 been improved by means of State aid. At the close of the same period about 6,000 miles or 10.8 per cent of the total road mileage of the State had been improved by surfacing, the cost having been borne in a small way by the State and the remainder by local funds.

Road and bridge expenditures during the year 1916 comprise \$102,422 of State funds and \$83,962 of local

funds expended by or under the supervision of the State highway commission. During the same period about \$4,000,000 of local funds over which the commission exercised no supervision was expended by local officials. In 1917 the total expenditure was \$2,669,022. The Commission thus had jurisdiction over about 4 1/2 per cent of the expenditures within the State for road and bridge purposes.

ORGANIZATION.

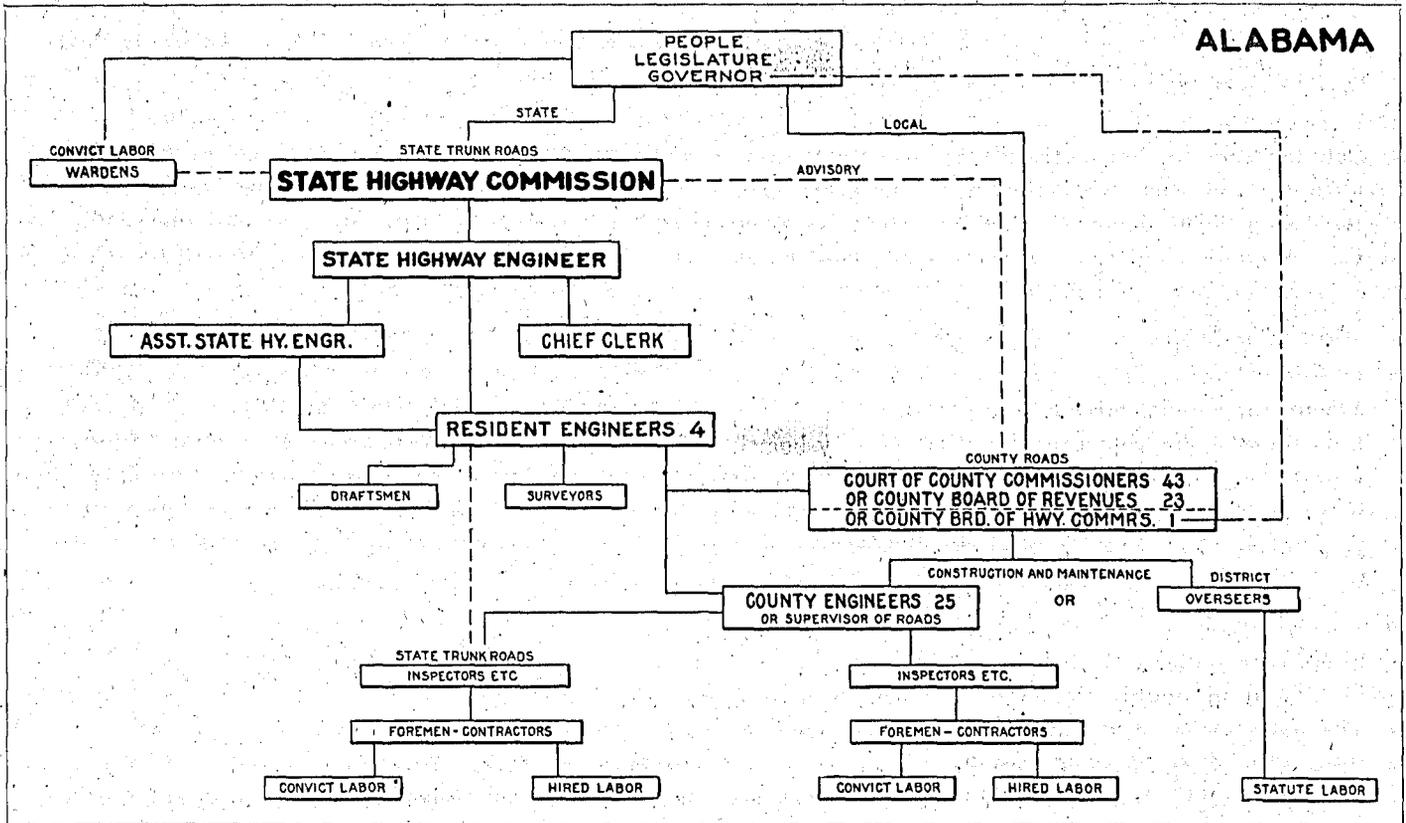
The road forces of the State and the relation existing between them is shown on this page.

State.—The State highway department is composed of a professor of civil engineering at the Ala-

ment of a system of State roads, and he is required when requested by local officials to serve as an advisor over local road matters coming under the jurisdiction of the officials requesting his services. Other powers and duties of the State highway department are indicated on the chart in the appendix.

County.—County authority over road and bridge affairs in Alabama is vested in boards composed of officials elected by the voters of the county, or appointed by the governor. These boards in general have broad powers over the roads under their jurisdiction.

In 43 counties of the State the governing board designated the court of county commissioners is composed of a probate judge as chairman, and one



bama Polytechnic Institute, who is selected by the board of trustees of that institution, the State geologist, and three civilians appointed by the governor of the State for terms of four years. The chairman of the commission is elected from its membership. The State highway engineer elected by the commission is required to be a competent civil engineer experienced and skilled in highway construction and maintenance. He serves as the executive officer of the commission, its secretary, and is custodian of the records of the State highway department. Such technical assistants and clerical force as may be required are appointed by him with the consent of the commission. The State highway engineer has unlimited supervisory charge and may take active charge, with the consent of the local officials affected, over all matters pertaining to the improve-

ment of a system of State roads, and he is required when requested by local officials to serve as an advisor over local road matters coming under the jurisdiction of the officials requesting his services.

In 23 counties the governing board designated the county board of revenues is composed of five elective members. The chairman is elected from the membership of the board.

In one county the governing board designated as the board of county highway commissioners consists of five members appointed by the governor.

The county board as above constituted may employ a county engineer or supervisor of roads to act as the executive official of the board in road and bridge affairs coming under their jurisdiction, or they may divide the county into districts and appoint overseers who have charge of the work performed by statutory labor.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The 55,446 miles of public road in Alabama are divided for the purpose of fixing responsibility for control, construction, and maintenance into three groups, namely, State trunk roads, county highways, and county roads.

State trunk roads comprise 32 routes with a total mileage of 2,700 designated by the State legislature. Roads of this group may be improved at the expense of the county or at the joint expense of the county and State. When at joint expense, application for State aid for a designated road or section thereof, and a certificate that the county's portion of the estimated cost is available, is made by the county board to the State highway commission. The application is examined by the State highway engineer and if deemed feasible and if the State's portion of cost is available, surveys, plans, specifications, and estimates of cost are made by the resident engineer detailed thereto, or by the county engineer under authority of the State highway engineer. The plans, specifications, and estimates when approved by the State highway engineer are transmitted to the county board with such recommendations as may be pertinent.

When the estimated cost exceeds \$250, the work may be advertised for contract or executed by force account or convict labor. After 30 days' publicity, bids are opened in open session of the county board, which is attended by the State highway engineer or his representative. Contracts may be let to the lowest responsible bidder, or all bids may be rejected and the work executed by convict labor or force account, under supervision of the county engineer or supervisor, or an engineer detailed by the State highway engineer. If by contract, the contractor files bond in double the amount of the contract. The bond must be acceptable to and approved by the State highway commission.

The work during progress is under the supervision and inspection of the county engineer or a resident engineer detailed by the State highway engineer if requested by the county board, and is subject to frequent inspection by the State highway engineer or his authorized representative. Monthly payments may be made covering 85 per cent of the completed work as evidenced by an estimate prepared by the engineer in charge of the work and approved by the State highway engineer, and transmitted to the probate judge, who draws a warrant on the county treasurer in favor of the contractor.

After \$1,000 has been expended from county funds, the State auditor on order of the State highway commission draws warrant on the State treasurer in favor of the county treasurer for payment of the State's portion of the total cost.

Each 2-mile block of road as completed is inspected by the State highway engineer or his representative

and, if satisfactory, is accepted. The payment therefor is made on receipt of final estimate prepared 30 days after the work has been completed. Final payment of the reserved 15 per cent and any other balance due is made in a similar manner.

County convicts may be employed or hired from or to, or exchanged with the governing board of another county for road building purposes, or State convicts may be employed under terms of a contract entered into by the county board and the State convict department. Roads of this group when constructed are maintained by the county with county funds under the instructions of and subject to the approval of the State highway engineer. When the county neglects or fails in its duty, maintenance is executed under direct supervision of the State highway engineer, the expense thereof being deducted from future allotments made to the county.

County highways.—Counties containing 200,000 or more inhabitants are required to maintain at their expense one public highway crossing the county in a northerly or southerly direction and one public highway crossing the county an easterly and westerly direction. Both roads are required to pass the county courthouse. Power is given to counties of this class to raise funds for this purpose.

County roads comprise all other public roads of the State and are located, constructed, controlled, and maintained by county boards with county funds. The State highway department has no jurisdiction over roads of this group unless requested to do so by the county officials having the proper jurisdiction.

REVENUES.

State funds for highway improvement are derived from the net proceeds of the State convict fund which amounts to about \$154,000 per annum. A sum of \$10,000 or \$20,000 with the approval of the governor is set aside from this amount and used to pay salaries of the State highway department. The remainder of the funds is divided equally among the 67 counties of the State, and is used for construction of State trunk roads conditioned, however, on the county providing an amount equal to the allotment made. When the county provides funds in addition to the amount required, the governor may if an unappropriated surplus is found in the State treasury, allot additional funds to the county provided that the amounts so allotted do not exceed \$4,000. All funds allotted by the State remain in the State treasury until disbursed on the order of the State highway commission.

County.—The county road and bridge funds are secured from several sources:

1. All males between the ages of 18 and 45 and not otherwise legally exempt are required to labor on the public roads for a period fixed by the county board. This period may not exceed 10 days per

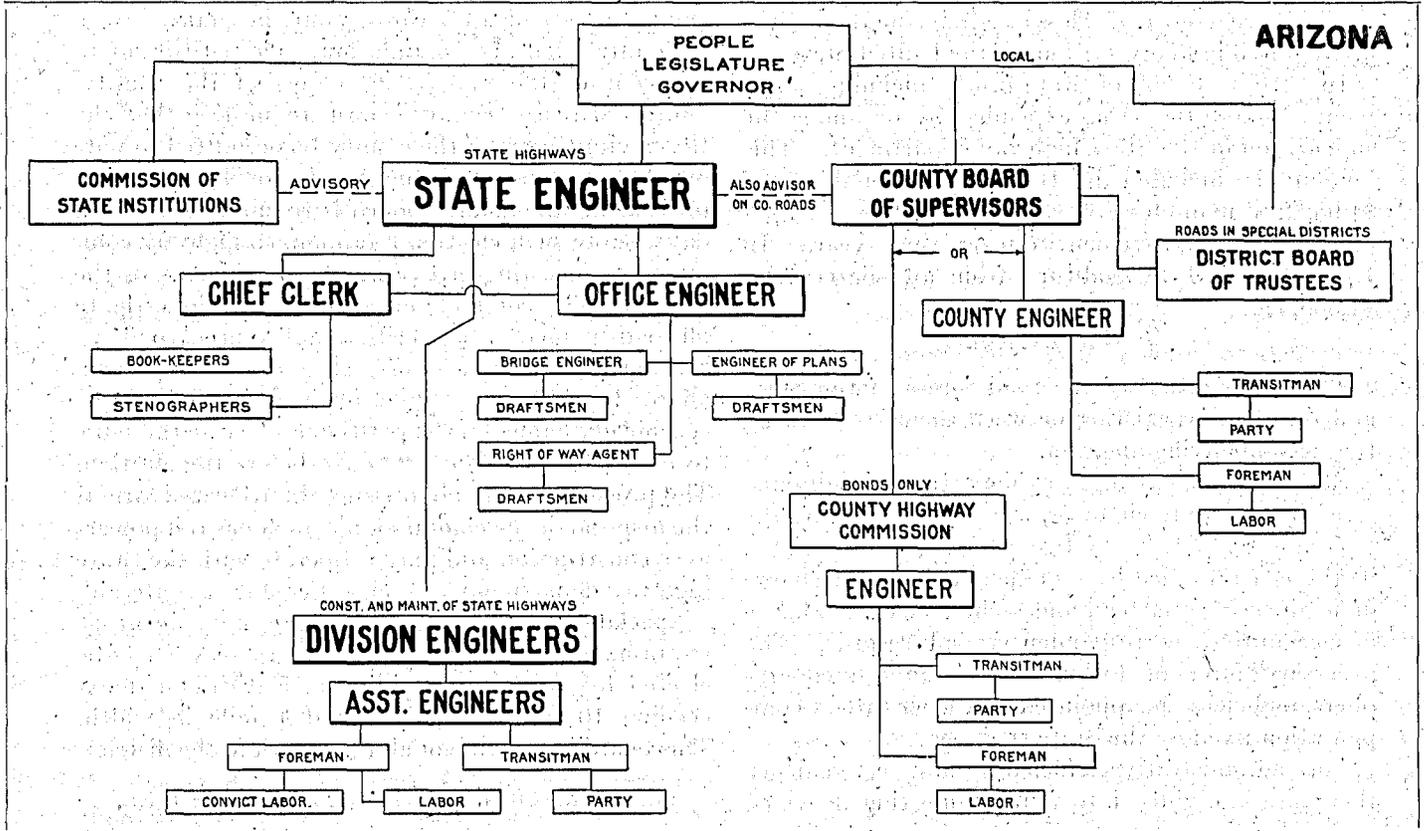
year, or in lieu thereof the board may exact a cash payment not to exceed \$5.

2. The revenues accruing from a license tax which may be imposed by the county boards upon vehicles using the public roads, bridges, and ferries of the county.

3. Any surplus funds in the county treasury may by order of the county board be transferred to the road and bridge fund.

for construction of a system of State highways and technical advice and assistance rendered to local officials at their request, and is effected through the State highway department.

The highway law, effective in 1912, provided a fund for road construction, for the appointment of a State highway engineer, and the administration of this fund. This fund was divided by law as follows: Seventy-five per cent of the amount col-



4. The proceeds of an ad valorem tax levied at a rate not to exceed one-fourth of one per cent on all taxable property in the county.

BONDS.

Bonds for road and bridge purposes may be issued by the counties in an amount not exceeding 3 1/2 per cent of the assessed valuation of the county and at a rate not to exceed 5 per cent. Before bonds are issued, the question must be submitted to the qualified voters of the county and a favorable verdict returned by a majority of the voters. The type and term of such bonds is not specified by State law.

ARIZONA.

DEVELOPMENT.

State participation in road improvement in Arizona is of recent origin, is effective in each county of the State, consists of money aid to the counties

lected in each of the 14 counties constituting a separate fund to be administered by the State engineer with the approval of the board of supervisors of the county concerned, and 25 per cent of that collected in all the counties constituting a fund to be administered by the State engineer with the approval of the board of control. These funds are provided by a State-wide tax of 1 mill. At that time the board of control was composed of the governor, the State auditor, and a civilian member appointed by the governor. This board was replaced in 1917 by the Commission of State Institutions, consisting of three appointive members.

A system of State highways comprising about 13 per cent of the total mileage of roads in the State has been designated by the county boards, with the approval of the State highway department, for improvement under the direction of the State highway department with funds allotted by the State and provided by the county boards.

On January 1, 1917, 375 miles, or about 3 per cent of the total road mileage of the State, had been improved. Of this total all but 3 miles had been improved under the State-aid plan.

Arizona is sparsely settled and has at its disposal a limited amount of funds for the improvement of roads and bridges essential to the development of the resources of the State. However, soil and climatic conditions are of such nature in a major portion of the State that road construction and maintenance can be carried out under less expensive methods than are required in many sections of the United States.

In 1916, \$441,202 of State funds (including allotments to counties) was expended by or under the supervision of the State highway department. This amount is included in the total expenditure of \$1,988,221 made by State and local forces for road and bridge improvement during that year. In 1917 the total expenditure from all sources was \$1,569,422.

ORGANIZATION.

The organization of the road forces of the State and the relation existing between them is shown by the accompanying diagram.

State.—The State highway department is administered by the State engineer, who is appointed by the governor for a term of two years. He is assisted in the central office by an office engineer, in charge of engineering matters, and a chief clerk, in charge of accounting, correspondence, and records. The necessary force of technical assistants, stenographers, and clerks is appointed and their rate of compensation fixed by the State engineer.

For administrative efficiency and convenience the State is divided into four engineering districts, each administered by a division engineer, who reports to the State engineer and represents him in all highway work, either advisory or supervisory, in his district. Division engineers are provided with assistant and resident engineers, who serve as chiefs of survey and location parties, and as engineers in charge of construction.

The State highway department has charge of the construction of all work financed wholly or in part with State or Federal funds, and is required to serve in an advisory capacity to local officials or to detail capable technical assistants to take charge of and superintend local work when so requested.

County.—Counties in Arizona are governed by boards of supervisors, each composed of a chairman and two members elected for terms of two years. The clerk is appointed by the board, and the county treasurer, an elective official, is its fiscal agent. The board so constituted has charge of all road and bridge matters in the county where county funds are used and has the power within statutory limits to levy taxes, expend the proceeds, and to establish,

open, and construct roads and bridges. Each county has appointed a county engineer, who, subject to the orders of the board of supervisors, is the administrative official in charge of all road and bridge work instituted under their direction. All county boards have, on request of the State highway department, arranged to keep records of their road and bridge expenditures in accordance with the cost accounting system used by the State highway department, thus providing a means of readily comparing the costs of similar classes of work throughout the State.

County Highway Commission.—On petition of 15 per cent of the tax-paying voters of the county, addressed to the county board, requesting that the tax-paying voters of the county be permitted to vote on the proposal, to issue bonds for highway improvement, the county board is required at least 90 days before such election to appoint a highway commission, consisting of five members, residents of the county. The commission is required to investigate all roads named in the petition and to prepare plans, specifications, estimates of cost, and a full report on all roads of the county or on each road or roads specifically named in the petition and cause the same to be published at least 20 days before the election. The proceeds of the bond issue, if authorized, are at the disposal of the commission, which has full powers over construction and may cooperate with the State highway department to secure Federal or State aid.

Special district trustees.—Under certain statutory requirements a board of three trustees may be elected by the voters residing in a district not exceeding 10 miles in length and 1 mile in width. This board has charge of all road work in the district.

CLASSIFICATION, CONTROL, AND PROCEDURE.

For the purpose of fixing responsibility for control, construction, and maintenance, the 12,075 miles of public road in Arizona are divided into two groups, State highways and county highways.

State highways comprise about 1,600 miles of public road selected with the approval of the State engineer by the boards of county supervisors for improvement under the direction of the State department with funds provided by the State road fund. When a project has been approved by the State engineer, surveys, plans, specifications, and estimates of cost are prepared under his direction, and when approved are forwarded to the county boards of supervisors for their consideration and approval. In actual practice the State engineer exercises at his discretion the authority vested in him over the expenditures for roads of this group. In specific instances the counties have provided in addition to the sum or sums allotted by the State sufficient funds to complete a project in a satisfactory manner. Construction is carried out by force account consisting of convict or paid labor

under the general supervision of the division engineer and his assistants. Convict labor when allotted to counties with the consent of the commission of State institutions, together with the special funds provided therefor, is often used in conjunction with the portion of the 75 per cent fund accredited to such counties. Contracts for public works are prohibited by State law in Arizona. When the work is executed by force account, semimonthly pay rolls and expense vouchers are submitted to the State engineer, who, in conjunction with the commission of State institutions or the county supervisors, provides for the payment from the funds allotted to the project. The completed roads are maintained by the State, using either the 25 per cent fund or the 75 per cent fund, whichever may be available at the time the work is required.

County highways.—County highways comprise all other legally designated highways of the State. They are opened, constructed, and maintained by the counties with county funds or by the highway commissions or district boards of trustees, if such organizations exist within the county. A large number of trails are used as highways, but not having been officially designated by the county board as highways, county funds can not be expended thereon.

REVENUES.

State.—A State-wide tax is levied at the rate of one mill on each dollar of valuation on all taxable property in the State. The proceeds of this tax are divided into a 75 per cent fund for allotment to the counties and a 25 per cent fund for the use of the State highway department. The 25 per cent fund is increased by the revenues accruing from the operation of the motor vehicle license act. The 1 mill State tax produced about \$686,000 in 1917 and the motor vehicle act produced about \$125,000. There is also a special fund amounting to \$65,000 per annum for the expenses incurred in highway construction with the use of convict labor. These funds are all available for the support of the State highway department, for allotment to meet Federal aid funds, and for the construction and maintenance of highways and bridges.

The method of handling these funds and of making appropriations from them differs according to the fund from which the money used is to be drawn and in the following manner: All projects that are to be paid for out of the 25 per cent portion of the State road fund, out of the motor vehicle license tax, or out of the special fund for the use of convict labor, must be approved by the State engineer and the commission of State institutions. All payments under such project must also be similarly approved.

The allotment to each county from the 75 per cent portion of the State road fund is made by law

and amounts to 75 per cent of the State road tax collected in that county. All projects to be paid for from this fund must be approved jointly by the State engineer and the board of supervisors of the county concerned and all payments under such project must be similarly approved.

On some projects where funds are used from both 75 per cent fund and 25 per cent fund, the project is approved by the State engineer, commission of State institutions and board of supervisors of the county concerned and any specific payment is made with the approval of the State engineer and either the commission of State institutions or the board of supervisors of the county concerned, according to the fund from which payment is made.

County.—Additional funds for the counties to be expended under the supervision of the board of supervisors with the advice and assistance of the State engineer when requested are provided by a tax levied at a rate not to exceed 25 cents on the \$100. A \$2 poll tax is levied on all male inhabitants between the ages of 21 and 60, residents outside the limits of cities, towns, and villages, and who are not otherwise legally exempt. Highway commissions and boards of trustees for districts also have power to levy special taxes for road purposes within their jurisdiction.

Bonds.—Bonds may be issued by the county boards of supervisors when authorized by a majority vote of the property tax paying voters and when a county highway commission has been legally constituted. The bonds are required to be of the serial type, bear not to exceed 6 per cent interest, and may not run longer than 40 years.

Sinking fund bonds bearing not to exceed 6 per cent interest, when authorized by a two-thirds majority of the property tax paying voters affected, may be issued by the trustees of a legally constituted special road district or the district may levy a special tax for a period not to exceed five years and at a rate not exceeding 75 cents on the \$100.

There were \$295,000 of county road and bridge bonds outstanding on January 1, 1915.

ARKANSAS.

DEVELOPMENT.

State participation in road improvement in Arkansas is of quite recent origin, and of State-wide scope. The State highway commission, established in 1913 and limited to an existence of 30 years as a division of the Department of State lands, highways, and improvements, has jurisdiction by the terms of an act of 1913 over all State and Federal funds provided for State aid for road improvement of a system of State roads comprising about 6 per cent of the

road mileage. The advisory board of the State highway commission, however, is required to recommend the amount of funds to be expended by the State on each particular project. Funds for State-aid purposes exceeding in amount funds provided by the Federal Government have been provided by the legislature.

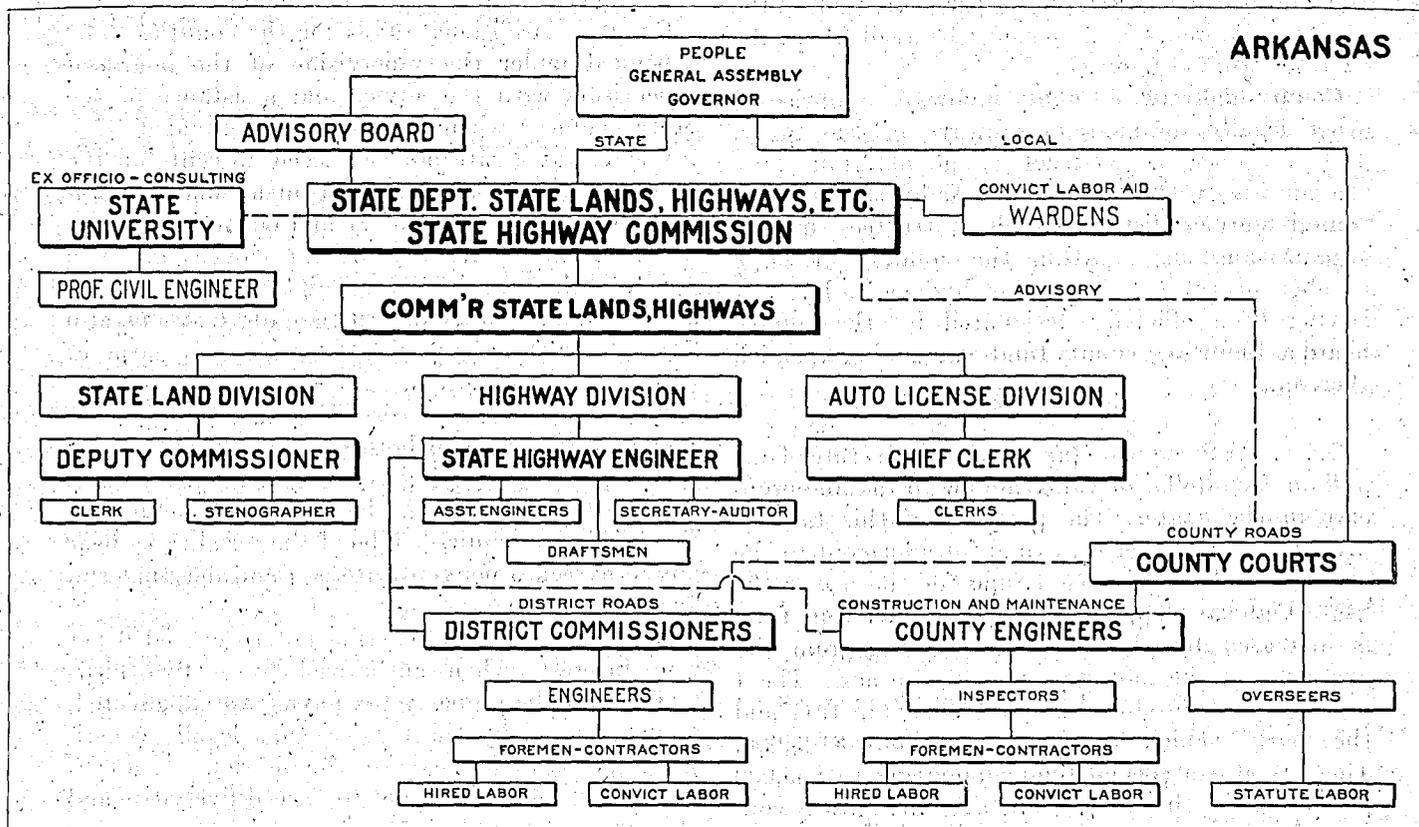
Prior to 1917 the activities of the highway commission were limited to advisory and supervisory duties connected with projects financed by local funds. Considerable work in connection with the preparation of plans and specifications for roads, and more especially bridges, has been done by the organization at State expense for the benefit

Thus State supervision extended to 49 per cent of the total expenditures. In 1917 total expenditures were \$3,335,262.

ORGANIZATION.

The organization of the highway forces and their relation to each other is shown by diagram.

State.—The State Highway Commission is a division of "The State department of State lands, highways, and improvements." The commissioner of this department, who is chairman, and two members appointed by the governor, compose the State highway commission. The chairman, subject to the approval of the commission, selects the State



of county, township, and district improvement boards.

The laws require that all road or bridge improvements throughout the State, executed from special tax levies or bond issues, be constructed in accordance with plans and specifications prepared or approved by the State highway commission.

About 3 per cent of the road mileage of the State has been hard surfaced, the expense of construction being borne by counties, townships, or special districts. In 1916, the highway commission expended \$55,483 on account of its duties as technical advisor of local officials, and supervised or furnished plans for work costing \$1,683,549, which was financed from bond issues. The total expenditures for 1916 by all road forces of the State reached \$3,443,887.

highway engineer, who is required to be a graduate civil engineer of some reputable school, and who is skilled in road building and surveying.

The head professor of civil engineering at the State university of Arkansas is ex officio consulting engineer of the department of State lands, highways, and improvements.

The advisory board of the State highway commission, limited to an existence of 20 years, is composed of the State highway engineer, the consulting engineer above referred to, and a member appointed by the governor for a term of two years. No State or Federal funds may be expended by the highway commission for road construction or improvement unless a specified amount therefor has been recommended by the advisory board.

The number and compensation of the regular technical assistants and other employees of the commission is fixed by law. Among the more important duties of the commission are the following: To prepare and approve plans and specifications of proposed improvements financed in part by State funds, and to supervise all such work during construction; to supervise maintenance of such work when completed; to prepare and furnish when requested by local officials plans and specifications for road improvement financed with local funds. To prepare a uniform system of blanks and to require local road officials to make detailed reports thereon at stated intervals and to investigate any road improvement or construction in progress in the State; and to make reports thereon to the governor should irregularities of administration or construction be ascertained.

The approval of the highway commission is required before the appointment of an engineer by a county or road improvement district becomes valid.

County.—The governing board of the county is the county court, composed of the county judge, all of the justices of the peace of the county, the justices being apportioned on a basis of one justice for each 1,200 qualified voters, constitutes the quorum court or levying court which levies taxes and appropriates funds for the use of the county court. However, no township may have less than two justices. These officials are elected for terms of two years. The county clerk and the county treasurer are, respectively, clerk and fiscal agent of the board. The county court is in charge of all road and bridge work of the county, appoints a superintendent of public dirt roads, creates road districts, and appoints overseers therefor. The county courts of six counties of the State are required to employ a county highway engineer, who is the executive officer of the court in all road and bridge work. The county court may authorize the creation or organization of special road improvement districts. The organization is made in accordance with statutory law, which requires the county court to appoint three members to constitute a governing board of the district. Districts when legally organized have the power to levy taxes, issue bonds, enter into contracts, and carry out construction. They may employ attorneys, engineers, etc.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The total mileage of roads in Arkansas is about 50,000, and for purposes of fixing responsibility for administration, construction, and maintenance, is divided into two groups, State roads and county roads.

State roads.—Comprising a system of about 3,000 miles of intercounty-seat roads, and such other rural

post roads as may be designated by joint agreement between State and local officials. Roads of this class are constructed under State supervision by means of Federal or State funds combined with the local funds.

It is the intent of the highway act of Arkansas to distribute equally among the various counties of the State the funds provided by the Federal Government and by the State legislature. However, the funds at the disposal of the State highway commission are distributed only to counties or districts furnishing satisfactory evidence that the local organization is willing and able to bear its share of the cost of construction and the entire cost of maintenance when completed. The procedure is as follows:

The county court is required to present to the State highway commission preliminary surveys, plans, specifications, and estimates of cost which are required to have been made or approved by the commission and which bear the approval of the county judge, together with evidence that the road has been legally established and opened, that funds available to meet the county's share of the cost of construction, and that maintenance will be executed by the county after completion.

When aid is requested by a road improvement district, certified copies of all legal documents, publication notices, petitions, acts of the board of commissioners, bond of officials, and all legal steps taken from the inception of the district to the date of making the application, are required to be furnished to the commission in addition to the data required from the county. The county court is required to furnish certified copies of all notices or orders given by or under authority relative to the district or any official acts of the board, and to pledge the good faith and resources of the county to carry out maintenance when the road has been completed and become a part of the county system.

When the data provided by the county or improvement district boards has been approved by the commission, the application is presented to the advisory board which recommends to the State highway commission a specified amount of Federal or State funds for allotment to the project for construction purposes.

After the project has been favorably recommended by the advisory board, the local officials, county or district, present to the State highway commission a project statement showing in such detail as will enable the commission to ascertain, (a) whether the project conforms to the regulations of act 105 of the acts of 1917 (the State aid act), (b) whether adequate funds or their equivalent are available by or on behalf of the applicant, (c) what purpose the project will serve, and how it correlates with the other highway work of the county, (d) the administrative control of and responsibility for the project, (e) the practicability and economy of the project from an engineering and construction standpoint, (f) the adequacy of the plans and provisions for the proper maintenance of the road when constructed.

Each statement is required to be accompanied by a copy of the proposed contract and bond together

with copies of all documents referred to therein, and a sketch map showing the general location of proposed project and all main contiguous transportation features. When an agreement has been arranged between the State highway commission and the local board, contracts may be let by the board under the following general conditions:

The local board is required to give due publicity before accepting bids for construction purposes. The bids are required to be submitted in such form as to show the unit price of the various services to be performed and of the materials to be furnished. Copies of the notices of publicity and of all bids received are required to be furnished to the State highway commission sufficiently in advance to enable the commission, if it so desires, to have a representative present at the award of the contract.

If the contract is awarded to other than the lowest bidder, the State is not obligated to pay more than its pro rata share of the lowest bid unless proof be produced that the most advantageous offer was accepted. Copies of all contracts, including plans and specifications which were made a part of each contract, must be furnished the State highway commission as soon as it can be done conveniently.

Male convicts confined in the State penitentiary may be employed by counties or road improvement districts for road construction purposes, subject, however, to the rules and regulations of the State penitentiary commission and to the approval of the State highway commission as to time, place, and manner of such work. The pay of the warden and guards for such forces is borne by the State from the highway improvement fund. The other expense incurred in connection with utilization of the convicts for road construction purposes is borne by the county or district.

The engineer employed by the board with the approval of the State highway commission is in charge of the work during construction and is required to exercise strict inspection and supervision during the progress of the work.

Vouchers for partial payments at intervals of not less than one month and final payment when the work is completed are submitted by the proper county authority, the county judge, or the district improvement board to the State highway commission on forms supplied by the commission. Payments of the State's portion thereof are made by the chairman of the commission to the proper fiscal agent of the county or district.

The State highway commission requires that the board in charge of the work keep the records of such work in a manner prescribed by the commission, and the commission may at any time inspect such records, require certified copies thereof, and withhold payments for such portion of the work as has not been completed in accordance with the contract.

Maintenance is executed by the county with funds raised by the imposition of a three-mill tax and in accordance with the rules and regulations of the State highway commission.

County roads include all roads of the State not included in the State system. Such roads are under the county officials subject, however, to inspection of methods of construction and maintenance by the State highway commission.

County prisoners may be employed on road work with the approval of the county court having jurisdiction over them. Expense of feeding, clothing, housing, and superintending such prisoners is borne by the district when used under direction of the district board.

REVENUES.

State.—The State legislature appropriated for highway improvement purposes for the two-year period 1917 to 1919, \$593,745.60 from the highway improvement fund. This fund is used for the support of the State highway commission and \$496,134.60 of said amount for construction purposes. The highway improvement fund is accumulated from fees accruing to the State department of State lands, highways, and improvements. Fees for the registration of motor vehicles produce the greater portion of the revenue thus obtained.

County.—County funds are obtained from a highway and bridge tax not exceeding three mills on the dollar of assessed valuation. This tax is required to be paid in cash or county scrip. Four days labor or commutation thereof at the rate of \$1 per day is required of each able-bodied male inhabitant not legally exempt.

Bonds.—Bonds may be issued by the board of commissioners of a district in an amount not exceeding 30 per cent of the assessed valuation of the district. Such bonds shall not bear interest at a rate exceeding 6 per cent. On January 1, 1915, \$1,467,066 of indebtedness was outstanding. This total was composed of \$217,140 of short time non-interest bearing scrip issued by counties and \$1,249,926 of bonds issued by districts for terms of 12 to 20 years at a rate of 6 per cent.

CALIFORNIA.

DEVELOPMENT.

State participation in road improvement in California, dating from 1897, is now of State-wide extent and of considerable magnitude as regards expenditure of State funds, raised principally from the sale of bonds, and is administered by a well-organized State highway force.

The State department of engineering, through its subdivisions, the advisory board and the California highway commission, forms the organization by which State funds are expended for construction and maintenance of State highways wholly built with State funds and such highways as are desig-

nated by the State legislature for State aid to counties improving prospective sections of the system of State highways and of other roads designated by joint agreement between State and local officials.

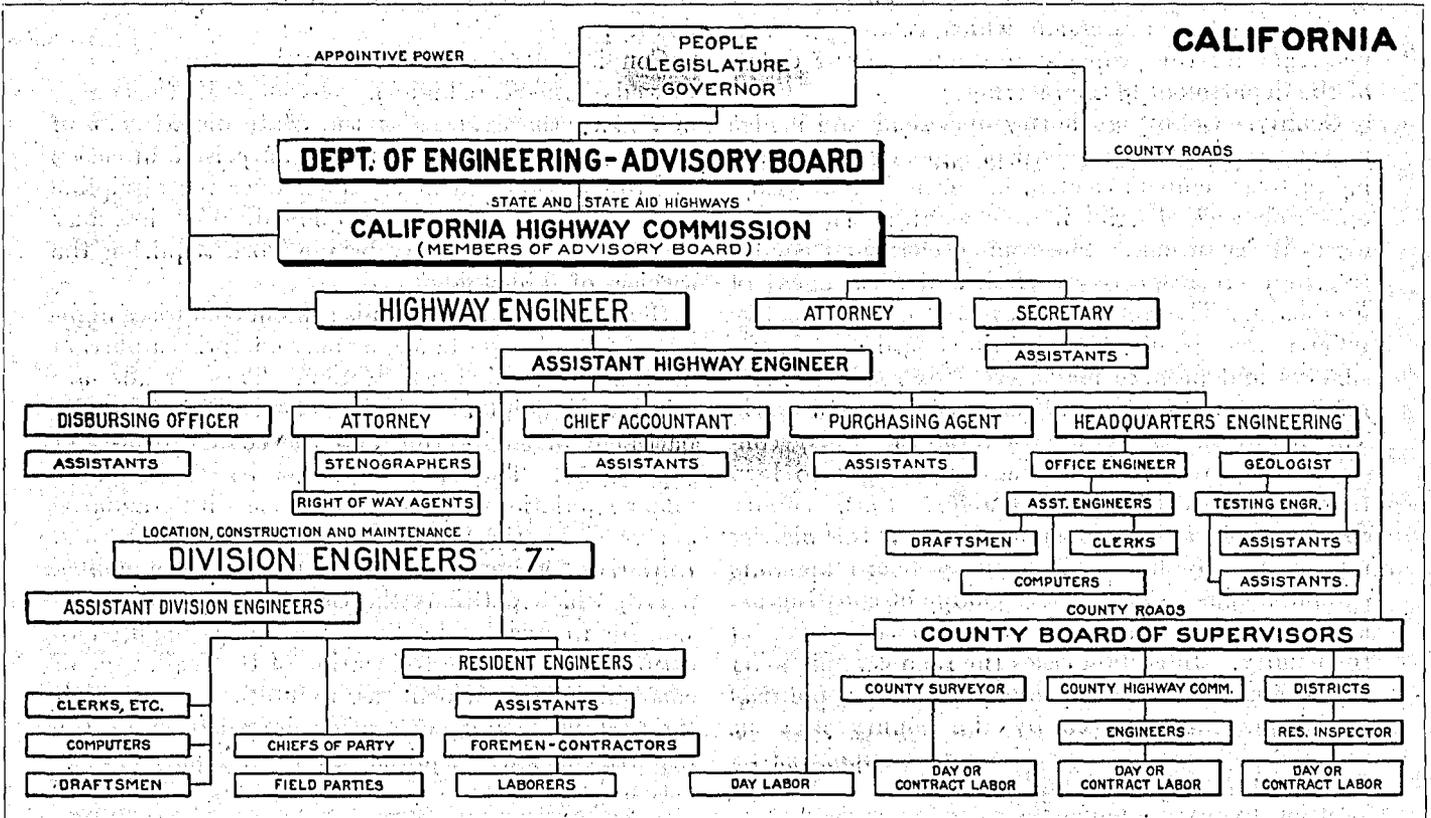
State bonds aggregating \$33,000,000 have been authorized and the proceeds have been or will be expended on road construction extending throughout the State, principally on a State system comprising about 5 per cent of the total road mileage.

At the close of the year 1916, 20.2 per cent of the total road mileage of the State had been hard surfaced. In that year \$4,285,964 was expended by or under the supervision of the State highway

ORGANIZATION.

The organization of the highway forces of the State and the relation between the State and local officials is shown herewith.

State.—The State highway commission is vested in a department of engineering, consisting of an advisory board composed of ex officio members as follows: The governor as chairman; the State engineer, who is executive officer of the department; the general superintendent of State hospitals; the chairman of the board of harbor commissioners of San Francisco, and three members appointed by the governor. The three appointed members of the advisory board constitute the California highway



commission. The total expenditures during the year by State and local officials for road purposes amounted to \$20,392,432, and in 1917, to \$18,245,200.

Road improvement in California is well supported by both State and local funds and through the control exercised by the State department of engineering over location and types of construction by means of its right to extend aid to local organizations conforming to certain requirements; a well-planned and well-constructed State-wide system of improved highways is rapidly coming into existence.

The State of California agrees to become defendant in any or all suits brought against contractors engaged in road construction under State supervision on account of alleged infringement of patents involving types of roads under construction.

commission, which ranks as a subdivision of the department of engineering. The advisory board is restricted by statute to the position of advisor to the highway commission in matters relating to finances, general policy, the general administration of the department, and in matters relating to location, securing of right-of-way, granting of aid to counties or districts, and the acceptance of roads constructed by local officials as a part of the State highway system.

The California highway commission, whose executive official is the State highway engineer, appointed by the chairman of the department of engineering, has charge of the construction and maintenance of all State road work, and of such other roads as may be placed under its control by

local officials. The commission, in addition to such other duties as may be imposed upon it by law and the advisory board, is required to investigate the methods of construction and place the most approved methods at the service of the State; to compile and publish statistics relative to road system of the State; to advise with county or district officials relative to improvement work financed with local funds; to prepare plans, specifications, and estimates for and to supervise the construction of such work when requested to do so by local officials, and to establish standards of construction suitable to the different sections of the State.

The commission has the power to require State, county, or municipal officials to furnish any information in their possession which relates to or is necessary for the proper performance of the duties of the department of engineering.

County.—County authority over road and bridge matters is vested in a board of supervisors consisting of five members elected for terms of four years, one from each district in the county. The board elects its chairman. The county clerk and county treasurer are respectively clerk and fiscal agent of the board. The county surveyor, who is an elective official, may be directed by the board to execute surveys and prepare plans, etc., for road improvement, and to act as an inspector on road work. The board has the power to establish roads, construct, improve, and maintain them, and to levy taxes to provide funds therefor. Each county supervisor is also road supervisor for the district represented by him. The county board appoints commissioners to take active charge of construction and repair of the roads in the various districts of the county. In certain cases the road commissioner is provided with two inspectors of different political affiliation. Maintenance by the county may be under the charge of a superintendent appointed by the board or may be let by contract.

Special boulevard districts may be organized in counties for road improvement purposes. The governing board of the district is known as the boulevard commission. Such commissions have broad powers over construction, location, etc., under some circumstances in the discretion subject to the general supervision of the State department of engineering. Bonds may be issued by such districts, or special taxes may be levied.

Special divisions of a county may be organized for similar purposes, and have similar powers as are designated for special districts.

CLASSIFICATION, CONTROL, AND PROCEDURE.

For the purpose of fixing responsibility for control, construction, and maintenance, the road system of California, comprising 61,039 miles, is

grouped as follows: State highways, State-aid highways, State roads, and county roads.

State highways.—These are selected by the State legislature and comprise about 3,000 miles of road included in the coast route, and the valley route in the interior of the State both extending from Mexico to Oregon, and such branch lines as will connect with the county seat of each county. Such roads are constructed and maintained by the State with State funds. The counties, however, are required to assume the interest charges on the bonds the proceeds of which are expended in the county. The State department of engineering may, when the county is financially unable to bear this burden, reduce the amount of interest to be paid by the county.

Convicts confined in State prisons may be employed on the State highway system under the charge of and at the expense of the State department of engineering. The State board of prison directors has full jurisdiction at all times over the discipline and control of convicts so employed. Convicts may not be employed on any bridge work requiring the services of skilled labor.

State-aid highways.—This system comprises highways of local importance, or may comprise a portion of the State highway system. These roads are selected by joint agreement between the State department of engineering and the county boards of supervisors. They are improved by the counties under regulations and in accordance with standards approved by the State department of engineering. Initiative for improvement is taken by the county board, which petitions the State highway commission for financial aid. Such petition is required to contain data relative to location of the road, type of construction, statement as to status of proposed right of way, and such other information as the department may require. Surveys, plans, specifications, and estimates are prepared by county officials for the consideration and approval of the highway commission. All bridges, culverts, and right of way required by the proposed improvement, are secured by and at the expense of the county, and such expense is not considered as a part of the total cost of the highway under the State aid act. When the plans and specifications approved by the highway commission are returned to the county board, contract for the work is let by the county board of supervisors, and inspection is performed by the county engineer.

The total cost, comprising the cost of surveys, plans, inspection, and construction, is borne one-third by the State and two-thirds by the county. Payment of the total cost is made by the county board on presentation of estimates made by the engineer in charge and approved by the California

highway commission. The county, when the work has been completed and accepted, presents bills to the State department of engineering covering the expense to be borne by the State. Payment of this account is made on order of the advisory board.

Completed roads are maintained by the county under State supervision and inspection, the cost being borne equally by the State and county.

State roads are special roads for which State funds are appropriated by the legislature, and are constructed and maintained by the State department of engineering under the direction of the State highway engineer. They are, as a rule, located in mountain counties which are unable to provide the necessary funds for their improvement.

County roads.—These comprise all other public roads of the State, are established, controlled, constructed, and repaired by county officials with county funds. They may be improved by the district or division organization, with local and State-aid funds, and when so improved may become a part of the State highway system, or be retained as a part of the improved county system.

REVENUES.

State.—Funds for highway purposes are derived from four sources and for the calendar year 1917 the following amounts were available:

1. Legislative appropriation for support of the highway branch of State department of engineering, \$20,800.
2. Legislative appropriation for construction of certain specified roads and bridges, \$6,000.
3. Proceeds of State bond issues, \$1,300,000.

In 1910 \$18,000,000 of 4 per cent bonds and in 1916, \$15,000,000 of 4½ per cent bonds were authorized. They are of the serial type and \$400,000 of the first issue are retired each year and \$375,000 of the second issue are to be retired in 1923, and an equal amount in each year thereafter.

4. One-half of the net proceeds of the motor vehicle tax are available for maintenance of State highways, \$1,247,269.

County.—Revenues for road purposes are obtained from the following sources:

1. Highway tax at a rate not to exceed 40 cents on \$100 on all taxable property in the county.
2. One-half of the net revenues from the motor vehicle tax is divided among the counties in the ratio in which fees were collected.
3. From bond issues or special taxes levied for road improvement.
4. Refund from Federal Government of a percentage of the receipts collected in national forest reserves located in the county.
5. Fines and penalties accruing from violation of motor vehicle laws, when the arrest and conviction

is executed by county authorities. Poll or head taxes are not levied in California.

BONDS.

State bonds aggregating \$33,000,000 have been authorized, as noted under "Revenues."

Sinking fund bonds in an amount not exceeding 5 per cent of the assessed valuation of a county or district, bearing interest at a rate not exceeding 6 per cent may be issued when authorized by a two-thirds majority of the voters of the territory affected.

County bonds may run 40 years, while district bonds are limited to a term of 20 years.

On January 1, 1915, there was outstanding \$14,277,000 of bonded indebtedness for roads and bridges, issued by counties or districts.

ILLINOIS. ✓

DEVELOPMENT.

State participation in road construction and improvement, while of comparatively recent origin, is extended throughout Illinois by means of aid to counties, and is administered by the department of public works and buildings, which possesses broad powers over location, standards of construction, and maintenance of all roads improved wholly or in part with State funds.

The State-aid system, which comprises about 18 per cent of the total road mileage of the State, is limited in extent by law to 15, 20, or 25 per cent of the road mileage of each county, the percentage being based upon the population of the county. On June 30, 1917, about 5.5 per cent of this system had been improved.

The voters of Illinois, at the general election this year, will pass on a constitutional amendment authorizing the issue of \$60,000,000 of State bonds, the proceeds of which will be available for construction by the department of public works and buildings of a comprehensive system of State roads, comprising about 4,800 miles. The principal towns to be connected by this system are designated in the proposed law. The bonds, if authorized, will be sold as needed from time to time and will be of the serial type, limited to a life of 20 years. The interest and principal of this issue will be paid from the net revenues derived from motor-vehicle licenses.

At the close of 1916, about 12,400 miles, or 13 per cent of all public roads of the State, had been improved by surfacing. In 1916, \$1,119,202 of State funds, and \$1,503,953 of local funds were expended under the direct supervision of the State highway commission. The total expenditures for road and bridge purposes by State and local officials in that year reached \$10,356,669. State super-

vision was thus extended to 25.4 per cent of the total expenditures, while the State contributions comprised 10.8 per cent of the total. A total of \$10,083,728 was expended in 1917.

Considerable progress in road and bridge construction has been made under the State-aid plan and the State legislature has provided funds for the continuance of this assistance during the period 1917-1919.

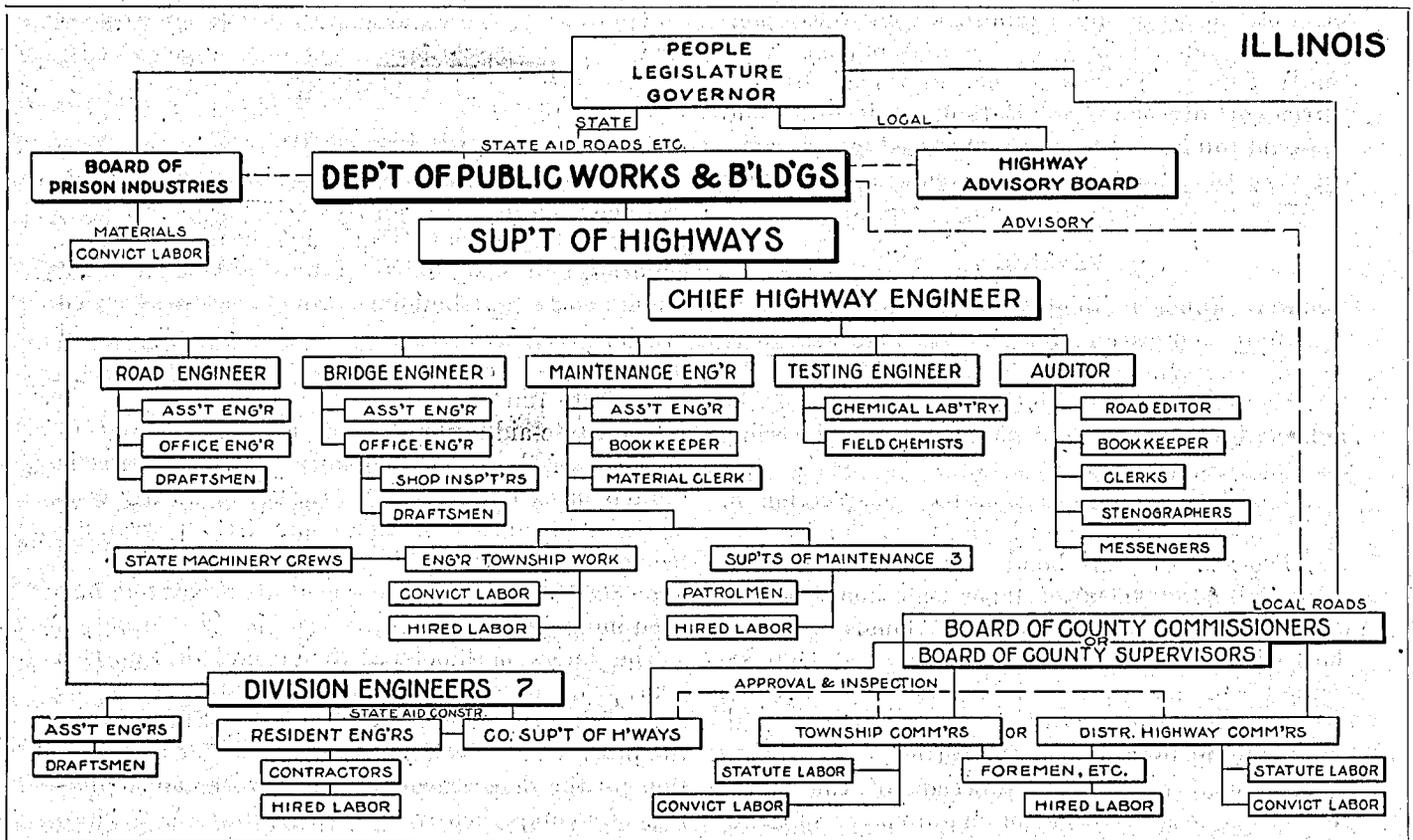
ORGANIZATION.

The organization of the road forces of the State and the relation existing between them is shown on the chart.

State.—Supervision over road affairs is vested in the department of public works and buildings,

executive officials of the department, or it may of its own initiative recommend policies or practices for the consideration of the executive officials of the department.

The department of public works and buildings has full administrative control over the expenditure of the "Federal-aid" fund, composed of an appropriation by the State legislature and the funds allotted by the United States Government for road construction. The department has the right to prescribe rules and regulations not inconsistent with the law relative to the duties of its employees and of county superintendents of highways. It may undertake and supervise local construction when requested by local officials to do so, and on request is required to



which is subdivided into several divisions with duties specified by law. The division in charge of road work is administered by a superintendent of highways, a chief highway engineer appointed by the governor with the advice and consent of the senate, and other subordinate employees, their number and compensation fixed by State law under a budget system.

The board of highway advisors, composed of five nonsalaried members, appointed by the governor with the consent and approval of the Senate, has advisory powers over the highway division of the department. It has access to all records of the highway division, may require written or oral information from any officer or employee thereof, and is required, when requested, to tender advice to the

furnish plans, specifications, and estimates of cost of proposed improvements initiated by local officials.

The department has the necessary authority to prescribe a system of auditing and accounting covering all road and bridge matters handled by State and local highway officials and to compel accounts to be carried in such manner as may be indicated in the system.

County.—In 17 counties of the State county authority over roads is vested in a board of three commissioners, one being elected each year for a term of three years. The county clerk and the county treasurer are clerk and fiscal agent, respectively, of the board. In 85 counties of the State where township organization is in force, county authority is

vested in a board composed of an elective supervisor from each township. Administrative supervision over road and bridge construction and maintenance is vested in a county superintendent of highways appointed by the board of supervisors from a list of eligibles certified by the department of public works and buildings. The county superintendent, while paid by and employed under the direction of the county board, is required to perform his duties in compliance with rules and regulations issued by the State department of public works and buildings.

District or township.—Counties not under township organization are divided into road districts. Each district is at least equal in area to a congressional township. Road affairs in the district are administered by a highway commissioner elected for a term of two years. Township road affairs are administered by a commissioner elected for a term of two years. The highway commissioner has general charge of the road and bridge improvements in his district or township when financed with funds raised by ordinary local taxation, and he has the power to fix, within statutory rates, both poll and property taxes.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The 95,647 miles of public road in Illinois are divided for the purpose of placing the responsibility for control, construction, and maintenance into three groups.

1. Federal-aid roads, comprising about 586 miles of road selected by the department of public works and buildings with the approval of the United States Secretary of Agriculture, to be constructed under their jurisdiction by force account or contract with funds provided by the Federal, State, and local governments. Maintenance will be executed by and at the expense of the State. Convicts may be employed in the preparation of road materials for Federal-aid or State-aid roads.

2. State-aid roads comprise about 16,900 miles of road selected by the various county boards of commissioners with the approval of the department of public works and buildings. Of this, 920 miles were completed on June 20, 1917. These roads are constructed under State supervision by the counties in accordance with plans and specifications prepared by the department with funds provided by the State and county. Initiative for construction is taken by the county board which agrees to provide not less than 50 per cent of the total cost and requests an allotment of State funds. The type of road construction is selected by the county board or by the State department of public works from standard types established by State law and contracts are let by the department of public works and buildings.

The work is carried out under the supervision of the division of highways, department of public works and buildings. The completed work is inspected and accepted by an agent of the department.

Maintenance is executed by and at the expense of the State, although sometimes carried out under the supervision of the county superintendent of highways, but in this instance he is considered a State official. However, when gravel or macadam roads are constructed, the county is required to pay one-half of the cost of maintenance, and when earth roads are constructed, the county is required to pay the entire cost of maintenance.

3. County or township roads comprise all public roads of the State not included in the preceding systems. Supervision of road and bridge construction and maintenance involving amounts of \$200 or more is vested in the county officials. The responsibility for construction and maintenance of local roads and bridges is divided between the county and the district or township officials in such manner as may be prescribed by statute in special cases, decision or order of the county board, or by mutual agreement between the county board and the district or township board.

REVENUES.

State.—The funds available for expenditure by the State department of public works and buildings for road purposes are derived from the following sources:

1. Appropriation by the State legislature, \$346,060 for the two years 1917 to 1919 for the expense of the highway division of the department of public works and buildings.

2. Appropriation of \$1,326,000 for the same period for Federal-aid roads.

3. Appropriation of \$1,200,000 for the same period and the reappropriation of the balance remaining on hand July 1, 1917, for State-aid roads. This balance on June 8, 1917, amounted to \$1,173,979.07. Thus the State funds available for the 2-year period amount to approximately \$4,000,000.

The funds provided for State-aid roads are allotted yearly by the department of public works and buildings to each county in the ratio that the road and bridge funds of the county bear to the total road and bridge fund of all the counties, provided, however, that in counties in which more than 40 per cent of the total amount provided by the State legislature for State aid is collected for the local road and bridge fund there shall be allotted to the county from State funds an amount equal to 25 per cent of the amount collected in such county.

The amounts allotted to the various counties of the State shall be used to defray not more than 50 per cent of the actual cost of construction. If the

county fails within six months to provide an equal amount, the allotment is forfeited and is divided among the counties complying with the provisions of the State-aid law.

The fees received from licenses of motor vehicles and chauffeurs will be applied first to the payment of bonded indebtedness of the State and the interest thereon, when such bonds are issued and the remainder is deposited in the State treasury.

County.—Ordinary county revenues for road and bridge purposes are limited in amount, and are secured from a general levy for all county purposes. This levy may not be more than 45 cents on each \$100 assessed valuation in counties having 300,000 inhabitants and 75 cents on each \$100 of assessed valuation in counties having less than 300,000 inhabitants. The total tax levied for all purposes except to pay principal and interest of bonded indebtedness or judgments against the county, may not exceed 3 per cent of the total assessed valuation.

District or township.—Road and bridge revenues are derived from a direct property tax levied at a rate not to exceed 61 cents on each \$100 of assessed valuation, and a poll tax not less than \$1 nor greater than \$3 levied on all male citizens between the ages of 21 and 50, not otherwise legally exempt. Townships and districts may transfer their road fund to the county for the purpose of securing and participating in State aid in road construction.

Bonds.—Counties, districts, and townships may, when authorized by a majority of the voters affected, issue serial type bonds of not more than 20 years' term in amounts not exceeding 5 per cent of the assessed valuation of the county, district, or township.

There was outstanding on January 1, 1915, \$798,761.55 of local bonds and \$3,656,500 of similar bonds were authorized but not issued during the year 1914. Interest rates on the outstanding bonds varied from 4½ per cent to 6 per cent.

GEORGIA.

DEVELOPMENT.

State interest and participation in road and bridge improvement in Georgia is of limited amount, dates from 1908, consists of convict labor allotted to the various counties under certain conditions, and of technical advice to county road officials and is administered by the State highway department.

By the terms of an act, approved in 1908, the State prison commission was required to allot the prisoners under its control to the various counties of the State, the allotment being based on the population of the counties and the convicts so allotted to be used for road construction purposes.

In 1917, 1,800,000 days of convict labor, valued at \$2,700,000, were utilized by the counties on road work, about 6,000 convicts being employed.

In 1916 the State highway department, composed of the prison commission and three ex-officio members, was created and designated by the legislature as the proper body to cooperate with the Federal Government in the expenditure of Federal funds allotted to the State. As no State funds are provided for road purposes under the jurisdiction of the State highway department, its principal duty is to represent the various counties requesting Federal aid and to exercise supervision and inspection over work financed in part by Federal funds.

State convicts allotted by the prison commission comprise the principal road-building force of the State. This force is supplemented by statutory labor required of certain male inhabitants, cash taxes, and the proceeds of bond issues. Practically all work, except Federal aid work, is entirely in the hands of local officials and is constructed and maintained in accordance with such plans and standards as may be acceptable to the officials in charge.

The State highway department has designated a system of 5,500 miles, or 6.75 per cent of the total State mileage, for improvement with Federal and local funds under the supervision of the department. But as half of the cost is supplied by the counties, the initiative for construction lies in their hands, and they are thus able to control to a considerable degree the location of new improvements.

At the close of 1916 about 13,500 miles, or 15.3 per cent of the total State mileage, had been surfaced by and at the expense of the counties. The expenditures for road and bridge improvement throughout the State during the year 1916 approximated \$3,750,000. In 1917 it reached \$4,318,350.

ORGANIZATION.

The organization of the road forces of the State and the relation existing between them is shown in the diagram on page 51.

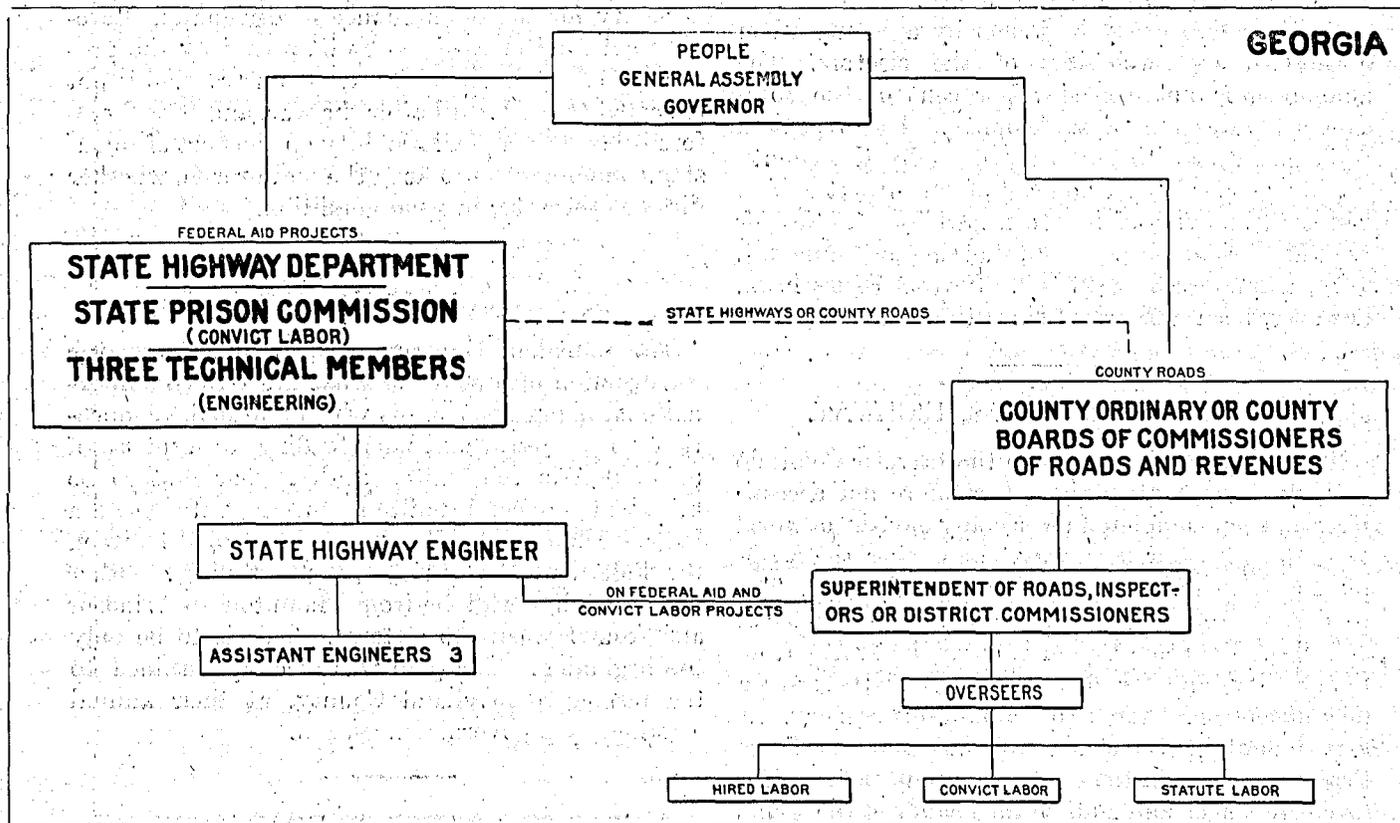
State.—The State highway department is composed of three ex-officio members, namely, the State geologist, the dean of the college of engineering of the State University, the professor of highway engineering of the Georgia School of Technology, and the prison commission, consisting of three members elected for terms of six years. The State highway department represents at their request the various counties of the State in negotiations with the United States Government regarding the expenditure of the Federal aid allotted to the State and is required to supervise such work while in progress. When the State highway department was created no appropriation was made for its maintenance, but the law provided that four supervisors, to be civil engineers, be employed by the prison commission

and turned over to the highway department. A State highway engineer and three assistants are now so employed.

The prison commission employs inspectors who inspect camps, treatment of convicts, clothing, sanitation, etc., but they have nothing to do with road work.

County.—Administration of road and bridge affairs in the counties is vested either in an official termed "ordinary," or in a board of commissioners of roads and revenues. The ordinary is elected for a term of four years, and in addition to his road and bridge duties, serves as judge of the probate court.

supervision with Federal and local funds or with convict labor and local funds. Improvements executed with Federal aid are initiated by the county with the approval of the State highway department. Surveys, plans, specifications, and estimates are prepared by the department at the expense of the county, and when approved by the county authorities are transmitted by the State highway department to the Secretary of Agriculture for consideration and allotment of Federal funds. If executed by contract, contracts are let by the State highway department and the work is executed under the inspection of the department. Main-



Boards of commissioners are authorized by special acts of the legislature, or counties of certain qualifications may elect boards under the terms of a general act of the legislature. The membership of the board varies from one to eight elective members with terms of office ranging from two to six years. Because of the number of special acts and forms of procedure optional with the county authorities, a uniform organization of local road forces does not prevail throughout the State.

CLASSIFICATION, CONTROL, AND PROCEDURE.

The 80,669 miles of public roads in Georgia are classed as county roads of the first, second, or third class, dependent on the width of cleared right of way. Fifty-five hundred miles of this system have been designated for improvement under State

tenance is executed by the county in accordance with the terms of the allotment of Federal funds and is subject to inspection by the department.

Roads of the above class or other county roads may be improved by the county with statutory or paid labor or by convicts allotted by the prison commission. The counties are required to pay all expenses incurred on account of the convicts.

All roads except those receiving Federal aid are administered by county authorities with county funds.

REVENUES.

No State revenues are available for expenditure in counties, State participation being limited to the allotment of State prisoners to counties.

County.—County funds for road and bridge purposes are secured in part from the apportionment by

the State, of the net revenues from the registration of motor vehicles; on a basis of rural road mileage; from the imposition of an ad valorem tax at a rate not exceeding 40 cents on \$100 of valuation of taxable property in the county for the public road fund and from the imposition of a tax at a rate of 10 to 25 cents on each \$100 valuation for general road tax fund or in lieu of this latter tax, the county may require statutory labor, for a period not exceeding 15 days per year, of all able-bodied males between the ages of 16 or 21 and 50, not otherwise legally exempt. Statute labor may be commuted at a rate of 50 cents, 75 cents, or \$1 a day, dependent on the special law adopted by the voters of the county.

Bonds.—These may be issued by a county when authorized by two-thirds of the electors. The amount may not exceed 7 per cent of the total assessed valuation of the county. The type and term and rate of interest are fixed by the county board or other body or official of concurrent duties. The total amount of bonds, issued by counties for road and bridge purposes outstanding on January 1, 1915, amounted to \$127,500. Several issues have, however, been authorized since that date.

NEW COLORADO SCENIC HIGHWAY.

A new road which opens to the traveler Colorado scenery of great attractions, heretofore not accessible, has been completed after many months of work. It is the Phantom Highway, connecting the Cripple Creek district with the Arkansas Valley. The road runs from Canon City to Victor, a distance of 35 miles. Phantom Canon is entered 11 miles from Canon City, and for 20 miles the road traverses a magnificent panorama of mountain scenery. A little mountain stream fed from the snows of Pikes Peak runs through the canon alongside the road for its entire length and adds to the beauty of the scene. The Phantom Canon highway forms the western side of a great quadrilateral figure of which Canon City, Cripple Creek, Colorado Springs, and Pueblo form the angles. Each side of this figure now has a fine State highway. Although the road climbs to an elevation of nearly 10,000 feet the incline is so

gradual that at few if any points does the grade exceed 4 per cent. The road was built under the supervision of the State highway commission and the commissioners of Fremont and Teller Counties.

TO KEEP ILLINOIS ROADS IN CONDITION.

Clifford Older, chief highway engineer of Illinois, has issued a circular letter calling attention to the importance of keeping the main arteries of travel at the highest possible point of maintenance, so as to be available for motor truck transportation. The State council of defense has also pointed out the necessity for the maintenance of designated State-aid roads and of roads to be improved by the proposed \$60,000,000 bond issue, as construction is not expected to start until after the war, and that therefore it becomes a patriotic duty on the part of township commissioners to keep the main roads, whether dirt or otherwise; in good condition.

NEW INTERNATIONAL HIGHWAYS.

The Canadian Government has undertaken the construction of a series of what are termed "international highways," roads which will make connection with improved roads leading to centers of population in the United States. The first to be built will connect Hamilton, Ontario, with Niagara Falls. There is already an improved road between the Falls and Fort Erie, opposite Buffalo. Other roads to follow will be from Hamilton to Windsor and from Prescott to Ottawa. This is to be only the beginning. The plan was recently outlined to the farmers of Welland County, at their annual meeting, by a government official.

WAR PRISONERS FOR ROAD WORK.

In his report at the fifth annual meeting of the Dixie Overland Highway Association at Shreveport, La., August 14, the president, John S. Beecker, of Columbus, Ga., advocated that war prisoners and interned aliens be put at work on road construction.

OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING ROAD PUBLICATIONS.

NOTE.—(Application for the free publications in this list should be made to the Chief of the Division of Publications, U. S. Department of Agriculture, Washington, D. C. Applicants are urgently requested to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets, nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free).

REPORTS.

- *Report of the Director of the Office of Public Roads for 1914. 5c.
- *Report of the Director of the Office of Public Roads for 1915. 5c.
- Report of the Director of the Office of Public Roads for 1916.
- Report of the Director of the Office of Public Roads for 1917.

BULLETINS.

(In applying for these bulletins the name of the office as well as the number of the bulletin should be given, as "Office of Public Roads Bulletin No. 23").

- *Bul. 28. The Decomposition of the Feldspars (1907). 10c.
- *37. Examination and classification of Rocks for Road Building, including Physical Properties of Rocks with Reference to Their Mineral Composition and Structure. (1911.) 15c.
- *43. Highway Bridges and Culverts. (1912.) 15c.
- *45. Data for Use in Designing Culverts and Short-span Bridges. (1913.) 15c.
- 48. Repair and Maintenance of Highways (1913).

DEPARTMENT BULLETINS.

(In applying for these bulletins the name should be given as follows: "Department Bulletin No. 53.")

- *Dept. Bul. 53. Object-Lesson and Experimental Roads and Bridge Construction of the U. S. Office of Public Roads, 1912-13. 5c.
- 105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
- 136. Highway Bonds.
- 230. Oil Mixed Portland Cement Concrete.
- 249. Portland Cement Concrete Pavements for Country Roads.
- 257. Progress Report of Experiments in Dust Prevention and Road Preservation, 1914.
- *284. Construction and Maintenance of Roads and Bridges, from July 1, 1913, to December 31, 1914. 10c.
- 347. Methods for the Determination of the Physical Properties of Road-Building Rock.
- *348. Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials. 10c.
- 373. Brick Roads.
- 386. Public Road Mileage and Revenues in the Middle Atlantic States.
- 387. Public Road Mileage and Revenues in the Southern States.
- 388. Public Road Mileage and Revenues in the New England States.
- 389. Public Road Mileage and Revenues in the Central, Mountain, and Pacific States, 1914.
- 390. Public Road Mileage in the United States. A summary.
- 393. Economic Surveys of County Highway Improvement.
- 407. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.
- 414. Convict Labor for Road Work.
- 463. Earth, Sand-Clay, and Gravel Roads.
- 532. The Expansion and Contraction of Concrete and Concrete Roads.
- 537. The Results of Physical Tests of Road-Building Rock in 1916, including all Compression Tests.
- *555. Standard Forms for Specifications, Tests, Reports, and Methods of Sampling for Road Materials. 10c.
- 583. Report on Experimental Convict Road Camp, Fulton County, Ga.
- 586. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1916.

*Department supply exhausted.

OFFICE OF PUBLIC ROADS CIRCULARS.

(In applying for these circulars the name of the office as well as the number of the circular should be given, as "Office of Public Roads Circular No. 89.")

- Cir. 89. Progress Report of Experiments with Dust Preventatives, 1907.
- *90. Progress Report of Experiments in Dust Prevention, Road Preservation, and Road Construction, 1908. 5c.
- *92. Progress Report of Experiments in Dust Prevention and Road Preservation, 1909. 5c.
- *94. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1910. 5c.
- *96. Naphthalenes in Road Tars. 1. The Effect of Naphthalene upon the Consistency of Refined Tars. (1911.) 5c.
- *97. Coke-Oven Tars of the United States. (1912.) 5c.
- 98. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1911.
- *99. Progress Reports of Experiments in Dust Prevention and Road Preservation, 1912. 5c.
- *100. Typical Specifications for Fabrication and Erection of Steel Highway Bridges. (1913.) 5c.

OFFICE OF THE SECRETARY CIRCULARS.

- Sec. Cir. *49. Motor Vehicle Registrations and Revenues, 1914. 5c.
- 52. State Highway Mileage and Expenditures to January 1, 1915.
- 59. Automobile Registrations, Licenses, and Revenues in the United States, 1915.
- 62. Factors of Apportionment to States under Federal Aid Road Act Appropriation for the Fiscal Year 1917.
- 63. State Highway Mileage and Expenditures to January 1, 1916.
- 65. Rules and Regulations of the Secretary of Agriculture for Carrying out the Federal Aid Road Act.
- *72. Width of Wagon Tires Recommended for Loads of Varying Magnitude on Earth and Gravel Roads. 5c.
- 73. Automobile Registrations, Licenses, and Revenues in the United States, 1916.
- 74. State Highway Mileage and Expenditures for the Calendar Year 1916.

FARMERS' BULLETIN.

(The Farmers' Bulletins are a series of popular treatises issued by the Department of Agriculture. The following list includes only numbers contributed by the Office of Public Roads, and should be applied for by numbers, as "Farmers' Bulletin No. 239.")

- F. B. *239. The Corrosion of Fence Wire. 5c.
- 311. Sand-Clay and Burnt-Clay Roads.
- 338. Macadam Roads.
- *403. The Construction of Concrete Fence Posts. 5c.
- *461. The Use of Concrete on the Farm. 5c.
- 505. Benefits of Improved Roads.
- 597. The Road Drag.

SEPARATE REPRINTS FROM THE YEARBOOK.

(In applying for these separates the numbers should be given, as "Yearbook Separate No. 638.")

- Y. B. Sep. *638. State Management of Public Roads; Its Development and Trend. 5c.
- *712. Sewage Disposal on the Farm. 5c.
- 727. Design of Public Roads.
- 739. Federal Aid to Highways.

REPRINTS FROM THE JOURNAL OF AGRICULTURAL RESEARCH.

- Vol. 5, No. 17, D-2. Effect of Controllable Variables Upon the Penetration Test for Asphalts and Asphalt Cements.
- Vol. 5, No. 19, D-3. Relation Between Properties of Hardness and Toughness of Road-Building Rock.
- Vol. 5, No. 20, D-4. Apparatus for Measuring the Wear of Concrete Roads.
- Vol. 5, No. 24, D-6. A New Penetration Needle.
- Vol. 6, No. 6, D-8. Tests of Three Large-Sized Reinforced-Concrete Slabs under Concentrated Loading.
- *Vol. 10, No. 5, D-12. Influence of Grading on the Value of Fine Aggregate Used in Portland Cement Concrete Road Construction. 15c.
- Vol. 10, No. 7, D-13. Toughness of Bituminous Aggregates.
- Vol. 11, No. 10, D-15. Tests of a Large-Sized Reinforced-Concrete Slab Subjected to Eccentric Concentrated Loads.

*Department supply exhausted.

A Message from the Secretary of Agriculture to American Farmers

TO THE PATRIOTS ON THE FARMS:

You are asked to undertake another offensive—to go “over the top” this fall for a great harvest of wheat in 1919. I need give only a few figures and facts to impress you with the increasing and urgent need of our people, our armies, the allied peoples and their armies for large supplies of American wheat.

Our reserve supply or carry-over from the 1917 crop is practically exhausted and is the smallest on record. The need of building up reserves of wheat is evident. Although this country produced a small crop of this grain in 1917, the total exports of wheat in excess of imports, including flour in terms of wheat, amounted to approximately 100,000,000 bushels for the year ending June 30, 1918. This is in comparison with 178,000,000 bushels exported in 1917, 236,000,000 bushels in 1916, and 331,000,000 bushels in 1915. It was possible for the United States to export wheat in large quantities in 1915 and 1916 only because of the large wheat crops of 1912-13-14-15, which gave this country an accumulation of stocks of this grain. Both the 1916 and 1917 crops were smaller than any crops since 1911, and besides this there was a greater demand for seed wheat and an increased population to be fed.

Moreover, it must be borne in mind that the carry-over in all the ten importing countries in Europe was practically exhausted this year before the new harvest; that the normal requirements of the exporting countries are increasing instead of diminishing; that some losses in storage and transit may be expected to continue; and that it is highly desirable that a surplus should be accumulated as insurance against partial crop failure next year.

You have been asked to sow to winter wheat this fall not less than 45,000,000 acres—an increase of 7 per cent over last year's sowing—and the department has suggested that an even greater area, 47,500,000 acres, is desirable. The increased planting asked of each State has been carefully determined with regard to its local conditions and its reasonable capabilities. Your county agent can tell you the quota assigned to your State and you can apply the responsibility to your case.

You have occupied and do occupy the first line trenches of the food army. You have to fight difficulties too. I am not unmindful of these. In the Department of Agriculture we consider them daily, and daily we give our best efforts to help you meet them. You know of the difficulties in your community; but I know of them in many communities of many States, and so seriously do they impress me that I might almost consider them insurmountable had not American farmers last year, and again this year, revealed the true American fighting spirit and ability to meet serious situations. They will not let the war fail because of deficient food production.

Let us sow liberally for a big harvest in 1919. It has been called the Liberty Wheat Harvest. We all hope it will be. But let us undertake the task with the determination that we will sweat our blood for many more if need be before we yield one measure of our freedom to a Prussian domination. Let us fight in the furrows.

D. F. Houston

Secretary of Agriculture.