Seventh Biennial Report

of the State Engineer of the State of Arizona

SEVENTH BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR

OF THE

STATE OF ARIZONA

FOR THE PERIOD

JULY 1, 1924, TO JUNY 30, 1926

"KELLY PRINT"

ARIZONA HIGHWAY DEPARTMENT

Phoenix, Arizona

Honorable Geo. W. P. Hunt,
Governor of Arizona,
Phoenix, Arizona.

Dear Sir:

The State Engineer has the honor of transmitting herewith the Biennial Report of the operations of the Arizona Highway Department for the fiscal years ending June 30, 1923, and June 30, 1924.

Wherever practicable additional data, of the activities of the Highway Department, has been included to extend the information to a later date for the enlightenment of both yourself and the State Legislature.

Respectfully yours,

W. C. LEFEBVRE,
State Engineer.

ARIZONA HIGHWAY DEPARTMENT

DEPARTMENTAL HEADS

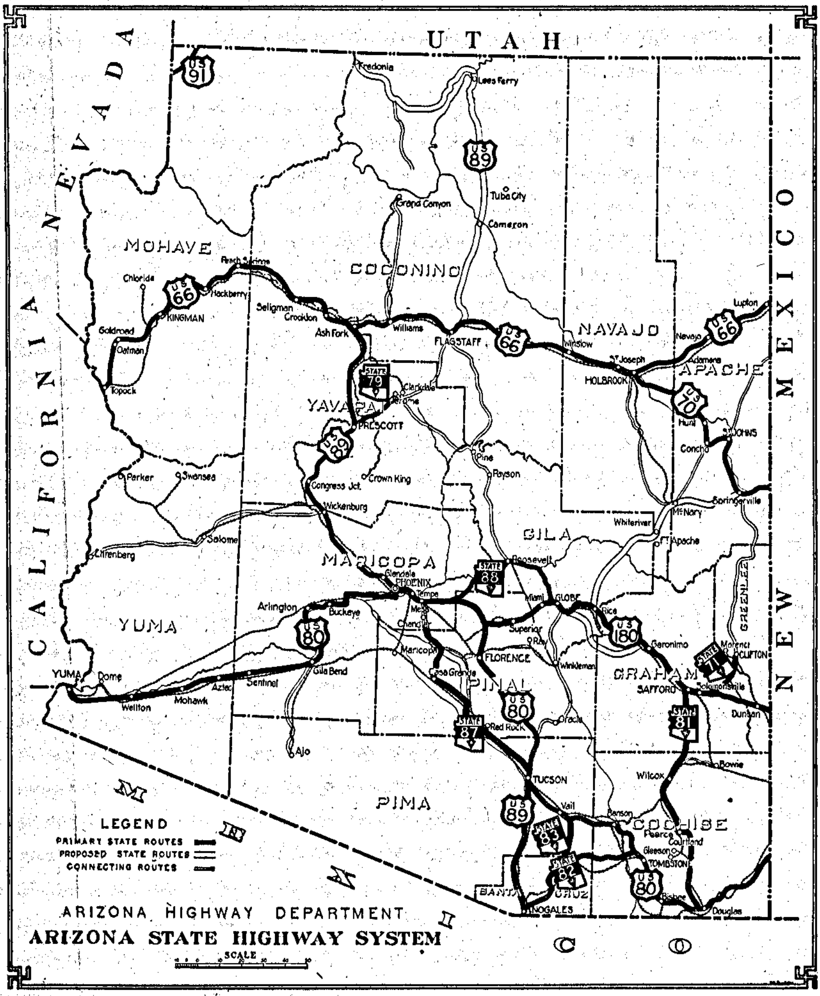
July 1, 1926

W. C. LEFEBVRE, *State Engineer*
W. W. LANE, *Chief Engineer*

C. C. SMALL, *Chief Location Engineer*
B. M. ATWOOD, *District Engineer*
T. S. O'CONNELL, *District Engineer*
GEORGE B. SHAFFER, *District Engineer*
E. M. WHITWORTH, *District Engineer*
W. R. HUTCHINS, *District Engineer*
R. A. HOFFMAN, *Bridge Engineer*
J. W. POWERS, *Testing Engineer*

V. A. WOOD, *Chief Clerk*
O. S. FRENCH, *Assistant Chief Clerk.*

A. E. STELZER, *Purchasing Agent*
C. R. JONES, *Superintendent of Equipment*


UTAH
NEVADA
CALIFORNIA
NEW MEXICO
MEXICO
MOHAVE
COCONINO
NAVAJO
APACHE
YAVAPAI
MARICOPA
GILA
GREENLEE
YUMA
PINAL
GRAHAM
PIMA
SANTA CRUZ
COCHISE
Kingman
Flagstaff
Holbrook
Prescott
Phoenix
Tucson
Florence
Globe
Safford
Nogales
Bisbee
Douglas
Yuma
Tombstone
LEGEND
PRIMARY STATE ROUTES
PROPOSED STATE ROUTES
CONNECTING ROUTES
ARIZONA HIGHWAY DEPARTMENT
ARIZONA STATE HIGHWAY SYSTEM
SCALE

REPORT OF THE STATE ENGINEER

W. C. LEFEBVRE, *State Engineer*

WITH probably one of the poorest systems for highway financing of any State in the Union, the Arizona Highway Department during this biennial period, looked forward to the legislature that convened in January, 1925, for relief from its financial difficulties. The bill under which the Highway Department was working at that time was drawn with the idea of tying the hands of the department in every possible way, and the outlook at the start was that it was likely to succeed.

The legislature in 1925 failed to rectify the law or to make adequate appropriations for the carrying on of the work of the department. In fact it was freely predicted by members of the legislature in conversations with persons that, with the exception of maintenance, the activity of the Highway Department would cease.

It was only through a flaw in the Highway Bill of 1923 that the Highway Department has been able to carry on any construction work or to meet any of the Federal Aid appropriations during the biennial period. The result has been that in November, 1926, it was necessary to stop all State force work, with a resulting economic loss that is not to be underestimated. The ceasing of construction work and breaking up of large organizations, the storing of equipment and the resulting re-establishment at a later date of these organizations, certainly cannot be looked upon in any other way than a great economic loss.

Control of Funds

The control of the funds that are supposed to be available for State highway purposes are not spent under the direction of the State Engineer; on the other hand most of them are controlled by 52 other men besides the State Engineer. In most cases these members of the boards of supervisors of the respective counties do the best

they can for their county, and this means that they try in some cases to have the funds that should be spent on the State highways and used to match Federal funds used in the construction of roads of a purely local character. Not only has a lack of proper legislation resulted in the shutting down of State forces but there is one major Federal Aid project in Greenlee County upon which construction had to be stopped.

The contract has been let and construction started on the Coolidge Dam Project. The water of this dam will inundate and cause the Highway Department to rebuild 54 miles of road across an Indian Reservation. The Highway Department has prepared plans for the construction of this 54 miles of road and is prepared to go ahead with the construction of the first section. This is a 100 per cent Federal Aid Project, and will not cost the State of Arizona more than 5 per cent of the estimated cost of $1,300,000, which is for items in which the Government does not participate.

The Highway Department is unable to go ahead with the construction of this project, for it must be remembered that while this is 100 per cent Federal Aid, the Government does not advance the money for the construction work, but, on the other hand, pays its pro rata of the contractor's monthly estimates.

We find ourselves in the position of a man who discovers a philanthropist who tells him that he will pay the entire cost of building him a house provided he will go ahead and have the house built, and the man's reply is—as our reply is—that he cannot take advantage of his most generous offer.

If Arizona is to avoid the large economic losses which it has suffered in this biennial period because of a lack of proper legislation, the coming legislature must realize this and plan for an expenditure over a term of years. This is most essential where a State is getting a large percentage of Federal Aid, for in some cases a Federal Aid project that is initiated will not be actually under construction for a term of 18 months or more.

Due to a shortage of funds beginning in November, 1926, it is impossible to pay contractor's estimates. This is putting a burden on the contractors which has no semblance of being a fair deal.

Old Bills Inherited

Another thing that has been a millstone around the neck of the Highway Department is the matter of old bills. In 1923 the liabilities of the Highway Department were $1,200,000 in excess of its assets. This meant, in plain English, that if the Highway Department had closed down for a period of one year and had not paid a single salary of any employe nor spent a cent, it would have been unable in this one year to have liquidated its indebtedness. From 1923 to date the department has succeeded in bringing this amount down to $800,000. There are thousands of dollars in bills that are within a matter of days being outlawed by the legal limitation of time. It is the policy of the Highway Department to dispense with the services of its employes who do not pay their bills, and yet we find a department of State, one of the largest, which does to its merchants what it will not allow its own employes to do. This situation must be relieved.

It has been the policy of the Highway Department, during this biennial period, first, to maintain its roads, and second, to do all the work possible toward completing its seven per cent system; and then followed the policy of spending only the necessary money on State highways off of the seven per cent system. Some of the boards of supervisors have done heroic work in assisting the department, while other boards have gone to the extreme in the other direction. It was necessary, in one county, to discontinue the maintenance for a period of 50 days in order to make the board realize its position.

The Arizona Highway Department has worked consistently with the Bureau of Public Roads and the American Association of State Highway Officials to the end of having a standard system of road signs for highways and the selection of arterial routes from north to south and east to west across the United States. We have had a survey made of all our State highways and have ordered signs in conformity with the standards set forth by the Joint Board on Interstate Highways. Part of these signs have been delivered, the balance will be delivered within the next 60 days, and as soon as funds are made available by the legislature these signs will be erected. It is of interest to note, at this juncture, that 22 States have already caused these standard signs to be erected.

Organization

The present law provides that the board of directors of State institution shall validate all contracts made by the State Highway Department through the State Engineer. The assistant to the State Engineer has the rating of Chief Engineer. The department is then divided into an organization which consists of the superintendent of equipment, who has charge of the warehouse and shops at Phoenix, Holbrook, Ash Fork and Tucson; the laboratory, in charge of a thoroughly competent testing engineer; the stock room, which furnishes all supplies of an engineering nature and takes care of all engineering equipment, in charge of the stock clerk; the accounting department, under the direction of the chief clerk, takes care of all accounting and cost accounting work; the purchasing department, through which all supplies for the entire State are purchased, in charge of the purchasing agent; the right-of-way department, which handles the myriad of detail necessary in the procurement of rights-of-wayfor all State highways, in charge of the right-of-way agent; the Arizona Highway publication, known as *Arizona Highways,* in charge of the editor.

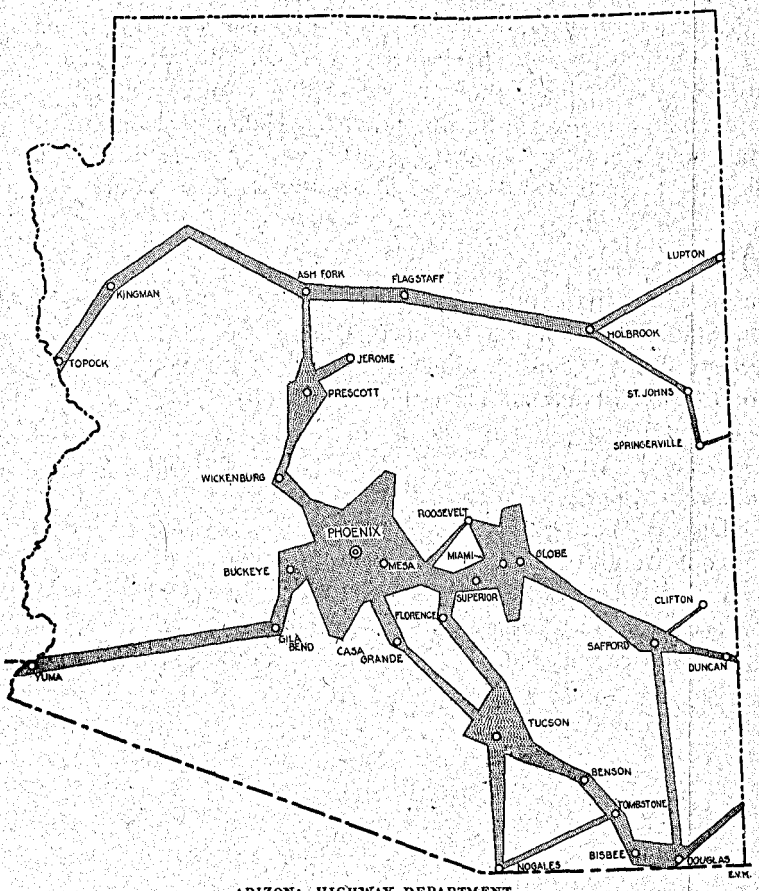
One of the most important departments is the location department, in charge of the chief location engineer. Another department which has had very heavy detail this year is the bridge department, under the direction of the bridge engineer. A department that is always busy is the estimating department, which is in charge of the chief estimator. The drafting room comes under the direction of the engineer of plans.

The field organization consists of five district engineers, who supervise the construction and maintenance work in their respective districts. Under the district engineers' direction each project has an engineer in charge who has the rating of resident engineer.

On account of the shortage of funds during the biennial period, it has been necessary to work out many problems that never would have been encountered had there been sufficient finances available. In working out these problems we are proud of the fact that, almost without exception, each head of department has given the best that was in him to cooperate in every way to the solution of the common problem.

One of the duties that falls on the State Engineer is his duties as a member of the State Certification Board. With the large number of irrigation projects being constructed and proposed for construction in the near future, the duties in this department on projects submitted and proposed projects have been unusually heavy. The heaviest duties of this board are of an engineering nature and fall upon the State Engineer, which means that the Highway Department must detail men almost constantly to cover this phase of the work. The following projects were acted upon in the biennial period:

Name of District	*Amount*	*No. of Acres*
Queen Creek Irrigation District	$ 125,000	4,920
New State Irrigation and Drainage District	112,000	2,388.57
Buckeye Water Conservation District	200,000	20,000
Chino Valley Irrigation District	85,000	2,538
Southside Irrigation District of Maricopa County, Arizona	130,000	2,000
Mohawk Municipal Water Conservation District	500,000	19,592
Maricopa County Municipal Water Conservation District No. 1	3,325,000	39,026.26
Roosevelt Water Conservation District of Maricopa County	2,000,000	41,000
Total Acreage		121,464.83



ARIZONA HIGHWAY DEPARTMENT

TRAFFIC FLOW

OVER

STATE HIGHWAY SYSTEM

CARS IN 24 HOURS

0 1000 2000 3000 CARS

CONDITION OF STATE HIGHWAYS

BY W. W. LANE, *Chief Engineer*

IN a discussion of the condition of the State Highways of Arizona, the basis for the discussion should first be expressed. The usual discussion is based upon the present condition, which is natural, as that is what affects the user now, and therefore receives his primary interest. Upon this basis, the State Highway System is generally considered to be in excellent condition and so much better than many of the States, that praise of Arizona highways is national in scope. This is mainly true in fair weather, and is due to the constant attention and standard of maintenance applied to their upkeep. This is good publicity for the State, as the tourist, as well as the citizen, is primarily interested in the present travel condition. The effect of this condition of highways is bringing many tourists and much prosperity to the State at large, and the welfare of the State is materially dependent upon the maintaining or betterment of these conditions.

The other basis of discussion is one not so pleasant, as it must be analytical. The problems of tomorrow must be analyzed and applied to today's contemplated highway improvements or the improvements will be based upon false principles, and therefore will soon prove inadequate, with the result that the improvement to a large extent will be an economic waste.

Traffic increases steadily and in Arizona it is increasing rapidly. The registration of automobiles in Arizona in the past is an indication of the rapid increase. Also, the gallons of gasoline per registered car further indicates the increase in traffic. In 1922 there was an average of 464 gallons of gasoline used per registered car in Arizona and this gradually increased to 550 gallons per registered car in 1926. This is due to two factors: more mileage by local cars, due to better

highway facilities, and increasing numbers of tourists, both of which add to the increase in traffic.

It is impracticable to effect highway improvement upon a section of highway in the same constant ratio as the traffic flow increases, but it must be stepped up, and economically it should be stepped up slightly beyond the requirement at the time of the improvement to balance the future requirement.

Duty of State Highways

The duty of the State Highways is actually measured by the department by making an actual traffic count the first Wednesday of every month. The count is taken for 24 hours quarterly, and for 12 hours for the intervening months, and the factor for the 24 hours applied to the 12-hour counts to obtain the 24-hour average.

These results are very valuable to the State in many ways. They not only show the present duty of the highways, but are an indication of the future duty in considering improvement. Also they are an essential factor in maintenance and maintenance cost, and are one of the factors in determining the wear value of highway surface materials.

From these counts or traffic census we find that the improved sections of the State highways are carrying from 150 cars per day to 5,000 cars per day. This count applied to individual sections of the system and used in connection with maintenance cost and physical conditions, class of local materials available, clearly indicate where and the type of improvement demanded if the State system is to be economically improved in any degree parallel to traffic demands.

The traffic census for 1926 shows that the State Highway System carried 256,000,000 vehicle miles, a vehicle mile being one vehicle traveling one mile. Applying this to the total gasoline consumption of the State for that period and working it back from that, shows that the system carried 56 per cent of the total traffic of the State. Applying to this the average factor of 20 per cent of the total traffic upon city streets, leaves 24 per cent of the traffic upon the county

roads; or considering the rural traffic only, the State system carried 70 per cent and the county highways 30 per cent during the year 1926.

Construction or Improvements Required

Highway conditions will not remain stationary. This condition is directly affected by the elements and the traffic. The elements may be largely controlled by proper construction, except for the extreme storms. Comparatively speaking, however, this damage is usually slight and controlled quickly. But if improvements are not made commensurate with traffic flow, the limit of maintenance—although large maintenance expenditures are made—is ultimately reached and the highway begins to fail and rapidly deteriorates. Arizona has reached the point now upon several sections of the system where paving must be placed at an early date or the sections must go backward, as they are not now withstanding the traffic strain in spite of constant and expensive maintenance. These sections should be given first consideration, as additional connections and extensions to the system will aid to the burden already carried by the system.

A tabulated status of the State Highway System is included herewith, showing the mileage and type of improvement by counties and totals. A reference to this shows that many miles of the system as it now is requires additional construction—also, there are many bridges required to be constructed or reconstructed. Some will require large expenditures, but mostly they are small structures, but very essential, as their absence or loss will destroy the use of the highway and cause large losses to the individuals who have and are becoming dependent upon the highways.

Additions to Highway System

In addition to the completion of the system, now classed the State Highway System, and as shown by the map at the front of this report, there are several additions that should be made for several reasons. They will materially facilitate traffic to the people of the State, open up and permit of development of more business and valuable resources, greatly add to the many visitors now coming to

the State, and encourage them to remain longer and cause many to become residents.

The Lee's Ferry Route, or a highway from Utah to connect with the State system near Flagstaff, will connect with the State, the large and resourceful area north of the Colorado River known as the "Strip." It will open up a playground that is unexcelled in the nation, and will make a connection with the country to the north of the State which will probably bring more tourists into the State than any other inter-state connection.

The Rice-Springerville highway will connect the northern and southern part of the State in the eastern section, will permit of considerable development in the most scenic White Mountains, and facilitate both local and foreign traffic.

The Wickenburg-Colorado River highway will facilitate traffic from both northern and southern Arizona to and from southern California, and should be the cause of bringing many visitors and future residents into the State from California.

The Casa Grande-Gila Bend connection will greatly add to the convenience of both the southeastern and southwestern sections of the State, and will also add another loop of travel for the public of southern Arizona.

Financial Effect

In making these extensions or any additions to the State system, it must be remembered that the system is now overburdened for the finances provided, and that more finances must be provided for the present system if it is to withstand the duty imposed. Also, it must be borne in mind that additions cannot be made without providing adequate finances, as without the finances the added mileage can only detract from the present system and cause the system to fail much quicker. Consideration must also be given to the fact that added mileage means added maintenance required.

Highway Assets

From the foregoing it might be inferred that highways are only liabilities. It is true that highways require large expenditures, and

if the State and nation is to progress or even exist, transportation facilities for defense, business and pleasure must be provided, and these requirements alone will justify large expenditures, but a review of the highways as an asset reflect some startling facts.

Along with railroad and water transportation, the motor vehicle has become a standard means of transportation of the nation, and is becoming so over the world. There are in excess of 20,000,000 motor vehicles upon the highways of this nation alone. Each is an expense to operate and that expense is in direct proportion to the condition of the highways upon which they travel. In the year 1926 there was received from State sources and expended upon Arizona State highways $1,575,000. The State highways carried during that period 256,000,000 vehicle miles of automobile travel.

It has been estimated by authorities from years of research and experiments that a conservative figure is two and one-half cents saving per mile upon the average car between an average good gravel road and the old unkept trails of a few years ago, or a saving for this year over the old roads to the travelers of Arizona State highways of $6,400,000. If all of the State highways of Arizona were paved there would be a further saving of two and one-half cents per vehicle mile over the operation cost of a car upon the average good gravel road. Another factor that is a direct cash receipt by virtue of the highways is from the tourist. It is estimated that there was expended in 1926 by the tourist in Arizona $11,800,000. It is further estimated that 30 per cent of that money stayed in the hands of the retailers, jobbers andproducers of the State. In a word, $3,540,000 cash was earned by the people of Arizona directly credited to the highways.

Improved highways add to the valuation of the State by increasing property values adjacent to the highways, and by extending the area which may be profitably developed, thereby increasing the business and size of the cities, and materially increasing profits to every farmer or business using them for the transportation of their wares. These last items cannot readily be estimated, but are probably more than items that may be and are very closely estimated.

It is not possible to make expenditures in any business that will yield the returns both directly or indirectly as those judiciously expended upon the improvement of the main highways of the State.

STATUS OF ARIZONA STATE HIGHWAY SYSTEM

December 11, 1926

County	Total Miles	Graded & Drained	Gravel Surfaced	Asphalt Paving	Concrete Paving	Under Construction	Partly Improved
Apache	145.22	13.17	69.05	.....	.....	.....	63.00
Cochise	254.19	58.60	114.74	17.49	24.16	.....	39.20
Coconino	115.58	35.64	52.17	18.75	.47	8.55	.....
Gila	141.25	22.00	65.95	.....	6.80	.....	46.50
Graham	131.18	12.20	41.63	7.46	13.20	.....	56.69
Greenlee	35.40	23.72	5.25	.....	.....	6.43	.....
Maricopa	246.26	14.60	139.08	13.25	74.58	2.75	2.00
Mohave	143.36	43.85	62.20	.....	.....	.....	37.31
Navajo	101.64	7.10	49.09	.95	.....	.....	44.50
Pima	148.58	.....	132.94	3.00	12.64	.....	.....
Pinal	214.46	.....	166.06	5.00	1.50	31.90	10.00
Santa Cruz	83.15	1.75	79.08	.....	2.32	.....	.....
Yavapai	190.84	26.40	163.04	1.40	.....	.....	.....
Yuma	82.86	.....	66.47	4.97	.....	7.61	3.81
Total	2,033.97	259.03	1,206.75	72.27	135.67	57.24	303.01

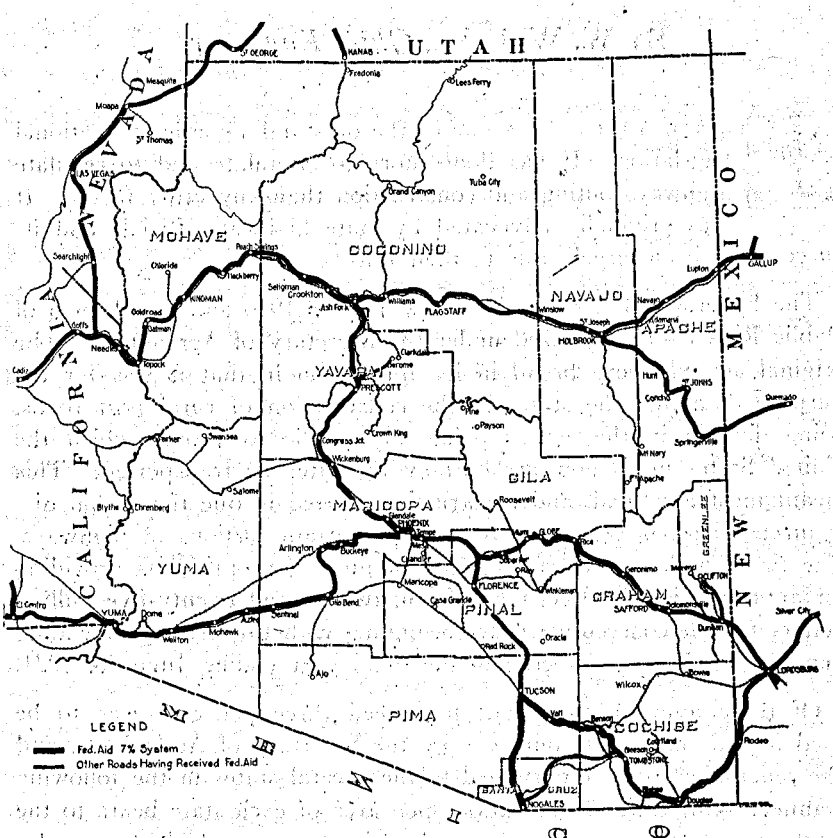
FEDERAL AID

BY W. W. LANE, *Chief Engineer*

FEDERAL AID has been one of the outstanding series of national legislation. It has done more to stimulate and to regulate highway routing and construction than any other factor. It was originally advocated by state highway officials and its success has been largely due to their efforts.

The Federal Aid Act became a law July 11,1916 and the Bureau of Public Roads was organized under the Secretary of Agriculture. The original act was very broad in its application in that it was for the purpose of aiding the states in the construction of rural post roads, being defined in the act as being any public road over which the United States mails now are or may hereafter be transported. This meant most any road, and construction started in due time upon disconnected and, in many instances, unimportant sections of highways. The first act, however, carried only nominal appropriations providing for appropriations of five, ten, fifteen, twenty and twenty-five million dollars for the consecutive years beginning with the fiscal year ending June 30, 1917, to and including the fiscal year ending June 30, 1921.

Of these appropriations, not to exceed three per cent was to be used for administrative purposes by the Secretary of Agriculture, and the remainder to be apportioned to the several states in the following manner: One-third in the ratio which area of each state bears to the total area of all of the states; one-third in the ratio which the population of each state bears to the total population of all of the states, as shown by the latest available Federal census; one-third in the ratio which the mileage of rural delivery routes and star routes in each state bears to the total mileage of rural delivery routes and star routes in all states, at the close of the next preceding fiscal year. Under this provision Arizona receives about 1.4 per cent of the annual appropriations.



ARIZONA HIGHWAY DEPARTMENT

FEDERAL AID 7% HIGHWAY SYSTEM

SCALE

First Federal Aid Money

It took some time for the Bureau of Public Roads to organize and promulgate rules and regulations; likewise for the states to become adjusted to this plan. Arizona received its first Federal Aid money in January, 1918, on Federal Aid Project No. 1, the Florence Bridge, and has initiated 91 projects to date, many of which are divided into several sections, which are virtually projects within themselves.

The original Act also carried a limitation of $10,000 per mile, exclusive of bridges over 20 feet in length, of payments that the Secretary of Agriculture may make.

February 28, 1919. The Act was amended mainly in the annual appropriations, increasing the annual appropriations to $50,000,000 for the fiscal year ending June 30, 1919, and $75,000,000 for the two succeeding years, increasing the limitations that the Government would participate per mile to $20,000. In both the original Act and the Amendment of 1919 the basis of participation within the limits previously mentioned was not to exceed 50 per centum of the value of the labor and materials actually put into said construction.

As Federal Aid for highway construction came into existence just at the beginning of the past decade, which has been the greatest highway construction period the nation has ever known, and practically had no limitations upon what roads the money may be expended within the States, it soon became apparent that it was being expended upon disconnected and, in many instances, roads relatively unimportant. This was due to the ability of local communities to finance them, or to induce the legislature to make appropriations for such sections, the merits of the various projects were not of particular interest. This system of highway construction could not result in anything but a waste of funds.

In view of this condition and the further recognition of the fact that county lines and even state lines were rapidly vanishing to the highway users, it was apparent that something must be done if a connected highway system were ever to be constructed. It was recognized that a system must be established, standards presented commensurate with traffic rquirements, and the expenditures confined to the established

system if the states and the nation were ever to complete a system of highways.

Seven Per Cent System

On November 9, 1921, an amendment was approved which was much more in detail and provided may advanced features. The Seven Per Cent System, which was for the purpose of expediting the completion of an adequate and connected system of highways, interstate in character was established by this amendment. It provided that seven per centum of the total highway mileage of such state as shown by the records of the state highway departments at the time of the passage of the act was to be determined, and that a system of highways were to be selected and designated which would not exceed this mileage. The total mileage of this state reported at the passage of the act was 21,400, seven per cent of which gave a maximum mileage for the Federal Aid, or since called the Seven Per Cent System of Arizona, of 1,498 miles. This system for Arizona was selected and the designation approved in December, 1922. There is also a provision in the act for extending the mileage of the Federal Aid System. The last paragraph of Section 6 of the act reads as follows:

"Whenever provision has been made by any state for the completion and maintenance of a system of primary or interstate and secondary or inter-county highways equal to seven per centum of the total mileage of such state, as required by this act, said state, through its state highway department, by and with the approval of the Secretary of Agriculture, is hereby authorized to add to the mileage of primary or inter-state and secondary or inter-county systems as funds become available for the construction and maintenance of such additional mileage."

Section 7 of the act provides:

"That before any project shall be approved by the Secretary of Agriculture for any state, such state shall make provisions for state funds required each year of such states by this act for construction, reconstruction, and maintenance of Federal Aid Highways within the state, which funds shall be under the direct control of the State Highway Department.

It is believed that Arizona is not complying with the Section 7, in that there is not sufficient annual appropriations or funds provided to meet these requirements, which is clearly evident by the fact that Arizona is now practically three years behind in taking the allotments made to the state of approximately $3,000,000.

Arizona's Percentage

In this amendment the limitation of $20,000 per mile was not changed, but it was provided that in states containing unappropriated public lands in excess of five per centum of the total area of all lands in the state that the share or participation by the United States was not to exceed 50 per cent of the total estimated cost thereof, plus a percentage of such estimated cost equal to one-half of the percentage which the area of the unappropriated public lands in such state bears to the total area of such state. As Arizona contained approximately 22.22 per cent of such unappropriated land, this increased the percentage of participation to the state to approximately 61.11 per cent.

This act also specified that "all monies hereafter appropriated for expenditure under the provisions of this act shall be available until the close of the second succeeding fiscal year for which the appropriation was made, and if not expended by the end of the period during which it is available for expenditure it shall be re-apportioned within 60 days thereafter to all the states in the same manner as apportioned under this act the first time."

On June 19, 1922, there was a further amendment to the act, but other than appropriations for the fiscal years of 1923, 1924 and 1925 the only material change was the reduction of the limitation per mile that the United States would pay from $20,000 exclusive of structures over 20 feet to $16,250 for the fiscal year ending June 30, 1923, and $15,000 per mile, exclusive of structures over 20 feet, thereafter, plus the per centum to the public land states. This is still the base maximum per mile.

On February 12, 1925, there was a further amendment to the act by inserting after each place where the words "unappropriated public lands" occur, the words "and non-taxable Indian lands, individual and tribal."

The affect of this amendment is to increase the amount of public lands upon which the percentage of such public lands to the total area of the state is a basis of the percentage of additional participation over the 50 per cent as a base for the Federal participation, with the unappropriated public lands and the non-taxable Indian lands making a total of 44.68 per cent of such lands to the total area of the state; one-half of that giving 22.34 per cent which is the additional percentage of participation that Arizona is allowed under this act, or a total of 72.34 per cent.

Allotments Not Affected

The allotments as made by the United States Government to the various states are not affected by the variations in percentages of participation on an individual project and these additional participations do not affect the total amount of money that the state receives for Federal Aid. The annual allotments that the state is now receiving, or as previously stated herein, approximately $1,050,000 per annum based upon the past few years appropriation of $75,000,000 by the United States Government for Federal Aid, will remain constant so long as appropriations made by the Government remain as they have been in the past few years, and no change in the basis of participation or change in our Federal Aid Seven Per Cent System will give the state more money.

The only thing that we may do by increasing our participation or by changing any route on our Seven Per Cent System will have only the effect of placing more Federal Aid money on a single project or several projects, and will not affect the amount of money required by the state at large a change in the Seven Per Cent System at this time or until we have much more nearly completed our Seven Per Cent System and it has reached the status to where we may increase the Seven Per Cent System, will not receive any more Federal Aid or any greater financial assistance from the government in constructing our Federal Aid System by such changes.

MILEAGE CONSTRUCTED WITH FEDERAL AID

	Graded and Drained	Gravel Surfaced	Asphalt	Concrete	Under Construction	Total	
Apache	.....	51.05	.....	.....	.....	51.05	
Cochise	.....	*64.05	6.19	8.50	.....	78.74	*15.0 miles not on Seven Per Cent System.
Coconino	26.64	*25.47	18.67	.....	8.55	79.33	*23.43 miles built by U. S. Forest Dept. and 5.86 miles of which is under construction.
Gila	.....	27.65	.....	.....	.....	27.65	
Graham	.....	27.63	7.46	13.20	.....	48.29	
Greenlee	.....	*10.89	.....	.....	6.43	17.32	*5.64 miles not on Seven Per Cent System.
Maricopa	14.60	87.65	8.05	73.35	1.60	185.25	
Mohave	.....	24.25	.....	.....	.....	24.25	
Navajo	.....	49.09	.95	.....	.....	50.04	
Pima	.....	33.13	.....	12.64	.....	45.77	
Pinal	.....	*54.86	.....	.50	.....	55.36	* 2.60 miles not on Seven Per Cent System.
Santa Cruz	.....	*14.97	.....	.....	.....	14.97	*14.20 miles not on Seven Per Cent System.
Yavapai	.....	*125.11	.....	.....	.....	125.11	*15.58 miles built by U. S. Forest Dept., and 19.77 miles not on Seven Per Cent System.
Yuma	.....	*74.43	4.00	.....	7.61	86.04	* 7.96 miles to be abandoned on completion of project under construction.
	41.24	670.23	45.32	108.19	24.19	889.17	

STATUS 7 PER CENT SYSTEM

December 11th, 1926

County	Total Miles	Graded and Drained	Gravel Surfaced	Asphalt Pavement	Concrete Pavement	Total Improved	Under Construction	Unimproved
Apache	145.22	.....	69.05	.....	.....	69.05	.....	76.17
Cochise	136.89	.....	69.24	17.49	24.16	110.89	.....	26.00
Coconino	115.58	26.64	25.47	18.75	.47	71.33	8.55	35.70
Gila	45.95	.....	33.65	.....	6.80	40.45	.....	5.50
Graham	89.48	.....	27.63	7.46	13.20	48.29	.....	41.19
Greenlee	19.10	5.25	.....	.....	.....	5.25	6.43	7.42
Maricopa	200.65	14.60	94.62	13.25	74.58	197.05	1.60	2.00
Mohave	130.66	31.15	35.25	.....	.....	66.40	.....	64.26
Navajo	79.14	.....	49.09	.95	.....	50.04	.....	29.10
Pima	99.98	.....	84.34	3.00	12.64	99.98	.....	.....
Pinal	112.26	.....	103.76	5.00	1.50	110.26	.....	2.00
Santa Cruz	29.75	.....	25.68	.....	2.32	28.00	.....	1.75
Yavapai	164.04	24.00	105.34	1.40	.....	130.74	.....	33.30
Yuma	82.86	.23	66.47	4.97	.....	71.67	7.61	3.58
	1,451.56	101.87	789.59	72.27	135.67	1,099.40	24.19	327.97

The approved mileage of Seven Per Cent System is 1,498.0, but due to line changes this has been reduced to 1,451.56, leaving 46.44 miles yet to be applied.

FEDERAL AID PROJECTS COMPLETED AND UNDER CONSTRUCTION

From July 1, 1924 to December 11, 1926

F. A. No.	Name of Project	Federal Aid Received
19—B	Prescott-Jerome	$ 41,919.92
19—B Reo	Prescott-Jerome	None
22	Winslow-Coconino County Line	8,051.91
36—B	Prescott-Jerome	11,673.27
36—A Reo	Prescott-Jerome	None
40—1st Reo	Holbrook-Winslow	17,451.23
40—2nd Reo	Holbrook-Winslow	21,749.78
55	Yuma-Phoenix	180,144.17
62—B	Prescott-Ash Fork	None
63	Geronimo-Solomonville	113,686.91
64—B	Phoenix-Yuma	68,477.00
67	Geronimo-Solomonville	145,397.06
68—B	St. Johns-Springerville	42,299.42
69	Phoenix-Yuma	75,853.49
71	Phoenix-Yuma	185,424.26
72—A	Prescott-Phoenix	135,716.87
72—B	Prescott-Phoenix	180,006.49
74	Winslow-Flagstaff	75,325.88
75	Tucson-Nogales	13,473.31
76	Phoenix-Wickenburg	34,511.30
77	Solomonville-Duncan	62,493.07
78—A	Concho-St. Johns	46,723.86
79—A	Benson-Douglas	69,610.57
79—B	Benson-Douglas	9,272.02
81	Winslow-Flagstaff	22,365.39
82—A	Yuma-Phoenix	None
82—B	Yuma-Phoenix	69,186.29
84—A	Phoenix-Wickenburg	17,995.49
86	Tucson-Nogales	99,418.65
68—B	St. Johns-Springerville	42,299.42
88—A	Solomonville-Duncan	36,287.87
88—B	Solomonville-Duncan	None..
		$1,814,515.48

Under Federal Aid received we include $95,220.04 that has been vouchered but not received from the Government.

FEDERAL AID PROJECTS COMPLETED PRIOR July 1, 1924

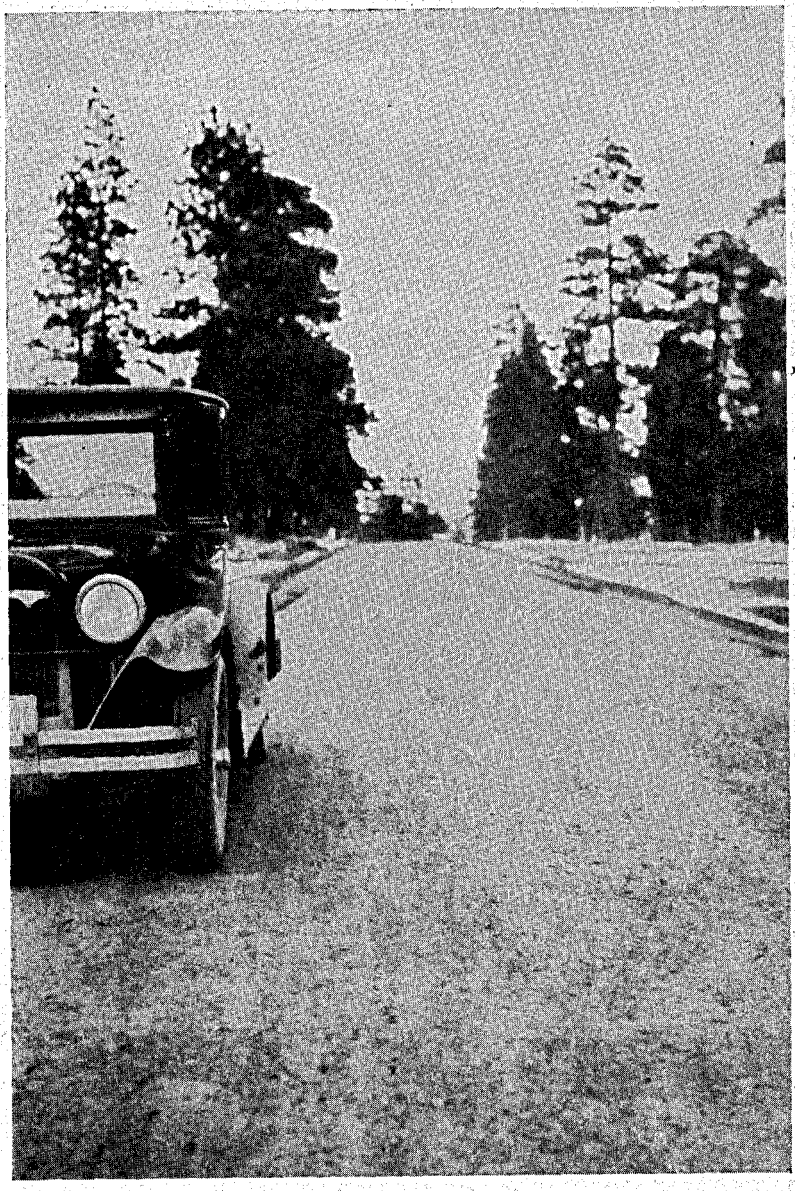
F. A. No.	Name of Project	Federal-Aid Received
1	Florence Bridge	$ 55,982.23
2	Phoenix-Tempe	46,249.84
3	Holbrook-St. Johns	13,990.46
5	Oatman-Goldroads	33,517.64
6	Holbrook-St. Johns	27,857.75
7	Mesa-Superior	62,910.04
8	Tempe-Mesa	103,209.54
9	Tucson-Florence	58,009.00
10	Agua Frio Bridge	30,138.78
11	Bisbee-Douglas	137,361.77
12	Prescott-Jerome	37,260.00
13	Clifton-Franklin	72,312.68
14	Douglas-Rodeo	40,618.27
15	Globe-Geronimo	87,657.38
16	Superior-Miami	422,349.50
17	Prescott-Jerome	99,539.16
18	Benson-Vail	156,712.01
19—A	Prescott-Jerome	43,393.97
20	Winslow Paving	24,488.97
21	Flagstaff Paving	24,205.97
23—A.C.E.F.	Florence-Superior	124,699.37
23—B-D	Florence-Superior	112,614.54
24	Flagstaff-Williams	87,249.80
25—A	Tucson-Nogales Bridges	20,165.77
25—B	Tucson-Nogales Bridges	22,134.01
26	Yuma-Wellton	73,922.16
27	Nogales-Fairbanks	47,700.38
28	Ray-Superior	29,204.09
29	Tucson-Nogales	128,103.17
30	Phoenix-Tempe	47,252.23
31	Wickenburg Bridge	34,816.38
33	Phoenix-Glendale	124,763.45
36—A	Prescott-Jerome	48,380.47
37	Williams-Ash Fork	30,606.77
38	Douglas-Rodeo	80,301.76
39	Topock-Oatman	81,547.17
40	Holbrook-Winslow	85,073.89
42	Holbrook-St. Johns	41,319.88
43	Geronimo-Solomonville	99,553.20
44	Oatman-Goldroads	5,557.29
46	Phoenix-Yuma	502,230.43
47	Mesa-Superior	67,937.03
48	Glendale-Mariette	150,263.23
49	Nogales-Fairbanks	62,732.29
51	Williams-Ash Fork	12,819.27
53	Phoenix-Yuma	95,962.83
56	Phoenix-Yuma	42,793.59
57	Ash Fork-Seligman	64,974.08

FEDERAL AID PROJECTS COMPLETED
Prior July 1, 1924

F. A. No.	Name of Project	Federal-Aid Received
59	Phoenix-Wickenburg	210,168.69
60	St. Johns-Springerville	47,611.49
61	Prescott-Ash Fork	129,287.15
62	Prescott-Ash Fork	186,301.80
64—A	Phoenix-Yuma	49,823.63
65	Mesa-Superior	85,084.66
66	Tucson-Nogales Bridges	11,323.60
68—A	St. Johns-Springerville	28,582.21
70	Phoenix-Wickenburg	72,565.13
		$4,723,091.85

7 RECAPITULATION

Total Federal Aid Appropriations (Inc. 1927)		$9,617,249.00
Federal Aid Received		
Completed prior to July 1, 1924	$4,723,091.85	
Completed and under construction Since 7-1-24	1,814,515.48	6,537,607.33
		$3,079,641.67
Allotted to Projects		$ 492,937.97
Available for eNw Projects		$2,586,703.70



Flagstaff-Angel Highway

FOREST HIGHWAYS

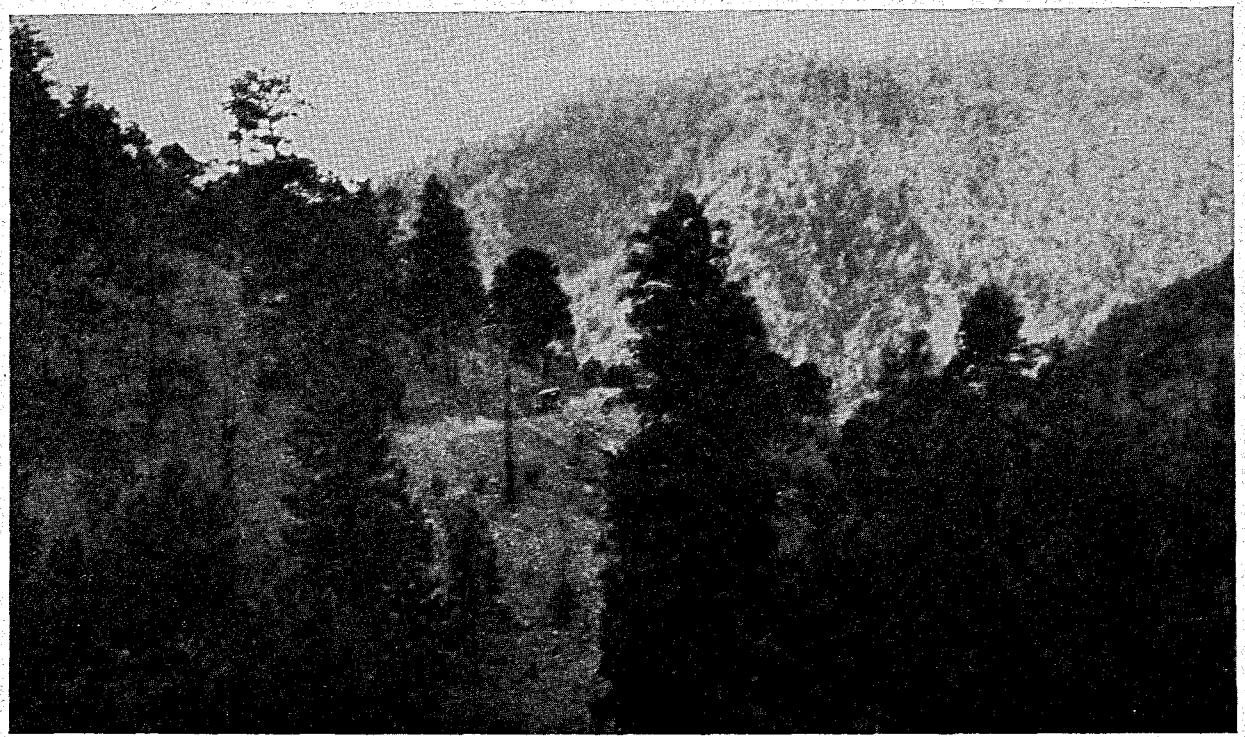
C. G. MORRISON, *Senior Highway Engineer*
United States Bureau of Public Roads

THE roads classed as Forest Highways and known as The Forest Highway System, comprise 862 miles of the roads of the State. This system has been agreed upon by officials of the State, Forest Service and Bureau of Public Roads. These roads are either in National Forests or adjacent thereto. Funds for their construction are derived from various sources. The Federal government builds some of them entirely from Federal Funds, others in co-operation with the Counties, and still others in co-operation with the State. However, these Federal Funds are separate and apart from those expended under the Federal Aid plan.

The Forest Highway System includes 140 miles of the Seven Per Cent System. The State has improved 74.5 miles of this amount in co-operation with the Government. The Bureau of Public Roads has improved 39 miles entirely from Federal Funds. The remaining 26 miles have not been brought up to the Seven Per Cent Systm standards, but are in good condition.

Sections of the remainder of the Forest Highway System have been and are being constructed from co-operative funds of the Government and the Counties. The location, design and construction of such sections is under the supervision of the Bureau of Public Roads. The standards used on these roads vary and are based on the traffic the road is expected to carry.

One of the longest and most expensive stretches of such improvement is the Clifton-Springerville Highway. The portions of this road from Metcalf to Alpine were completed during the year of 1926 at a total cost of $873,460.



Clifton-Sringerville Highway

LEGISATION RECOMMENDATIONS

W. W. LANE, *Chief Engineer*

RECOMMENDATIONS for legislation for Arizona Highways is made by this Department, with the hope of being of assistance to members of the Legislature in their deliberations upon this subject, by giving them the benefit of any information that may be had by the Department, and from observation and study of the highways, traffic and laws pertaining to the highways at the present time; also deductions made from such study as to the future highway demands.

Arizona is in extreme need of intelligent highway legislation, and those familiar with the operations of the present highway laws are in accord that revisional and additional legislation are essential. This is a condition that must and will be met. If it is faced now in the proper manner, the highway construction and maintenance that are required may immediately go forward efficiently and intelligently providing adequate highways for the present and future without undue burden now or upon posterity. Procrastination by the Legislature will be very detrimental to the efficiency in highway development, to economic transportation for the present, and will pass a greater burden on to posterity.

In making our recommendations to the legislature, it is not being done in the form of suggestion, but we are actually preparing two bills. Highway legislation is a subject requiring much time, effort and information, and by presenting the suggestions in the form of measures, it will require much less time and search for the necessary information on the part of the legislature.

Motor Vehicle Code

The first measure, being called the "Motor Vehicle Code," is rather

voluminous but it covers all regulations pertaining to the use of the Highways, Motor Vehicle Regulations and Motor Vehicle Fees, so that a person obtaining a copy of the Act has all laws under which he is to operate while using the highways.

This measure is taken from the Uniform Motor Vehicle Regulation Act as recommended by the National Conference on Street and Highway Safety. This Conference is made up of a committee of approximately eight hundred persons called by Secretary Hoover from all branches of industry, state and local government which were directly or indirectly connected with highways, vehicles and the laws pertaining thereto. It is the result of the deliberation of the best authorities of the United States. It was necessary, however, in the drafting of the bill that many changes be made in order that the bill may be fitted to the constitution and laws of the State of Arizona, and which was recommended by the above Conference.

This measure creates a Motor Vehicle Division with a Vehicle Commissioner for the control of all the highway regulations and the collection of all fees, with County Assessors or Deputy Officers of the Division.

The first title of this Act covers the Motor Vehicle Registration and provides the standard registration regulations as those recommended and are being adopted over the Nation; it also provides for the fees to be charged under the registration and which fees are to be $3.00 for the registration of all cars plus additional fees for the various classification of trucks, trailors, etc. This is a reduction from the present Motor Vehicle Fee, which now ranges from $5.00 to $15.00 based upon the horsepower of the car, and from $10.00 to $25.00 upon trucks. Some vehicles under the present Act are not included, so that they are going free while others are paying.

Title 2 of the Act is a Uniform Operators and Chauffeurs Act which was taken from the standard as recommended by the Conference.

Regulation of Operator

Title 3 covers the regulations of the operator of a vehicle on the highways as recommended by National Street and Highway Safety,

and for which Act standard provisions are provided for the regulation of speed, railroad crossings, rules of the road, accidents, weight and size of vehicles and loads, tire equipment, trailors, accessories, light equipment, traffic signs and advertising signs upon the highways. With the adoption of this by Arizona, and the rapid manner in which other states throughout the Nation are making their laws to conform to the recommended standard, a person taking a trip outside of the State will be driving under the same regulations as he is accustomed to drive in his own State. This will greatly simplify driving and will greatly reduce the possibility of accidents from not doing the right thing at the right time. This will be a great aid to the traveling public and is something that is really vital with the increased use of the automobile.

Title 4 provides for the One Mill Property Tax Levy, or one mill on each $1.00 assessed valuation of property within the State, and which tax is to go for construction and maintenance of State Highways. This is the same amount of property tax for State Highway purposes that has been in force for a number of years.

Title 5 covers the Motor Vehicle Fuel Act, or what is commonly known as the Gas Tax, and which amends the present gas tax law in a very necessary manner, in that it protects the exemptions on the gas tax, which are now amounting to approximately 20 per cent and which should not exceed 2¾ to 3 per cent. As a matter of fact in 1926 the State and Counties lost approximately $125,000 through illegal exemptions. The Act is further amended in that it increases the gas tax from 3c to 4c with a division of the receipts between the County and the State—the Counties receiving 1½c as they now receive under the present Act, or ⅜ of the 4c levy, and the State to receive ⅝ or 2½c of the 4c levy. As all of the Motor Vehicle Fees go for the use of State Highway purposes, and as these fees are reduced in this Act, the State is reimbursed for that reduction by the additional 1c of gas tax which goes to them by this revised gas provision or the 4c tax.

Common Carrier Tax

Title 6 provides for what is known as the Common Carrier Tax, or tax upon the Motor Bus or Truck Lines, which are operated over the highways for revenue.

At the present time these carriers are taxed upon the seating capacity of the busses and the tonnage capacity of the trucks irrespective of the loads they may carry. This has not been a good manner of taxation, and has created a considerable of discontent on the part of the companies and a great deal of evasion of the law on the part of others. In the discussion of the best methods of taxation upon these companies with several members of some of the companies, they recommended that the same basis be used in this State as is used in California—or a gross tax upon the earnings of the common carrier companies.

The California Act exempts certain taxes and makes their rates sufficiently high so that they may be in lieu of those taxes exempted. But as we could not exempt taxes in this State without an amendment to the constitution the rates upon the earnings of the companies were reduced to cover this tax alone.

By going into the earnings of a number of companies over a period of time and comparing their payments under the mill tax, it was determined that a two per cent tax upon the gross receipts for the motor bus companies and a two and one-half per cent tax upon the truck companies seems a fair rate. This apparently checks very closely with the net collections received from this tax by the California Act.

Title 7 creates a State Highway Fund for the purpose of placing the revenues as set up under this Act into one fund for State Highway purposes.

It is believed that the passage of this Act will be of great assistance to the automobile users of the State as well as to the visitors coming into the State and the motorists from this State visiting other states. With the exception from the revenues derived under the bill, it is primarily a means of standardizing the use and regulations of the highways by the motorists and not for the sole benefit of the Highway Department.

The revenues as set up under this measure do not increase to the taxpayers of the State the amount that they are now paying for State Highways.

Finance Code

The second measure which is being presented is termed a "Finance Code" and which regulates the expenditures by the State Highway Department upon State Highways. In the previous measure all receipts thereunder were placed in one fund, or what is termed the "State Highway Fund," and in this measure provisions are made for the disbursement and use of those funds.

By making a study of the requirements for the State Highways of Arizona based upon their present physical condition, present traffic, and estimating future traffic, it is determined that the State will have to expend approximately $5,000,000 per annum if the State Highways are to continue to serve the duty imposed upon them by traffic. By virtue of past construction and the high type of maintenance that has been done upon the State Highways, many communities and the entire population of the State have become dependent upon them, the failure of the Highway System will therefore work a very great hardship upon the entire State. Some of these highways are now functioning only by virtue of the high type of maintenance that is being applied to them and which cannot continue to take care of the traffic, as maintenance alone cannot keep up a road when the material is insufficient to withstand traffic duty. Many stretches of the State Highway are gradually losing out and getting ahead of our maintenance so that it is only a matter of a short preiod of time when they will become a great impediment to traffic because of the excessive amount of traffic and the inability of maintenance to supplant the weakness of the material.

In view of this fact and the further fact that the revenues as provided in the previous measure for 1927 will raise approximately $2,000,000 and with Federal Aid accruing to the State on the basis of the present Federal allotments of approximately a $1,000,000 per annum, we find that within the next year the highways will be short approximately $2,000,000.

Revenues Highway's Earnings

The revenues that are set up in the previous measure are in reality the earnings of the State Highways and by virtue of the increased

mileage and increased population in the State, this traffic is rapidly increasing; therefore, the earnings of the State Highways are likewise increasing so that the revenues as provided will materially increase from year to year.

This finance measure anticipates that increase and provides for anticipation bond issues for the next years of an amount between the difference of these annual revenues and $4,000,000 as fixed in the measure for the annual anticipation bond issue. By the usual principle of anticipating the earnings of the company or of the law of averages, it is estimated that the revenues as proposed in the first measure will equal $4,000,000 to the State (which is based upon a $5,000,000 per annum program less the anticipated Federal Aid allotments of a $1,000,000) plus the interest for outstanding anticipation bonds that may be issued within eigth years.

The bill further provides that after the revenues equal the $4,000,000 plus interest on the bonds, that all monies received in addition thereto must be placed into a sinking fund for the purpose of retiring the bonds. By the principle, as before mentioned, all bonds should be retired in the year 1942. This places two limitations on the amount of bonds to be issued by the State—first, the limitation on the bonds that may be issued in any one year, and, second, the limitation that the aggregate of these anticipated bonds may not exceed a total of $10,000,000, and furthermore, that no bond will be issued for a longer term than fifteen years.

This provides a means of financing the State Highway System at the present time without additional cost to the taxpayers of the State, nor does it add to the burden of posterity, as the earnings of the highways will pay for them.

This is an old principle which is used in business of all kinds, and while it has never been applied to the financing of State Highways in this State, it has been applied in part in several states and is proving equally as satisfactory for the financing of State Highways as it is in other business.

Highways a Business

The State Highways are in reality a business and do have earning

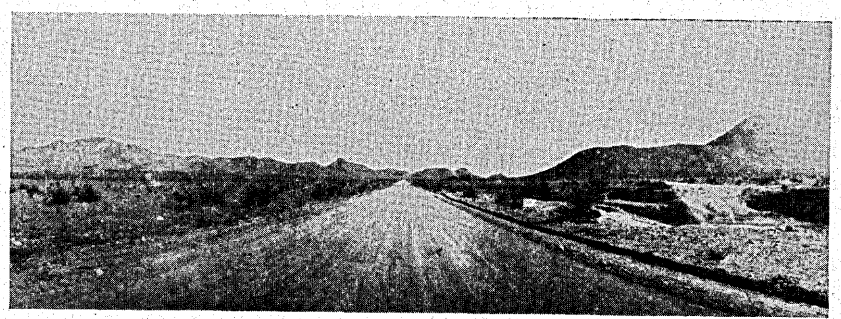
capacities by virtue of the revenues created to them, and those revenues can be just as accurately estimated as the earnings of any other business.

If the revenues are not supplied for State Highway work, sufficient to keep up with the rapidly increasing demands upon the State Highways, the State will be piling up a burden for future years that will be almost prohibitive when it reaches the breaking point, and will probably end up in a large State bond issue, and for which property-holders within the State will be called upon to pay a large share, if not all, of it.

By using some judgment and common sense, and accepting the responsibility for which there is no doubt at this time, the State will progress with its Highway construction and the taxpayers of the State will only be benefited.

At the expiration or completion of the payment of the bonds under this plan, the state's revenue will be free for the additional highway work that unquestionably will be required, while if another method of bond issues are resorted to the bond monies will be expended, and the revenues applied for the payment of those bonds will then be tied up for an indefinite number of years, and the highways will have less revenue for the future than they will have at the times the bonds were issued.

This plan was submitted and worked up in connection with the Arizona Good Roads Association and approved by that organization. A bill was drafted and initiated for the last General Election, but due to a typographical error, which in all probability would have put the bus companies out of business, the Good Roads Association, and acquiesced in by the Highway Department, withdrew the bill, or, they themselves requested the non-support of the measure. This bill, as now presented to the Legislature, was again approved by the Good Roads Association just prior to the meeting of the Legislature, and has also received the approval of at least ten of the fourteen Boards of Supervisors of the various Counties.



Fairbanks-Nogalas Highway

Tombstone-Nogales Highway

ENGINEERING DEPARTMENT

W. W. LANE, *Chief Engineer*

THE Engineering Department of the Arizona Highway Department, under the direction of the Chief Engineer, has jurisdiction over all engineering work of the Highway Department. Its work consists of the location and surveys of proposed highways, the making of all designs; the preparation of plans, specifications and estimates; the preparing and advertising of contracts; the testing of materials, the collecting and tabulation of statistics; the custody of records; and the supervision of all engineering work of the highways of the State System.

All preliminary and location surveys necessary for the design and preparation of plans, estimates and the like are under the direct supervision of a chief location engineer, whose duties are to make the necessary reconnaissance surveys; to direct and supervise the location of highways; todirect the operation and methods of the several location survey parties, thereby standardizing the locations and methods; and to make final check upon location, gradient, drainage and the like.

Upon Construction, the engineering work is under the direct supervision of the district engineers within their respective districts, with the aid of resident or project engineers. Upon all highway contract work, in addition to the engineering work and inspection, the Engineering Department has supervision over the compliance of the terms of the contract on the part of the contractors.

Upon construction work done by State forces on Federal Aid Projects, bridge work and other highway construction, deemed of sufficient importance to require engineering supervision, the engineering work and inspection is carried out in the same manner as upon

contract work, without jurisdiction over the construction forces other than as to their compliance of the specifications.

This department, through the direct supervision of the district engineers, has supervision as to requirements and methods of the maintenance of the State Highway System.

Divided Into Sub-Departments

The Engineering Department is further divided into sub-departments for the purpose of more systematic handling of the office engineering. The sub-divisions include the bridge department, testing department, estimating department, department of plans, statistical departmnt, right-of-way department. The duties of these sub-departments are described in detail under their respective headings.

It is the further duty of the Chief Engineer to prepare, transmit or receive all documents required of the State in the execution of the Federal Aid Road Act; to handle all communications with the Bureau of Public Roads, and do all work necessary or expedient to the carrying on of Federal Aid in Arizona, insofar as it pertains to the State Highways. The Chief Engineer also maintains a status of all Federal Aid work and funds; prepares and transmits vouchers for Federal Aid monies as earned; and is the custodian of all Federal Aid records.

It is incumbent upon the Chief Engineer to budget the receipts and resources of the Highway Department to the projects and sub-departments through the medium of the "Authority For Expenditure," which has been previously described.

The statistics of the Department, and which are more fully described elsewhere in this report, are of great advantage in many respects, as they are a guide to the Department in the total of construction for the present and future, a record of the earnings of the highways and a basis for estimating future earnings, and are also a guide upon the maintenance and a very material assistance in checking the cost of maintenance upon the various projects. Without statistics properly kept and formulated, the work of the Department would be largely by guess and would result in an economic waste in the application of the funds of the highways.

Research is another very material assistance in determining the class of materials and the proper method of construction. But the Department has been very greatly handicapped in this branch due to the lack of funds and the lack of ability to plan ahead due to the uncertainty of which monies are appropriated for highway purposes.

Research Work Essential

A great amount of research work has been done throughout the country by many of the Highway Departments, the Bureau of Public Roads, and others, of which this Department has been able to take advantage of, but they are only general as to the application in this State and research work is very essential for the Department so that the proper appliaction of materials and class of construction may be properly adjusted to the highways and the materials in this State. The construction standards are continually changing due to research work, greater knowledge of materials and their applications due to such research and observation in its actual use, and also due to the increased amount of traffic and heavier type of traffic which the highways are continually required to carry.

Naturally with the increase and change of construction standards and construction materials, specifications must be changed and adjusted in order that the construction and maintenance may be properly performed. For every indication, the future standards of construction will be increased due to the increased traffic and further research work, and which research will have a great bearing upon the economics of future highway construction.

In addition to the laboratory work on materials, a great deal of attention is being given to the materials which have been used in the State to date for surfacing and particularly in regard to the wear resistance under traffic. The Department is establishing what we term "Wear Sections" over the various sections of surfacing material and upon which sections an accurate check is kept on the wear of material in its relation to the number of cars daily used on the road.

From this practical test, together with our Laboratory research work, a very close approximation may be made of the life of the material and which will be the basis for determining the value in dollars

and cents of a material that may be available for surfacing our highways.

Saving Is Foreseen

The data as obtained from these research works, together with our statistical department data, showing the present and estimated future requirements, should be the basis of determining when we should go from selected local materials for surfacing to paving. If such methods are followed in the future paving of the State, many thousands of dollars will be saved by the proper application of paving sections, or the paving done on the sections where the traffic requies a better surfacing than the local materials in order to withstand the wear, and paving will not be placed on sections where the local materials would suffice. This not only reflects on the construction cost, but will have a great deal of bearing upon the economics of our future maintenance.

The Engineering Department also works with the railroad companies in the matter of railroad grade separations in co-operation with the said companies. Grade separations are very necessary on the through highways where they cross main line railroads, for the safety of the public. The railroads in the past have shown very marked co-operation with the State in the elimination of these crossings and the indications are that the State will receive very close co-operation for future separations. The separation of the grade crossing means a great deal to the railroad companies as well as the State, as accidents at the crossings are expensive to the railroad companies as well as disastrous to the public. The State of Arizona is very fortunate in that its main roads have practically all been laid out in the last few years, and a great deal of attention has been given to railroad crossings and where it was practical to prevent crossing them by location of the highways, that condition was taken advantage of. The results are that the State has comparatively few railroad crossings of its main highways with main line railroads.

LOCATION STANDARDS

BY C. C. SMALL, *Chief Location Engineer*

STANDARDS are, perhaps, of less use in location than in many branches of engineering.

Topograph governs location to such an extent that standards applicable to open or slightly rolling topography would be impractical in rough, mountain country; at least from a financial standpoint.

As there is no marked line between the various classes of topography, location standards must necessarily be governed more or less by the judgment of the locator.

However, from the above it is not to be inferred that the locations made by the Arizona Highway Department follow in each location the ideas of the individual locator, nor that no effort is made to obtain uniformity in the locations over country of somewhat similar topography, or over routes where the traffic is, or is estimated will be, of like volume.

Any attempt to note the standards of the year 1926 may be obsolete in 1927, so rapidly do the demands of the traffic increase, and any location made today should not only consider the present traffic but must consider the increase in the traffic likely to occur within the next several years; so far, at least, as our finances will allow us to anticipate the future.

Good Alignment Necessary

It is self-evident to anyone who drives an automobile that a highway laid out with long radius curves, both horizontal and vertical, will accommodate, with safety and comfort, a much greater volume of traffic than a road of similar width of roadbed where short radius curves are numerous. This being so, money is well invested in ob-

taining good alignment, as such not only is equivalent to a wider roadbed on a more tortuous line, but also provides a structure on which future improvements can be made without a change of location.

To criticise a location made in the past is generally unfair to the locator by whom the route was surveyed, unless one is conversant with the instructions under which the locator was working, and with the financial problems of his superior.

However, from my observations during the past eight years with the Arizona Highway Department, whenever an improvement in a route is contemplated, a new location on a higher standard than the old is necessary. This applies to nearly all highways located prior to eight years ago, and to too many located since that time. This may denote progress, but it also entails a great expense. Will it not be well then to anticipate our future necessities in our highway locations a little further in advance than was done by our predecessors?

Financing a road program will always be a problem in a State situated as is Arizona, and it may appear that the result of a higher standard of location will result in fewer miles of improved road built each year. This will undoubtedly be true for the first few years, but the period will not be long before the results are the reverse.

Higher Standards Necessary

It is believed that higher standards are now advisable, and this being so, the following so-called, but elastic, standards have been adopted by the Arizona Highway Department:

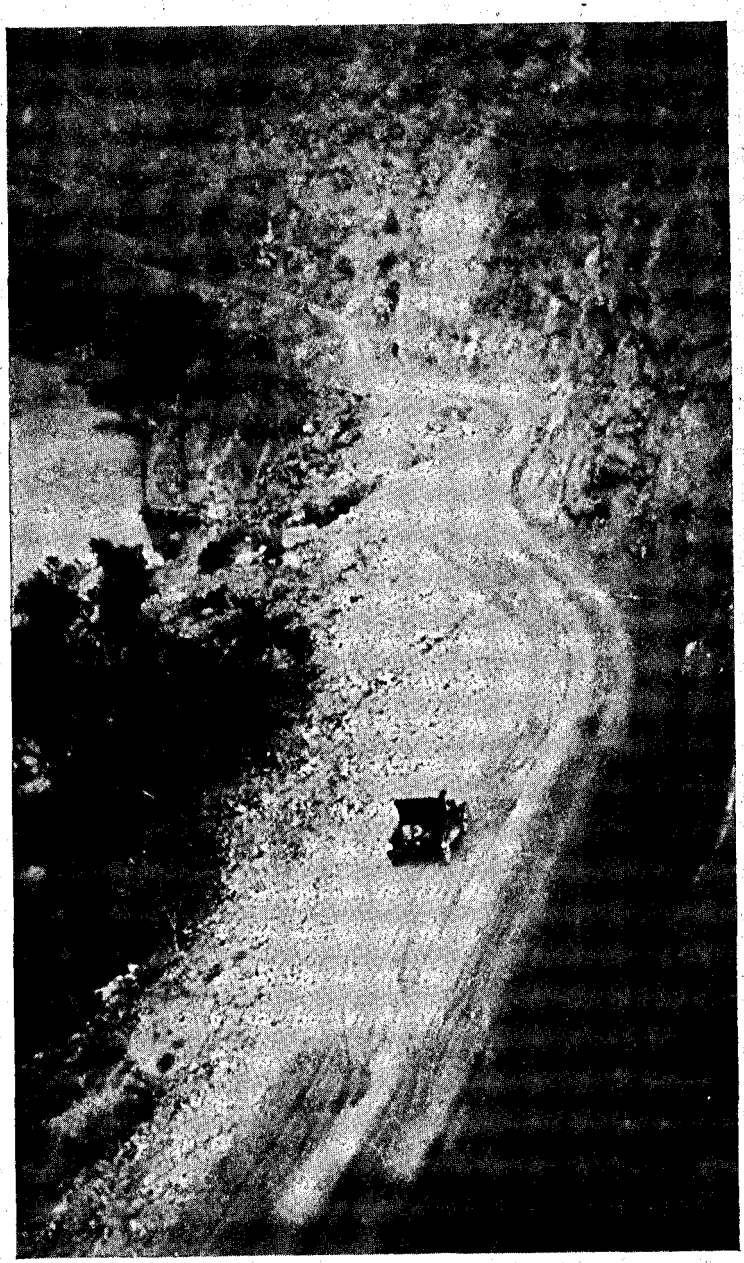
In all cases, excepting mountain location or topography equally difficult, a minimum curve radius of 955 feet is used. However, a minimum radius of 1,910 feet is maintained where possible without increased cost of construction. About the only exception to the above is when right angle turns at section lines are made through agricultural lands, and near towns and cities, where lands are valuable and right-of-way difficult to obtain. In these places we endeavor to obtain a minimum radius of 300 feet.

The locations through the mountains vary so greatly with the char-

acter of the topography that standards can hardly be said to be attempted. The best alignment that our finances will permit is our objective, and with an absolute minimum of 200-foot radius on outside curves and 100-foot radius on inside curves. These figures are fixed by the Bureau of Public Roads on Federal Aid work, but the Arizona Highway Department has so endeavored to improve this standard that I can, for several years past, recall no place where these minimum values have been used that they have not been approved by the bureau's engineers.

Using a higher standard of location and, as we hope, anticipating the traffic years ahead, we expect fewer changes in our locations in the future than there have been in the past. But who knows? Another decade may show that we are no wiser in anticipating the future traffic and necessities of highway location than were the engineers of the past.

One must remember, however, that a balance must be struck between the anticipated needs of the future and the financial ability of the present. Our present standards may not be sufficient for the former, but they certainly come very near to the latter.



Apache Trail Highway

PROJECTS LOCATED SINCE JUNE 1, 1924

APACHE COUNTY

St. Johns-Concho Highway

Federal Aid Projects Nos. 78-A and C

Lengths 8.8 and 5.9 Miles

Located During April, 1925

Relocation of these projects reduced the distance between St. Johns and Concho 2.5 miles and liminated some bad grades and objectional curvature. A few curves of 477.5 radius were used to avoid extremely heavy work; however, the maximum radius of 955 was seldom exceeded. Section "A" has been constructed. The construction of Section "C" will follow as soon as funds are available. Earl Parker and J. M. Shepherd were the locating engineers.

Holbrook Lupton Highway

Length 55 Miles Federal Aid Project No. 83

Located June to November, 1924

The survey of this section was a continuation of the same project in Navajo County and most of the remarks pertaining to the route in one county apply to the other. However, in Apache County, the route deviates more from the present road. Between Sanders and Allentown, the route in lieu of making two crossings of the Puerco River and two crossings of the Santa Fe railroad follows to the north of both. This change calls for heavier work which is somewhat compensated by the elimination of the two railroad crossings. It is furthermore desirable from the facts that the two bridges across the Puerco are now up to Federal Aid Standards and reduced distance and curvature.

A question that arose in connection with this location was between routes one via Adamana and the other via the Painted Desert. The former would bring the road near the railroad and materially reduce the haul on gravel and other surfacing materials. The latter gives an excellent view of the Painted Desert. It was concluded that the Painted Desert was too important an asset to be ignored and the latter route chosen. These surveys were made by Locating Engineer Percy Jones, Jr.

COCHISE COUNTY

Benson-Douglas Highway

Length 24.2 Miles Federal Aid Project No. 79-D

Survey Made January-April, 1925

A resurvey as made of the Benson-Tombstone Highway. The route was shortened 1.5 miles and two railroad crossings were eliminated. The same high standard of location was maintained as on other recent surveys.

Included in the above dates a relocation of 2.1 miles was made immediately east of the paved section of the highway between Tombstone and Bisbee.

The grades were reduced to six per cent and the alignment materially improved. This project, Federal Aid Project No. 79-B, 2.1 miles in length was constructed in 1925.

Percy Jones, Jr. was the Locating Engineer on both projects.

After the flood of September 1926, when every bridge or their approaches were washed out, a resurvey was made of the first 6.1 mils from Benson towards Tombstone. The object of the survey was to so locate the line that one bridge would serve for both the wrecked St. David's bridge and the wrecked county bridge east of Benson.

Nearly a mile of road is eliminated by this survey and a better crossing of the San Pedro River secured. There is, however, some difficult drainage to handle and soil conditions are unfavorable over

some distance. A comparison of this survey and the old route is now being investigated.

This location was made by Percy Jones, Jr.

North and South Highway

Length 5.1 Miles **Survey Made May, 1926**

A few changes were made in this location by W. R. Stevens. This line was constructed this past summer. A reconnoissance was made over a section of the North and South Highway from Cochise, four miles east. Survey has not yet been made.

COCONINO COUNTY

Flagstaff-Williams Highway

Underpass and Paving—Federal Aid Project No. 89-A

Length 8.75 Miles **Located in December, 1925**

This survey was made to obtain the data for paving the Old Trails Highway through the town of Williams and to eliminate an objectionable grade-crossing. An underpass will do away with this crossing. R. E. Allison made the final survey.

GILA COUNTY

Globe-Safford Highway

Federal Aid Project No. 87

Total Length 57.5 Miles—25.5 Miles in Gila County

Survey Made April, 1925 to July 1926

The contemplated construction of the Coolidge Dam made necessary a relocation of the Globe-Safford Highway from a point approximately six miles east of Globe to a point one mile east of Bylas. The survey of this route was across the drainage for practically all the distance. The counry traversed is badly eroded by deep gulches and

the drainage is heavy. It is the most difficult piece of location ever undertaken by the Arizona Highway Department. A high standard of location was maintained throughout, although for a distance of two miles near the Coolidge Dam mountain standards were used.

This highway will cross the Gila River over the proposed dam now under contract. Work will start on this project in the spring of 1927.

Following this survey a resurvey was made from the city limits of Globe to the west end of the above survey, a distance of 5.7 miles.

The present highway is narrow and has much objectionable alignment. While the new route divated but little from the old, material improvement was made in the alignment. This improvement will call for two permanent bridges in lieu of wooden trestles where the highway passes under the Southern Pacific railroad.

These surveys were made by Locating Engineer Percy Jones, Jr.

GRAHAM COUNTY

Safford-Duncan Highway

Length 7.9 Miles Federal Aid Project No. 88-A

Survey Made May, 1925

This project was located and has been built to Federal Aid Standards. The road before the recent construction was built five or six years ago by Graham County, but for absolute lack of maintenance was fast reaching a condition where it was less tolerable than the old desert over the same route.

The relocation did not differ materially from the county road, although several curves were eliminated and the alignment improved.

Globe-Safford Highway

Length 26.2 Miles in Graham County

Federal Aid Project No. 87

This highway is described under surveys of Gila County.

GREENLEE COUNTY

Safford-State Line Highway

Federal Aid Proejct No. 88-B and C

Lengths 11.7 and 6.9 Miles

Survey June to October, 1925

These projects were located as one but were later sub-divided for the purpose of contsruction. The route deviates but little from the present county road but by taking heavier work, a decided improvement was made in the alignment and grades. Eexcepting through he town of Duncan, a high standard of location was maintained. Roy White was the locating engineer.

MARICOPA COUNTY

Phoenix-Yuma Highway

Length 1.6 Miles Federal Aid Proect No. 64-B

Survey May, 1925

This project connects Federal Aid Projects Nos. 64-A and 53. It includes the bridge across the Gila River below the Gillespie Dam. This work is now under contract.

Apache Trial Highway

Length 10 Miles

Survey Made October-December, 1924

This location was made necessary by the construction of the Horse Mesa Dam of the Salt River Valley Water Users' Association. The topography is extremely difficult and as the commercial travel is light no attempt was made to maintain the standards used on the Federal Aid System or other main routes. Grades up o 10 per cent were used and the alignment is not up to a high standard. This route was located by Roy White.

MOHAVE COUNTY

Ash Fork-Kingman Highway

Length 4.4 Miles **Federal Aid Project No. 8-E**

Survey Made March-May, 1926

The old county road near Hackberry was relocated with the object of bringing this section of the Old Trails Highway up to Federal Aid Standards. Two grade crossings are eliminated by this change, the distance reduced 4000 feet and the alignment materially improved. This project is on the program for construction during 1927.

Another location of 3.9 miles was made in the vicinity of Valentine.

R. E. Allison was in charge of these locations.

Kingman-Topock Highway

Federal Aid Project No. 85

Length 32 Miles **From Kingman to Boundary Cone**

Survey Made November, 1924 to January, 1925

This section of the Old Trails Highway was relocated. As part of the work is extremely heavy, a further study may be necessary before any construction is undertaken. The survey was made by Earl Parker.

NAVAJO COUNTY

Holbrook-St. Johns Highway

Length 5.9 Miles **Federal Aid Project No. 78-B**

Located During December, 1925 and January, 1926

The location of this road covers a section of the Old Trails Highway from Holbrook to Federal Aid Project No. 42. Thenew route shortens the distance over the old road and eliminates several sharp curves. One curve immediately west of the Little Colorado River Bridge which was particularly objectionable will be replaced by a

curve of 1432 radius. The location was made by A. E. Allison, locating engineer.

The new line will call for a steel bridge across the Little Colorado River in the Town of Holbrook. The concrete arch that spans the Little Colorado five miles east of the town will be utilized.

This project is on the program for construction in 1927.

Holbrook-Lupton Highway

Length 21 Miles Federal Aid Project No. 83

Located June to November, 1924

A relocation of this section of the Old Trails Highway follows closely the present road in Navajo County. Although no attempt was made to utilize the present grade, which is only a grader section, it was estimated that this grade would be of more value as a detour than as a part of the reconstruction.

The grading is light and but few large structures will be required but the problem of securing suitable surfacing material is a serious one. Surfacing the road will call for a greater expenditure than the grading and structures combined. Unless some now unknown source o fgravel or caliche is developed, this material may have to be hauled from a considerable distance by train. The location was made by Percy Jones, Jr.

PIMA COUNTY

Tucson-Nogales Highway

Length 13.7 Miles Federal Aid Project No. 86-A

Survey Made August-September, 1924

This change of route eliminates much curvature and reduces the distance by 1.5 miles. This project has been constructed.

Tucson-Benson Highway

Length 21.1 Miles Federal Aid Project No. 90

Survey Made October, 1925 to January, 1926

This route was surveyed with the object of shortening the present

traveled route and o obtain data for the construction of this Project to Federal Aid Standards. One and one-half miles of distance was eliminated and only one railroad crossing made in lieu of the three grade crossings on the present route. The work is light and the alignment largely tangent. Roy White located this project.

PINAL COUNTY

Chandler-Casa Grande Highway

A section of this road from San Tan to the Gila River bridge (Sacaton) was relocated to avoid complications with the new main line of the Southern Pacific railroad and conform with certain requirements of the United States Indian Service.

Sacaton-Pichacho Highway

Length 31.9 Miles

Survey Made August to November, 1926

This section of the Chandler-Tucson Highway was located by R. E. Allison and F. A. Berg. As the party was called in before the work was completed, some work yet remains to be done.

5.8 miles of the Globe-Safford Highway noted under Gila County is in Pinal County.

YAVAPAI COUNTY

Ash Fork-Kingman Highway

From Yavapai County Line East of Ash Fork to East End of Federal Aid Project No. 57 and from the West End of Federal Aid Project No. 57 to the East Boundary of the Hualpai Indian Reservation.

Lengths 8.6 Miles and 37.3 Miles

Survey Made December, 1924 to February, 1925

This survey was undertaken with the object of securing data for

Federal Aid Projects and to eliminate a few curves of short radius. The present road was followed for a greater part of the distance. However, material changes were made in several sections. East of Ash Fork a change was made to eliminate the grade crossing of the Prescott-Phoenix Branch of the Santa Fe railroad. The railroad has since located a new line entering Ash Fork from the west, so this survey will be abandoned and a new survey made. The change in the location of the railroad will probably be to the advantage of the highway as the elimination of the crossing will be less expensive on the west of the town than the proposed elimination on the east.

At Pan Draw, east of Seligman, a change was made eliminating considerable sharp curvature and some distance. Some heavy rock work and fill will benecessary but the new line is a decided improvement over the old.

Near the west end of Federal Aid Project No. 57 a minor change was made that will eliminate a grade crossing with the main line of the Santa Fe.

Immediately west of Seligman a line change was made which eliminates two crossings of the Santa Fe.

West of Pica, a line change was made that reduces the distance over the present traveled road by a quarter of a mile. Other minor changes were made. This relocation was made by Percy Jones, Jr.

Prescott-Jerome Highway
Federal Aid Projects Nos 19 and 36, Relocated
Lengths 1.8 Mile and 4.4 Miles
Survey Made November and December, 1925

A resurvey was made of this part of the Prescott-Ash Fork Route. While the present highway was followed for a greater part of the distance some material changes were made to reduce sharp curvature. The present road is to be widened and the roadbed made ready for paving. The reconstruction is now in progress. R. E. Allison was in charge of the location.

Phoenix-Prescott Highway

Length 16.0 Miles Federal Aid Project No. 84-C

Survey Made May to August, 1926

Frequent washouts of parts of this route made desirable a change of location. The present highway was built during 1923 by Yavapai County.

A satisfactory line was obtained and parts of this project will be undertaken as soon as funds are aavilable.

Following this survey a location was made to connect Federal Aid Projects Nos. 59 and 76. This change in location eliminates a grade crossing near the Hot Springs Jct. depot. The length of this project is 1.5 miles. R. E. Allison was in charge of these surveys.

YUMA COUNTY

Wellton Overpass

Length .8 Mile Federal Aid Project No. 55, reopened

The construction of the new main line of the Southern Pacific Railroad developed an objectional grade crossing east of Wellton. With the elimination of this crossing in view a relocation was made. This work will be undertaken when funds are available.

Phoenix-Yuma Highway

Federal Aid Project No. 82-B and C

Length 14.7 Miles

Survey Made November, 1923 to January, 1924

This section of the Phoenix-Yuma Highway was located with the object in view of eliminating a long swing in the present road in the vicinity of Dome and to place the location above the high-water mark of the Gila River. The distance over the present road was reduced 6.7 miles and better location for an overpass over the Southern Pacific railroad was secured. The construction of this section will

eliminate the last section of unimproved highway between Phoenix and Yuma. The work is now under contract.

An additional distance of 3.0 miles from the end of this project towards Wellton has been located but is not a part of the present project.

RECONNAISSANCE REPORTS

Reconnaissance reports were made covering the following projects on which no survey has been made:

Globe-Springerville

At the request of parties interested in the asbestos mines along the Salt River a reconnoissance was made from Showlow to Globe and a summary of this report is as follows:

The distance from Showlow to Globe is estimated as 88 miles.

The distance from Globe to McNary and Springerville is the same as by the present Rice-Springerville Road—that is, from Globe to Showlow, thence to McNary and Springerville by the present road between Showlow, McNary and Springerville.

The highest elevations crossed are considerably less than the corresponding points on the Rice-Springerville Road and the high points crossed are narrow ridges as compared with broad flat mesas at greater elevations on the Rice-Springerville Road. These factors would make the work of keeping the Showlow road open the year round much less than that on the present Rice-Springerville Road. Making a connection between Showlow and Concho this project would connect with the Federal Aid System and furnish a through route from the South Central part of the state to St. Johns-Gallup, New Mexico, and thence east. It would be much shorter than other existing routes.

The material for road building, particularly surfacing, is much better on the Showlow Route than on the Rice-Springerville Route; at least 20 miles is through granite and the remainder of the distance indications for surfacing materials are more favorable. It would be

a material aid in developing the extensive asbestos deposit near or through which the line passes and it would be a much more scenic route than the Rice-Springerville.

A reconnoissance estimate of the cost of constructing this road is $1,800,000. An estimate made years ago for the Rice-Springerville Route (Rice to McNary) was $1,400,000. The estimate of the Show-low Route was made with a higher standard of location in view than that made years ago over the Rice-Springerville. It is probable that when the Rice-Springerville is estimated to the same standard that the two estimates will be equal.

United States Route 91
Utah-Nevada State Line Highway

This route—a part of the Arrowhead Trail—crosses the northwest corner of the State for a distance of 19.0 miles.

This road is of but little interest to local state traffic; however, it is a part of the seven per cent System and ultimately must be constructed. In its present condition—narrow, crooked and rough—it is as effective an adverse advertisement for the Arizona Highway System as can be imagined. All travel on the Arrowhead Trail sees this part of our highway system and no other.

The estimated cost of bringing this route up to Federal Aid Standards is $300,000. A sizable bridge across Beaver Dam Creek is included in this estimate.

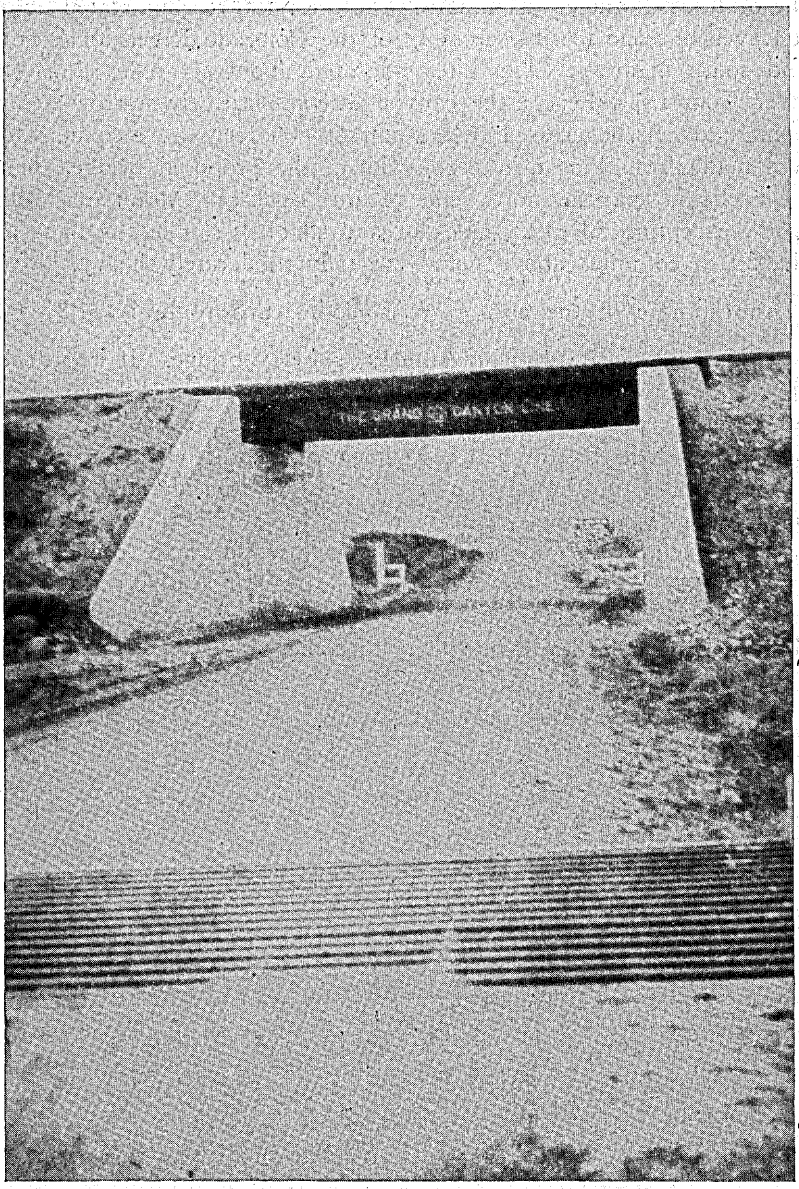
U. S. Route 89
Flagstaff-Lee's Ferry-Fredonia

Nowhere in North America and in very few localities in the world are there any such barriers to road building as the Grand Canyon of the Colorado. Practically cutting the State from east to west, the canyon offers only two or three crossings feasible from a financial standpoint. Two of these possible crossings are in the vicinity of this very involved situation is cleared, these sites cannot be considered; furthermore, they are too far west to be any any value to the numerous proposed dam sites on the Colorado River and until

the State as a whole. Eliminating these for the reasons stated above, it leaves but one feasible crossing of the Colorado River for a north and south highway. This site is located about six miles down the river from Lee's Ferry; the canyon is comparatively narrow at this point and can be crossed by a span of 600 feet. A reconnoissance was made from Flagstaff to this site of the proposed bridge, thence to Fredonia via the north end of the Buckskin Mountains. The work, excepting 20 to 25 miles of a total of 182 miles, is light and the 20 to 25 miles above noted are only moderately heavy.

An estimate of the cost of constructing this route is $1,212,000.

This above does not include the Lee's Ferry bridge. It is probable that an improved highway built over this route would bring to the State more new traffic than any one other improvement that can be made. The traffic between the north and south rims of the canyon would, in the summer at least, be a considerable item and it is natural to suppose that it would be as important a route of travel as our other main highways. At least alternate routes either east or west for a distance of 500 miles will not divert the traffic from this road as there are none and the prospects are good that there will be none for many years to come.



Underpass on Prescott-Jerome Highway

BRIDGE DEPARTMENT

R. A. HOFFMAN, *Bridge Engineer*

SINCE the inauguration of the Federal Aid System, a need for standardization of specifications for design and construction of highways and highway structures has been felt by the various States and by the bureau of public roads, in order to arrive at a basis of understanding for the preparation of plans by the States and the checking of those plans by the bureau. Much has been done along this line in the past two or three years by the American Association of State Highway Officials, cooperating with the bureau of public roads. Although these aims have not yet been accomplished to the satisfaction of all, many recommendations of the Committee on Bridges have been unofficially adopted and are now in use by the Department.

We have received two sets of specifications on bridges; the first dealing with the design and fabrication of structural steel bridges, and the second, a set of general specifications covering the design and construction of concrete and steel bridges. Of these two sets, the former has been adopted, with some minor revisions, by the bureau of public roads and published in the Department of Agriculture Bulletin No. 1259, but has not been officially adopted by the State, although many of the features of design included are now in use. The other set is still under consideration, both by the State and the bureau of public roads, and it is believed that some revisions will be necessary before adoption by either. Such specifications of course must be general and will have to be reduced to more specific form to fit local conditions in each State.

At present we are in more of a quandary than before the advent of these new specifications as regards to certain points of design, such as distribution of loads, moment factors, etc. We are using parts of the two new sets of specifications for design as well as part

of the old bureau requirements. This Department is now preparing a comprehensive set of formulas for use in the design of structures which will give the men working on design a ready reference on points now covered in three sets of specifications.

Force Employed

It has been necessary to increase the force of the Bridge Department by the addition of an Assistant Designer and one draftsman, making a total force of five. There are two outstanding reasons for this increase: one being the new standards of design mentioned above, which, combined with the new manufacturers' standards of steel bars, voids practically all of the present standard plans for bridges and culverts; and the other being the advanced standards of location which precludes the use of standard plans, except for minor structures, and requires more and more special details.

For example, the old practice of using excessive curvature in the road in order to make a right angle crossing on a stream, or to fit a particular bridge site, has, for the sake of safety and future economy, been abandoned, and, whereas, it was a former practice to fit the road to the bridge, we now build the bridge to fit the road and stream regardless of the angle. All these things increase the volume of work in the office and even with the increased force the Department is barely able to keep up with the schedule.

In addition to design, there are many other duties performed by this Department, including: Inspection of new sites; checking orders for additional work on the construction and making field inspections on these; making up orders for steel, cement and other material furnished by the State; checking construction reports for quanties on each structure built.

In all, 205 designs and detail plans have been turned out for special structures. Estimating two full size sheets of details per structure would give a total of 410 tracings during this biennium for special structures, besides many sheets of layouts for bridges using standard plans. Construction reports for all culverts, dips and bridges are checked and approved, and from these the final estimate to the contractor is checked by this Department. Each item receives a

double check, and errors are minimized both in design and computation of quantities.

The cost of operation of the department in salaries during the 30 months' period covered by this report has been $24,535.48, and the estimated cost of the structures over 20-foot spans built from plans prepared by this department was $766,500. Plans are completed for $150,000 more. These figures do not include small culverts and structures less than 20-foot clear span and are for those structures on Federal Aid Projects only.

Important Structures

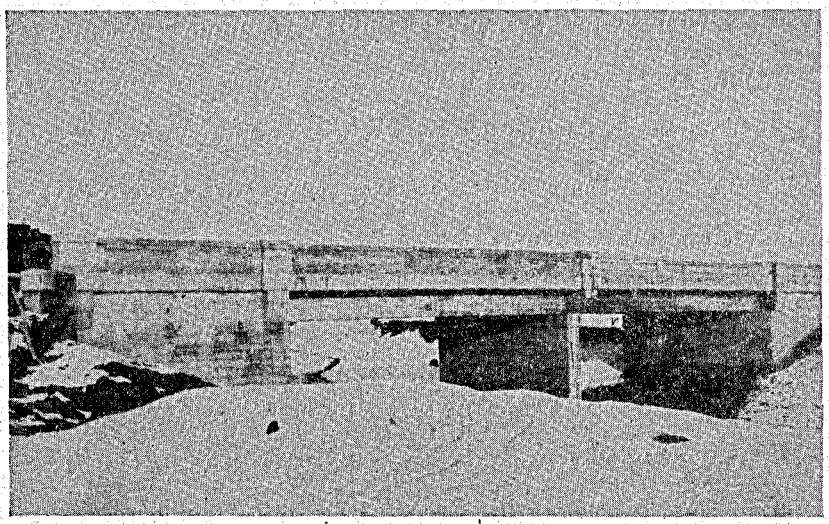
Important structures of any considerable size require special detailing and are not readily adaptable to standard plans. For structures in this class it has been proven repeatedly that standard plans are not economical, even though there were such plans made available for conditions existing in what may be termed major structures.

One of the most important structures yet constructed by the Highway Department is the Gillespie Dam Bridge, located just below the dam of the same name. The first estimated cost of this project, for the bridge alone, was $300,000. On account of the magnitude of this undertaking a consulting engineer was employed to assist the bridge engineer in making a thorough study of the site and an analysis of the proper and most economical design.

Borings were taken up and down the river below the dam to select the most logical site from the standpoint of depth of foundations, and, after making a preliminary layout, two holes were drilled on each pier location, and samples taken from bed rock and foundation material encountered. It was found that most of the foundations could be placed on solid bedrock at an average dept of about 25 feet, and the rest on a hard, firm caliche at from 30 to 40 feet, which is not a difficult depth for working.

The through camel back truss type of steel bridge on concrete piers and studments was selected after careful study, and the final layout consisted of nine spans, five 200-foot spans over the main channel, with two 160-foot spans on each end, where the shallow

bedrock made short spans more economical. The total length of the bridge from end to end of the U abutment is 1,701 feet six inches, with a roadway width of 21 feet four inches clear between trusses. The deepest pier is 43 feet below river bed and 16 feet above, or a total height of 59 feet over all. The final plans called for 1,175 tons of structural steel, 4,081 cubic yards of class "A" concrete, 179,740 pounds of reinforcing steel and 5,600 cubic yards of structural excavation. A total of 54 sets of plans were sent out to contractors and inquiries received from many others from California to New York. Eleven bids were received, the high bid being $399,247.41.



76-Foot Bridge on Winslow-Holbrook Highway

Bids were opened January 18, 1920, and the contract awarded to the low bidder, the Lee Moor Construction Company, on January 21, 1926, for the sum of $292,167, including all materials, which, with the 10 per cent allowance for engineering and extras, brings the total to about $320,000.

Construction Starts

Construction was started February 2, 1926, and will probably be

finished in April or May of 1927. Some delay was experienced, but the work is showing fair progress at the present time.

Foundations are proving even more satisfactory than the results of the borings would indicate. The caliche in some cases being practically a solid lime rock, and there is little or no indications of scour below 20 to 25 feet.

The department was fortunate in securing R. E. Perkins, an engineer of wide experience and sound judgment, for the residency on this project, and the State will be assured of one of the finest and most up-to-date bridges of its kind in the West. This structure, when complete, should be well advertised, as it is on one of the main arteries of East and West travel, and replaces a crossing which is known from coast to coast for its hazards and tieups.

Other steel bridges which should also receive special note are: The San Simon bridge near Safford, a 105-foot pony span, and the Willow Creek, on the Mormon Flats section of the Apache Trail, a 160-foot through truss, both of which have been completed during this period. Plans are also completed for a steel bridge over the Little Colorado at Holbrook, consisting of four pony spans of 87½ feet with a 20-foot roadway and two 4½-foot sidewalks.

Special Concrete Bridges

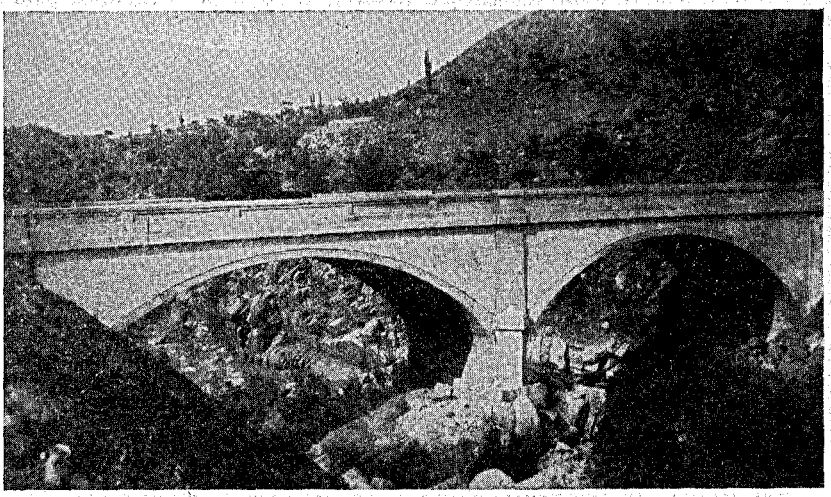
Three bridges of the concrete pile trestle type have been completed in this period; one near Joseph City; one near Congress Junction, and the other near Continental. This type of bridge has proven economical for certain locations where foundation conditions were of such a nature that no satisfactory material could be obtained at a reasonable depth, and the ground water was of such depth that timber piles could not be protected from rot. This type has been used quite extensively in Eastern States, but these three bridges are the first to be built in this State.

Grade Separations

The railroads are cooperating with the State to eliminate, as rapidly as possible, the dangerous crossings in this State as well as in

other States. Many devices have been tried for safeguarding the public at railroad crossings, but none so far have the absolute positive safety of the complete separation of grades. Two types have been employed for such separation of grades; the overpass and the underpass.

Three of the latter have been built and placed in service, and one of the overpass type recently opened to traffic near Drake over the Phoenix branch of the Santa Fe.



Bridge on Apache Trail

The overpass near Drake is an example of economical construction for this type of separation. It consists of three 34-foot R. C. Girder decks on column piers, giving a clear distance from top of rail of the railroad to the roadway of 26 feet.

The department now has plans completed and accepted for two more crossings similar to the Drake overcrossing, and has in preparation plans for two additional overcrossings, which, instead of being for two tracks like the above, are for three-track layouts. Plans are also under way for four additional underpasses. The underpass has a slight advantage in cost over the overhead type due to the

difference in clearance requirements; that is, the clearance between highway grade and railroad grade is 19 feet to 20 feet for an underpass, whereas the clear distance between grades for an overpass is about 26 feet. Offsetting this difference in elevations is the difficulty of draining the underpass, and the more massive construction required for a railroad structure as against a highway structure.

Other concrete bridges worthy of note are shown in Table I accompanying this report. Some of the more important are: Kirkland Creek, four 38-foot R. C. Girder spans; San Tan Canal, near the Sacaton Diversion Dam; the Twin Arch over Pine Creek on the Apache Trail, and Manilla and Tanner Wash bridges near Joseph City on the Northern Route.

State Force Construction

Excellent work has been done on several State Force jobs under Mr. Hasler and Mr. Taylor, foremen. Three bridges on the Apache Trail—Willow Creek steel truss bridge; Pine Creek twin arch, and a small timber bridge on concrete foundation, and also the three-span R. C. Girder bridge over the San Tan Canal near Sacaton—were built under the direction of Mr. Hasler at a very low unit cost, considering the location and the long haul on materials. A two-span R. C. Girder bridge north of Douglas on the Safford-Douglas highway, constructed under the direction of Mr. Taylor, also was built at a low unit cost for material in place.

Other State Force work consists of two pile trestle extensions, one at Wickenburg bridge and one at Winslow, and also a new pile trestle, 180 feet in length, to replace the bridge at St. David, washed out by floods of September, 1926. The work at Winslow also included about 400 lineal feet of steel rail and wire bank protection.

Special Repair Work

Concrete bridges are usually considered more permanent than steel, but when improperly constructed from the standpoint of expansion provisions, are apt to prove very short lived, due to the destructive action of the extreme temperatures. Such was the case with some

of our older concrete girder bridges, namely, New River near Marinette and Granite Creek near Whipple Barracks, Prescott.

In these bridges steel expansion plates were used which had become frozen together from corrosion. A roller nest consisting of four rollers—three rollers for Granite Creek—and a pin joint was designed and fabricated. These were placed as units under one end of each girder, the concrete of the pier or abutment being chipped out to make room for the new shoe. The spans were raised by means of false-work timbers and oak wedges and lowered back on the new shoes. These spans are now moving in a satisfactory manner, and safe from further destruction by temperature stresses.

In many cases the cracks which had developed in the girders and piers closed up after installation of the shoes. These shoes were placed at a cost of about $250 per shoe, whereas the same shoe placed during the construction of the bridge would have cost less than $70, but the expenditure at this time saved many thousands of dollars had the spans been left as they were built. Twelve of these shoes were placed at New River and nine at Granite Creek. The cost at New River being $500 per span on a span worth $4,000 to replace.

On the Tempe bridge considerable work was necessary to make it safe and prevent further disintegration. The bridge is designed for light traffic only and that feature combined with the stresses produced by the failure and settlement of one of the piers has been the cause of the partial failure of many members, especially the spans adjacent to the pier on which the settlement occurred.

The work of repairing this bridge was started in January, 1925, and consisted of placing new expansion plates in the roadway slab and rebuilding several columns and beams by means of gunite concrete.

Steel expansion plates were not provided in the original construction and angle irons place at these joints during the repairs in 1920 were a complete failure, leaving large holes in the floor and causing enormous stresses in the structure due to the impact of heavy loads. It was seen that in order to save the bridge from complete destruction by these forces that these joints would need immediate replacement. The old joint and part of the concrete slab was cut out and a joint

consisting of angles and a heavy plate was securely anchored in place and backfilled with concrete placed with a cement gun. This method of placing of concrete was used on account of its great strength and the bond which could be secured between the new and the old concrete. Plans were ready for this work in December, 1924, but owing to the necessity of closing the bridge for the major portion of the work, operations were delayed until after the holiday season and the work was done in January, 1925.

The bridge now has a smooth riding surface and is in a better condition structurally than after the repairs of 1920, but is still too light for present day traffic conditions. The ultimate solution is a new bridge to which heavy traffic can be diverted, thus leaving the old bridge for light cars and local traffic.

Standard Plans

As stated before, the present standard plans are virtually all out of date on account of recent changes in loading specifications and manufacturers' specification for reinforcing bars. It would have been useless to change these plans until these specifications were satisfactorily completed.

The revision of these standard plans will take many weeks of tedious work and the department is making plans for immediate revision of those standards most frequently used. Those which will come first in the list will be: box culverts, abutments and decks for slab and girder bridge.

As has been stated before, the value of standard plans has been considerably reduced by advanced type of location, but nevertheless their use greatly reduces the labor and time required for the preparation of highway plans and are also valuable and necessary to the locating engineer in selecting the proper type and size of structure for a particular location.

Along with the revision of old standards will be several new ones such as double boxes, four-girder spans from 22 feet to 44 feet, three-girder spans from 44 feet to 60 feet, and a group of standard U-abutments, many of which have been used on special structures in the past two or three years.

Conditions of Bridges

The Tempe bridge, mentioned above, is one of the important structures needing most serious consideration in the near future. The 18-foot roadway is altogether too narrow to accommodate the traffic, which averages more than 4,000 cars per day, and it is almost impossible for a light car to pass the heavy, slow moving trucks. The bridge, as has already been stated, is of too light type for the heavy traffic. A new bridge, with a roadway of 36 feet to accommodate four traffic lanes and designed for modern traffic conditions, is needed at or near the location of the old bridge.

Some preliminary work has already been done at this site in preparation for such a bridge. Surveys have been made and a complete set of borings taken on one location. These borings consisted of 22 holes, varying from 20 feet to 75 feet in depth. Samples were taken from materials passed through and also from bedrock where encountered. It was found by these tests that most of the foundations could be placed on solid rock at a depth of 18 feet to 25 feet and the rest on a good caliche at a depth varying from 30 feet to 40 feet below stream bed. It will be necessary to make a few more soundings to accurately determine the most economical location and type of structure.

Agua Fria Bridge

Another bridge of considerable importance and which is now in very poor condition is the Agua Fria bridge at Coldwater on the Buckeye Road. The original bridge, a concrete girder type on column piers, was founded on pile pedestals. Two sections of the bridge and part of the approaches were washed out during the floods of 1919 and 1920. These sections were replaced by timber pile trestle in 1921 and additional length added at the same time. The pile trestle part is less than six years old and is in such a state of decay that any appreciable flood in the channel will take out the major portion of the structure, thus tying up traffic on this important route for a considerable length of time.

Thousands of dollars have been expended in repairs to this makeshift, temporary structure. This work has had to be done piecemeal, as weakness shows up in any part of the trestle it is necessary to

send a special bridge crew out to replace the parts affected and this occurs every few weeks. Many of the piles are partially or entirely rotted off at the ground and to repair these to a satisfactory state would require in the neighborhood of $25,000 and then the life of the structure could not be extended more than four or five years. The roadway is narrow and a dangerous railway crossing exists at one end of the bridge on the new Southern Pacific main line. A new structure here will cost about $250,000, with additional amounts for approaches and relocation of the highway at both ends.

The Hassayampa River bridge on the same highway is in a similar condition as regards the pile trestle as the Agua Fria bridge. Two additional steel spans are required here to replace the pile trestle, making a total of four 90-foot steel spans. Plans are already complete for this work.

Wickenburg Bridge

The problems of the Hassayampa River crossing at Wickenburg have been intensified by recent washouts in the earth fill approaches to this three-span steel bridge. Extensive protection work will be necessary and possibly an additional 100-foot span, as will be determined by surveys.

In the Globe-Miami District are several small structures which need immediate reconstruction. One of these, a timber trestle on the Roosevelt-Globe; one a timber bridge on the Superior-Miami, and two on the Miami-Globe highway.

On the Northern Route between Holbrook and Winslow are four large structures in need of immediate consideration. For one of these, the Little Colorado, at Holbrook, plans have been completed for a modern steel highway bridge to replace an old dilapidated steel bridge now in use. Theother three consist of steel spans, narrow of road way, but still fairly good serviceable structures, joined at the ends by pile trestles which have been added from time to time as required to replace washouts in the approaches. The piles in these trestles are in a serious state of decay and some provision should be made for immediate replacement with permanent structures.

These structures mentioned are all major structures, the loss of

any of which, owing to the difficulty in fording the streams even in low water, would mean a complete tieup of that route for many weeks and a great monetary loss to the State as a whole. The past few years of tourist travel through the State has seen an ever-increasing business prosperity along the main arteries of travel and to allow such hazards as temporary and unsafe structures to stand merely from the lack of proper and adequate financial investment, is sufficient to drive these tourists from out State Highways and paralyze this new business.

TABLE 1—BRIDGE DEPARTMENT
Spans Over 20 Feet
A—Special Designs

	F.A. No.	Name of Bridge	Name of Highway	Description Type, Spans, Etc.	Overall Length
COMPLETED	19-B	Underpass	Prescott-Jerome		
	36-B	Underpass	Prescott-Jerome		
	40-Reo	Joseph City	Holbrook-Winslow	3-34′ R. C. Girder Spans	108′0 ″
	40-2nd Reo	Tanner Wash	Holbrook-Winslow	2-35½′ R. C. Virder Spans	76′-0 ″
	40-2nd Reo	Manilla Wash	Holbrook-Winslow	2.35½′ R. C. Girder Spans	76′-0 ″
	62-B	Drake Overhead	Prescott-Ash Fork	3-32′ R. C. Girder Spans	102′-0 ″
	67	San Simon	Geronimo-Solomonville	105′ Pony Truss	109′-0 ″
	68-B	Springerville	St. Johns-Springerville	2-30′ R. C. Girder Spans	64′-0 ″
	72-A	Kirkland Creek	Prescott-Phoenix	4-38′ R. C. Girder Spans	160′-0 ″
	72-B	Martinez Creek	Prescott-Phoenix	(2-32′ R. C. Girder Spans (2-36′	168′-0 ″
	74	Tuckers Flat	Winslow-Flagstaff	2-30′ R. C. Girder Spans	64′-0 ″
	74	Burro Canyon	Winslow-Flagstaff	1-30′ R. C. Girder Spans	32′-0 ″
	75	Continental No. 2	Tucson-Nogales	4-30′ R. C. Girder Spans	128′-0 ″
	77-Ext.		Solomonville-Duncan	1-30′ R. C. Girder Spans	32′-0 ″
	86-A		Tucson-Nogales	3-30′ R. C. Girder Spans	96′-0 ″
	72-B		Prescott-Phoenix	2-14′ R. C. Slab	32′-0 ″
	Non	Moffet Wash	Douglas-Safford	2-28′ R. C. Girder Spans	60′-0 ″
	Non	Little Gila Canal	Chandler-Casa Grande	Triple 8′x7′x26′ Box	28′-0 ″
	Non	San Tan	Chandler-Casa Grande	(2-29′ R. C. Girder Spans (1-37′ R. C. Girder Spans	104′-0 ″
	Non	Willow Creek	Apache Trail-Mormon Flat Sec.	1-160′ Steel Trus Spans	180′-6 ″
	Non	Pine Creek	Apache Trail-Horse Mesa Sec.	2-48′ R. C. Arch Spans	132′-0 ″
	Non	Brush Corral Creek	Apache Trail-Horse Mesa Sec.	3-19′ Timber Deck	58′-0 ″
	Non	Amado		7-19′ Timber Decks	134′-0 ″
	Non	Ashurst	Geronimo-Solomonville	2-11½′ Concrete Rail Top	25′-4¾″
	Non	Bruners Wash	Phoenix-Yuma	Triple 10′x5½′ Concrete Culvert	33′-4 ″

TABLE 1—BRIDGE DEPARTMENT

Spans Over 20 Feet

A—Special Designs

	F. A. No.	Name of Bridge	Name of Highway		
UNDER CONSTR.	36-A Reo	Government Draw	Prescott-Jerome	1-30′ R. C. Girder Sapn	32′-0 ″
	64-B	Gillespie Dam Bridge	Phoenix-Yuma	(4-160′ Steel Spans (5-200′ Steel Spans	1701′-6 ″
	88-B		Safford-State Line	4-20 R. C. Slab Spans	90′-0 ″
	88-B		Safford-State Line	2-34′ R. C. Girder Spans	72′-0 ″
	88-B		Safford-State Line	2-34′ R. C. Girder Spans	72′-0 ″
PLANS COMPLETE	55-Reo	Welton-Overhead	Yuma-Phoenix	3-42′ R. C. Girder Spans	132′-0 ″
	78-B	Holbrook Bridge	Holbrook-St. Johns	4-87½′ Steel Truss Spans	397′-0 ″
	78-B		Holbrook-St. Johns	1-24′ R. C. Girder Span	26′-0 ″
	78-B		Holbrook-St. Johns	2-30′ Steel Girder Spans	64′-0 ″
	80-B	Crookton Overhead	Ash Fork-Kingman	3-38′ R. C. Girder Spans	120′-0 ″
	82-C	Ligurta Overhead	Yuma-Gila Bend	(2-38′ R. C. Girder Spans (1-51′ R. C. Girder Spans	133′-6 ″
	89-B	Ash Fork Overhead	Ash Fork-Flagstaff	(4-36′ R. C. Girder Spans (2-32′ R. C. Girder Spans	268′-0
	89-B		Ash Fork-Flagstaff	Double 12′x6′ R. C. Culvert	27′-0 ″
	64-C	Arlington Extension	Phoenix-Yuma	2-90′ Steel Truss Spans	183′-6 ″
	91-A	Miami Wash	Miami-Globe	4-24′ R. C. Girder	108′-0 ″
	91-A	Miami Wash	Miami-Globe	3-24′ R. C. Girder	81′-0 ″

TABLE 1—BRIDGE DEPARTMENT

Spans Over 20 Feet

B—Bridges from Standard Plans

	F. A. No.	Name of Highway	Description Type Spans, Etc	Overall Length
COMPLETE	72-A	Prescott-Phoenix	2-20′ Slabs	45′-0″
	72-A	Prescott-Phoenix	3-20′ Slabs	67′-6″
	72-B	Prescott-Phoenix	2-14′ Slabs	33′-0″
	86-A	Tucson-Nogales	2-16′ Slabs	37′-0″
	86-A	Tucson-Nogales	2-16′ Slabs	37′-0″
	86-A	Tucson-Nogales	3-16′ Slabs	55′-6″
	86-A	Tucson-Nogales	2-16′ Slabs	37′-0″
	86-A	Tucson-Nogales	3-16′ Slabs	55′-6″
	86-A	Tucson-Nogales	2-16′ Slabs	37′-0″
	86-A	Tucson-Nogales	2-16′ Slabs	37′-0″
	Non F. A.	Vail-Sonoita	4-10′ Slabs	48′-0″
	Non F. A.	Vail-Sonoita	3-14′ Slabs	49′-6″
	Non F. A.	Vail-Sonoita	2-16′ Slabs	37′-0″
	Non F. A.	Chandler-Casa Grande	3-18′ Slabs	61′-6″
UNDER CONSTR.	82-B	Yuma-Gila Bend	2-20′ Slabs	45′-0″
	82-B	Yuma-Gila Bend	3-16′ Slabs	55′-6″
	82-B	Yuma-Gila Bend	2-12′ Slabs	28′-0″
	82-B	Yuma-Gila Bend	3-16′ Slabs	55′-6″
	88-B	Safford-State Line	3-20′ Slabs	67′-6″
	88-B	Safford-State Line	4-20′ Slabs	90′-0″
PLANS	78-B	Holbrook-St. Johns	2-16′ Slabs	37′-0″
	80-B	Ash Fork-Kingman	3-16′ Slabs	55′-6″
		Ash Fork-Kingman	4-16′ Slabs	74′-0″
	89-B	Ash Fork-Flagstaff	3-12′ Slabs	42′-0″

TABLE II.—BRIDGE DEPARTMENT

Bridges 20 Feet and Less

A—Built From Special Plans

Completed:

8—Concrete Slab Bridges
65—Concrete Boxes
57—Miscellaneous Structures

Under Construction:

3—Concrete Slab Bridges
3—Concrete Boxes
5—Miscelaneous Structures

B—Built From Standard Plans

Completed:

34—Concrete Slab Bridges
117—Concrete Box Culverts
91—Gravel Fords
6—48″ C. M. P. Culverst
2—42″ C. M. P. Culverts
100—36″ C. M. P. Culverts
88—30″ C. M. P. Culverts
260—24″ C. M. P. Culverts
15—18″ C. M. P. Culverts

Under Construction:

4—Concrete Slab Bridges
36—Concrete Box Culverts
18—Gravel Fords
67—36″ C. M. P. Culverts
17—30″ C. M. P. Culverts
85—24″ C. M. P. Culverts

DEPARTMENT OF PLANS

E. V. MILLER, *Engineer of Plans*

THE process of preparing plans for State and Federal Aid Highway projects within Arizona has not been changed in the last three years and reference to the last Biennial Report (1922-1924) will give the procedure from the survey period to the acceptance of the final plans; however, a brief outline of work required in preparing these plans is given.

The locating engineer is required to submit to this office a detail map of located line showing all alternate locations and drainage areas. A profile with grade line, classification of material, structure sizes and all other notations necessary in the estimating and designing of the highway, together with all field notes.

All field data is checked in the office, cross sections plotted, templets laid and roadway quantities figured. These quantities are balanced against the grade line, and grade changes made where ncessary. Tracings are made of line and profile with grade line, and structures shown in pencil. These preliminary plans are then checked in the field by the chief location engineer and on Federal Aid work by the Bureau of Public Roads, and returned with its recommendations, if any. The plans are then completed and submitted for final approval.

Evolution Apparent

The evolution of our standards is apparent and we are now using a much higher standard in road location and design then even two years ago. Our road design today carries the word "Safety" in many details which were overlooked or thought unnecessary in earlier road building. Radii of certical curves as well as horizontal curves have been lengthened; super-elevation increased, the use of

more and better guard fence and the proper display of signs all help toward "Safety."

The general rule used for length of vertical curves is: Length in stations equals ½ algebraic difference in grades. This gives ample sight distance, and although has no theoretical reference to varied speeds, is in actual practice proving adequate in practically all conditions.

Super-elevation of curves is arrived at by consulting a chart which gives varied super-elevation per foot width of roadway for each degree or redius of curve. This chart was worked up from the combination of several accepted theories and a simple conclusion arrived at by increasing the super-elevation per foot width of roadway, by .01 for each degree of curve up to 7 degree curve, and thence on a varied super until the maximum of .125 per foot width is reached at 28 degree curve.

Two types of guard fence are used. One being of the woven wire type and the other the cable. The general rule followed is to use guard fence on all fills over five feet high, on the outside of all curves when not in cut and at approaches to all bridges which are narrower than the total width of the highway.

Our profiles show that 1,752 tracings, including cross-sections, have been made by this department since July 1, 1924, comprising 318 miles of standard road work. The cost of preparing these plans, including estimate, was $54.25 per mile, or one-half of 1 per cent of the total cost of projects involved.

Approximately 250 miscellaneous maps and tracings and 10,000 blue prints also were made.

There are now in the office 15 projects to be completed involving 115 miles of standard construction. Plans on nine of these projects are more than 75 per cent complete.

Personnel

The personnel of this department for the last two years has averaged four computers and two draftsmen, besides a blue print boy, file clerk and engineer of plans.

We are now installing a new filing system, using the Kardex file for index. Every project will have its separate card, showing maps, profiles, notes, tracings and all data from field and office. By using a system of numbers and color tabs any of this data can be readily located even though it has been sent to the field, and by referring to a small attached card the date sent out and to whom, or the date returned can readily be found. This index system will adequately take care of all future growth of the department.

ESTIMATING DEPARTMENT

J. S. MILLS, *Estimating Engineer*

ONE reason for the preparation of an estimate is to ascertain the probable cost.

The Highway Department's aim is twofold; to determine such probable cost, and to prepare a brief but complete recapitulation of the distribution of all items and phases of the work.

The department's estimates are used for various purposes. The most important being, (a) for comparison with bids received; (b) for record; (c) for the setting up of Federal Aid funds by the Bureau of Public Roads.

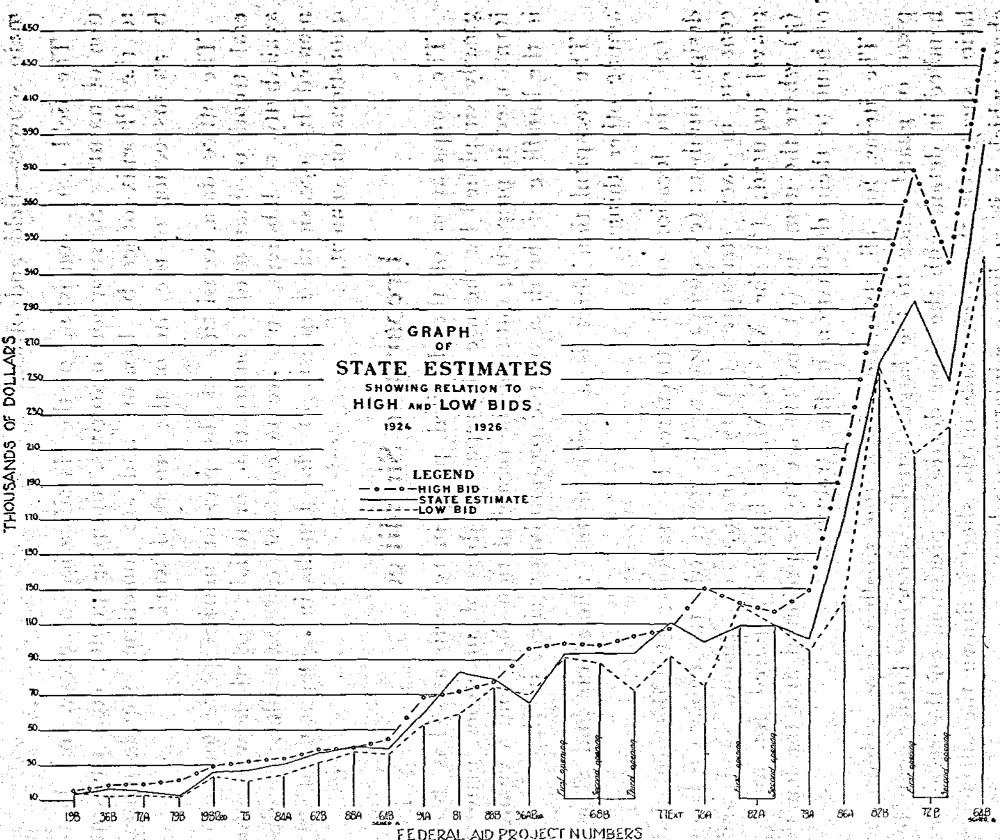
How Estimates Are Used

Estimates are used:

(a) For comparison. If it is known that a certain piece of work is worth a certain sum, allowing a fair percentage for contingencies and profit, the Highway Department (no more than the private individual) will not willingly pay one penny more for that work. A glance at the graph accompanying this report will show that the Highway Department has saved the State approximatedly $28,000, partly by the use of these estimates as a "measuring stick."

(b) For record. This is treated in detail farther on, but this can be said here, that a document, which shows completely the distribution of all items and phases of a piece of work, can be other than a valuable record.

(c) For setting up Federal Aid funds. The estimates are forwarded, in advance of the opening of bids, to the local office of the bureau of public roads and thence to San Francisco and Washington. In Washington an agreement is prepared, based on these estimates.


GRAPH
OF
STATE ESTIMATES
SHOWING RELATION TO
HIGH AND LOW BIDS
1924 1926
LEGEND
HIGH BID
STATE ESTIMATE
LOW BID
THOUSANDS OF DOLLARS
FEDERAL AID PROJECT NUMBERS
First opening
Second opening
Third opening

and returned to the State immediately. This saves considerable time and relieves the State from awkward financial situations.

The estimates of cost are prepared from data obtained from two main sources—field and office.

The field data, consisting of the classification of excavation, location of nature's construction materials, shipping points, etc., are sent to the Phoenix office by locators and are sometimes supplemented by an inspection of the site of the proposed work.

The office data, consisting of the present market price and general trend of man-made construction materials, together with the availability of laborers, etc., are taken from our own files, supplemented by occasional requests of the Purchasing Department for quotations on cement.

Preparation Simplified

The preparation of the detailed preliminary estimates has been greatly simplified by the use of prepared tables of quantities, printed forms used in preparing data for the recapitulation sheet and a change in the handling of the data on the recapitulation sheet itself.

The recapitulation sheet is a brief of the whole job and shows among other things:

(a) The location of all structures by stations; (b) the size and design number; (c) excavation to be done; (d) the cubic yards of concrete in each structure; (e) the amount of cement, sand and gravel required; (f) the M. B. M. of lumber required for forms; (g) where the items in (e) and (f) are to be procured and the length of haul to their destination in the structures.

The items for all structures, from the smallest pipe culvert or piece of guard fence to the largest steel or concrete bridge, can be handled in detail, with the same degree of precision, on the recapitulation sheet. On the reverse side of the sheet is drawn the surfacing chart, which is in reality a miniature roadway.

The chart shows: (a) The location of all tested and approved surfacing pits, with the probable amount of material available in each; (b) the portions of the road to be surfaced; (c) the location

of all bridges either in use now or to be constructed; (d) the centers of gravity of haul; (e) a cross-section of the roadway, showing width and depth of surfacing; (f) a tabulation of the required amount of surfacing, with the length of haul for each portion.

The recapitulation sheet is a complete record of the distribution of the various items and is constantly referred to in checking the construction reports.

Estimates Prepared

Since July, 1924, estimates have been prepared for 33 Federal Aid projects involving $3,800,000 for the construction of 185 miles of gravel surfaced highways; 36 miles of graded and drained roads; 17.7 miles of asphaltic concrete pavement; 16.3 miles of cement concrete pavement; two underpasses; four overpasses and seven large span special bridges.

There have also been prepared estimates on six non-Federal Aid projects involving $180,000 for the construction of 24 miles of gravel surfaced highways; 36 miles of graded and drained roads; three miles of cement concrete pavement; one mile of asphaltic pavement and 10 miles of flush coating.

Total amount of estimates prepared Federal Aid and non-Federal Aid, $3,980,000.

The percentage of accuracy based upon the lowest bids is 15 per cent. In other words, the State estimates on Federal Aid work have averaged 15 per cent higher than the lowest bid received.

Prices Paid

The average prices paid for the various items for the period from July, 1924, to December, 1926:

Excavation Roadway (Unclassified) Per Cu. Yd.	Excavation Borrow (Unclassified) Per Cu. Yd.	Gravel Surfacing Per Cu. Yd.	Surfacing Overhaul Per C. Y. Mi.	Cement Concrete Pavement Per. Sq. Yd. 6" Thick
$ .77	$ .38	$ .64	$ .40	$1.65* *Exclusive of cement.

Asphaltic Concrete Pavement Per Sq. Yd. 6" Thick	Asphaltic Concrete Pavement Per Sq. Yd. 3" Thick	"A" Concrete Exclusive of Cement Per Cu. Yd.	"B" Concrete Exclusive of Cement Per Cu. Yd.	"C" Concrete Exclusive of Cement Per Cu. Yd.
$2.20	$1.15	$19.50	$17.45	$17.09

Cement Rubble Masonry Exclusive of Cement Per Cu. Yd.	Rip Rap Per Cu. Yd.	Excavation for Structures (Unclassified) Per Cu. Yd.	Haul and Place 24" C.M.P. Per Lin. Ft.	Haul and Place 30" C.M.P. Per Lin. Ft.
$10.89	$2.51	$1.30	$ .93	$ .93

Haul and Place 36" C.M.P. Per Lin. Ft.	Haul, Bend and Place Rein. Steel Per Lb.	Ditching Per Cu. Yd.
$1.29	$ .036	$ .49

STRUCTURES OVER 20' CLEAR SPAN

Excavation Structures (Unclassified) Per Cu. Yd.	"A" Concrete Exclusive of Cement Per Cu. Yd.	"B" Concrete Exclusive of Cement Per Cu. Yd.
$1.38	$19.50	$14.27

Haul, Bend and Place Rein. Steel Per Lb.
$ .035

TESTING LABORATORY

BY J. W. POWERS, *Testing Engineer*

THE increasing demand for better and better materials and results in the construction of roadways and their appurtenances, has lead to the establishment of testing laboratories throughout the country to pick the "wheat from the chaff" in construction materials.

With the law passed by Congress granting Federal Aid for highway development, to the several States of the Union, it was made mandatory that each State maintain a laboratory or designate a commercial laboratory to do the work. Arizona, being in rather an isolated position with regard to the location of commercial testing laboratories, chose to set up its own. In addition to this reason, there are several others which should be mentioned, such as:

1. High freight and express rates.
2. Commercial laboratory fees.
3. Time element.
4. Lack of personal responsibility and supervision.

Of these probably the most important is the time element. The State does not allow the use of materials until after completion of tests—except in case of cement—and so it is necessary that some tests be rushed. This could not be done in commercial laboratories where each test would have to wait its turn. Such delay means expense and inconvenience in the case of both contractor and State.

Testing Equipment Purchased

Because of the above known conditions and for the several reasons the State purchased testing equipment for its own testing laboratory. With this equipment the laboratory is now in a position to give

complete physical tests on sand, gravel, crushed rock, asphalt, cement, steel, surfacing, gasoline, kerosene and lubricating oils.

To get a comparative rating on the laboratories throughout the United States which test for Federal Aid work, E. F. Kelley, chief of the division of tests, U. S. Bureau of Public Roads, has inaugurated cooperative tests. This laboratory has participated in tests, for such comparative rating, on asphalt, steel and crushed rock with excellent results.

The work of conducting these tests is vested in a testing engineer and three assistants. The actual work of performing the tests is done by the three assistants and interpreted and reported by the testing engineer. From the observation of results under actual conditions, and profiting by the results, the laboratory is continuously benefiting and helping in the selection of better and better materials. The result has been that specifications governing road building materials have been or are being raised. At the last meeting of the American Society for Testing Materials the requirements for cement were raised; hence better concrete is to be expected.

Cost of Tests

Based on a price for each test, agreed to by the Bureau of Public Roads, the cost of testing all construction material per project ranges from 0.2 per cent to 1.5 per cent of the total amount expended for the building of the project.

The smaller percentage represents the proportion of the total cost that may be expected on projects on which only surfacing and concrete structures are to be built. On such a project, after all preliminary tests have been made, an occasional sample, other than cement, need only be submitted to check predetermined grading and quality. The larger percentage may be expected to apply on asphaltic concrete projects. On such a project it is necessary to check the mix for asphaltic content and grading every day. On these two factors, plus the compaction of the finished pavement, depends its life and stability. It is also necessary to take a sample from the compacted pavement to check asphaltic content, grading and specific gravity—an index to compaction and stability.

Aids All Departments

Not only does the laboratory make all routine tests, but it strives to be of service to all departments. To the district engineers who have charge of maintenance, the laboratory serves in giving analysis on surfacing materials. From such analysis they then may know similar materials found in other places under almost identical conditions should then give the results that were observed on that material which has been actually tried out.

While not specifically making any research tests (as such) all the data collected on routine testing, serves that purpose. Being a member of the American Concrete Institute and the American Society for Testing Materials, such investigations as they make are taken cognizance of.

In addition to routine tests on material used in state construction, the laboratory has some revenue from tests made on material for outside organizations.

Amount of Work

The amount of work that is conducted by the laboratory might well be shown by some figures.

In the period from July, 1924, to December, 1926, there have been submitted to the laboratory approximately 4,650 samples, as follows:

2177 Cement concrete test specimens.

528 Sand samples.

438 Rock samples.

402 Surfacing samples.

351 Cement samples.

218 Steel reinforcing bars.

137 Asphalt mixture samples.

129 Sand, silt and gravel samples (for screen analysis only)

92 Corrugated metal pipe samples.

90 Asphalt samples.

54 Asphalt pavement samples.

34 Miscellaneous (oils, expansion joints, gasoline and kerosene).

STATISTICAL DEPARTMENT

H. C. HATCHER, *Statistician*

DURING the last two years there has not been many changes made in this department, and the work now being done is practically the same as that outlined in the sixth biennial report of the State Engineer. But due to the many requests for information of such varied character which have been received daily, we have gone into details in compiling our charts and records in order to be able to furnish this desired information.

In the past year we have worked out a card system in a Kardex file that shows in detail the construction projects, and particularly those that have or are to receive Federal Aid. This system shows every phase of a project, from the date of submission of the Project Statement to the date of completion and acceptance of construction, as to name, number, route, length, type, Federal Aid assigned, Federal Aid received, contractor, bondsman, sub-contractor, percentage work completed, amount paid contractor, date started, date completed and other useful information. Beginning with Federal Aid Project No. 1, we have brought this file up to date, including Project No. 91. Although this system was installed to give us this information in a quick and compact form, the progress charts and detail records of each project are also being compiled from the weekly construction reports submitted by the Resident Engineer, and gives us information that we do not have in the Kardex file.

Federal Aid

As since its origin this department's most important work is that concerning the Federal Aid. A record of appropriation by fiscal years is made showing each project and amount allotted to these funds, thereby showing at all times the balance of Federal Aid that has not been allotted. The Highway Department in its opera-

tions depends to a certain extent on the money we receive as Federal Aid, so it is very important that the routine by which this money is to be received be done expediently and correctly. Vouchers in five copies, showing all quantities and prices in detail of construction with the pro rata share of the Government, are submitted monthly to the local office of the Bureau of Public Roads. That office checks and approves these vouchers and forwards them to Washington for payment. It usually takes from 20 to 30 days from time vouchers are submitted to receive payment. On other pages we have compiled the status of the Federal Aid projects and funds.

Besides the aforementioned, other duties of this department will be briefly outlined. Since beginning the publication of the "Arizona Highways" in April, 1925, this department has written monthly for the publications the condition of all roads on the Arizona Highway System by Routes. Also the progress and conditions of the roads under construction in each of the five districts.

A monthly personnel report is made of the Highway Department and Contractors' Forces working on highway contracts.

A Gas Tax and Motor Vehicle Fees Chart is compiled each month showing the total amounts and the percentage available to each county, also the amounts available for construction and maintenance from these taxes.

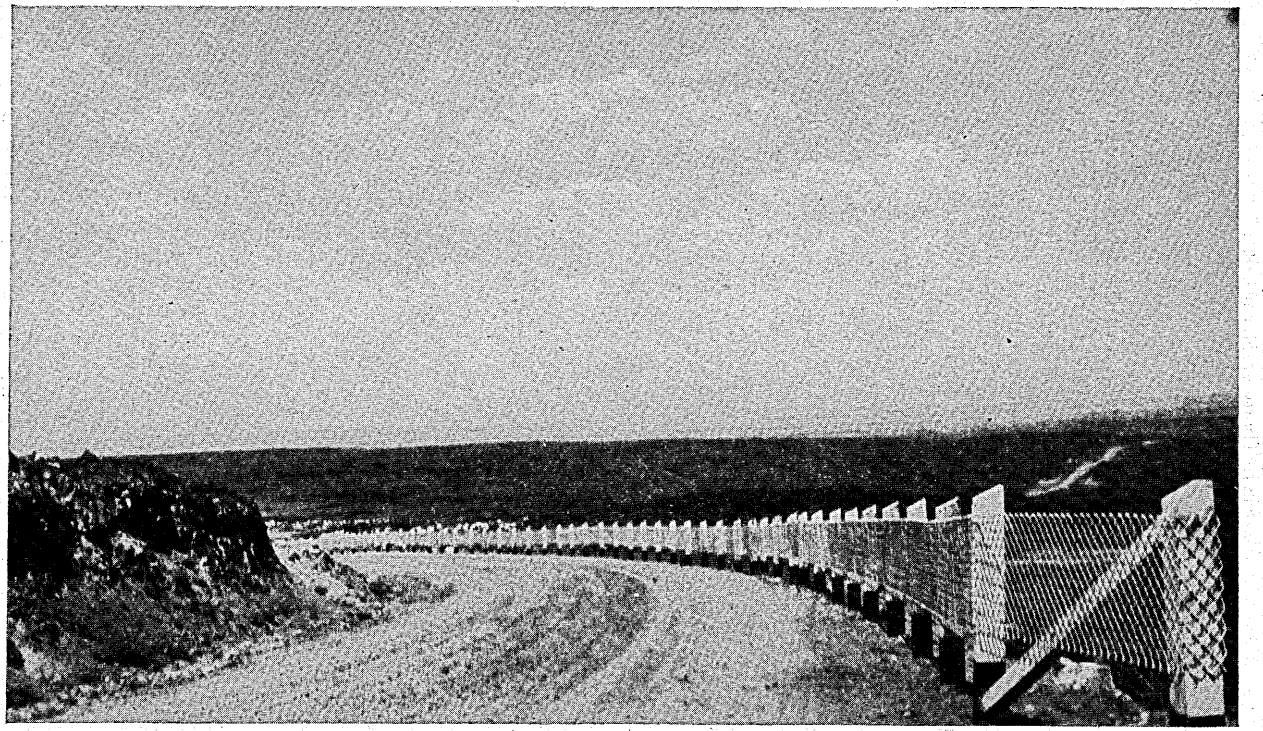
A Traffic Census is taken monthly by the maintenance foreman over the entire system, and from this census, charts and records are compiled which show by projects and routes, number of cars, number of trucks, native or foreign, and the percentage of increase or decrease over these projects or routes. (Traffic chart is shown on another page.)

Since the introduction of the "A. F. E." (authority for expediture) by the Chief Engineer, this department, working under and in conjunction with the Chief Engineer, compiles the budget and makes and submits the request for "A. F. E."

A complete and authentic record is kept of all roads of the State Highway System. This chart shows the status in miles of the seven per cent system and State system by counties, projects, types and

when constructed. A status of the State and seven per cent system will be found elsewhere in this report.

As requests for unusual information are received by the office we have tried to change or add to our records to take care of those certain phases, but nevertheless we receive many requests for information which require considerable time. But 90 per cent of the information requested by States, automobile clubs, magazines and individuals, regarding the Arizona Highway System, is now available with little trouble.



Guard Fence On Federal Aid Project No. GR*A*

RIGHT-OF-WAY DEPARTMENT

BY IRA W. WAGNON, *Right-of-Way Agent*

THE right-of-way department has jurisdiction over all affairs pertaining to the right-of-way of the State highways, and works in conjunction with the engineering department. It is also the duty of this department to acquire for the State, rights or titles to land to be used as a source of sand, gravel, and other surfacing materials, as well as sites for camps of the highway caretakers.

Rights-of-way for highways to be constructed by or under authority of the Arizona Highway Department are secured either by appropriation of public domain, declaration of the Boards of Supervisors, condemnation, dedication, grants of easement, and other instruments of conveyance.

The statutes make no specific provisions for the acquisition of rights-of-way for the State acting through the Arizona Highway Department or the State Engineer. As a consequence, in procuring rights-of-way, the State is obliged to purchase it direct from the owners, accept donations of land, or have it transfered from the various counties, whenever the State takes over a county road.

The establishing of public highways in this State is a function peculiar to the counties acting through their Boards of Supervisors, under the provisions of paragraph 5057 of the Revised Statutes of 1913, which invests the Boards of Supervisors with power and jurisdiction to sit as a special tribunal to condemn and appropriate private and public property for highway purposes. Until a highway has been duly established in the manner prescribed by this statute, it does not have the status of a legal highway.

Serious Problems Arise

The legal right, the requisite funds, the necessary equipment for

the construction of a road are of but little use and avail to the State until it has the necessary land, or right-of-way, upon which to build the highway. Owing to the inadequate provisions of the law and the failure to prescribe the manner in which the State is to obtain its rights-of-way, this department is confronted with the serious problem of securing the required land the best way it can, and often meets with many perplexing problems which are obstacles to timely and efficient road construction.

In spite of these very serious handicaps, this department, with the cooperation of the various county officials, has secured the rights-of-way for all highways constructed by the State during the last two years, as well as settling many claims and controversies regarding rights-of-way for roads previously constructed. The securing of rights-of-way for the construction of new highways is only a very small part of the duties of the right-of-way agent. Protecting the highways against encroachments by service stations and other small business adventurers is becoming a task of enormous size. However, no signs, advertising matter, obstructions, or any business of a commercial nature is permitted on the right-of-way of the State Highway System.

In all business transactions this department is governed by the principles of equity and justice. It does not ask for more acreage than is actually required for the construction of the proposed road, and where property is taken or damaged, the owner, in all cases, is adequately compensated.

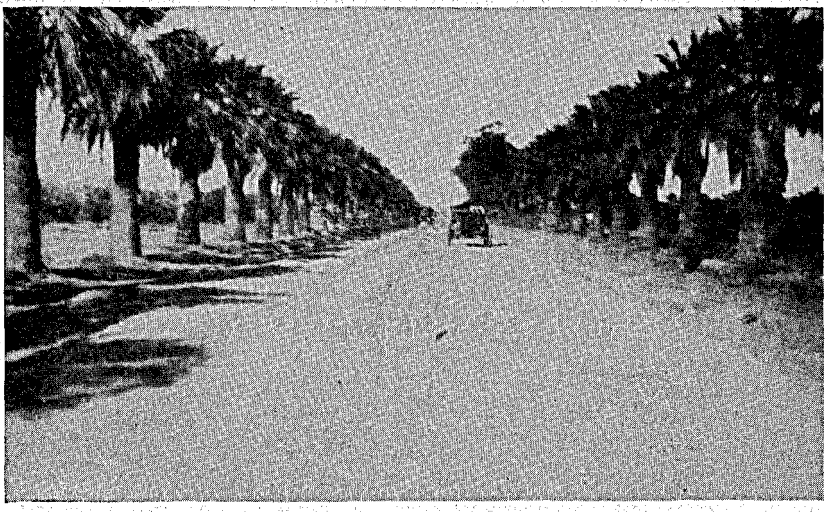
Right-of-Way Maps

In order to serve the public best and to keep an accurate record this department has made up detailed right-of-way maps of the more important highways, and intends to extend this work to cover the entire State Highway System. These maps are used in conjunction with and supplemental to the document files, where all legal papers and documnts which pertain to right-of-way matters are filed.

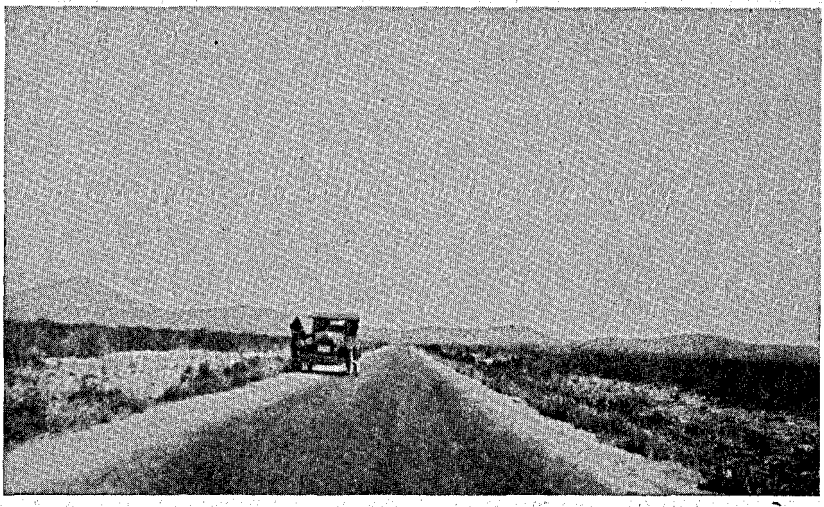
During the period of time covered by this report, the right-of-way department has entered into and executed eleven agreements with railroad companies relative to grade crossings and right-of-way encroachments.

The table given below will show the amount of right-of-way which the State controls in each county, together with the number of acres obtained during the last two years and the instruments of conveyance secured.

County	Acres of Right-of-Way	New Right-of-Way Acres Acquired	Gravel Pits and Camp Sites. Acres	Number of Documents Taken
Apache	1,757.16	1,370.25	80	12
Cohise	3,075.69	1,419.33	400	10
Coconino	974.50	153.40	380	14
Gila	1,709.12	.....	40	2
Graham	1,049.44	.....	80	4
Greenlee	428.34	111.50	40	9
Maricopa	2,944.62	182.80	330	44
Mohave	1,734.65	.....	80	2
Navajo	1,229.84	355.70	90	11
Pima	1,797.81	460.80	105	34
Pinal	1,941.54	1,176.60	40	17
Santa Cruz	665.20	.....	5	1
Yavajai	2,309.40	337.22	120	18
Yuma	1,002.60	234.49	580	12
TOTAL	22,619.91	5,802.29	2,370	189



Phoenix-Yuma Highway



Tombstone-Bisbee Highway

CONSTRUCTION

THE construction for the past biennial has been gradually dropping in volume, due to the gradual decline in finances for State Highways. In previous years, the counties through their bond funds contributed very heavily to State Highway construction and practically all of the Federal Aid that was matched came from that source. While the State Highway revenues have been gradually increasing, they have not increased as rapidly as the bond funds of the counties have been exhausted. During the past two years there has been very little money available from the counties, and therefore the State construction and maintenance has been carried on almost entirely from State revenues plus what Federal Aid those funds could earn.

The cost of construction of main State Highways is gradually increasing per mile due to increased standards which involve increased width, lighter curvature, both horizontal and vertical, and many safety features.

Traffic is not only increasing in volume but in weight and speed, making this requirement in highway construction a vital necessity. The State, however, in the past two years has made progress in its construction, as shown by the tabulations included herewith, and from which will also be noted that the construction has been generally distributed throughout the State.

It has been the aim of the Department to construct the most necessary sections of the highways as money was available so as to get a connected system of highways as early as practicable. The Department receievs many requests for additional highways both from the Boards of Supervisors of the various counties and from the general public.

Many of these additional routes are very desirable and would be great assets to the State were they included in the State System and constructed to State standards. Some of them are interstate in chara-

cter and many are intercounty, and which would open and develop great resources of the State, which naturally would result in greater valuations in the State, and more population through greater accessibility. Such construction from the standpoint of the highways would also materially increase the earnings of the highways.

While these are desirable, they are certainly not advisable to be included in the Highway System unless at the time they are authorized to be included in the State System sufficient finances are also provided for their construction. If this is not done, the additional mileage so added would only detract from the available funds from main State Highway System as it is now laid out.

A review of the construction as given herein shows the comprehensive construction program over the past two years.

CONSTRUCTION BY CONTRACTS AND STATE FORCES

July 1st, 1924 to December 11h, 1926

Project	F.A. No.	Length Miles	Character of Work	Contractor	Date Started	Date Completed	Constructed Since 7-1-24 %	Constructed Since 7-1-24 Miles
APACHE COUNTY								
Concho-St. Johns	78A	9.65	G.-D. Surf.	Udall & Udall	3-5-25	10-31-25	100	9.65
St Johns-Springerville	68B	8.83	G.-D. Surf.	Udall-Tanner-Turley-Hamblin	10-1-25	7-27-26	100	8.83
COCHISE COUNTY								
Benson-Douglas	79A	6.19	G.-D. Asp. Pav.	Phoenix Tempe Stone Co.	7-13-26	1-16-26	100	6.19
Benson-Douglas	79B	2.12	G.-D. Surf.	Rogers Bros.	5-11-25	9-11-25	100	2.12
Bisbee-Tombstone	Non	10.00	Flush Coat	Phoenix-Tempe Stone Company	7-30 25	1-12-26	100	10.00
Douglas-Rodeo	Non	2.60	Re. Surf.	State Forces	8-15-26	11-30-26	100	2.60
Douglas-Safford	Non	50.00	G. & D.	State Forces	10-15-22	8-14-26	40	20.00
COCONINO COUNTY								
Winslow-Flagstaff	74	20.35	G. & D.	State Forces	8-20 24	6-20-25	100	20.35
Winslow-Flagstaff	74	.....	Surfacing	Tanner-Turley	7-25-25	8-19-25	100	3.22
Winslow-Flagstaff	81	12.20	G. & D.	Whiting Bros.-Tanner-Turley	8-10-26	.....	80	9.76
GILA COUNTY								
Globe Streets	Non	.97	Concrete Paving	Phoenix-Tempe Stone Co.	2-9-26	6-12-26	100	.97
Globe-Roosevelt	Non	24.30	Betterment	State Forces	7-1-24	8-30-26	100	24.30
GRAHAM COUNTY								
Geronimo-Solomonville	63	7.46	G.D. Asp. Pav.	El Paso Bitulithic Company	6-13-23	8-31-24	15	1.12
Geronimo-Solomonville	67	7.06	G.-D. Conc. Pav.	El Paso Bitulithic Company	2-7-24	4-4-25	92	6.50
Solomonville-Duncan	77	14.63	G.-D. Surf.	State Forces	5-13-24	9-4-25	88	12.87
Solomonville Duncan	88A	7.87	G.-D. Surf.	Geo. W. Orr	1-14-26	6-2-26	100	7.87
GREENLEE COUNTY								
Solomonville-Duncan	88B	11.68	Grad. Surf.	State Forces	6-25-26	.....	40	4.67
Solomonville-Duncan	88B	.....	Structures	Borderland Construction Company	8-17-26	.....	50	.....
Mule Creek	Non	17.5	Betterment	State Forces	11-15-25	2-15-26	100	17.5
MARICOPA COUNTY								
Hassayampa-Gillespie Dam	64B-A	1.32	G.-D. Surf.	Schmidt & Hitchcock	10-6-26	.....	35	.46
Hassayampa-Gillespie Dam	64B-B	.32	Bridge	Lee Moor Cont. Company	2-15-26	.....	32	.....
Phoenix-Yuma	69	21.82	G.-D. Surf.	State Forces	12-1-23	7-29-24	5	1.09
Phoenix-Buckeye	71	9.21	G.-D. Conc. Pav.	Pacific Construction Co.	5-17-24	3-26-25	95	8.75
Phoenix-Wickenburg	76	7.01	Surfacing	A. A. Ray	10-9-24	2-12-25	100	7.01
Phoenix-Wickenburg	84	14.60	G.-D. Surf.	State Forces	4-1-24	11-8-24	50	7.30
Phoenix-Wickenburg	84	.....	Structure	R. H. Martin	4-19-26	6-26-26	100	.....
Chandler-Casa Grande	Non	5.30	G.-D. Surf	State Forces	3-1-25	11-7-25	100	5.30
Apache Trail	Non	8.81	G.-D. Surf.	State Forces	2-20-25	.....	87	7.66
Mormon Flat Bridges	Non	.....	Bridges	State Forces	11-15-24	2-28-25	100	.....
Gillespie Dam Bridge	Non	.....	Test Drilling	Cannon & Cannon	3-6-25	4-4-25	100	1000 Ft.
Tempe Bridge		.....	Test Drilling	Cannon & Cannon	9-19-26	10-30-26	100	861 Ft.
MOHAVE COUNTY—No Construction								

CONSTRUCTION BY CONTRACTS AND STATE FORCES

July 1st, 1924 to December 11h, 1926

Project	F.A. No.	Length Miles	Character of Work	Contractor	Date Started	Date Completed	Constructed Since 7-1-24 %	Constructed Since 7-1-24 Miles
NAVAJO COUNTY								
Winslow-Coconino Co. Line	22	2.72	G. & D.	Tanner & Turley	7-28-24	9-18-24	100	2.72
Winslow-Coconino Co. Line	22	.....	Surfacing	Rogers & Larson	10-24-24	1-13-25	.....	.....
Holbrook-Winsolw	40 1st Reo	.45	G. Surf.	Tanner & Turley	9-20-24	4-28-25	100	.45
Holbrook-Winsolw	40 1st Reo	.....	Bridge	L. C. Lashmet	10-4-24	4-18-25	100	.....
Holbrook-Winslow	40 2ndReo	.47	Bridges and App.	G. W. McMillan	5-12 26	11-6-26	100	.47
PIMA COUNTY								
Tucson-Nogales	75	.61	Bridges and Apprs.	Shumway and L. C. Lashmet	11-27-23	2-28-25	58	.35
Tucson-Nogales	86A	13.66	G.-D. Surf.	Downer & Fredell	5-26-25	3-2-26	100	13.66
Vail-Sonoita	Non	23.60	G. D. Surf.	State Forces	10-15-25	2-4-26	100	23.60
PINAL COUNTY								
Chandler-Casa Grande	Non	27.00	G. D. Surf.	State Forces	5-5-24	.....	77	21.00
SANTA CRUZ COUNTY								
Nogales-Patagonia	Non	21.00	Betterment	State Forces	8-1-24	12-15-24	100	21.00
Amado Bridge	Non	.....	Bridge	Lown & Wood	10-12-24	1-8-26	100	.....
Vail-Sonoita	Non	4.10	Betterment	State Forces	2-5-26	5-30-26	100	4.10
YAVAPAI COUNTY								
Prescott-Jerome	19B	.27	Underpass	Lee Moor Cont. Co.	7-31-25	11-21-25	100	.27
Prescott-Jerome	19B Reo	1.90	Reconstruction	Henry Galbraith	9-8-26	.....	94	1.79
Prescott-Jerome	36A Reo	4.49	Reconstruction	Henry Galbraith	9-11-26	.....	30	1.35
Prescott-Jerome	36B	.03	Underpass	Coleman & Day	11-4-24	3-3-25	100	.03
Prescott-Ash Fork	62B	.30	Overpass	Henry Galbraith	2-1-26	10-31-26	100	.30
Prescott-Phoenix	72A	18.84	G.-D. Surf.	Phoenix-Tempe Stone Co.	5-20-24	6-17-25	82	15.45
Prescott-Phoenix	72B	9.04	G.-D. Surf.	Schmidt & Hitchcock	5-1-25	4-10-26	100	9.04
Prescott-Jerome	Non	14.00	Re-Surf.	State Forces	6-1-25	12-20-25	100	14.00
Prescott-Phoenix	72A	.....	Bridge	T. M. Caldwell	3-22-26	6-26-26	100	.....
YUMA COUNTY								
Yuma-Phoenix	55-2	6.89	G.-D. Surf.	State Forces	4-15-24	7-29-24	15	1.03
Yuma-Phoenix	82A	4.00	G.-D. Asp. Pav.	White & Miller	10-4-26	12-10-26	100	4.00
Yuma-Phoenix	82B	14.09	G.-D. Surf.	Ken Hodgman	4-16-26	.....	46	6.48
Yuma Streets	Non	.97	G.-D. Asp. Pav.	White & Miller	1-8-25	2-6-25	100	.97

SUMMARY OF CONSTRUCTION

County	Asphalt Paving Miles	Concrete Paving Miles	Gravel Surface Miles	Graded & Drained Miles	Surfacing Only Miles	Flush Coat Miles	Better-ment Miles	Test Drilling Feet	Underpass & Overpass No.	Bridges Feet
Apache	.....	.....	18.48	.....	.....	.....	.....	.....	.....	64
Cochise	6.19	.....	2.12	20.00	2.60	10.00	.....	.....	.....	60
Coconino	.....	.....	.....	30.11	3.22	.....	.....	.....	.....	96
Gila	.....	.97	.....	.....	.....	.....	24.30	.....	.....	
Graham	1.12	6.50	20.74	.....	.....	.....	.....	.....	.....	166
Greenlee	.....	.....	4.67	.....	.....	.....	17.50	.....	.....	196
Maricopa	.....	8.75	21.87	.....	7.01	.....	.....	1,861 ft.	.....	948
Mohave	.....	.....	.....	.....	.....	.....	*21.00	.....	.....	.....
Navajo	.....	.....	3.64	.....	.....	.....	.....	.....	.....	260
Pima	.....	.....	37.61	.....	.....	.....	.....	.....	.....	655
Pinal	.....	.....	21.00	.....	.....	.....	.....	.....	.....	194
Santa Cruz	.....	.....	.....	.....	.....	.....	25.10	.....	.....	134
Yavapai	.....	.....	25.09	.....	14.00	.....	3.14	.....	3	537
Yuma	4.97	.....	7.51	.....	.....	.....	.....	.....	.....	85
Totals	12.28	16.22	162.73	50.11	26.83	10.00	91.04	1,861	3	3,395

*Betterment and Reconstruction done by the Maintenance forces which were increased for this purpose.

DISTRICT NO. 1

W. R. HUTCHINS, *District Engineer*

DISTRICT No. 1 was divided in October, 1925, creating District No. 5 and leaving District No. 1 sufficiently small for economical supervision by one District Engineer.

District No. 1 starts at the north city limits of Prescott and extends north to Ash Fork, with a branch starting six miles north of Prescott and extending to the town of Jerome. That portion running from Prescott to Ash Fork is on U. S. Route No. 89 and is also on the Federal Aid or Seven Per Cent System. That portion running into Jerome, although built largely with Federal Aid under the old provisions extending Federal Aid to the States, has been taken from the Federal Aid System and is now known as State Route No. 79.

The balance of District No. 1 is all on the Federal Aid or Seven Per Cent System, extending from Topock on the Colorado River through Kingman, Seligman, Ash Fork, Williams to the western city limits of Flagstaff. This entire length has for years been known as the National Old Trails Highway, but under the recent national rulings regarding the Federal numbering of highways is now known as United States Route No. 66.

District Office

All work in the district is in charge of the District Engineer for that district, and the district is divided into five subdivisions:

(1) The District Transitman, who acts during the absence of the District Engineer and who is in charge of all office work.

(2) The Shop Foreman, who is in charge of the shops and yards for the district, employing the necessary mechanics, blacksmiths and laborers, as well as night watchman, who sleeps upon the premises.

(3) The Resident Engineers, who have active charge of any con-

struction, whether it be contract or State force work, employing the necessary transitman, rodmen, chainmen and inspectors.

(4) The Construction Foremen, all in active charge of all construction work being done by State forces or day labor, employing the necessary sub-foremen, cashiers, timekeepers, mechanics, teamsters, laborers, etc.

(5) The Caretakers, who are in active charge of each maintenance section, employing the necessary truck drivers, laborers, etc.

The organization as outlined shows the organization of the district and is used for the most economical supervision and construction.

All documents and correspondence must pass through the District Transitman, for it is he who is responsible for the material and supplies that are sent out to the various camps in the district.

Shops and Yards

The shops and yards are located at Ash Fork upon property leased from the Santa Fe railway. These yards were built during 1922 and have been added to and patched, with the usual result that no general scheme has been followed so as to procure the best results for shop and yard operation.

The shop consists of a series of sheds open in front with practically no machinery to work with. It is in a bad state of repair, the entire roof surfacing leaking badly in case of wet weather.

The men working in these shops in the condition as described are necessarily exposed to all the weather conditions, which at times are very severe. Frequently the temperature goes below zero, and under these conditions cannot and should not be expected to work, for they are practically working out in the open.

Although the cost would be somewhat higher to construct a warehouse and yards in this district, owing to lack of local material, than they were in District No. 5, the approximate cost of the layout in District No. 5, located at Holbrook, is given below, and these figures will be an approximate estimate of the money necessary to construct the same in District No. 1.

The acre of ground procured in Holbrook cost the State Highway Department $2,500. The fencing around the entire property—the cyclone type of burglar-proof fence, eight feet high—cost approximately $1,700 in place. The building proper cost approximately $8,000, with an estimated expenditure of $5,000 for a complete line of shop equipment, which will allow these shops as units to perform any type of work that is necessary to keep all equipment in first-class order.

The shop and yards are run as a branch of the main shop and yards at Phoenix.

A new warehouse and yards in District No. 1 may seem to be extravagant or unnecessary, but it would be cheaper and more satisfactory than trying to patch the old sheds that go to make up the present shop.

U. S. Route 89

Prescott-Ash Fork Highway **Yavapai County**

Length 4.52 Miles **F. A. 36-A Reopened**

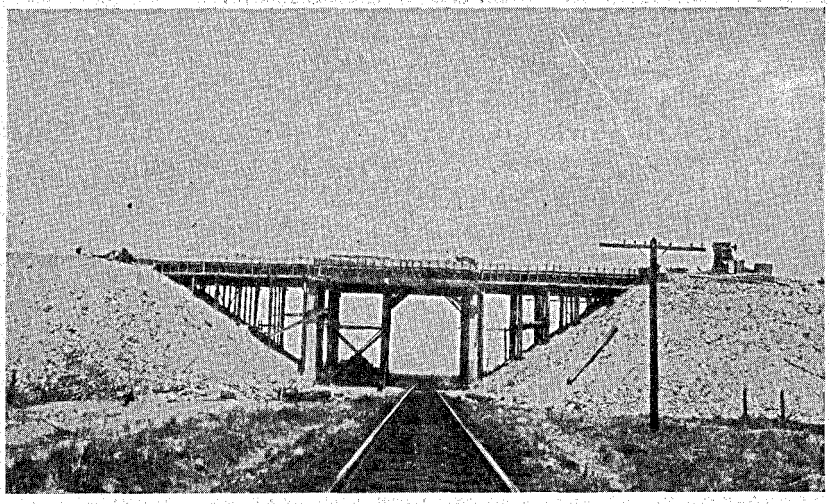
R. E. ALLISON, *Resident Engineer*

The grading on Federal Aid Project No. 36-A was completed under the old Federal Aid and State Standards in January, 1923, but owing to the greatly increased traffic and to the fact that both the Federal Aid and State Standards have been greatly improved as regards every feature of construction, this project was reopened and a contract was awarded to Henry Galbraith of Jerome during 1926 for the reconstruction of this entire section up to the full Federal Aid and State Standards for a gravel surfaced road There was no call for surfacing, as it is anticipated that this entire section will be paved just as soon as complete settlement takes place. But those places that will not make a good riding surface will be surfaced with enough selected material to bring this road up to first-class condition until such time as a pavement is laid.

A one-span girder type bridge 32 feet long is being constructed under this contract over Government Draw, made necessary by the

elimination of a series of very dangerous curves near the south end of the project.

The location of Federal Aid Project No. 36-A Reopened was made to fit a three-span girder type bridge 144 feet long and 20 feet wide over Granite Creek. This bridge was constructed prior to 1923 and



Drake Overhead—Prescott-Ash Fork Highway

the proper provisions were not made for expansion. The department recently, with State forces, has placed nine rollers in nests of three under this bridge, so as to take care completely of the expansion and contraction.

The contract calls for the completion of this project April, 1927.

U. S. Route 89

Prescott-Ash Fork Highway **Yavapai County**

Length 150 Feet **Federal Aid 36-B**

D. L. BUNDY, *Resident Engineer*

Federal Aid Project No. 36-B is a 34-foot class "BB" 65 degree

skew underpass, eliminating a grade crossing with the Santa Fe railway, with a clearance of 14 feet. Work was started upon this structure by the contractors, Coleman & Day, November 4, 1924, and was completed on May 12, 1925.

The Santa Fe participated to the extent of driving all falsework and the construction of the deck of the structure.

U. S. Route 89

Prescott-Ash Fork Highway — Yavapai County

Length 1.8 Miles — Federal Aid 19-B Reopened

R. E. ALLISON, *Resident Engineer*

Federal Aid Project No. 19-B begins at the north end of Federal Aid 36-A and extends 1.8 miles to the Jerome Junction on United States Route No. 89 and 2.18 miles toward Jerome on State Route No. 79.

The portion of 1.8 miles of Federal Aid Project No. 19-B was constructed, as was Federal Aid Project No. 36-A, under the old standards, prior to 1923, and owing to the greatly increased traffic and higher standards, this section was reopened and was contracted to Henry Galbraith of Jerome during 1926 for reconstruction to full Federal Aid and State Standards. It will be completed early in 1927.

There are two rather unusual or new features upon this project. The first is a cattle guard, serving not only the purpose of a cattle guard but also as a box culvert. The supporting walls for the cattle guard were carried down with the necessary wings placed on each end properly to support the fill, which allows the flood waters to run under the cattle guard proper, thus saving the installation of an extra box culvert.

The greater part of Federal Aid Project No. 19-B is through what is known as Granite Dells and the granite bluff walls rise abruptly from the edges of the roadbed on either side, allowing only enough space for the 28-foot roadbed.

To care properly for the surface drainage on this section by drain

ditches outside the roadbed proper would have entailed moving an enormous amount of solid rock, and as this road is to be paved just as soon as proper settlement has taken place, it was decided to put in a curb and gutter section on either side of this roadbed through the Granite Dells section. This will allow the surface waters through this section to be carried away by the concrete gutters. This type of construction is virtually the same as used on city streets.

U. S. Route 89

Prescott-Ash Fork Highway **Yavapai County**

Length 0.26 Miles

Federal Aid 62-B—A. F. E. 21-590

GEO. L. BURNS, *Resident Engineer*

A contract was let January 5, 1926, to Henry Galbraith of Jerome for the construction of the overpass over the Santa Fe railroad near Drake under Federal Aid Project No. 62-B and was completed October 31, 1926.

The road and railroad being on the same level, this project necessitated the building of two approach fills 23 feet high at their highest part, rising from the road proper on a six per cent grade, with the entire distance protected on both sides by a two-strand three-fourths inch cable guard fence, strung on 6-inch by 6-inch posts spaced 10-foot centers. The railroad crossing proper is a three-span reinforced concrete structure with a total clearance of 22.7 feet above the rails.

State Route 79

Prescott-Jerome Highway **Yavapai County**

Length 0.27 Miles **Federal Aid 19-B**

D. L. BUNDY, *Resident Engineer*

Federal Aid Project No. 19-B consists of 0.27 miles of grading and surfacing to Federal Aid standards, one 6-foot by 3-foot standard

reinforced concrete box culvert, two standard cattle guards and one 24-foot span underpass structure with 14-foot clearance, reflecting a separation of grades between the highway and the Santa Fe railroad.

The roadway and structures are all of approved standard type and drainage is well under control. Contract was awarded to Lee Moor Contracting Company of El Paso, Texas. Work began July 31, 1925, and the project was completed on November 21, 1925.

The Santa Fe railroad participated in this construction to the extent of driving all falsework and the construction of the deck.

State Route 79

Prescott-Jerome Highway — **Yavapai County**

Length 17.0 Miles — **State Forces**

D. H. KLEINMAN, *Foreman*

Work was started May 1, 1925, on resurfacing the Precott-Jerome Highway by State forces directed by D. H. Kleinman, foreman. Starting at a point near the southwest end of Federal Aid Project No. 19-A and extending across Lonesome Valley, and parts of the road over Mingus Mountain.

This road was first scarified, reshaped and widened from 16 feet to 24 feet and resurfaced. In addition to the resurfacing many storm ditches were put in to take care of the drainage.

The work on this project was completed on November 30, 1925.

DISTRICT NO. 2

GEORGE B. SHAFFER, *District Engineer*

U. S. Route 80

Phoenix-Yuma Highway — **Yuma County**

Length 0.97 Miles — **Yuma Streets Paving**

GEORGE L. BURNS, *Resident Engineer*

THIS work was contracted with White & Miller of Yuma, Arizona, and was started on January 6, 1925, and completed on February 6, 1925. The project consisted of the State participation in city paving in Yuma. First Street was paved from Second Avenue to Fourth Avenue, a width of 30 feet without curb or gutter. The State participated in the center 18-foot strip. Pavement continued on Fourth Avenue from First Street to Eighth Street, width 40 feet, with 6-inch by 18-inch concrete curb. The total length of the project was 5,144 lineal feet, or 10,288 square yards.

The sub-grade was decidedly sandy and the method used was to saturate at night so that it would be dry enough to lay pavement on in the morning. The pavement consisted of 3½-inch bituminous base, 1½-inch asphaltic concrete surface and coat. The rock and sand were obtained from the White & Miller quarry and pit on Tenth Street, Yuma. The specific gravity of the rock was 2.66 and sand was 2.413. Asphalt was obtained from the El Segundo, Calif., plant of the Standard Oil Company. Penetration was 40-45.

One 14-ton three-wheel roller, one tandem with 300-pound compression per square inch and one tandem with 250 pounds per square inch were used.

No time was lost due to mechanical trouble or weather.

U. S. Route 80

Phoenix-Yuma Highway — Yuma County

Length 4 Miles — Federal Aid Project 82-A

H. H. BROWN, *Resident Engineer*

This project consists of four miles of two-course asphaltic concrete, six inches in thickness and 18 feet wide, beginning at the city limits of Yuma and extending three miles south, thence one mile east.

The contract was let to White & Miller of Yuma June 7, 1926, work to begin at the end of the hot weather season and to be finished by December 1, 1926.

This project was surfaced with six inches of crushed rock in 1921-

1922, but due to action of fast-moving vehicles and strong winds the fine material had all blown away, leaving a rough and jagged surface, which was very injurious to tires.

In preparation for the pavement, this surface was plowed up and all low places filled with crushed rock or gravel to give an easy riding and graceful grade line. Then the grade was rolled and partially shaped. Four- by six-inch planks were laid to grade for headers and the grade rerolled and checked with a template cut to true crown to assure the correct thickness of pavement at all points. Two- by four-inch timbers were nailed to the base headers for surface course headers. One three-wheel roller and two tandems were used throughout the job on surface and base. At the point where the pavement turns east, a curve of one thousand foot radius was used, with a widtn of pavement of 19 feet and a super-elevation of nine and one-half inches. The roadway, for the entire length of the curve, was surfaced with six inches of gravel, then wet and rolled with a 12-ton roller before the header-boards were set.

The contract on this project called for completion by December 1, 1926, but the contractors were allowed an extension of 10 days on account of heavy rains filling their asphalt tanks. The project was completed by December 10, 1926.

U. S. Route 80

Phoenix-Yuma Highway — Yuma County

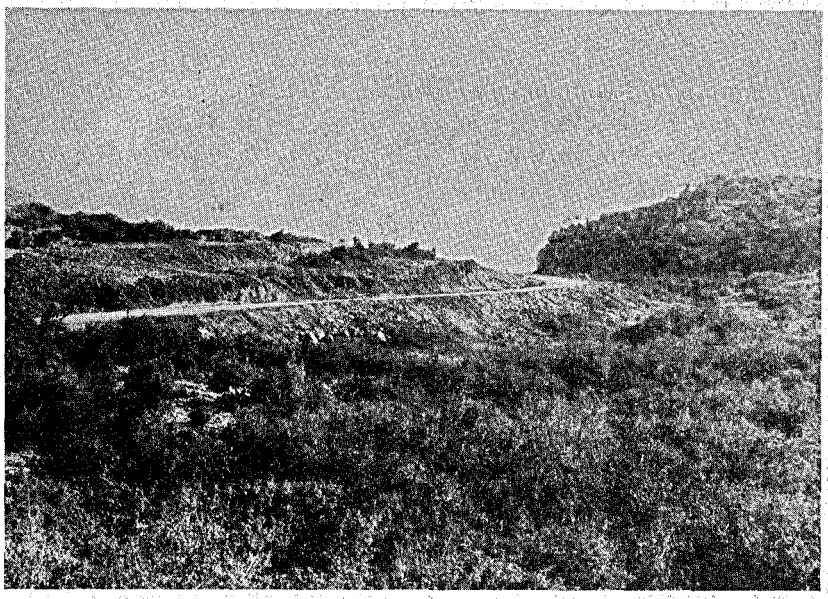
Length 14.1 Miles — Federal Aid Project 82-B

F. N. GRANT, *Resident Engineer*

This project is 14.1 miles in length and lies along an entirely new route from the present road. It leaves the old State Highway about ten miles east of Yuma, and runs almost due east, through Telegraph Pass, a low pass in the Gila Mountain range, to connect again with the old road near Ligurta, about nine miles west of Wellton.

When completed, this road will reduce the distance from Wellton to Yuma by 6.7 miles, eliminating the big swing around the point of the mountains by way of Dome as the present road goes.

The contract was awarded in April, 1926 to Ken Hodgeman of Oakland, California, whose bid was the lowest of four received, and work was begun on April 17, 1926. The work consists of grading, surfacing in part, and building drainage structures and retaining walls. Of the grading, ten miles is fairly light team work. The other four is heavy mountain work and is being done with a gasoline shovel.



Prescott-Phoenix Highway

The team work is being done by Hodgeman and is 95 per cent completed. The shovel work was sub-let to Kreider-Chase Construction Co. of Los Angeles, and was 45 per cent complete December 11, 1926.

Surfacing is being done by Hodgeman. The material used is crushed gravel, containing sand, some lime and caliche. The first seven miles of the project crosses a desert of fine sand, and the sub-grade of this sand requires a thorough wetting to secure compaction before the surfacing is put on. This is done just ahead of the surfacing.

The surfacing is put on in two courses, a three-inch base course and

a four-inch top course. Each course is thoroughly wet to get compaction. This work is now in progress and is 25 per cent complete.

The construction of drainage structures is being done by sub-contractors Fritz & Fields of Yuma. This work consists of building pipe headwalls, gravel fords, concrete box and arch culverts, and five small concrete bridges. This work is 45 per cent complete. Fritz & Fields also had the sub-contract to build the two retaining walls, one of which is completed.

The State will build the guard fences on this project. Due to excessive heat, all work was suspended for two months in the summer of 1926. The time for completion is March 15, 1927. The entire project was 45 per cent complete, December 1.

U. S. Route 80

Phoenix-Yuma Highway **Maricopa County**

Length 21.8 Miles **Federal Aid Project 69**

F. B. JACOBS, *Resident Engineer*

W. D. MOSS, *Foreman*

Due to a loose sandy sub-grade at a point beginning 3 miles west of Sentinel to Stanwix 3½ miles an additional 6 inches of surfacing was allowed. This work was done with State Forces. Trucks were used for hauling and fresnos and trap for loading. Selected surface being used. There was an over-haul of 9,500 feet.

U. S. Route 80

Phoenix-Yuma Highway **Maricopa County**

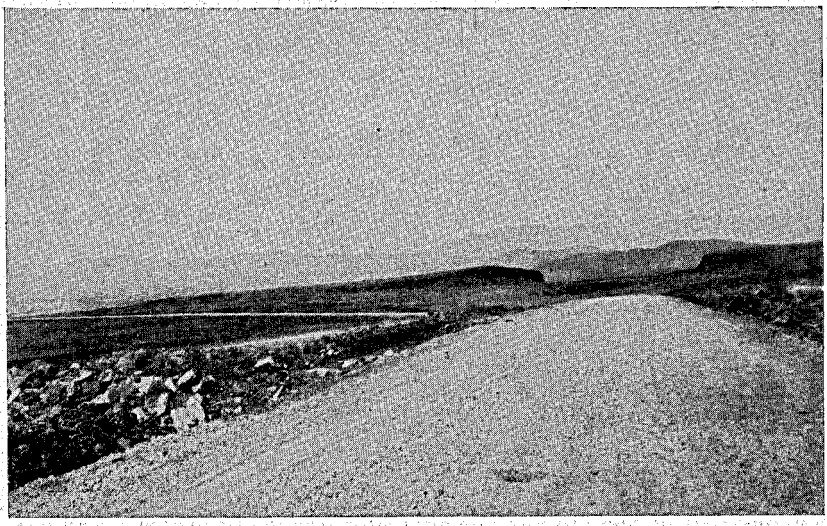
Length 1,702 Lineal Feet

Federal Aid 64-B Schedule "B"

R. E. PERKINS, *Resident Engineer*

The Gillespie Dam Bridge now under construction across the Gila River at a point just below the Gillespie Dam will eliminate the pres-

ent necessity of crossing this river on the apron of the dam. This structure, a through camel-back truss type, of steel on concrete piers and abutments, will consist of nine spans totaling some 1,700 feet long when completed. The tallest pier is 59 feet high, 43 feet of this being required below streambed.



Phoenix-Prescott Highway

The contract was awarded to the Lee Moor Contracting Co. of El Paso. Construction was started February 12, 1926 and December 1 was 31 per cent completed.

Of the 10 piers, four are on bed-rock and six are on caliche. The bed-rock in piers 1, 2, 3 is a hard seamy malpais, the surface being very rough and full of deep holes, which made the finest kind of a seal or dowel between bed-rock and concrete.

On piers 1, 2, 3 Wakefield piling were used and were very successful down to a depth of approximately 25 feet. On piers 4 and 5 a crib consisting of 2-inch sheeting nailed to a heavy crib of whalings was used. The crib has a batter of about 3 inches per foot at both ends and sides. Brush was cut in large quantities and laid in layers crisscrossed. This was done so the crib was free to go down at all

times and driving was not necessary in many cases to put the crib down to caliche. As the caliche was very rough and uneven, a false set of sheet piling was driven on the neat lines of footings, thus giving approximately 18 inches of water way around the footings into the sump.

On pier No. 6, which is one of the deepest, Lackawanna steel piling was used and was very successful. The pumping equipment on this job consists of both steam and electricity, the electric power proving both the cheaper and the better.

Very close inspection has been given on this job to all materials used in concrete. A small portable screening and washing plant of about 100 cubic yards per day capacity is being used. The rock and sand are as good concrete materials as can be obtained. The one drawback is small layers of adobe mud sometimes not six inches thick and from that up to 18 inches. When this adobe is encountered all material must be thrown away as the adobe cannot be washed out, and one load is sufficient to ruin a large pile of good clean material.

The rock grades well up to the 2½-inch standard as allowed by the specifications for mass concrete. The sand is well washed and all fines taken out leaving only the larger and coarser grains. Two test cylinders (6 inches by 12 inches) are taken from each pour of concrete.

Test cylinders taken and broken in compression tests show an average of approximately 4,000 pounds per square inch.

U. S. Route 80

Phoenix-Yuma Highway — Maricopa County

Length 1.64 Miles — Federal Aid 64-B Schedule "A"

R. E. PERKINS, *Resident Engineer*

This project consists of grading and installing necessary drainage structures on 1.64 miles adjacent to and including both approaches to the Gillespie Dam Bridge. The major portion of the grading is through solid rock.

The contract was awarded to Schmidt & Hitchcock. Work started October 4, 1926 and December 11, 1926 was 37 per cent completed.

The equipment includes one gasoline shovel, one air compressor, two jackhammers, dump trucks, mules and fresnos.

U. S. Route 80

Phoenix-Yuma Highway **Maricopa County**
Length 9.2 Miles **Federal Aid Project 71**

GEO. L. BURNS, *Resident Engineer*

Construction on the above mentioned project was started May 17, 1924 by the Pacific Construction Co. of Phoenix. Work was 5 per cent completed July 1, 1924. The entire project was completed March 26, 1925.

The section is 9.2 miles long extending from Buckeye to the Hassayampa River. It consists of a concrete pavement 18 feet wide with seven-foot dirt shoulders. Adequate drainage structures were constructed to a roadway width of 32 feet.

Owing to the fact that this section passes through an irrigated area the grade line was held from six inches to one foot above the adjacent lands, which proved a decided advantage. The adoption of the longitudinal center joint on this project has proved to be unquestionably a great benefit, due to the fact that the sub-grade is of a dark heavy adobe soil and for the greater portion of the time is in a semi-saturated condition.

Sand and gravel were obtained from the Gila River 1.5 miles south of mile three of the project.

The pavement was cured in the usual manner by the ponding method, being kept wet from 15 to 17 days and opened to traffic in 21 days.

U. S. Route 80

Phoenix-Yuma Highway **Maricopa County**
Brunners Wash Bridge

N. G. HILL, *Resident Engineer*
M. H. HASLER, *Foreman*

This project covers work done by State Forces in the construction

of three 10-foot box culverts near Palo Verde on the Phoenix-Yuma Highway.

Brunners Wash, heading several miles north of the highway in the White Tank Mountains is ordinarily diverted to the Hassayampa River via the Buckeye Canal before reaching the highway. However, frequent breaks in the south bank of the canal, with a resultant impounding of the water above the highway, and consequent damage to adjacent alfalfa fields, together with the loss of approximately 1,000 lineal feet of the shoulder on the downstream side of the concrete highway, after the water rose above grade at this point, made it advisable to provide this outlet.

Recent heavy rains have proved this drainage adequate, the high water mark being two feet below the center line grade.

U. S. Route 80

Prescott-Phoenix Highway — Yavapai County

Federal Aid Projects Nos. 72-A and 72-B

Length 27.8 Miles

F. N. GRANT, *Resident Engineer*

The past two years have witnessed the building in District No. 2 of one of the most important and most needed highways in the State, when the new road from Prescott to Congress Junction via White Spar, was completed in April, 1926. This road, often called the Hassayampa Trail, was built at a cost of approximately $1,000,000, of which amount the Government has paid more than 75 per cent. It has cut the distance from Prescott to Phoenix from 138 miles, as the old road went, by way of Skull Valley, Kirkland, and Hillside, to 113.5 miles, and has eliminated the tremendous and dangerous climb over the mountains between Prescott and Copper Basin by going through some low pases to the east of the old Copper Basin route. The distance now can be covered in less than four hours, and practically all in high gear.

The construction of the first section of this new road was by the

Government through the Prescott National Forest, a distance of 15.5 miles. Nearly all of this 15.5 miles was heavy mountain work, and cost approximately $500,000. It was completed in the fall of 1925.

At the Forest Boundary, the State took up the work, and divided the remaining 27.8 miles into two projects, known as Federal Aid Project No. 72-A and No. 72-B.

Federal Aid Project No. 72-A comprised 18.8 miles through rolling and valley country, and ended on top of Yarnell Hill, nine miles from Congress Junction.

The contract for this project was awarded to the Phoenix-Tempe Stone Co. of Phoenix, in May, 1924, to be completed in January, 1925. The work to be done consisted of grading, surfacing, and building drainage structures.

The Phoenix-Tempe Stone Co. sub-let all of the work. The grading was sub-let in two sections, the first 11 miles to Gore & Mays, and the other 7.8 miles to Willis, Roger, Coleman & Winsor. No serious difficulties were encountered in the grading, except for about one mile through malpais rock. The surfacing was also sub-let to these contractors, and Gore & Mays in turn sub-let their part to Farley & Osborne, of Cottonwood. Farley & Osborne abandoned their contract in December, 1924 and their part was finished by Phoenix-Tempe Stone Co.

The material used for surfacing was disintegrated granite, which was found in plentiful quantities, and which makes an excellent surfacing material, and is comparatively easy to maintain.

The structure work was sub-let to DeWard & Sons, of San Diego, Calif. This consisted of placing corrugated metal pipes and building headwalls, building gravel fords, concrete box culverts, two small concrete bridges and one large four span concrete bridge across Kirkland Creek.

The progress made on structure work by DeWard & Sons was very poor, due mainly to inadequate equipment, and dissension among their men, and to disagreement between the Phoenix-Tempe Stone Co. and DeWard & Sons over payment for foundation work on the Kirkland Creek Bridge. By the end of December, 1924 the structure work was

less than 60 per cent completed, whereas the grading and surfacing were 95 per cent completed.

The Phoenix-Tempe Stone Co. took over DeWard & Sons work in January, 1925, and completed it with its own forces. As a result of this and the above mentioned disagreement over pay on foundation work, DeWard & Sons brought suit in the Federal Court against the Phoenix-Tempe Stone Co.

This project was completed in June, 1925. However, in the fall of 1925, very heavy rains showed the necessity of replacing one of the firavel fords with a concrete bridge, and of building another gravel ford. This work and the attendant grading comprised Federal Aid Project No. 72-A, Contract No. 2.

Contract No. 2 on Federal Aid Project No. 72-A covered a much needed bridge. The bridge is a three-span concrete slab type. Included in this contract were nine hundred feet of surfacing and 4,048 cubic yads of borrow in order to raise the approach to the bridge.

This contract was let on Mach 9, 1926 to Tom Caldwell of Phoenix. Construction was started on March 22, 1926 and completed on June 26, 1926. This work was supervised by Resident Endineer Geo. L. Burns.

Federal Aid Project No. 72-B, nine miles in length, was the last link to be built. It connected Project No. 72-A with the old road at Congress Junction. In this nine-mile section there is some of the heaviest and most difficult work in the State.

The contract was awarded to Schmidt & Hitchcock, of Phoenix, in April, 1925. The work consisted of grading, surfacing, in places and building drainage structures, retaining walls and guard fences.

All of the work was done by Schmidt & Hitchcock. They began construction in April, 1925 and completed it about one year later. Although the contract was to have been completed in October, 1925, delays caused by floods and the addition of considerable work made it impossible to complete on time.

The grading of the four and one-half miles between the foot of the mountain and Congress Junction was fairly light team work, but the

four and one half miles along the face of the mountain was very heavy and slow. This part was done with two gasoline shovels and teams. All of this was through granite rock and boulders, some of these boulders containing as much as 300 cubic yards.

In this four and one-half mile section the road drops from an elevation of 4,900 feet on top of Yarnell Hill, to 3,600 feet at the foot. There is a continuous 6 per cent grade for about three miles, which is the maximum grade used on Arizona highways.

Very little surfacing was required on this project, as the road-bed was made of disintegrated granite and granite-sand-clay. Approximately one and one-half miles of the nine miles required surfacing, disintegrated granite being the material used.

The building of drainage structures and retaining walls offered difficulties. Cement rubble masonry retaining walls were built in steep gulches to hold the embankment. One of these walls, containing more than 400 cubic yards of masonry, required more than two months to build. In many instances, pipes and box culverts on the mountainside were placed on skews instead of square across the road, in order to save length.

The one large bridge on this project is a five span concrete bridge across Martinez Creek, one and one-half miles out of Congress Junction. It is of the concrete pile type, and is built on a 45 degree skew. The original design was a four span bridge, but heavy floods in the fall cut back into the north bank, making it advisable to add another span on that end. Due to this change, and to over-runs in excavation quantities on the mountain, and to time lost from rains and floods, the contractor was granted extension of time.

Schmidt & Hitchcock completed their contract early in April, 1926, but had hardly left the work when very heavy rains caused several hundred yards of rock slides on the mountain.

The State immediately put men, teams and trucks to work to remove these slides and repair the road. The cost of this was participated in by the Bureau of Public Roads on the same basis as for the regular contract.

This highway is now one of the scenic drives in Arizona, and a

parking place large enough to accommodate six or eight cars, was built near the top of the mountain, where the motorists can give their cars a rest, and at the same time take in a wonderful view.

U. S. Route 89

Prescott-Phoenix Highway **Maricopa County**

Length 7 Miles **Federal Aid No. 76**

ROY WHITE, *Resident Engineer*

Federal Aid Project No. 76 from Nadaburg to Hot Springs Junction, comprising seven miles of dirt road with adequate concrete drainage structures, was completed by contract May 26, 1924. Originally proposed and constructed as a self surfacing project, it was later deemed advisable to surface 4.5 miles with selected material. This was done by contract, the work being let to A. A. Ray, who began operations October 8, 1924, and completed his contract February 12, 1925.

An overhead crossing of the Santa Fe Railroad near Hot Springs Junction is proposed.

R. E. Allison, location engineer, made a revised location on this situation in August, 1926.

U. S. Route 89

Prescott-Phoenix Highway **Maricopa County**

Length 14.5 Miles **Federal Aid Project 84-A**

ROY WHITE, *Resident Engineer*

A. F. RATH, *Resident Engineer*

Construction on this project has been carried on over a considerable period of time, with lapses due to lack of funds. On this desert section, 14.5 miles in length, lying between the end of the pavement near Marinette and the town of Nadaburg, construction progress July 1,1924, showed a grader road over the entire project with earth dips providing the major drainage.

About this time it was decided to rebuild this section to conform to a uniform grade and standard 24-foot roadbed. E. Ruppers, Foreman, completed this construction with State Forces in February, 1925. A surfacing program has been carried on simultaneously with maintenance.

Early in 1926 Federal Aid was obtained for the construction of concrete drainage structures. This work was contracted to R. H. Martin of Tucson who began operations April 19, 1926. The installation of permanent waterways on this project completed July 26, 1926, an exceptionally fine stretch of gravel highway.

State Route 87

Phoenix-Casa Grande Highway Maricopa County

Length 5.33 Miles

J. R. VAN HORN, *Resident Engineer*

N. G. HILL, *Resident Engineer*

This project consisting of 5.33 miles on the Chandler-Casa Grande Highway beginning at the end of the pavement, four miles south of Chandler and ending at Pinal County Line, was built by State Forces. Work started on March, 1925 and the grading was completed November 7, 1925. Rough grading was done with caterpillar and 12-foot blade and finished with fresnos.

The roadbed is 26 feet wide and surfaced with selected material. Surfacing was hauled with a fleet of trucks over an average distance of 5.5 miles. The material used was a mixture of decomposed granite and caliche loaded with fresno and trap.

Approximately two miles of this project crosses the flood plane of the Queen Creek Wash. Being in a cultivated area the drainage could not be concentrated by the angle type of surface ditch and was accordingly handled by a series of long easy riding gravel fords. This dainage has proved satisfactory.

State Route 87
Phoenix-Casa Grande Highway — Pinal County
Length 18.59 Miles

J. R. VAN HORN, *Resident Engineer*
JESS B. HEDGPETH, *General Foreman*

The project covering 18.59 miles of the Chandler-Casa Grande Highway, beginning at Pinal County line and ending at the Southern Boundary of the Gila River Indian Reservation, was under construction and 9 per cent complete June 30, 1924. On March 30, 1925 work was suspended on this project and the State Forces under Jess B. Hedgpeth, general foreman, were moved to that portion of the road lying in Maricopa county, this section of the Chandler-Casa Grande Highway being more important construction, pending the completion of the U. S. Indian Service Bridge of 25 spans, each 50 feet in length then being constructed in conjunction with the Sacaton diversion dam across the Gila River.

The same forces resumed operations November 9, 1925 with the addition of a bridge gang under M. H. Hasler, bridge foreman.

The San Tan Canal was bridged with three spans totaling 104 feet of concrete girder type designed to conform to the adjacent Government structure across the Gila River. Also at the Little Gila River the highway department co-operated with the U. S. Indian Service in placing three 8-foot box culverts to be further constructed by the addition of headgates and become a part of the canal system in that vicinity.

The roadbed is 26 feet wide and is being surfaced with selected material where necessary. As much as possible of the grading has ben done with Caterpillar and blade; the remainder necessary to produce a uniform grade being accomplished by the use of fresnos.

Required surfacing on the first mile south of the Gila River Bridge necessitated an average haud of three miles to procure suitable material. Disintegrated granite and caliche having a high cementation value was used.

Dump body trucks and dump wagons were used for hauling; loading being accomplished by means of an elevating grader and caterpillar tractor.

Work was again suspended June 1, 1926 pending adjustment of right-of-way contract through that portion of the Gila River Indian Reservation where the proposed Highway location lay between the Southern Pacific railroad and the San Tan Canal. Right-of-way difficulties through this portion have been cleared up. The bridge gang resumed operations in October, 1926, constructing three 18 feet concrete spans, bridging a wash at station 789. This bridge should be completed prior to December 31, 1926. The unbuilt portion of this section is 5.3 miles long.

State Route 87

Casa Grande-Tucson Highway Pinal County

Casa Grande-Pima County Line Section

Length 38.5 Miles

N. G. HILL, *Resident Engineer*

In August, 1926 when the Arizona Highway Department took over that section of the Casa Grande-Tucson Highway comprising 38.5 miles from Casa Grande to the Pima County line, a brief description would show the first 8.5 miles from Casa Grande to Toltec to be a grader section long neglected and in some places so badly washed as to be virtually impassable.

The remaining 30 miles showed an improved highway which had been constructed by the Pinal County Highway Department. Grade and alignment showed to advantage and drainage had been well provided for. The poor features were a narrow roadbed, 18 feet wide, and numerous short abrupt fords. Maintenance had been neglected with a consequent sloughing of the shoulders and rough riding surface.

The Arizona Highway Department contemplates building the first 8.5 miles and widening the remainder where necessary to bring the entire project to a standard 26-foot roadway. Selected surfacing mate-

rial will be used where the nature of the sub-grade shows this requirement. Maintenance over the entire section will be carried on simultaneously with construction.

E. Ruppers, foreman, started construction on the section adjacent to Caca Grande on October 16, 1926 with State Forces. Four miles of grading had been completed December 15, 1926; the work being accomplished as much as possible with a caterpillar tractor and 12-foot blade, thus economizing on the amount of fresno work.

Four Mile Post-Picacho Highway — Pinal County
Length 31.5 Miles — A. F. E. 701

F. A. BERG, *Resident Engineer*
W. D. MOSS, *General Foreman*

From Four-Mile Post, near Sacaton on the Chandler-Casa Grande Highway to Picacho on the Casa Grande Highway, a distance of 31.5 miles, a cut-off has been located which will materially reduce the mileage between Phoenix and Tucson, besides serving the towns of Coolidge and Randolph in the Casa Grande Valley.

Construction on this project started in September, 1926 with state forces and had just gotten well under way when the work had to be discontinued, november 15, 1926, on account of lack of funds. At the time of closing down the grading was approximately 10 per cent complete.

The major portion of this work was done with an elevating grader with a 10-ton caterpillar for motive power. Teams were used to finish to a uniform grade 26 feet wide.

DISTRICT NO. 3

T. S. O'CONNELL, *District Engineer*

U. S. Route 180
Globe-Safford Highway
Length 1 Mile — Globe Streets

H. H. BROWN, *Resident Engineer*

The Globe paving work was started in February 1926, and completed in May, 1926. The project is one mile in length, extending from the Court House to the County Hospital. It is paved with Portland Cement Concrete, six inches thick, and 18 feet wide with a crown of one and one-eighth inches in surface and sub-grade.

Expansion joints were placed perpendicular to centerline, every 40 feet. Considerable care was used in placing the joints to make an absolute separation of each block of concrete from the block adjoining it, thereby giving each block the entire thickness of joint in which to expand. Care was also exercised to get a smooth riding joint; a straight-edge being used on each joint before the concrete had received its initial set.

Burlap was used to hold the expansion joints down, and 24 gauge metal strips bent in the shape of a U were placed over the joints to aid in holding the joints straight and rigid; also to aid in getting a neatly finished joint. After the final belting these strips were pulled up flush with the surface of the pavement and a half inch edging tool used. Then the strips were carefully lifted off and placed on another joint ahead of the lay.

Due to the steep hillsides it was necessary to warp the section in places to fit the existing curbs and intersecting streets. All manholes were raised or lowered to be flush with the finished pavement.

The coarse aggregate for the pavement was obtained from the Clark Quarry east of Globe and the sand was obtained from pinal Wash, south of Globe. A washer was installed in the wash near the Standard Oil Co. plant, and all sand was thoroughly washed before being hauled into the street. The mixture used was: One part cement, two parts sand, and three and a half parts crushed rock.

U. S. Route 180
Globe-Solomonville Highway
Federal Aid Project No. 63
E. M. WHITWORTH, *District Engineer*

This project was reported in previous report as completed July 15,

1924. After that date state forces under Oscar Lyons brought up shoulders to standard 5 feet width. This work was completed August 31, 192b.

U. S. Route 180
Globe-Solomonville Highway
Federal Aid Project No. 67

This project from Safford to a point two miles east of Solomonville, was described in detail in last report. It is a cement concrete road, Arizona Type, Standard 18-foot width, with 5-foot shoulders. On July 1, 1924, the project was 11 per cent complete; and 100 per cent complete on April 4, 1925.

U. S. Route 180
Solomonville-Duncan State Line Highway
Length 8 Miles Federal Aid Project 88-A

ROY WHITE, *Resident Engineer*

This project connects Federal Aid Projects No. 67 and Federal Aid Project No. 77. Work was started January 14, 1926, and project was completed June 15, 1926. The road was designed as a two phase project, the grading and drainage being let first. During construction it was found that most of the road would not need surfacing, but that on portions of the mesa that there lacked sufficient metal below 1-4 inch, two inches of wash gravel was added to these portions. The results were very satisfactory. The project was about eight miles long.

U. S. Route 180
Solomonville-Duncan State Line Highway
Length 14.5 Miles Federal Aid 77 and Extension

O. H. SWANEY, *Resident Engineer*

ROY WHITE, *Resident Engineer*

This is a self surfaced project approximately 14.6 miles in length,

built by state forces. It was partially described in previous report. Sections of the road showed an excess of clay so wash gravel was adde. This made a very satisfactory road. The project was completed September 4, 1925. John Webster was general foreman.

U. S. Route 180
Solomonville-Duncan State Line Highway
Graham and Greenlee Counties

Length 12 Miles **F. A. 88-B**

ROY WHITE, *Resident Engineer*
A. F. RATH, *Resident Engineer*

Borberland Construction Company, contractors, structures. This project of some 12 miles was let in two contracts. The State took grading and the Borderland Construction Company the structures. Work by state forces started June 25, 1926 under General Foreman John Webster. Due to the lack of funds the work was closed December 1, 1926. Three miles of road was constructed.

The Borderland Construction Company commenced work August 17, 1926, and should be finished about February 1, 1927. On completion of this project the entire road between Mathews Wash and Duncon will have been brought to Federal Aid Standard.

Extra Gang
No State or Federal Route Number
Mule Creek Highway

J. R. VAN HORN, *Resident Engineer*

The Clifton-Mule Creek Section begins at a point 10 miles east of Clifton on the Duncan Road and extends 17.5 miles to the New Mexico line. The original construction left this road without suitable drainage and with narrow dangerous curves. In November, 1925, an agreement was made with the Board of Supervisors of Greenlee coun-

ty whereby the highway department would provide necessary drainage and widen the dangerous curves, and on the completion of this work Greenlee county would take over the maintenance.

This work was begun November 15, 1925, and completed February 15, 1926. The work was done by extra gang with John Webster as foreman. Greenlee County took over the maintenance of this road on February 15, 1926.

State Route 88
Apache Trail Highway
Willow Creek Bridge
M. H. HASLER, *General Foreman*

In October, 1924 state forces started construction of a steel bridge over Willow Creek. The bridge was completed February 28, 1925. The structure as designed by the bridge department is satisfactory for a concrete floor, but owing to the lack of funds and the speed with which it was necessary to complete the bridge to care for traffic around the New Lake, a timber floor was placed. The steel was almost entirely erected and the floor laid under heavy traffic which was necessary on account of the lower road being flooded.

State Route 88
Apache Trail Highway
Fish Creek-Roosevelt Section—Non-Federal Aid
O. H. SWANEY, *Resident Engineer*
HUGH MCKAY, *General Foreman*

The construction of the Horse Mesa dam on the Salt River in Maricopa County at a distance of about 20 miles below the Roosevelt dam and subsequently the forming of a reservoir which will rise within a few feet of the Roosevelt power house floor at maximum filling of the reservoir, necessitated the relocation and construction of a portion of the Apache Trail.

The construction of this new link in the Apache Trail, started by state Forces in February, 1925, was carried toward completion until the curtailment of state highway construction in November, 1926. The construction was then temporarily abandoned on account of lack of funds.

The new construction deviates from the old road at a point about nine miles below Roosevelt dam and seeks higher ground, winding along the steep slopes adjacent to Salt River. A junction is made with the old road at about one mile below the Roosevelt dam.

The new road is of a minimum width of 18 feet and in order to save on construction costs a maximum grade of eight per cent toward Roosevelt and 10 per cent from that direction was adapted in the location of the new road.

The greater part of the project is self surfacing and of excellent material. The minor structures are corrugated metal pipe with dry masonry headwalls, built of local rock. There are two bridges, one a small two span wooden deck structure and the other a two arch spandrel filled concrete structure 110 feet in length. The latter spans Pine Creek.

Where the new highway joins the old road at the north end of the project it was necessary to keep traffic under control. This was caused by the proximity of the two roads for about two miles. It was not possible to build a detour road because of the rugged nature of the country.

When completed this portion of the Apache Trail, aside from being necessitated by the formation of the Horse Mesa reservoir, will add greatly to the scenic value of the drive and will be a vast improvement over the one way road that winds its course along the upper eight miles of Salt River below Roosevelt dam.

State Route 88
Apache Trail Highway
Globe-Roosevelt Section—Non-Federal Aid

HUGH MCKAY, *General Foreman*

Widening of this road was reported in the last report to November 30, 1924. Work was stopped in January, 1925.

DISTRICT NO. 4

E. M. WHITWORTH, *District Engineer*

State Route 81

Douglas-Safford Highway — Cochise County

Length 15 Miles

W. R. STEVENS, *Resident Engineer*

THIS project was constructed by State forces. Work began March 23, 1926, and ended August 15, 1926. The project begins at a point two miles west of Douglas on the Douglas-Bisbee highway, extends in a northerly direction 15 miles, connecting with the previously constructed section from McNeil to Pearce, and passes through Sulphur Springs Valley, which, prior to this construction, was practically impassable in wet weather. Approximately 90 per cent of this construction was done with a caterpillar and grader. None of this work was surfaced in the original construction. Observing conditions after rains on this project, extra gang force was placed on the section to surface objectionable portions. This surfacing will be completed by January. During the recent unprecedented rains traffic traveled this section without difficulty.

State Route 81

Douglas-Safford Highway — Cochise County

Length 5.5 Miles

W. R. STEVENS, *Resident Engineer*

This work was done by State forces. Work started January 30, 1926, and ended March 23, 1926. The project begins at the Graham County line and extends south 5.5 miles, where it connects with the Willcox-Bowie highway eight miles west of Bowie. The major part

of the work was done with caterpillar and grader; satisfactory surfacing material was encountered throughout the project. The road passes through a rolling country with shallow washes and the drainage is well cared for. This construction eliminated a very objectionable piece of road and makes possible uninterrupted traffic at all times, which previously was not the case.

U. S. Route 80

Douglas-Rodeo Highway **Cochise County**

Length 2.6 Miles

W. R. STEVENS, *Resident Engineer*

This work was done by State forces and was an improvement of Maintenance Section 466. It consists of grade raise and surfacing a total mileage of 2.6 miles. Said work was needed due to the overflow of roadway.

U. S. Route 80

Tombstone-Bisbee Highway **Cochise County**

Length 2.1 Miles **Federal Aid Project No. 79-B**

O. H. SWANEY, *Resident Engineer*

This project commences 16 miles out of Tombstone, in the direction of Bisbee. It joins onto the end of Federal Aid Project No. 79A and extends 2.1 miles to the foot of the Divide. Construction was started in May, 1925, by Rogers Bros., and completed in August, 1925.

The road is a standard 24-foot roadway, following very closely the location of the old road, except that its curves are less sharp and its maximum grade is 6 per cent. All pipe culverts were lengthened from 22 feet to 26 feet, and headwalls added to retain the fill.

U. S. Route 80

Tombstone-Bisbee Highway **Cochise County**

Length 10 Miles **Non-Federal Aid Project**

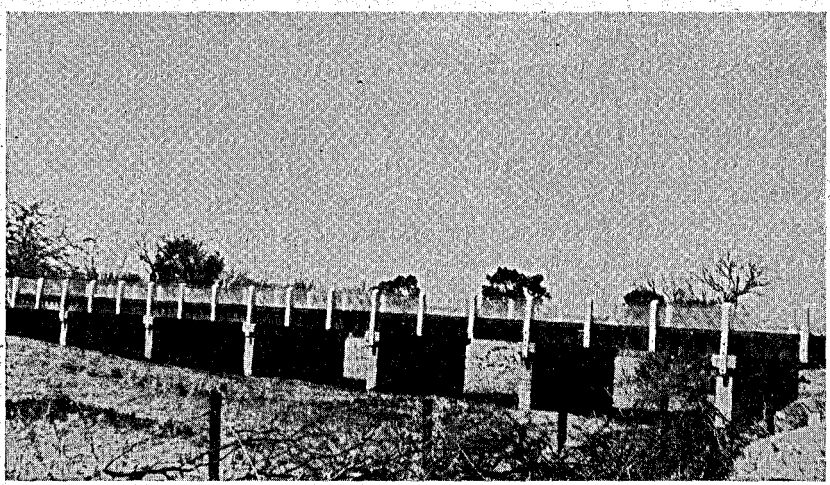
O. H. SWANEY AND H. H. BROWN, *Resident Engineers*

This project was paved in 1922 and 1923 with 2-inch asphaltic

concrete. No flush coat was applied at that time. Subsequently failures occurred at several places in the pavement.

In July, 1925, the Phoenix-Tempe Stone Co. started work applying the flush coat and squegee. This work was suspended about the first of August while the contractor's forces started laying pavement on Federal Aid Project No. 79A, and was resumed on completion of this project in January, 1926. Work was also started at this time repairing the failures in the old pavement.

In repairing these failures, an asphaltic concrete mixture was used. The sizes of aggregate and proportions in the mixture were adjusted to suit the particular places to be patched. In some instances the



Amado Bridge

broken pavement was removed and the old subgrade dug out and replaced with selected material and tamped in. This built up subgrade was covered with new paving mixture. In other places where the old pavement was not broken but settled due to grade failure, it was left in place, thoroughly cleaned and sprinkled with hot asphalt. Then the hot mixture was immediately spread and raked to the grade of the adjacent pavement, and rolled with a ten-ton roller. As soon

as the patch was well compacted the flush coat of liquid asphalt and hot squegee was applied and rolled.

A total of 80 tons of mixture was used on the patch work, at a cost of $6 per ton, making a total of $480. There were 105,945 square yards of flush coat on the project, costing 18 cents per square yard, making a total of $19,070 for the cost of the flush coat.

U. S. Route 80

Tombstone-Bisbee Highway Cochise County

Length 6 Miles Federal Aid Project No. 79-A

O. H. SWANEY AND H. H. BROWN, *Resident Engineers*

This project begins ten miles out of Tombstone and extends a distance of six miles towards Bisbee. Construction was started by the Phoenix-Tempe Stone Co. in June, 1925, and completed in January, 1926. This section was constructed of one course asphaltic concrete, 16 feet wide, with 4-foot shoulders. The thickness of the pavement varied, with a minimum of three inches and a crown of one inch.

This is the first project under this specification to receive participation of the Bureau of Public Roads. This road, to date, has received one year of decidedly heavy traffic and shows no evidence of failure, and the judgment of both bureau and State has been justified by the adoption of this lower cost type of pavement.

The old grade was used as a foundation without being disturbed, except to fill the depressions with selected materials. These places were then rolled before pavement was laid over them.

All drainage pipes were lengthened from 22 feet to 26 feet and headwalls added. During the summer rains of 1925 water overflowed the road in several places. To remedy this, two double 6x3-foot box culverts were installed, in addition to the original drainage structures.

The wing walls of all the existing bridges were raised to retain the fill of the increased width of roadway. To insure a proper bond

between the new concrete and the old, three-quarter inch round steel was dowelled into the old wall, and then the new wall poured around it.

The paving of this section eliminated the roughest stretch of road between Tombstone and Bisbee, and has also very materially reduced the maintenance cost of this section of highway.

State Route 83

Vail-Sonoita Highway — Pima County

Length 7.5 Miles

ROY WHITE AND S. W. WATKINS, *Resident Engineers*

This project was constructed with State forces, and extends in a southerly direction from the end of a previously constructed 17-mile section to the Pima-Santa Cruz County line. Work started November, 1925, and was completed May, 1926. The section is built to State standards as regards structures, and should the system become sufficiently important to justify the improvement, the construction would permit of a 24-foot roadway. All drainage on the project was either bridged or provided for by culverts, with the exception of Gardner Wash Canyon, at which point a dip was installed. These structures involved a yardage of Class "A" concrete of 622.7; of Class "B," 56.2.

This highway passes through one of the most scenic sections in the southern part of Arizona; rolling hills well covered with grass, and ranges heavily stocked with cattle. The country's adaptability to grazing of cattle develops a condition on this section that is seldom found on State systems, for nine cattle guards are in stalled in this short mileage.

The construction of this road makes possible the development of mining claims in the Greaterville district. It is becoming, in addition to a valuable road from a business standpoint, a popular route for motorists on week-ends making loop trips to Sonoita-Nogales-Tucson. Should one consult the traffic census of this project, which is developed monthly, he would be favorably impressed with the practica-

bility of this construction. The road passes through what is, in the main, natural road material. Those sections that were found, during the period of construction, to be heavy in clay were graveled by maintenance force.

As a result of the October flood in the San Pedro River, and the loss of the St. David bridge on the main east and west highway system, all through traffic was detoured over this section with no delay to the necessarily revised time schedule of the stage lines.

State Route 83

Vail-Sonoita Highway — Santa Cruz County

Length 4 Miles

W. D. Moss, *General Foreman*

This improvement begins at the Pima County line, extending southerly to Sonoita, the improvement being made by the same force, and at the same time that A. F. E. 644 was constructed. As but $1,000 was available for the improvement of this section, the old roadway was followed, same being improved by shaping with a caterpillar and blade. Where drainage crossed the project, dips were installed, planks being used as headers.

AMADO BRIDGE

GEO. L. BURNS, *Resident Engineer*

A non-Federal Aid Project across the Santa Cruz River one-half mile fro mthe Nogales-Tucson Highway and adjacent to the Station of Amado.

The project consisted of a seven span bridge 134 feet in length. Piers and abutments are of concrete, completed with a wooden deck. 500 feet of bank protection was added.

The contract was let on Sept. 11th, 1925 to Lown & Woods of Nogales. Construction was started on October 12th, 1925, and completed January 20th, 1926.

U. S. Route 80

Tucson-Nogales Highway — Pima County

Length 13.7 Miles — Federal Aid Project No. 86-A

F. J. BEEGHLY, *Resident Engineer*

This project begins at the south limits of Federal Aid Project No. 29. Actual work was started May 26, 1925, by the Downer & Fredell Contracting Co., and completed March 1, 1926. Section "A" was a new location, paralleling the Nogales branch of the Southern Pacific railroad, and thus eliminated two old grade crossings and shortened the route. The contract included the grading of a 24-foot roadway, construction of reinforced concrete bridges and C. M. P. culverts with concrete headwalls, and the placing of a six-inch selected gravel surfacing course for the entire length of 13.7 miles.

Early in the progress of the construction, it was discovered that nearly five miles of this line was subject to overflows of the Santa Cruz River. This was remedied by raising the grade line of the affected areas to such height as would insure the protection of the roadway from flood waters.

All of the waterways of the project were bridged, thereby eliminating about 30 fords of the old line. The result has been of utmost convenience to motorists, as formerly traffic had been delayed frequently for hours at a time because of high water in the fords.

A newer type of surfacing, composed of stone of a maximum size of one inch, and bound with 30 to 35 per cent of caliche, sand and clay, was used throughout.

Pit material was made ready for use with a Cedar Rapids portable crushing and screening plant. An effort was made at all times, by careful selection and mixing of material in the pits and by regulating the spread of the jaws of the crusher, to secure a mix of the greatest maximum density. At times when it was impossible to secure pit material which did not carry an excess of stone, a man was placed by the trap conveyor to remove the larger boulders before they entered the crusher. A great deal of difficulty was encountered in placing the material to prevent a segregation of the larger stone,

Material was being hauled over the new surfacing in four-ton trucks, and thus to secure a true section as it compacted, it was necessary to keep up constant maintenance. This brought about a sifting action which dropped the fine material and caused the larger stone to float to the surface.

It was found that some segregation was being brought about in the storage bin, as the material was dropped from a belt conveyor, resulting in the deposit of the fine material in the center of the trucks, and the coarser material at the edges. As hand spreading was being employed, the coarser surfacing was selected from the piles deposited by the trucks and placed on the subgrade at a depth of about five inches, and then covered with slightly more than one inch of fines or binder material. Subsequent traffic and maintenance then brought about a very good mixture. This is not considered the best practice of preventing segregation of the various sizes of materials, but in this one particular instance very good results were obtained.

State Route 81

Douglas-Safford Highway — Cochise County

Moffat Wash Bridge, Sta. 1000

FLOYD J. BEEGHLY, *Resident Engineer*

M. E. TAYLOR, *Extra Gang Foreman*

Work started April 28, 1926, by State extra gang force, and completed June 3, 1926. The work consisted of 50 cubic yards of Class B and 90 cubic yards of Class A reinforced concrete throughout, 200 cubic yards excavation and the pending and placing of 16,000 pounds of reinforcing steel. The bridge is of the four girder type, with two 30-foot decks supported by two 15-foot abutments with wing-walls, and one 15-foot pier.

Moffat's Wash is one of the few well defined channels across the Sulphur Springs Valley, and has for many years been a great hindrance to traffic during the rainy season of the year.

DISTRICT NO. 5

W. R. HUTCHINS, *District Engineer*

IN October, 1925, District No. 1 having grown too large for economical supervision was divided, and District No. 5 was created.

District No. 5 starts at the west city limits of Flagstaff, then east to the Arizona-New Mexico state line at Lupton on the Holbrook-Gallup route, and from Holbrook to the Arizona-New Mexico state line via Springerville.

Both of these highways have for years been known as the "Old Trails Highway," but under the new Federal routing system the highway from Flagstaff via Winslow and Holbrook to Lupton is now known as Federal Route No. 66, and the highway from Holbrook to the Arizona-New Mexico state line via Springerville as Federal Route No. 70, both routes being on the seven per cent systm of Federal Aid roads.

The organization in District No. 5 is the same as in District No. 1.

Shops and Yard

Immediately upon taking over District No. 5 it was realized that for an economical operation of the district it would be necessary to establish a central distributing point, as well as a centralization of major repairs to equipment and housing facilities for supplies, materials and extra equipment. The town of Holbrook, in Navajo County, was chosen for this purpose, as it was not only in the center of the district but was a natural distributing point for the present activities of the district, and also for an enlargement of the present activities of the district.

The site for the location of shops and yard was chosen for its natural conveniences and freedom from floods. This site comprises ninety-six one-hundredths of an acre adjacent to the city hall of Holbrook and at the junction of the Apache railroad with the Santa

Fe. It is owned by the town of Holbrook. A ninety-nine year lease was procured upon this property for the sum of $2,500.

A burglar-proof fence eight feet high, of the cyclone type, was erected around the entire plot, with a main entrance for vehicles and a small gate adjacent to the office for the entrance of pedestrians. This fence is identical with the fence enclosing the main shop and yards in Phoenix.

A building 92x82 feet was erected in the northeast part of the yard, housing the office, store-room, watchman's room, oil room and shop, as well as storage facilities for a large number of vehicles.

The building was erected at a cost of less than $8,000, being built of native sandstone, allowing a wall of 18 inches. Sixteen feet on either side of this building is taken up by stalls for car storage, together with the office, store room, watchman's room, lavatory and oil room, leaving the central part of 92x50 feet clear of all obstruction, with two 12x13 feet sliding doors at each end of the building and smaller doors into the office and other parts of the building from the inside, for convenience. One-third of the entire floor space is covered with a six-inch concrete floor; the balance by six inches of selected gravel material. Four working pits were placed in the concrete floor; these pits are concreted throughout.

The only unusual feature of the construction of the warehouse is the roofing of the 92x50 inside space. This was covered by what is known as the Lamella type of roof and allowed the department to cover this space without the use of trusses or supporting posts. This type of roof is made up of 1-inch by 8-inch by 9-foot boards, called "Lamellas," bolted together and a patented washer used to prevent slipping. The roof takes the form of an arch segment and is guaranteed for a total load of 102 pounds per square foot. This was covered by one-inch shiplap and a vulcanite type of roofing over the shiplap, with six 3x6-foot skylights for ample lighting.

The machinery and equipment for economical shop operation has been requisitioned; and after this machinery is set up, all necessary work can be done at the Holbrook shop. The other parts of the building are fully equipped.

The shop and supply department of the district headquarters are run as a branch of the Phoenix plant, using forms as sent out by the Phoenix office. Quick service is the motto of the shop force.

The district has standardized on F W D trucks for all heavy truck work, and the shop keeps a complete engine assembled in the shop, so that if a truck is brought in with a badly damaged engine the transfer is made and the truck put back in condition with very little delay. An extra truck is kept on hand, and if a truck is brought in badly damaged the extra truck is used until the damaged truck is repaired. A minor break-down in the field is telephoned or telegraphed to the shop and a mechanic is dispatched to the site of the break-down in a Ford car kept for that purpose at the shop.

The shop is now partly heated by small stoves, but it is recommended that steam heat be installed as soon as finances are available, as the temperature is frequently below zero.

U. S. Route 66

Winslow-Flagstaff Highway **Coconino County**

Length 12.18 Miles **F. A. No. 81**

D. L. BUNDY AND O. H. SWANEY, *Resident Engineers*

Contracts were let to Whiting Bros. and Tanner & Turley of St. Johns, Arizona, on August 3, 1926, for the construction of Federal Aid Project 81, extending from the east boundary of the Coconino Forest (just west of Canyon Padre) to Canyon Diablo. As this is what is known as a two-stage project, this contract only included the grading to sub-grade proper, inclusive of the necessary retaining walls and drainage, and the necessary guard fence protection, the building of the lower wall on all fords, and the construction of a two-span, slab type of concrete bridge 33.5 feet long. The location of this road was made to fit a 147.8-foot concrete arch bridge in place at Canyon Padre and a 146-foot concrete arch bridge in place at Canyon Diablo.

This contract was to be completed in December, 1926, but owing to bad weather will not be completed before February, 1927.

U. S. Route 66

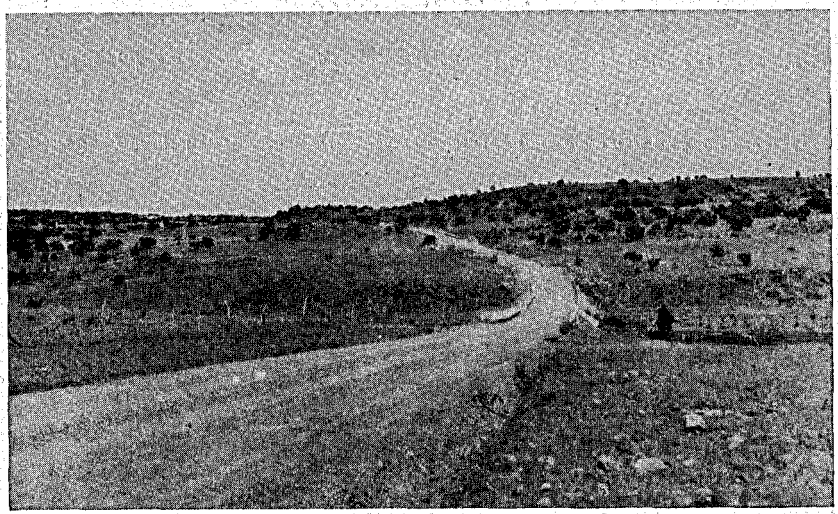
Flagstaff-Winslow Highway — Coconino County

Length 19.95 Miles — F. A. No. 74

D. L. BUNDY, *Resident Engineer*

This project extends from Canyon Diablo to the Coconino-Navajo County line, 27 miles west of Winslow.

The work of grading and constructing all drainage structures was done by state forces, starting construction on August 20, 1924, and completing the entire job in its entirety June 20, 1925. A lower



On Federal Aid Project No. 78-A

wall was constructed on the lower side of all fords, which made provision for paving these fords with a six-inch concrete slab at some later date.

A 64-foot two-span reinforced concrete bridge was constructed near the center of the project. Also a grade crossing with the Santa Fe railroad was eliminated by reinforcing the abutments of a railroad bridge already in place and paving and draining the floor by a ditch

carrying the water away on the lower side. Although the railroad structure only allowed a width of 17 feet 9 inches, clear vision is obtained on approaching this structure from either direction.

Before this project was closed a contract was let to Tanner & Turley for the surfacing of 3.28 miles west from the Coconino County line. Work was started July 25, 1925, and completed August 19, 1925, a local surfacing being used by running all material through a revolving screen, with a maximum size of 1¼-inch circular openings. This leaves a balance of 16.67 miles upon this project to be surfaced or paved with the paving of all fords.

U. S. Route 66

Flagstaff-Winslow Highway — **Navajo County**

Length 2.72 Miles — **F. A. No. 22**

O. L. BUNDY, *Resident Engineer*

Federal Aid Project No. 22 extends from the Coconino-Navajo County line to the west city limits of Winslow. This project was constructed in two stages, the first included grading and all drainage structures, all of which were fords or small structures. Contractors Tanner & Turley began work on this July 28, 1924, and completed it September 18, 1924.

A contract for a six-inch surfacing, using the same type that was used upon the previous project, was let to Rogers & Larson, who started work October 24, 1924, and completed it on January 13, 1925.

U. S. Route 66

Winslow-Holbrook Highway — **Navajo County**

Length 0.45 Miles — **F. A. No. 40 Reopened**

D. L. BUNDY, *Resident Engineer*

Federal Aid Project No. 40, extending from Winslow to Holbrook, was constructed prior to 1924, but the large drainage structures were not built at this time.

A flood destroyed the old wooden structure at St. Joseph City during 1924, and two contracts were let to replace this structure, one to Tanner & Turley for the construction of the approach fills and the other to L. C. Lashmet for the building of the structure. Tanner & Turley began work September 20, 1924, and completed the contract on April 28, 1925. This contract included the surfacing of these fills with six inches of selected surfacing material.

The contract let to L. C. Lashmet for the construction of the structure provided for a three-span, reinforced concrete piling girder type of bridge, 105 feet long. Mr. Lashmet began work upon this structure October 24, 1924, and completed same on April 18, 1925. This structure filled a very bad gap on this U. S. Route No. 66.

U. S. Route 66

Winslow-Holbrook Highway — Navajo County

Length 0.47 Miles — F. A. No. 40, Second Reopening

O. L. BUNDY, *Resident Engineer*

During 1925 floods destroyed the old wooden structure upon Federal Aid Project No. 40 at Manilla over Manilla wash, and the old wooden structure over Tanner wash near Holbrook was in very bad shape, together with two unpaved fords near Winslow, which on account of lack of drainage and being too low stood full of water after each rain.

Federal Aid Project No. 40 was reopened for the second time for the construction of the above structures and a contract was let to G. W. McMillan of El Paso for the four structures, inclusive of the approach fills and surfacing. Mr. McMillan started work upon these structures May 17, 1926, and completed it on November 6, 1926.

The Tanner wash structures consisted of a 76-foot two-span girder type of reinforced concrete bridge, with the necessary approach fills surfaced with six inches of selected surfacing material.

The Manilla Wash structure consisted of a 76-foot two-span girder type of reinforced concrete bridge, with the necessary approach fills

surfaced with six inches of selected surfacing material, a part of this approach fill was rip-rapped with the standard rip-rap.

The location of the Manilla Wash bridge was subject to wash during high water, and it was necessary to construct under this same contract a rail brush type of jetty, 100 lineal feet near the bridge, and 120 lineal feet farther up stream. This jetty was constructed by driving 30-foot, 56-pound rails eight feet apart, leaving eight feet above the ground line. A space of five feet was left between these lines of rails, which was filled with brush and rock after hog wire had been placed on the rails enclosing this space, and after the rails had been interlaced with ¼-inch cable.

The two fords near Winslow—one 270 feet long and the other 220 feet long—were raised and paved with a six-inch concrete pavement.

The entire length of Federal Aid Project No. 40 was surfaced under the old specifications, which allowed a maximum of two and a half inch rock in the surfacing, which necessarily makes the maintenance of Federal Aid Project No. 40 a rather difficult task. It is recommended that the entire length of ths project should be resurfaced to put this projct in first-class shape as to riding qualities.

U. S. Route 70

Holbrook-St. Johns Highway — Apache County

Length 8.83 Miles — F. A. No. 78-A

D. L. BUNDY, *Resident Engineer*

This project extends from the town of Concho towards St. Johns for a distance of 8.83 miles, and was contracted to Udall-Udall-Tanner-Turley & Hamlin, who commenced work on October 1, 1925, and completed same on July 27, 1926.

This contract included grading, surfacing and construction of all drainage structures. The largest of these was a 10x12 reinforced concrete box, 43 feet long, and a 23-foot reinforced concrete bridge.

These projects were made to fit an old 32-foot reinforced concrete bridge in place near the town of Concho.

Local surfacing of excellent quality was procured from two pits along the project and run through a revolving screen with 1¼-inch circular openings, none being crushed. All of the project was surfaced six inches with the exception of about two and one-half miles, which was surfaced to three inches on account of an excellent subgrade. All fords upon this project were paved with six-inch concrete paving.

The entire project is well protected with the standard wire guard fence, placed on 6 by 6 inch posts, spaced eight feet apart, with all of the structure above ground painted white. The contract called for painting that part of these posts in the ground with creosote, but owing to lack of penetration procured by this method, a supplemental agreement was made calling for boiling these posts in half creosote for a period of two hours, which produced a penetration of between one-sixteenth and one-eighth inch, and penetrating the seasoning cracks, thus increasing the life of the posts at least double.

U. S. Route 70

St. Johns-Springerville Highway — Apache County

Length 9.7 Miles — F. A. No. 68-B

J. R. SHEPHERD, *Resident Engineer*

Federal Aid Project No. 68B extends from the east end of Federal Aid Project No. 68A into the town of Springerville, and was contracted to Udall & Udall, who started work March 5, 1925, and completed the project October 31, 1925. The contract called for grading, surfacing and the construction of all drainage structures.

The only large drainage structure upon this project was a two-span reinforced concrete bridge across the Llittle Colorado River near Springerville.

The surfacing is a six-inch surfacing compacted in place. About half the project is surfaced with a gravel procured near Springerville,

all of which was run through a revolving screen with 1¼-inch circular openings; the other half was surfaced with a yellow cinder treated the same as the gravel before placing upon the road.

MAINTENANCE

MAINTENANCE of highways is a very greatly debated subject. The word "maintenance" within itself has never been accurately defined. It may mean considerable work or it may mean very little.

Maintenance as applied by this Department stands for maintaining the best riding surface that is practicable to maintenance with the materials and class of construction of the highways. Primary attention has been given maintenance by this Department, and which has resulted in wide spread comments upon the Highways of Arizona, and which has given them the reputation for being the best roads of their kind in the country.

Practically every condition exists within the confines of the State ranging from snow-capped forested mountain summits to the arid deserts of the southern part of the State; from sections of the State where snow removal is a part of the maintenance to sections of the State where snow is never known. It is believed that every known material that is found in the United States is encountered in the highways in the territory traversed by them in Arizona.

This condition means that a standard method of maintenance for the entire State cannot be used, but that practically every section, and in some cases every few miles, different methods must be resorted to in order to properly and economically maintain the highways. Uniform methods and standardization may be resorted to to a certain extent but it cannot be used as a standard in the actual workings of the various sections of the highways.

Maintenance is a feature of highway work that was given very little attention some years ago in the construction of the highways, which resulted in a great deal of work having to be done as maintenance which really should have been done under construction. Therefore, in the construction of the highways in the present day, maintenance is considered from the very start of the location of a road.

Some of the highways of the State are today carrying a greater flow of traffic than the material which constitutes the sections of the highways will withstand. These sections are exsiting today not by the strength of the surfacing material but by the gerat eforts and careful application of maintenance by the District Engineers and their maintenance crews. A great deal of assistance is being rendered maintenance by the laboratory that is maintained by the Department, and which is saving the State a good deal of money and will save them a great deal more in the future by virtue of the laboratory and its application to maintenance materials.

In addition to the traffic, weather plays a great part in maintenance and necessity for maintenance. Much of the material that must be used in this State for highway surfacing is largely dependent upon moisture or rains for its stability. Winds are also very detrimental and cause a very rapid loss of the surfacing as the material is ground up and loosened by traffic and the winds sweep it away and in some sections of the State, where winds are frequent, we find this a very hard thing to combat with maintenance.

Maintenance in the future is something that is going to require a great deal of careful attention and study due to the low wear resistance of much of our local material and the financial inability to pave many sections upon which the surfacing materials are inadequate to withstand the wear of the present traffic, and will naturally very rapidly disintegrate under the future increased traffic. It seems almost impossible to hold some sections of the roads under present conditions, and from all calculations they should be total wrecks now, but due to the continual and intelligent application of maintenance, these sections are existing from day to day. They cannot hold out indefinitely and should be paved as early as financially possible.

Maintenance has become one of the large expenditures of the Department and many maintenance camps are necessary. As the Department has in the past been continually short of funds, these camps are in every sense of the word "camps." They are sore spots along the highways and greatly affect the morale of the maintenance crews. Evry effort should be made financially to permanently locate these camps upon State-owned land, and inexpensive, adequate quarters

providede by the State for the housing and protection of State crews, equipment and supplies. In the northern part of the State, particularly where the equipment necessarily sets out in the open during the winter season, it very often happens that the motor equipment is delayed several hours in getting out on the jobs in the mornings due to the inability to start the equipment by the maintenance crews. As a certain amount of work is always demanded upon equipment by the maintenance crews in order to keep them in running condition, this now must necessarily be done out in the open and in all kinds of weather—heat and sand storms in the desert—zero weather and snows in the north. This will not entail a vrey great expense on the part of the State and will save the amount expended within a very few years by the ability to protect the supplies from the traveling public and protection to the equipment and morale of the maintenance crews.

From the detail that follows, a comprehensive idea may be obtained of the volume and scope of maintenance which the Highway Department must do.

STATUS OF MAINTENANCE DEPARTMENT

County	Route No.	Graded	Graded and Drained	Gravel Surfaced	Asphalt Pavement	Concrete Pavement	Total by Route	Total by County
Apache	U. S. 66	48.00	6.00	.....	.....	.....	54.00	.....
Apache	U. S. 70	15.00	7.17	69.05	.....	.....	91.22	145.22
Cochise	U. S. 80	26.00	.....	69.24	16.49	24.16	135.89	.....
Cochise	State 81	.....	51.50	.....	.....	.....	51.50	.....
Cochise	State 82	.....	.....	19.50	.....	.....	19.50	206.89
Coconino	U. S. 66	.....	40.33	52.17	.....	.....	92.50	92.50
Gila	U. S. 180	5.00	.....	33.10	.....	.....	38.10	.....
Gila	State 88	.....	.....	33.00	.....	.....	33.00	71.10
Graham	U. S. 180	27.80	.....	42.17	7.46	13.20	90.63	.....
Graham	State 81	30.00	.....	.....	.....	.....	30.00	.....
Graham	State 71	.....	.....	10.30	.....	.....	10.30	130.93
Greenlee	U. S. 180	.....	19.50	.....	.....	.....	19.50	.....
Greenlee	State 71	.....	.....	23.70	.....	.....	23.70	43.20
Maricopa	U. S. 80	.....	.....	77.40	8.05	54.95	140.40	.....
Maricopa	U. S. 89	.....	.....	35.70	.....	18.85	54.55	.....
Maricopa	State 87	.....	.....	5.30	.....	.....	5.30	.....
Maricopa	State 88	.....	.....	41.50	.....	.....	41.50	241.75
Mohave	U. S. 66	18.85	31.15	62.20	.....	.....	112.20	112.20
Navajo	U. S. 66	21.87	.....	34.83	.....	.....	56.70	.....
Navajo	U. S. 70	.....	6.60	14.26	.....	.....	20.86	77.56
Pima	U. S. 80	.....	.....	57.21	.....	3.79	61.00	.....
Pima	U. S. 89	.....	.....	29.05	.....	8.85	37.90	.....
Pima	State 83	.....	.....	23.60	.....	.....	23.60	.....
Pima	State 87	.....	.....	25.00	.....	.....	25.00	147.50
Pinal	U. S. 80	.....	.....	77.76	5.00	.50	83.26	.....
Pinal	U. S. 180	.....	.....	26.00	.....	.....	26.00	.....
Pinal	State 87	.....	39.00	26.54	.....	.....	65.54	.....
Pinal	State 88	.....	.....	4.30	.....	.....	4.30	179.10
Santa Cruz	U. S. 89	.....	.....	26.98	.....	2.32	29.30	.....
Santa Cruz	State 82	.....	.....	49.00	.....	.....	49.00	.....
Santa Cruz	State 83	.....	.....	4.00	.....	.....	4.00	82.30
Yavapai	U. S. 66	.....	26.40	25.10	.....	.....	51.50	.....
Yavapai	U. S. 89	.....	.....	92.97	.....	.....	92.97	.....
Yavapai	State 79	.....	.....	26.80	.....	.....	26.80	171.27
Yuma	U. S. 80	.....	.....	84.00	4.00	.....	88.00	88.00
		192.52	227.65	1201.73	41.00	126.62		1789.52

DISTRICT NO. 1

W. R. HUTCHINS, *District Engineer*

DISTRICT No. 1 is divided into twelve maintenance sections which not only carry a great variety of types and kinds of roads, but a great variety and extremes of climatic conditions, the extreme west end of the district being at Topock on the Colorado River, with an elevation of only 500 feet above sea level and subject to no snowfall and very little rain. Through that part of the district near Flagstaff and Jerome the elevation is 7,000 feet above sea level and the sections are necessarily considered snow removal sections and snow plows and tractors are kept upon these sections for this purpose.

Although there is very little of the total mileage of District No. 1 constructed to full Federal Aid and State Standards, a large part has been constructed and surfaced by State forces and by the continual application of new material by the maintenance crews, but there are still parts of the district in which no definite improvements have been made.

The ultimate aim of maintenance is to keep as near a perfect riding surface as possible. This is easily done under the right conditions of a surfacing suited to the class of traffic. There are some few sections in District No. 1 that have these conditions, but the greater part is either unsurfaced or is carrying a traffic entirely too heavy for the type of road that is now being used.

U. S. Route 89—State Route 79

Prescott-Jerome Highway **Yavapai County**

Length 19.3 Miles **A. F. E. 317**

W. T. SINGLETON, *Caretaker*

This section extends from the city limits of Prescott north six miles

on the Prescott-Ash Fork Highway to the junction of the Jerome Highway and thence 13.3 miles towards Jerome. Equipment used is an F. W. D. truck, one grader, and drags.

That portion of this section extending from Prescott six miles to the Junction is now under construction to full Federal Aid and State Standards, and will be completed early in 1927.

During 1925 a part of this section from the Junction for a distance of 13.3 miles towards Jerome was scarified, reshaped, resurfaced and drained and widened from 16 feet to 24 feet, and is now in first-class condition.

The portion of this section from Prescott to the Junction six miles is on the Federal Aid or Seven Per Cent System and U. S. Route No. 89. The portion from the Junction to Jerome is on State Route No. 79.

State Route 79

Prescott-Jerome Highway

Length 13.5 Miles **A. F. E. 316**

SID SIMPSON, *Caretaker*

This section starts at the end of the preceding section 19.3 miles from Prescott and extends to the town of Jerome, a distance of 14.1 miles.

The Prescott end of this section is in and near Lonesome Valley and is not subject to much more storm than is the territory in and around Prescott, but the mileage over Mingus Mountain attains a high elevation and is subject to heavy snows. It is considered a snow removal section, necesitating a snow plow and ten ton Caterpillar equipment in addition to the F. W. D. truck, grader and drags for regular maintenance work.

This section is fairly well surfaced and drained, but there is about four miles of this entire distance that, although built under Federal Aid and State Standards, was one of the early projects and is entirely too narrow for a mountain road with the necessary curvature and grades.

U. S. Route 89

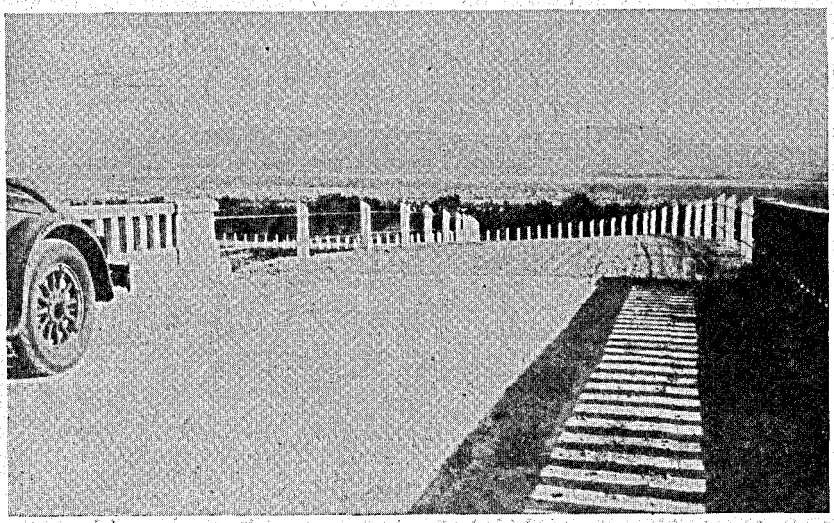
Prescott-Ash Fork Highway **Yavapai County**

Length 22.3 Miles **A. F. E. 318**

W. B. WREN, *Caretaker*

Thissection extends from the Jerome road six miles north of Prescott to the south end of Federal Aid Route No. 62 north of Chino Valley.

This section, although with a miscellaneous type of surfacing of gravel, sand and clay and disintegrated granite, with five miles re-



Prescott-Ash Fork Highway

surfaced during the last two years with crushed malpais and cinders, is in very good condition as to riding qualities.

The maintenance crew is composed of caretaker and truck driver, with an F. W. D. truck, a grader and drags.

Although this entire section was built as Federal Aid Project No. 61, the fords were not paved and give considerable trouble during storms. The surfacing was only placed twelve feet wide on top, feathered to

fourteen feet on the bottom, which makes passing very dangerous at high speeds.

U. S. Route 89

Prescott-Ash Fork Highway — **Yavapai County**

Length 23.55 Miles — **A. F. E. 320**

MELVIN HOOPES, *Caretaker*

This section extends from the north end of Federal Aid Project No. 61, or the north end of the previous maintenance section, to the east and west highway across the State through Ash Fork to Flagstaff, formerly called the National Old Trails Highway, now known as U. S. Route 66, connecting with this highway about one-quarter mile east of Ash Fork.

This section is surfaced with cinders and caliche gravel surfacing, and is fairly easy to maintain. A crew of caretaker and truck driver are kept upon this section with an F. W. D. truck, a grader and drags.

The worst feature of this section is that although it was constructed as Federal Aid Project No. 62, the fords were not paved, which makes for difficult maintenance, and the surfacing was only placed 12 feet wide, feathered to 18 feet, and is very dangerous for two cars passing at high speed.

U. S. Route 66

Ash Fork-Flagstaff Highway — **Coconino County**

Length 17.5 Miles — **A. F. E. 306**

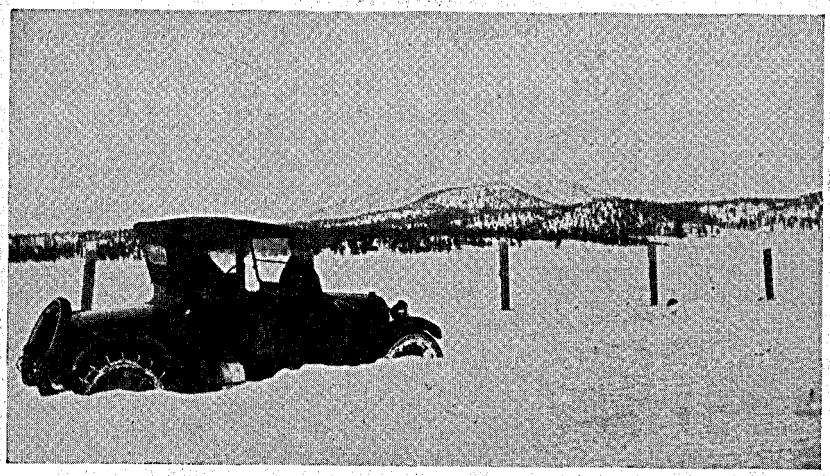
E. NEWBERRY, *Caretaker*

This section begins at the west city limits of Flagstaff and extends west for 17.5 miles.

Although 15-1 miles of this was built as Federal Aid Project No. 24 it was one of the early projects and is narrow, with excessive curvature. The entire section is very well surfaced with red cinders, which are being continually put on by the maintenance crew, and the roadbed

has been widened in all of the worst places by the maintenance crew. This section is a snow removal section and necessitates the use of a snow plow and ten ton caterpillar for snow removal, as well as an F. W. D. truck, grader and drags for ordinary work. A crew of caretaker and truck driver are the regular crew, augmented during the summer months by a few laborers and teams for extra work.

Although the maintenance crew has done excellent work in widening this entire section, there are some places, especially some of the rather high fills, that need widening badly, as these are dangerous during wet weather. The rather excessive crown is gradually being worked



Snow Removal Section, Ash Fork-Flagstaff Highway

out of this section, which makes for safer driving. There is one very dangerous grade crossing over the double track of the Santa Fe railroad upon this section.

U. S. Route 66

Ash Fork-Flagstaff Highway — **Coconino County**

Length 17.5 Miles — **A. F. E. 307**

BERT BROWN, *Caretaker*

This section extends from the west end of the previous section west

to the town of Williams, and is of State construction. It is very well surfaced with cinder surfacing and an excellent grade of gravel from Chalender, and although this section is being widened and surfaced continually by the maintenance crew, there are still some very narrow and crooked places that need work badly.

This section is a snow removal section and requires a snow plow and ten-ton caterpillar as part of the equipment, besides a F. W. D. truck, grader and drags for ordinary work.

The crew consists of the caretaker and truck driver.

U. S. Route 66
Ash Fork-Flagstaff Highway
Coconino and Yavapai Counties

Length 19.0 Miles **A. F. E. 308-A and B**

WILLIAM SMITH, *Caretaker*

This section extends from the west city limits of Williams, Coconino County, to the postoffice in Ash Fork, Yavapai County, and is made up of a State constructed road 8.36 miles and two Federal Aid Projects, F. A. No. 37, 2.83 miles in length, and F. A. No. 51, 4.81 miles, a total of 16 miles. The last three miles of this section, or that from the Coconino-Yavapai County line, to the postoffice in Ash Fork, is State constructed.

Although this section is made up of Federal Aid Projects and State construction, it needs widening badly in places, as the Federal Aid Projects were built narrow. There are two miles of dirt road upon this section that have never been surfaced, but which need surfacing badly, especially in wet weather. The balance of this section is fairly well surfaced with red cinders and is kept in fairly good condition by frequent applications of new surfacing placed by the maintenance crew.

This section is considered a snow removal section and a snow plow and ten-ton caterpillar are part of the maintenance equipment, besides an F. W. D. truck, grader and drags for the usual work. The crew consists of caretaker and truck driver.

Six thousand yards of crushed cinders and malpais have been placed on the worst worn sections of this road during the past year 1926. A 60-foot and a 30-foot wooden bridge have been entirely repaired and refloored, with the old wooden hand-rail replaced by the wire fence type of hand-rail at a cost of approximately $1,000.

There is one dangerous grade crossing upon this section just east of Ash Fork, crossing the Santa Fe railroad running into Phoenix from Ash Fork.

U. S. Route 66

Ash Fork-Kingman Highway

Length 25.1 Miles **A. F. E. 310**

J. F. ROGERS, *Caretaker*

This section extends from the postoffice at Ash Fork to the town of Seligman. The first six miles going west from Ash Fork is an old State road, rather narrow with some sharp curves, but has been surfaced more or less the entire distance and is in fair condition. This has been surveyed and plans and estimate made for the construction of the road to full Federal Aid and State Standards under Federal Aid Project No. 80-C.

The next 9.35 miles was built under Federal Aid Project No. 57 and is surfaced with a red cinder, which though fairly good, is not entirely satisfactory from an easy maintenance standpoint. Surfacing has been hauled upon a large part of this road by the maintenance crew.

The last 9.7 miles into Seligman is not only narrow and crooked, but is through a material that is very nearly impossible to control by maintenance. There has been some surfacing hauled upon this section, but the mileage is too great for complete improvement by a small gang. This stretch has been surveyed and plans and estimate made for the construction of this stretch, designated Federal Aid Project No. 80-B. This construction will eliminate a dangerous grade crossing with the Santa Fe railroad near Crookton.

The caretaker and truck driver constitute the regular crew upon this section, using an F. W. D. truck, a grader and drags.

U. S. Route 66
Ash Fork-Kingman Highway
Yavapai, Coconino and Mohave Counties

Length 38.5 Miles **A. F. E. 311 A. B. C.**

WALTER PECK, *Caretaker*

This section extends from Seligman to the Carpenter Hotel at Peach Springs, and covers a miscellaneous cross-section and alignment as well as surfacing. Parts of this section are good in dry weather and a large part is very bad during wet weather on account of the type of material encountered, but it is too large a job of surfacing for a small crew to do anything with.

It is recommended that this entire section be reconstructed to Federal Aid and State Standards at the earliest date possible. The first six miles west from Seligman have been surveyed, mapped and estimated under Federal Aid Project No. 80-D, eliminating as it does two very dangerous grade crossings on the Santa Fe railroad. The last 9.2 miles have been surveyed, mapped and estimated under Federal Aid Project No. 80-A and is entirely within the Hualpai Indian Reservation upon which 100 per cent Federal Aid can be procured.

The equipment upon this section consists of a ten-ton caterpillar and 12-foot grader, an F. W. D. truck and eight-foot grader, a one-ton Ford truck and drags. The regular crew consists of caretaker and four men.

This section in its present state is too long for the best maintenance by one crew, but if it were built to full standards this would not be the case. The present crew keeps this section in very good condition, considering the type of material it has to work with.

This section extends through three counties: Yavapai, Coconino and Mohave.

U. S. Route 66

Ash Fork-Kingman Highway **Mohave County**

Length 52.0 Miles **A. F. E. 325**

This section extends from the Carpenter Hotel at Peach Springs to

Kingman. About 15 miles of this section, west from Peach Springs, is a caliche gravel surfacing; the balance of 37 miles is made up of disintegrated granite and sandy clay surfacing. The greater part of this section is rather easy of maintenance as regards the surfacing with the exception of the sandy clay stretches, which go to pieces rather badly in dry weather with the heavy summer tourist traffic. An application of calcium chloride upon these stretches may solve to a great extent this trouble, as they are excellent when damp.

The greatest trouble with this entire section is poor drainage, of which proper care has never been taken, and although the maintenance crew has done a great deal of extra work to take care of this drainage such as about 2,500 lineal feet of retaining walls seven to 10 feet high along the various washes, the job of taking proper care of the drainage over this entire section is too great for a small crew.

The Santa Fe railroad has recently built 26 new structures from Hackberry to Kingman with nothing having yet been done on the highway to take care of this excessive water, and which during the first flood will destroy a large part of the present highway. But as this stretch of road is particularly straight over easy country and paralleling the railroad, the new structures to take care of this water could be built, using the present road until such time as money is available to construct the entire project.

The crew upon this section consists of a caretaker and five men, using two Wehr graders, one-man graders, one-ton Ford truck, one Ford roadster, one grader and drags. Although the present maintenance crew keep this section in very good shape, it is entirely too long in its present condition for one crew. This crew will probably be split up into two crews during the early part of 1927 with the establishment of another maintenance camp.

Approximately the first 10 miles west from Peach Springs has been surveyed and plans drawn and estimate made under Federal Aid Project No. 80-A, this being entirely within the Hualpai Indian Reservation and subject to 100 per cent Federal Aid participation. A survey, plans and estimates, have been prepared for four miles of this section through Hackberry, eliminating as it does two dangerous grade crossings with the Santa Fe railroad.

U. S. Route 66

Kingman-Topock Highway **Mohave County**

Length 28.8 Miles **A. F. E. 314**

W. J. CUMMINGS, *Caretaker*

This section extends from Kingman to Oatman, and is good for some two or three miles west from Kingman, but the greater part is a miscellaneous type of surfacing, for the most part a natural or unsurfaced. The two Federal Aid Projects Nos. 5 and 44 were built under the old specifications, which allowed a narrow cross-section and also a maximum size of two and one-half inch rock in the surfacing.

It is recommended that this entire section should be rebuilt, as it crosses a high divide just east of Gold Road, over which the alignment is crooked and the grades steep, with a narrow roadbed. This section also has a grade crossing of four tracks in Kingman, with another grade crossing about one mile west of Kingman.

The regular crew upon this section consists of caretaker and three men, with one Wehr one-man grader, one F. W. D. truck, one Ford ton truck, one grader and drags.

U. S. Route 66

Kingman-Topock Highway **Mohave County**

Length 25.0 Miles **A. F. E. 315**

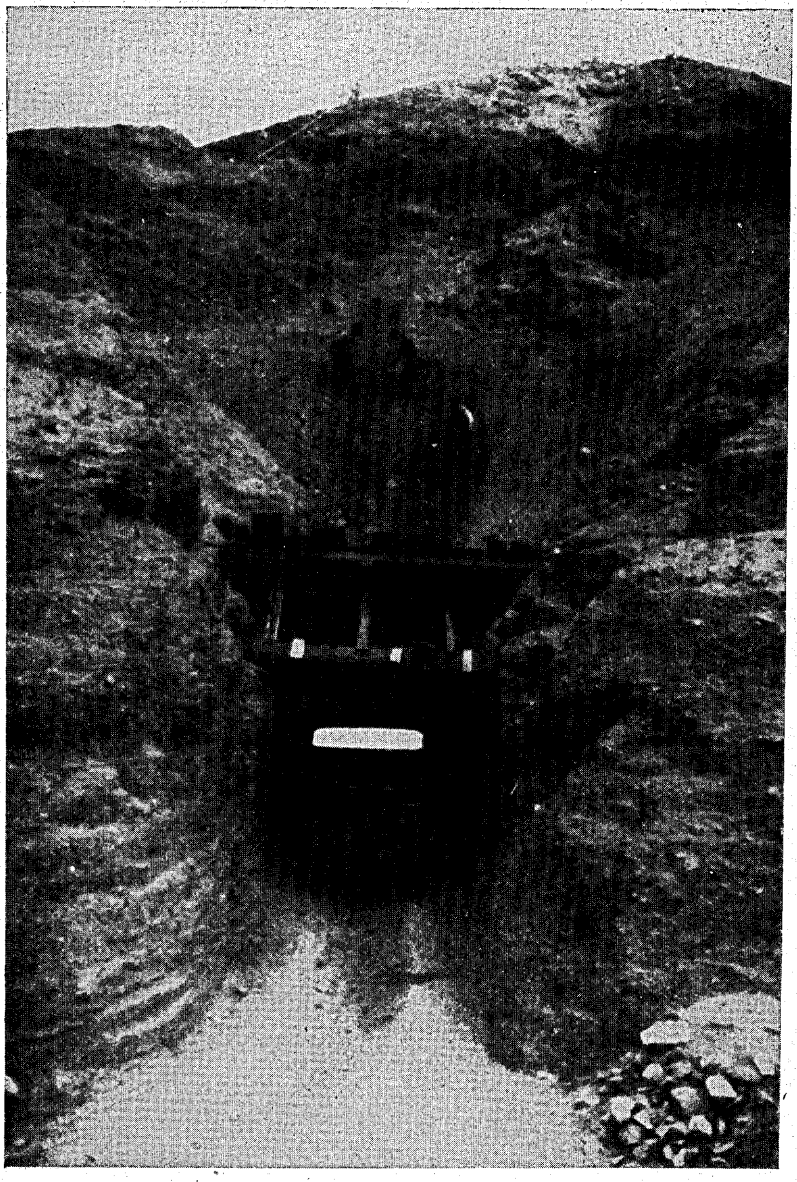
E. M. SHOTMILLER, *Caretaker*

This section extends from Oatman to the bridge over the Colorado River at Topock 16 miles east of Needles. It has two miles of State built road just west of Oatman and about one mile just east of Topock. These three miles have for the most part never been surfaced or were surfaced under the old specifications, allowing too much ovrsize in the surfacing.

The 22 miles built under Federal Aid Project No. 39 were built under the old Federal Aid and State Standards, which allowed a

narrow roadbed, excessive curvature and too much oversize in the surfacing. These conditions make this section difficult to maintain to a smooth riding surface.

There are three badly washed fords near the Topock and that will be repaired by an extra gang employed for this purpose. The regular crew upon this section consists of caretaker and truck driver, using one F. W. D. truck, one grader and drags.



Surfacing Pit at Topack

DISTRICT NO. 2

GEORGE B. SHAFFER, *District Engineer*

U. S. Route No. 80

Phoenix-Yuma Highway **Yuma County**

Length 38.5 Miles **A. F. E. 35**

F. O. DEBERRY, *Caretaker*

THIS section extends from Yuma through about 15 miles of sand mesa and the remainder skirts the foot of the mountains, practically on the banks of the Gila River to Wellton.

Four miles on the mesa has been paved and no maintenance has been applied to date. It is anticipated that very little maintenance will be necessary during the next two years.

The next 5.5 miles is an old macadam road, surfaced with a poor material. Wear is very apparent as the macadam is about all that is left and is in very poor condition. The source of surfacing is very remote and this part of the section should be paved at once.

The next six miles known as the Araby-Blaisdell section was built in about the same manner as the last mentioned section but by reason of its location has received a much greater traffic, and the maintenance has amounted to nothing less than continued light construction. Fortuna Wash is crossed on this section over ford crossings which have given considerable trouble during the rainy seasons.

The greater part of the road from Blaisdell to Ligurta, about 14 miles in length is very poorly constructed, the majority of it being the abandoned grade of the Southern Pacific Railroad. The maintenance of the part of this section has been a struggle from beginning to end on account of the narrow grade and bad drainage structures. Long hauls are required on all surfacing which isnecessary to make repairs on flood damaged ford crossings. Recommendations are of

no interest here owing to the fact that the 14 miles and the previously mentioned six miles will soon be abandoned and the State Highway will follow the new Telegraph Pass Highway now under construction.

The Ligurta-Wellton stretch, a standard built road on sand subgrade, has suffered severely through the extremes of weather. It is difficult to retain the binding material during the long dry spells and the ford crossings suffer great damage from the ravaging mountain streams during stormy periods owing to the fact that this is a cloud burst area. Owing to these two destructive conditions along with the ever increasing traffic, this part should be improved by resurfacing and drainage improvements.

U. S. Route No. 80

Phoenix-Yuma Highway — **Yuma County**

Length 23 Miles — **A. F. E. 352**

ARTHUR RENNER, *Caretaker*

The subgrade of this section is in a greater part a desert blow sand and frequently crossed by flat sand washes. There is no local surfacing material except on the extreme East end. The road was originally surfaced with this material which proved to be good and responded well to traffic and maintenance, but certain conditions, namely: extended dry periods accompanied by dry winds, high speed traffic and roadside material tended to destroy the binding and wearing quality of the surfacing.

This section was resurfaced with about two inches of fair material less than a year ago, but the summer drought, which was less severe than usual, proved to be the master of conditions, and it is doubtful if there is as much as 10 per cent of this material in place at the present time.

This section should be paved in the very near future. There has been some flood damage to this section but not of a serious kind. With a few minor changes in improvements, the present drainage structures are good except that they should be paved.

U. S. Route No. 80

Phoenix-Yuma Highway **Yuma County**

Length 26½ Miles **A. F. E. 368**

E. WELDON, *Caretaker*

This section has for its subgrade a soil very unfavorable to natural surfacing for the greater part of its length, inasmuch as it is unfit to be graded on to the road for binding purposes. It has a destructive effect on the surfacing.

As to resurfacing, this section is fortunate in having fairly good material at each end and contains some gravel which tends to aid in the process of maintenaance.

The maintenance of this section consists of the use of two heavy trucks, one No. 8 grader with blade extensions, and one heavy road planer. The road planer is apparently the most effective equipment for this section. Traffic is heavy and the dry spells are of long duration. The surfacing is getting thin but with careful maintenance the road should hold up for two more years, but owing to the character of roadside material, extensive droughts and increasing traffic it is not advisable to attempt to maintain this section as a natural road for very many years.

With a small amount of protection work, the drainage is good as now built.

U. S. Route No. 80

Phoenix-Yuma Highway **Maricopa County**

Length 21.8 Miles **A. F. E. 368**

TOM STORY, *Caretaker*

This section was built on a rather high grade line through easy rolling country. The roadside material is of a varied nature, some of which makes fairly good material for rebuilding and retaining good shoulders. The road was originally surfaced from local pits which gave up material composed of caliche gravel and caliche mud. The

caliche-gravel made a road very pleasing to traffic and responds well to maintenance, showing an even general wear.

The caliche-mud set up very hard, furnishing no float. Some pot-holes have developed which stubbornly resist repairs. The caliche-mud becomes slick during rainy periods and does not respond readily to maintenance, but does resist traffic wear. It is in no danger of break down within the next two years if properly maintained.

Two heavy trucks, one power planer and one No. 8 grader make up the maintenance equipment on this section.

An abnormal rainfall last summer caused considerable damage to the shoulders by side washing, but the structures are ample. Some protection work is necessary to control the approaching waters, and getaways should be improved to make this an ideal section.

U. S. Route No. 80

Phoenix-Yuma Highway — **Maricopa County**

Length 24½ Miles — **A. F. E. 353**

C. S. HARRINGTON, *Caretaker*

The west five miles of this section, the greater part of which runs through an irrigated district, was surfaced with a good grade of decomposed granite, brought in by train haul from a point on the Southern Pacific railroad 29 miles east. There was no suitable material near the project and the character of the subgrade was such that a long wagon haul was prohibitive. This is a draw back from the standpoint of maintenance, as all resurfacing material must be hauled from distant points, running the cost very high.

Resurfacing was done to the extent of about two inches, at a considerable cost, approximately one year ago. It was a good investment, however, as the road was about to be lost and has been one of the well kept sections since resurfacing, but a paving program is in the foreground for this section, owing to the scarity of surfacing, except at an expensive haul.

The next 10-mile section extending to Gila Bend has a more favor-

able outlook, owing to the fact that resurfacing material can be had at a reasonable distance. The present surfacing, which was obtained locally, resists traffic well, but it will be necessary to resurface in the near future. A crusher would pay, as most of the best surfacing contains a high percentage of over-size.

At least four streams in this section should be bridged. The structures at these points now are ford crossings which are dry most of the year, but being in a cloudburst area, the streams sometimes unexpectedly reach a dangerous depth and remain so for several hours. This condition is a great hindrance both to traffic and maintenance.

The next 9.5 mile stretch extends from Gila Bend towards Gillespie Dam, and with the exception of the first two miles, this part of the road has suffered about all of the adversities that maintenance could fall heir to. It is located below a supply canal which breaks it banks at promiscuous times and places. This unforunate condition is accentuated by the fact that the highway is built for the greater part of the distance on a silty subgrade which does not offer much resistance to the rushing waters from he canal breaks, which are some times added to by local rain fall.

This section was originally built and surfaced narrow and to a rather choppy profile. A great amount of oversize is contained in the surfacing which has been a nuisance to traffic, and maintenance has been a continual struggle. It would be far fetched to recommend any material improvement for this section until such time when a complete and thorough investigation of the drainage conditions will have been made. Two, sometimes three, heavy trucks, two No. 8 graders and one heavy planer is the regular maintenance equipment on this section.

U. S. Route No. 80

Phoenix-Yuma Highway **Maricopa County**

Length 25.2 Miles **A. F. E. 364**

C. J. MOON, *Caretaker*

About 14½ miles of this section lies between Gila Bend and Gillespie Dam. It is a continuation of the Piedra-Gillespie Dam Section

and shares in common all of the unfortunate conditions, having been washed out at several points by the waters from breaks in the canal above. The menace of canal flood waters makes it hard to recommend for the future, until full knowledge of all drainage conditions is known. It must be remembered that this is a cloudburst area.

The Gila River crossing is made on the apron of the Gillespie Dam, This crossing is probably the most widely known one in the southwest. During the greater part of the year, this crossing adds an interesting thrill to the trip, but during the rainy season tourists and business travelers have had to camp on the banks of a raging torrent for days or continue their journey by some other route. Watchmen are stationed at each end of the crossing during times of high water to warn traffic of the dangerous stage of the river, and a highway truck is maintained there to aid in ime of distress.

This condition will soon be eliminaed by the construction of a new highway bridge which is now under war and will be completed during the early part of the coming year. Standard roadway approaches totaling about one-half mile are being built simultaneously with the bridge which is 1700 feet in length thus connecting with standard highway sections on each side of the river.

The 10 mile section between Gillespie Dam and the Hassayampa River is a standard well drained highway surfaced with a very good material. Heavy local rains have caused some bad side washing and some slope ditches should be constructed where easy undulating grade is so exposed to washing. Careful maintenance will hold this section for several years if traffic does not increase too much. But additional drainage structures must be added.

Two heavy trucks, one No. 8 grader, one power grader, one medium sized planer are used in maintaining the Gila Bend-Hassayampa section, including the Gila River Crossing.

U. S. Route No. 80

Phoenix-Yuma Highway **Maricopa County**

Length 63 Miles **A. F. E. 354**

L. W. STATLER, *Foreman*

The Hassayampa River crossing is composed of two 90-foot

permanent steel spans over the main channel and the remainder of the flood area is spanned with 190 feet of pile trestle. It is recommneded the pile trestle be replaced at once with a permanent structure, mainly for the reason that it is dangerous to traffic and the cost of maintaining is very high. The trestle cannot last much longer.

The highway from Hassayampa River to Buckeye is nine miles of 18-foot concrete pavement with seven-foot dirt shoulders. Owing to the questionable character of the subgrade, which passes through a more or less flat irrigated country, the grade line was held a little above the adjacent fields and a longitudinal center joint was used. It is apparent that the center joint, is a pronounced advantage as no longitudinal cracking has occured. A 5-8-inch expansion was placed every 40 feet. Practically no maintenance has been found necessary except for the shoulders. Repairs were necessary on these on account of the careless disposal of the irrigation waste waters. This is a condition which has to be continually fought.

The Buckeye-Phoenix road, 35 miles in length, is 16-foot concrete. It is for the most of its length in an irrigated country and built on low grade line. This highway from right-of-way to right-of-way serves many purposes; namely, stock grazing, water gaps, irrigation ditches and sumps for waste waters, making it dangerous to traffic and causing a condition under which no type of highway can survive.

Failure to provide sufficient space for expansion movement makes it necessary to remedy this condition which is done by drilling, and this method is proving successful. A portable compressor is used for the work. A portable asphalt heating plant is used for refilling the joints and all ruptures and defects which appear. Although the road appears to be good for several years, some regulations regarding drainage, waste water control and loose running stock, would cut down the cost and prolong the life of the pavement to a considerable extent and also make the highway safer for the traveling public.

The highway passes over the Aqua Fria River 14 miles out of Phoenix. The crossing is composed of the remnants of a concrete bridge which was damaged by a flood some years ago. The gaps caused by the flood were replaced with pile timber type structures. Several times during the last two years, inspection of the timber struc-

turs have been made and each time repairs have been found to be needed. Several times portions of the bridge have settled considerably, upon examination it was found that the piles had rotted off. The bridge has been jacked up several times and mud sills placed and it continues to settle and hang together. How it remains under heavy traffic is remarkable but its abandonment is inevitable in the near future. A new bridge is the only solution. One general rain on the Aqua Fria Water shed will reduce this structure to a poor detour through the river bed.

U. S. Route No. 80 continues easterly out of Phoenix through Tempe and Mesa to Desert Wells a distance of about 19 miles and is subjected to the highest average traffic of any road in the State. As dainage, promiscuous usage of the right-of-way, causes the same condition to prevail as noted in the Buckeye-Phoenix section.

The first three miles out of Phoenix is 18-foot asphaltic concrete pavement. A small amount of raveling of the edges has occured but most of the maintenance has been devoted to shoulders.

The 12 miles of concrete on this road is in good shape but the lack of expansion space is more or less obvious. The process of relieving this condition is the same as on the Buckeye-Phoenix section. The drainage is fair only and the sub-grade fair in some places and excellent in others.

The next four miles is of 16-foot asphaltic concrete and 12x12-inch flush curbs making an 18-foot roadway. The road is holding up well and most of the maintenance has been confined to the shoulders.

This 19 miles is good for several years, but the amount of traffic is getting too heavy for the width of the highway. The inadequacy in width is strikingly apparent in the case of the Tempe Bridge crossing the Salt River at Tempe, which structure has but 18 feet clear roadway.

The repair to the bridge floor in 1920 proved a failure under heavy traffic and in order to save the structure from complete destruction, expansion joints of a different type were installed, together with other necessary repairs. This work entailed the removal of the old joints and a part of the slab.

The bridge is now in fair condition for ordinary light traffic, but a new, up-to-date structure is in order at this point to accommodate heavy loads and provide adequate roadway for the ever increasing traffic on this section. Present traffic census shows over 4000 cars per day.

The Buckeye-Phoenix-Desert Wells Section is maintained with one asphalt hot pot, one compressor and drilling outfit, one heavy truck, one No. 8 grader and one Ford runabout.

U. S. Route No. 89

Prescott-Phoenix Highway **Maricopa County**

Length 20 Miles **A. F. E. 354**

L. W. STATLER, *Foreman*

This section is an 18-foot cement cnocrete pavement running through an irrigated country. The usual water menace is present on this section and should be controlled. The Phoenix-Glendale section, being in the vegetable shipping district, is subjected to very heavy traffic during the shipping season. The shoulders show considerable wear during these periods. The remainder of the section has less traffic bu census shows a steady increase. There is no indication of failure and the same maintenance equipment is used and the same procedure is followed as on the Buckeye-Phoenix, Phoenix-Desert Wells and Phoenix-Marinette Sections and are cared for by the same foreman.

All streams are crossed with standard permanent structures.

U. S. Route No. 89

Prescott-Phoenix Highway **Maricopa County**

Length 21.6 Miles **A. F. E. 365**

CHAS. CARPENTER, *Caretaker*

The first 14.8 miles from Marinette to Nadaburg has been graded

and the drainage structures are standard but all the surfacing has been applied through the process of maintenance which has sometimes reached the proportion of an extra gang in order to keep ahead of the increasing traffic. The battle has been won by the Maintenance crew which is now down to the normal size of one heavy truck, one power grader, one No. 8 grader, one heavy planer and the use of one team for handling surface at the pit. Surfacing is of a good quality but not conveniently distributed for use on the road. Apparently the success of this road has been that just enough surfacing has been placed when and where most needed. The road maintains equally well through its length.

The next 6.8 miles was built to standard, including surfacing. This section is more forunate by having good local surfacing material which is the greatest advantage a natural road can have. The entire 21.6-mile section is in fair shape. The drainage structures throughout are good. The ford crossings on the Nadaburg-Hot Springs Junction section should be paved like those from Marinette to Nadaburg.

U. S. Route No. 89

Prescott-Phoenix Highway **Maricopa County**

Length 14 Miles **A. F. E. 361**

J. R. BARNETT, *Caretaker*

The first 11 miles from Hot Springs Junction to Wickenburg, although a high-class type of highway, has suffered at times from cloudbursts, proving that one or more of the ford crossings are bridge sites. Good surfacing material is convenient to the road. Making a short haul for resurfacing. All flood protection work is functioning successfully but some additional work along the same line must be done on this section and the road should be kept in good shape for several years at a nominal maintenance cost.

The three-span steel bridge at Wickenburg has to contend with a stubborn partnership affair between the Hassayampa River and Sols Wash. The two streams are usually on unfriendly terms during flood time. Sols Wash enters the Hassayampa River a few hundred feet

above the bridge and during the last flood the water of Sols Wash passed the bridge, bu not under it as was intended and consequently left the bridge high and dry over the main channel of the Hassayampa River. Additional bridge opening and protection to turn the water of Sols Wash are necessary to control the forces of these two combating streams.

Just above Wickenburg the highway is again confronted with the ravaging Sols Wash. The current is very swift and deep, and at times, traffic has been held up from eight to ten hours and at frequent intervals. The stream should be bridged..

The remainder of this section is not up to standard and there is more bad drainage to contend with. The section from Wickenburg to the county line should be brought up to standard roadway and drainage in the near future.

The 14-mil section is maintained with one heavy truck, one light truck, one No. 8 grader, one heavy road planer and one good road drag.

U. S. Route No. 89

Prescott-Phoenix Highway **Yavapai County**

Length 21.6 Miles **A. F. E. 376**

A. J. HENDERSON, *Caretaker*

From the Maricopa-Yavapai county line to Congress Junction, a distance of 12.6 miles is a grader section without standard structures. With two exceptions the location is favorable to very simple drainage structures, the drainage areas being very small and with gradual runoff. At least two standard drainage structures should be placed and a relocation of a short stretch should be made. This 12.6 miles can then be maintained as usual for several years.

The nine miles from Congress Junction to Yarnell Hill is a mountain section of a high-class type, built to standard roadway and drainage. Five miles of this part of the section is of a semi-self surfacing sub-grade and the remaining four miles is practically self surfacing of decomposed granite. This four miles meanders the mountain side and

has suffered some bank slides which have been promptly removed by th maintenance crew and traffic has been interrupted only at short durations of time.

Some temporary damage to the roadbed has been caused from overflowing of the side ditches, but this will discontinue when the bank sliding stops, which condition is expected in the near future. Revisions or further construction are not in sight for his nine mile section unless it be the addition of some guard fence.

The regular maintenance or equipment for this 21.6-mile section is one five-tone caterpillar, one heavy truck, two No. 8 graders, one seven-foot rotary fresno and one Ford runabout.

U. S. Route No. 89

Prescott-Phoenix Highway **Yavapai County**

Length 18.8 Miles **A. F. E. 372**

R. L. MITCHELL, *Caretaker*

This section built to standard roadway and drainage, extends from the top of Yarnell Hill through beautiful Peeples Valley to the edge ofthe Prescott National Forest, 16 miles out of Prescott. Both ends of the section located on the mountain slopes are of a decomposed granite or self surfacing material which is holding up very well. That portion passing through the valley has for sub-grade a dark heavy soil which was surfaced with decomposed granite and makes an excellent road. Cloudbursts often occur in this section and one of the ford crossing was washed out, giving way to the construction of a new bridge. At another place, additional water area was found necessary and a new ford crossing was provided. Two more of the ford crossings might have to be converted into bridges if the present scouring continues. This section maintains well and should last several years without a resurfacing program on any part of it.

The maintenance equipment is composed of one heavy truck, one light truck, one No. 8 grader and one heavy road planer.

State Route N. 87
Chandler-Tucson Highway
Maricopa & Pinal Counties
Length 31.8 Miles A. F. E. 373-A and B
H. C. DIXON, *Caretaker*

This section beginning 4 miles south of Chandler and extending to the county line was put up to a 26-foot standard by means of a 12-foot grader and fresnos. The sub-grade is of good material, but can not be classed as self surfacing by any means, but by careful distribution of a thin layer of good surfacing material the maintenance has succeeded in keeping the section in good shape for travel. If traffic continues to increase it will be necessary to surface this part of the highway or increase the maintenance force.

The section from the Maricopa-Pinal county line to Casa Grande is more fortunate inasmuch as part of it has been surfaced to standard and the greater part of it passes through self surfacing material. A gap of 5.3 miles has not been constructed and very little maintenance has been applied to it.

The Gila River is crossed with a new reinforced concrete bridge, built by the United States Government in connection with the diversion dam near Sacaton. The road from here to Casa Grande is in excellent condition but has in the past suffered from side washing, this, however, has been remedied by the consruction of wing ditches which has helped materially. The entire 31.8-mile section is drained by excellent riding ford crossings with the exception of the Gila River crossing heretofore mentioned.

The 5.3-mile section to be built will be rushed to completion as soon as finances are available.

Two heavy trucks, two No. 8 graders, two heavy road planers and a Ford runabout constitute the maintenance equipment on this section.

State Route N. 87
Chandler-Tucson Highway Pinal County
Length 38 Miles A. F. E. 707
EDW. RUPPERS, *Foreman*

This road has been taken over by the State recently and the major

portion of the work has been confined to the eight miles between Casa Grand and Toltec. This section has never been graded up to a safe elevation above the drainage which crosses it and is subject to overflow from time to time. The forces now working on this particular section are operating on the heavy maintenance scale with an effort to bring the road up to a standard 26-foot width and to a grade well above the ordinary high water. Part of this section will have to be surfaced following he grading, the amount being governed by the effect traffic has on it.

The remaining 30 miles from Toltec to the county line is up to grade, but to narrow for heavy traffic. Some of the ford crossings have proved to be too low and some are too small. Through lack of maintenance the water has been allowed to side wash he road embankment to a considerable extent. This will all be corrected in a progressive fashion and the section will be brought up to standard drainage and 26-foot roadway. Maintenance is now being applied to the entire 38 miles with a marked showing of improvement. The nature of the work being done on this road now makes it hard to recommend further, but it is the opinion here that this class of heavy maintenance will show for itself as the work goes on.

The equipment used on this work is one 10-ton caterpillar, four F. W. D. trucks, two graders and one Ford runabout.

DISTRICT NO. 3

T. S. O'CONNELL, *District Engineer*

DURING the latter part of November, 1925, the State Engineer and the Board of Supervisors of Greenlee County entered into an agreement that the State Highway Department do certain work on the Clifton-Mule Creek Highway. On the completion of this work Greenlee County took over the maintenance of this road. The State Highway Department further agreed to take over the maintenance of that portion of the Safford-Duncan-

Lordsburg U. S. Route 180, in Greenlee County. This change took effect about February 15, 1926.

At the same time the State Highway Department took over the maintenance of approximately 12 miles of road in Graham County, from a point about two miles east of Solomonville to the foot of Peloncita Mountains of the Clifton-Solomonville Highway. Eight miles of this section is on U. S. Route 180 and the remaining four miles on State Route 71.

July 1, 1926, the State Highway Department started maintenance on approximately 35 miles of the North and South Road, State Route 81, from the city limits of Safford in Graham County to the junction of Willcox-Bowie Road in Cochise County.

That portion of the White River Highway lying between Rice an the White River Indian Agency was turned back to Gila County July 1, 1925, for maintenance. This road was reconstructed jointly by Gila County and the State Highway Department, the work being done under county supervision.

Mesa-Superior Highway

Maricopa and Pinal Counties

Length 21.1 Miles A. F. E. 356-A and B

Apache Junction Section

FRANK DANA, *Caretaker*

The first eight-mile section is a wide, natural surfaced highway through a granite-sand clay country. Due to its width and the excellent material this stretch has withstood the heavy traffic burden remarkably well. The drainage situation, however, is very poor. The numerous washes are crossed by means of Class "B" fords.

A request was made and right-of-way obtained to wing ditch the entire project and clean out channels below the fords, but no money has been available to do this work. This should be done as soon as possible. The maintenance of this section is done entirely with a light power grader, which passes over the road daily, and an occa-

sional crew in a light dump truck to fill the fords with suitable material after rains. The average daily traffic on this piece of road is 600 cars.

The next 13.2 mile stretch was built as a gravel surfaced 24-foot road. However, due to side shrinkage the road in embankments is now not more than 20 feet wide. The road now is too narrow to take care of the heavy traffic and should be widened and paved. There are numerous cross washes that are forded at present. Some of these washes drain a considerable area and run for several hours. Bridges should be built over the washes, as traffic is too heavy to be inconvenienced by waiting for water to subside sufficiently for the public to cross. There are two short stretches of bed alignment that also should be corrected. There are also several small structures that are too small for area drained. In order to keep this piece of road in fair shap it is necessary for the caretaker to cover the entire road daily with heavy 12-foot blader or leveler. The average daily traffic is 450 cars.

U. S. Route 80

Mesa-Superior and Florence-Superior Highway

Florence Junction Section **Pinal County**

Length 19.8 Miles **A. F. E. 367**

JAMES CARDIN, *Caretaker*

The first five miles are surfaced with two and one-half inch asphaltic concrete. At present this paving is beginning to show signs of failure and should be treated with a flush coat as soon as possible. The shoulders in several places, notably at the Queen Creek bridge, are too narrow and should be widened. The average daily traffic is 500 cars.

The remaining 14.8 miles, extending from Florence Junction to the west end of the Gila River bridge at Florence, are gravel surfaced. With the possible exception of about two miles on each end, this section is in excellent condition and should hold up for the next two years. The four miles mentioned should be resurfaced.

In the fall of 1925 about six miles were washed out. Additional drainage was supplied and the entire project protected by wing ditches, and although it has since experienced several severe storms, no damage has been done to the road. The average traffic on this section is about 300 cars a day.

U .S. Route 80

Phoenix-Tucson Highway Florence Junction Section

Extra Gang

C. H. LEWIS, *Foreman*

J. R. VAN HORN, *Resident Engineer*

The reconstruction of the Florence Junction-Florence section was begun September 15, 1925, by extra gang under C. H. Lewis, foreman. The road had been badly damaged by heavy fall rains which had washed out the shoulders, carrying away the surfacing and destroying some portions of the road entirely. The roadbed was repaired and resurfaced, 2,345 cubic yards of surfacing being hauled. Seven new dips were constructed, two feet deep, and 200 to 300 feet long. The dips have long, easy riding vertical curves with a maximum of 4 per cent grade for the approaches.

Thirteen thousand, five hundred lineal feet of wing ditches, 14 feet wide and 18 inches deep were constructd to concentrate the water, preventing the borrow ditches from being overloaded. The ditches were dug with an elevating grader at a cost of 14 cents per cubic yard. The work was completed January 5, 1926.

Since the construction of the additional dips and ditches, this section has not suffered any damage from the floods during the past year.

U. S. Route 180

Florence-Superior Highway Pinal County

Florence Junction Section

Length 10.8 Miles A. F. E. 367

JAMES A. CARDIN, *Caretaker*

This section of road is generally a well constructed gravel road

through fairly heavy country, extending from Florence Junction to Queen Creek bridge, just west of Superior. In some places additional drainage should be placed and storm ditches constructed, but as a rule no great damage is done by floods. This road, together with the Florence-Superior section of U. S. Route 80 is maintained by means of a heavy power grader, which operates continuously, and a heavy truck which alternates pulling grader and resurfacing road. At intervals an additional truck is added to equipment to haul surfacing. There are about 450 cars daily over this road. Using the present type of maintenace the road should stand the next two years' traffic.

U. S. Route 180
Superior-Miami Highway — Pinal County
Superior Section
Length 15.5 Miles — A. F. E. 369
TOM REED, *Caretaker*

From Queen Creek bridge, 4.5 miles west of Superior, into Superior the road is becoming too narrow for the present traffic and should be widened. The present surfacing is a diabase material and although it makes an excellent roadbed it is not lasting. This section should be paved in the near future.

From Superior to the Pinal-Gila County line the road is of high type mountain construction, though rather crooked for future traffic. There are a few places where curves should be widened to increase sight distance. Additional drainage should be put in the vicinity of Devils Canyon and the roadbed widened on the fills near county line. About 750 cars a day is the average traffic.

The caretaker has one truck and grader. At stated intervals an additional truck is provided to help haul surfacing.

U. S. Route 180
Superior-Miami Highway — Gila County
Miami Section
Length 9.5 Miles — A. F. E. 407
JOHN H. DAVIS, *Caretaker*

Extending from the Pinal-Gila County line to the city limits of

Miami this section of road is in a very good condition, though in places rather crooked for present traffic. The drainage is generally good. The wooden bridge over branch of Bloody Tanks wash should be replaced by a standard concrete structure.

One Liberty truck, one grader and a leveler are the standard maintenance equipment. When necessary an additional truck is sent out for patch work on surface. The average traffic is about 800 cars a day. The present maintenance method should be adequate. However, a heavy type of motor patrol should be added to both this and the Superior section.

U. S. Route 180

Globe-Solomonville Highway — Gila County

Rice Section

Length 28.6 Miles — A. F. E. 405

HENRY THOMPSON, *Caretaker*

From Globe to a point about three miles east of Rice, this road is surfaced with gravel containing a large amount of over-size material, making it very difficult to maintain. As the new highway across Coolidge Dam takes off at a point about seven miles east of Globe, the road east of that point should stand future traffic with the addition of a thin layer of surfacing. However, the first several miles should be straightened and resurfaced. The two underpasses under the Southern Pacific railroad should be built as soon as possible, as the present ones are very dangerous.

The last five-mile section of this road is temporary in character, but, though slow, should be left as it is, provided the new road is built in the near future. At present the entire section is maintained by means of one F. W. D. truck and grader, and one light truck for patching. A heavy power grader should be added to maintenance equipment. There are at present about 400 cars traveling this road daily.

U. S. Route 180

Globe-Solomonville Highway — Graham County

Geronimo Section

Length 32.8 Miles — **A. F. E. 404**

J. N. HOLYOAK, *Caretaker*

From the San Carlos River bridge to Bylas, the present road is very poorly constructed. There are several old wooden structures in place now that will not stand heavy loads. The new road across Coolidge Dam will eliminate this stretch so that no great amount of betterment work should be attempted. From Bylas to Geronimo the road is of a higher class, although several washes are crossed by fords. Bridges should be built across these washes as soon as practical. The surface of the road here should hold up for some years to come.

The entire section is being maintained by one F. W. D. truck and grader. On account of the extreme length of road it is necessary for the truck to be used entirely for dragging. A light truck should be added to this equipment. The average daily traffic on this section is 210 cars.

U. S. Route 180

Globe-Solomonville Highway — Graham County

Safford Section

Length 34.7 Miles — **A. F. E. 410**

JAMES H. FINE, *Caretaker*

From Geronimo to Mathews wash the road is surfaced with decomposed granite. The alignment, with the exception of a few short sections, is good, but the drainage is very bad. A survey should be made in the near future and steps made to finance a new project. If it is impossible to finance entire project, drainage structures should be built and grade line raised in several places. Mathews Wash, Black Rock Wash, and Goodman Wash should be bridged. Additional rights-of-way should be obtained.

From Mathews Wash to a point two miles east of Solomonville the road is surfaced with standard section asphalt concrete or cement concrete paving. Considerable trouble is encountered with the maintenance of shoulders and borrow pits. The highway department has no regular width of right-of-way, and this should be obtained. Also provisions should be made to remove all irrigating canals from the right-of-way.

The caretaker has two F. W. D. trucks, one grader and one hot pot to maintain this section. One F. W. D. truck should be replaced by a heavy motor grader.

The average traffic on this section of road is 650 cars daily.

U. S. Route 180
Solomonville-Duncan-State Line Highway
Clifton Junction Section — Graham County
Length 18.5 Miles — A. F. E. 411

WM. BINGHAM, *Caretaker*

This section is a newly constructed, well drained, highway, with the exception of bridging. San Jose Wash no improvement should be necessary for some years.

The caretaker has one F. W. D. truck, one grader, one light truck and one long leveler. The light truck should be replaced by a heavy motor grader and the F. W. D. used for hauling surfacing material.

The average daily traffic is 140 cars a day.

U. S. Route 180
Solomonville-Duncan-State Line Highway
Duncan Section — Graham and Greenlee Counties
Length 24.1 Miles — A. F. E. 412-A and B

S. W. DUNEGAN, *Caretaker*

The first 4.6 miles of this section is a well graded, well drained

road. The surface over most of the road contains too much clay but the caretaker is remedying this by the addition of wash gravel.

The next 12.5 miles into Duncan is under construction, and on completion should be one of the best built roads in the State.

From Duncan to the State line is an old county road in excellent condition. With the addition of a few pipe, some surfacing and the lightening of a sharp curve about five miles east of Duncan, this road should stand several years traffic. These improvements can be made in the regular course of maintenance.

The equipment used is one F. W. D. truck and one grader. A motor grader should be added.

The average daily traffic is 140 cars.

U. S. Route 180
Globe-Safford Highway — Rice Section
Extra Gang
C. H. LEWIS, *Foreman*
J. R. VAN HORN, *Resident Engineer*

Work was begun January 8, 1926 by an extra gang on two miles of detour beginning about three miles east of Rice on Globe-San Carlos section. This detour was made necessary because of the loss of two large wooden bridges, destroyed by floods. Due to the fact that this road will be abandoned when the new road around San Carlos dam is built it was not worth the cost to construct new bridges. The detour heads the washes with a series of dips, and crosses the railroad two miles east of the original crossing. This crossing is far better than the old crossing. The dips are fairly easy riding and the detour in general is probably as good as the original road. This work was completed February 4, 1926.

U. S. Route 180
Globe-Solomonville Highway — Safford Section
Extra Gang
JNO. M. WEBSTER, *Foreman*
J. R. VAN HORN, *Resident Engineer*

Work on the concrete bridge one mile and a half west of Ashurst

on Geronimo-Safford section was begun April 15, 1926, by an extra gang under John Webster, foreman. This bridge was built to replace a dip that had long been a nuisance, being full of water practically the whole year. The bridge was two 10-foot spans with eight-inch slab reinforced with five-pound railway steel. This type of structure is very economical, although not up to Federal Aid standards.

A wooden bridge designed by the bridge department was also built to replace an old structure across canal one mile east of Glenbar. Work on the two bridges was completed May 31, 1926.

State Route 88

Apache Trial Highway — Pinal County

Apache Junction Section

Length 5.2 Miles — **A. F. E. 356-B**

FRANK DANA, *Caretaker*

This is a self-surfaced road passing through a country of wonderful road building material. The construction and alignment, though not up to the standard, will suffice for years to come. An occasional dragging is all that is necessary to keep the road in condition.

Average daily traffic is 125 cars a day.

State Route 88

Apache Trail Highway — Maricopa County

Tortilla Flats Section

Length 20.0 Miles — **A. F. E. 359**

HENRY MITCHELL, *Caretaker*

This portion of the Apache Trail, from the Maricopa-Pinal County line to approximately the top of Fish Creek Hill is one of the hardest pieces of road in the district to maintain. In the last two years the road bed was entirely resurfaced with a thin layer of rather indifferent

material and additional drainage added. A few blind curves were also widened.

Due to the heavy trucking, and the poor class of material available, a truck and sometimes two are needed to be conustantly hauling surfacing. On the whole, the entire section is in far better condition at present than it has ever been. The temporary wooden bridges across Boulder Creek probably will last two years more, but should be watched constantly.

The equipment used on this project is one Liberty truck, one grader and one leveler. An additional truck is sent to the caretaker at intervals to help resurface. The average daily traffic is about 115 cars.

State Route 88

Apache Trail Highway — **Maricopa County**

Fish Creek Section

Length 21.5 Miles — **A. F. E. 360**

LEON ELLSWORTH, *Caretaker*

From the top of Fish Creek Hill to Fish Creek Bridge considerable difficulty is encountered in keeping surfacing material on the road due to the excessive grades. From Fish Creek Bridge to the beginning of the new construction the road bed is built of excellent material. The drainage, however, was very bad. An extra gang was to work remedying that when state forces were shut down in November, 1926. A months work will put this drainage in excellent shape. On completion of the 8.8 miles of new road just west of Roosevelt this section will be very easily maintained. One truck, a grader and a leveler are used to maintain this section.

The average traffic is 65 cars daily.

State Route 88

Apache Trail Highway — **Gila County**

Globe-Roosevelt Section

Length 33.0 Miles — **A. F. E. 406**

JAMES M. SANDERS, *Caretaker*

This section is one of the most important pieces of road in Gila

county. Besides being a part of the famous Apache Trail it is also the main artery from Globe and Miami to the northern part of Gila County, Prescott, Ash Fork, Flagstaff, Winslow and Holbrook.

The road bed with the exception of a short stretch out from Roosevelt has been widened. The remaining stretch should be widened as soon as possible. The road bed is made for the most part of decomposed grainte and is easily maintained.

Several washouts occured in the last two years due to lack of sufficient drainage. An extra gang was put on in the summer of 1926 and the worst places were taken care of. However, considerable more drainage should be put in when money is available. The wooden bridge across Miami Wash should be replaced by a concrete structure within the next year.

One F. W. D. truck, one grader, one leveler, and one Ford truck are used for the maintenance of this section.

The average daily traffic is 700 cars.

State Route 88

Apache Trail Highway — Fish Creek Section

Extra Gang

C. H. LEWIS, *Foreman*

A. F. E. 684 provided for the rebuilding of retaining walls and road bed destroyed by the flood waters of Fish Creek and the construction of proper drainage openings, ditches and dykes and betterment in alignment from Fish Creek Inn to beginning of new construction. The retaining walls and road bed were reconstructed, 56 feet of 60-inch, 52 feet and 36-inch corrugated metal culvert pipe laid and 1300 feet of ditches and dykes constructed when the work was discontinued, due to lack of funds.

There is yet 108 feet of 60-inch, 72 feet of 36-inch, and 132 feet of 24-inch corrugated metal pipe to be placed. This work should be completed as soon as possible to prevent further damage to the road.

State Route 88

ApacheTrail Highway Globe-Roosevelt Section

Extra Gang

J. R. VAN HORN, *Resident Engineer*

Work on drainage structures on Globe-Roosevelt Section was begun February 6. 1926, by extra gang under C. H. Lewis, foreman. Six fords were constructed from 300 to 400 feet long. The fords have a cement rubble masonry wall on the down stream side with a rock basket apron. The baskets are constructed by lacing together two sides of 60-inch No. 12 hog wire, filling with rock and then lacing the two remaining sides together forming a continuous sausage like structure.

This form of apron has proved much more successful than the concrete apron due to its flexibility. As the stream scours the basket drops intothe cavity, thus precluding any chance of the retaining wall being under-mined. Dykes were built in the form of a "V" from each dip. These dykes should be rip-rapped in the near future.

Sixty feet of 48-inch; 160 feet of 36-inch; and 146 feet of 24-inch corrugated metal pipe was laid. Headwalls for these culverts were of cement rubble masonry construction.

Seventeen hundred and forty feet of bank protection was constructed along Pinal Creek and its tributaries. These were constructed by driving two-inch iron pipe five feet apart in two rows with six feet between rows. Forty-eight-inch hog wire was then fastened to posts and the space between the two rows filled with rock and brush. The work on this section was completed September 3, 1926.

State Route 71

Clifton-Solomonville Highway Graham County

Clifton Junction Section

Length 4.0 Miles A. F. E. 411

WM. BINGHAM, *Caretaker*

The maintenance of this stretch of road extending from Clifton

Junction to the foot of the Peloncita mountains, was taken over from Graham County in 1926. County forces regraded and resurfaced it before the State took it over. The surface is very thin but due to the small amount of traffic should last for sometime. The caretaker drags and reshapes this stretch with the same equipment he uses on U. S. Route 180.

State Route 71

Clifton-Solomonville Highway Gila River Section

Greenlee and Graham Counties

Length 30.0 Miles A. F. E. 402-A and B

CHAS. PERRY, *Caretaker*

This stretch of mountain road is for the most part in excellent shape. In the fall of 1926 the curves on that portion just out of Clifton were widened. The surface is in excellent condition in the entire length except for the six or seven miles in Graham County. This stretch was surfaced with volcanic cinders. The surfacing has worn very thin and an extra gang should be sent out next summer to do light resurfacing. The small drainage is not very well taken care of on some portions of the road. Additional pipe should be placed on these portions.

The equipment used consists of one F. W. D. truck and one grader.

The average daily traffic is 50 cars.

State Route 71

Solomonville-Clifton Highway

Gila River Section Extra Gang

CHAS. PERRY, *Foreman*

J. R. VAN HORN, *Resident Engineer*

Work was begun November 1, 1926 by extra gang under Chas. Perry, foreman, on the widening of dangerous curves and Smelter Hill.

The project extended from city limits of Clifton to the top of Smelter Hill. The curves were improved mainly by widening the road-bed on inside of curve, but in some cases, due to lack of funds, the inside bank was merely cut down level with the drivers eyes thereby lengthening the sight distance. Work was completed October 31, 1926.

State Route 81

North and South Highway — **Artesia Section**

Cochise and Graham Counties

Length 35.5 Miles — **A. F. E. 143-A and B**

L. B. SCARLETT, *Caretaker*

This section of the North and South highway was taken over as a State highway in July, 1926. The portion in Graham county from Safford south to the Graham-Cochise county line was built under the direction of Graham County. The remaining stretch was built by state forces.

For the most part the roads runs through undulating country and is self-surfaced. Portions of the first 10 miles south of Safford are surfaced with foreign material containing large amount of oversize. The road as a whole is very poorly drained, but should not cost much to be put in condition. There are about 150 cars a day over the road. The extent of betterment work next year will depend entirely on the amount the traffic increases.

The equipment consists of one F. W. D. truck and one grader.

DISTRICT NO. 4

E. M. WHITWORTH, *District Engineer*

U. S. Route 80

Tucson-Florence Highway — **Pinal County**

Length 22 Miles — **A. F. E. 453**

J. B. BOURNE, *Caretaker*

THIS section begins at the north end of the Gila River bridge and extends to the north city limits of Florence, a distance of one mile. Beginning again at south city limits of Florence it extends 21 miles in a southerly direction towards Tucson. During the past two years that portion of the project north of Florence was resurfaced by prison labor.

It is recommended the grade line of this project south of Florence be raised practically the entire length and that necessary drainage be provided. During rainy periods considerable damage is caused due to inadequate waterways and resultant overflow of roadway. As no ranches are located throughout length of project, the procuring of stock for cleaning out of dips after rains is a problem and often results in delay smoothing up dips. The Havelock Maintainer on rubber tires is used with F. W. D. truck for power, and gives good service on this section.

It is desirable that the department acquire title to land in the center of project that maintenance camp may be established.

U. S. ROUTE 80

Tucson-Florence Highway

Length 21.3 Miles **A. F. E. 452**

H. B. HALL, *Caretaker*

The section begins 21 miles south of Florence and extends in a southerly direction to junction of the Oracle Road with this highway. This section is maintained with a standard maintenance force who use F. W. D. truck, Havelock maintainer and eight-footgrader. It is recommended that Brady Wash on this section be bridged, as it invariably causes delay to traffic due to high water during rainy periods.

U. S. Route 80

Tucson-Florence Highway

Length 3.2 Miles **A. F. E. 451-A**

J. W. HORTON, *Caretaker*

This section extends from Oracle Junction to the Pinal-Pima

County line. A standard maintenance outfit maintains this section in addition to Project 451-B, which adjoins it.

U. S. Route 80

Tucson-Florence Highway — Pima County

Length 20 Miles — A. F. E. 451-B

J. W. HORTON, *Caretaker*.

The section begins at the Pinal-Pima County line and runs to Tucson. Of this section 16.2 miles are surfaced roadway and 3.8 miles are concrete pavement. It is proposed to cut down high joints in the pavement section when a compressor is available. In both Pinal and Pima County sections it is recommended that the major portion be surfaced, as maintenance treatment is much hindered by the presence of oversize rock, and long sections lack binder.

The Billito bridge is on this section; examination and recommendation has been made relative to flood control.

U. S. Route 80

Tucson-Benson Highway

Length 23 Miles — A. F. E. 454

A. V. LEMMONS, *Caretaker*.

This section begins at the junction of the Tucson-Nogales and Tucson-Benson Highways, and runs in an easterly direction towards Benson to the junction of the Vail-Sonoita Highway. A relocation survey of this road has been made and the plans are before the bureau of public roads for approval. This new location provides the elimination of three grade crossings. On the basis that this improvement may be made, nothing but straight maintenance is being given this old section, which would have been improved by grade raises, elimination of bad curvature and surfacing had not the new construction been contemplated.

U. S. Route 80

Tucson-Benson Highway

Length 18 Miles **A. F. E. 456-A**

J. I. ARCHER, *Caretaker*

This section begins at the junction of the Vail-Sonoita Highway with the Tucson-Benson and extends to the Pima-Cochise County line. It is maintained with a standard maintenance force of three men, being well maintained. Considerable Page Hi-Way Guard Fence has been installed on curves of this project.

U. S. Route 80

Tucson-Benson Highway **Cochise County**

Length 10.1 Miles **A. F. E. 456-B**

J. I. ARCHER, *Caretaker*

This section is maintained by the above mentioned force. It extends from the Cochise-Pima County line to the city limits of Benson. Redflex flash signals have been installed at all railroad grade crossings on the section. Page Hi-Way guard fence has been installed on curves.

U. S. Route 80

Benson-Tombstone Highway

Length 22 Miles **A. F. E. 458**

E. H. TILTON, *Caretaker*

This section extends from city limits of Benson to the junction with the Tombstone-Nogales Highway, and is maintained with standard maintenance force. The recent unprecedented floods in the San Pedro washed out steel truss bridge on this project at St. David. A temporary pile bridge is in place. A survey is being made to determine the practicability of a joint State and County bridge. Regardless of the findings, relocation will be made of a portion of this project.

U. S. Route 80
Tombstone-Bisbee Highway

Length 26.3 Miles **A. F. E. 463**

M. H. DULANEY, *Caretaker*

This section extends from the city limits of tombstone to the city limits of Bisbee; 16.2 miles of this section are paved with asphaltic concrete, 6.2 miles of which were commenced June, 1925, and completed January, 1926. More detailed information regarding this section appears elsewhere. The remainder of this section, 10.1 miles long, is surfaced highway; of this portion 2.1 miles have been reconstructed, work commencing May, 1925, and completed August, 1925. It is proposed to widen shoulders, lengthen structures and replace structures not up to F. A. Standards on the 10-mile pavement section immediately out of Tombstone. Authority has been granted for this improvement.

U. S. Route 80
Bisbee-Douglas Highway

Length 24 Miles **A. F. E. 464**

This section extends from the city limits of Lowell to city limits of Douglas. The section is paved with 18-foot concrete pavement. As this section was not shouldered on original construction and the fills are badly scoured, it is imperative that extensive repair to both pavement and fills be made soon. The maintenance of this pavement, such as treatment of cracks and the like, is cared for by extra gang force.

U. S. Route 80
Douglas-Rodeo (New Mexico)

Lenth 23 Miles **A. F. E. 465**

GUY DAVIS, *Caretaker*

This section extends from the city limits of Douglas in an easterly direction towards Rodeo, New Mexico. It is recommended that portions of this road should be resurfaced. Two short projects are contemplated to improve the section. One is a line change at Silver

Creek in a rock cut which will eliminate very bad alignment. The second change would eliminate two grade crossings, one of them a dangerous one, owing to sight distance of the approaching train being short.

U. S. Route 80

Douglas-Rodeo (New Mexico)

Length 25 Miles **A. F. E. 466**

BERT CLICK, *Caretaker*

This section extends from a point 23 miles from Douglas to the Arizona-New Mexico State line. Two and six-tenths miles of this section have been raised and surfaced by State forces under foremanship of D. H. Kleinman. Additional sections of this project are recommended for raising and resurfacing.

State Route 81

Douglas-Safford Highway

Length 19 Miles **A. F. E. 471**

E. J. KELLEY, *Caretaker*

This section extends from Douglas in a northerly direction to a points 1.5 miles north of McNeil, and was constructed by State forces during this biennial period. This section passes through the Sulphur Springs Valley, which has poor road material. None of this section was surfaced under original construction. After completion of work, heavy rains made it imperative that this section be surfaced and this is being done at present by extra gang force. Surfacing will be completed January, 1927.

State Route 81

Douglas-Safford Highway

Length 27 Miles **A. F. E. 468**

A. MCGEE, *Caretaker*

This section adjoins Section 471 and extends to Pearce. It is the

same class of material as the aforementioned section. For this reason five men are employed instead of the standard maintenance force of three. Their work, in addition to the regular maintenance, has consisted of surfacing such portions of the section that were in need of same. The entire system is now in first-class condition.

State Route 82
Tombstone-Nogales Highway
Length 24 Miles — A. F. E. 461
R. J. CORNELIUS, *Caretaker*

This section extends from the west end of the pavement at Tombstone towards Nogales to the Cochise-Santa Cruz County line. During the recent floods of the San Pedro in October the approach fill to the Fairbanks end of the bridge on this section was washed out. A cribbed incline approach was constructed to the bridge to replace the fill, and traffic was passed over the bridge 24 hours after the receding of the waters. Replacement of the fill will be made January, 1927. This entire section is well drained and easily maintained, and might be classified as one of the best surfaced roads in the State.

State Route 82
Tombstone-Nogales Highway — Santa Cruz County
Length 27 Miles — A. F. E. 462
W. H. COLLIE, *Caretaker*

This section extends from the Cochise-Santa Cruz County line to Patagonia. It is a well drained, surfaced highway and is comparable to the section which precedes it.

There are several dangerous grade crossings on this section which could be improved. Page Hi-Way guard fence has been installed on the bad curves of this section; also have had Redflex signals placed at all railroad crossings.

State Route 82
Tombstone-Nogales Highway

Length 22 Miles **A. F. E. 470**

JESS GATLIN, *Caretaker*

This sections extends from Patagonia to the city limits of Nogales. This maintenance section, reconstructed by State forces, is in the main through hilly country and difficult of maintenance during wet seasons on account of the nature of the material, which is clay. The worse sections are gradually being improved by sanding of the roadbed, the same being done by a standard maintenance force. Widening of road and drainage protection work on four miles of this is recommended.

State Route 83
Vail-Sonoita Highway

Length 4 Miles **A. F. E. 472-B**

L. S. OGLE, *Caretaker*

This section extends from Sonoita four miles north to the Pima-Santa Crnuz County line. It is practically a grader section road. Local material is unsatisfactory for the roadbed. Surfacing and the installation of drainage structures recommended.

State Route 83

Vail-Sonoita Highway **Pima County**

Length 24.5 Miles **A. F. E. 472-A**

L. S. OGLE, *Caretaker*

This section extends from the Pima-Santa Cruz County line to the junction of the Tucson-Benson Highway, of which adjoining Project 472-B is a minor section. A portion of this section was constructed by State forces under the supervision of W. D. Moss. It is a well drained, fast and scenic highway.

Construction of this section opened up the Sonoita country with the county seat of Pima, making practicable the development of mining claims in the Greaterville District. Considerable Hi-Way fence should be installed on this section.

U. S. Route 89

Tucson-Nogales Highway — **Santa Cruz County**
Length 29.3 Miles — **A. F. E. 459-B**

WM. LOWE, *Caretaker*

This section extends from the city limits of Nogales northerly to the Santa Cruz-Pima County line. It consists of 2.3 miles of 18-foot concrete pavement out of Nogales and 27 miles of dirt road. The entire dirt road should be reconstructed, portion of the present line bein abandoned and relocated to eliminate very bad and dangerous curves. The section was never surfaced and treatment by maintenance forces develops much oversize rock with resultant pot-holes in dry weather.

This section was not located with a thought of the high speed motor traffic which has since developed, and follows the route of the old horse-drawn stage.

The pavement section is in excellent condition and necessary maintenance is given by extra gang force.

Three miles north of Nogales recent heavy rains have damaged the roadway where wash parallels it. Immediate protection work should be done before recurrent rainy season, as the wash is encroaching upon the roadway. This protection should be in the nature of a retaining wall. The structure bridging this wash is also in need of repair, foundation of same having been undermined by said floods. Should it be impossible to relocate and reconstruct this section, additional drainage structures should be installed and considerable mileage surfaced.

U. S. Route 89

Tucson-Nogales Highway — **Pima County**
Length 8.9 Miles — **A. F. E. 455**

This section begins at the city limits of Tucson and extends 8.9

miles south towards Nogales. It is an 18-foot concrete pavement in first-class condition. Necessary maintenance, such as treatment of cracks, is done by extra gang forces. Work should be done on the shoulders of this section.

U. S. Route 89
Tucson-Nogales Highway

Length 29 Miles **A. F. E. 469**

D. O. MUMFORD, *Caretaker*

This section extends from the south end of the pavement aforementioned, Project 455, towards Nogales to the Pima-Santa Cruz County line; 13.6 miles of this section,which is known as Federal Aid Project 86A, was constructed during this period by contractors Downer & Fredell. A more detailed description of this project is noted elsewhere. It is recommended that considerable of the remaining mileage of this sectionbe reconstructed and surfaced.

Continental Bridge No. 1: In recent floods the river channel was very materially changed and this change endangers the southeast abutment of the bridge. Protection work is contemplated south of the bridge. A survey of this condition has been made and data submitted.

State Route 87
Tucson-Casa Grande Highway

Length 25 Miles **A. F. E. 473**

W. H. WHITE, *Caretaker*

This section extends from the junction of the Tucson-Florence and Casa Grande Highways in a northwesterly direction towards Casa Grande to the Pima-Pinal County line. This section was recently taken over by the State for maintenance from Pima County. It is a surfaced, well drained highway throughout.

It is recommended that land be acquired for the establishment of a maintenance camp. A standard maintenance force cares for this section.

Extra Gang Force

M. E. TAYLOR, *Foreman*

Credit is given the extra gang force under the able foremanship of Mr. Taylor. This force is called upon in emergency cases and renders most valuable service. During the recent flood conditions, when roads and bridges were washed out, the value of this force was strongly emphasized when it looked as though traffic might be delayed for several days, especially at the points where the St. David bridge on the main east and west highway system was lost and the Fairbanks bridge approach fill was washed out. However, immediately the water receded, traffic was made possible at the end of 24 hours through the energetic efforts of this force. During normal periods this force supplements the work of the regular maintenance forces.

DISTRICT NO. 5

W. R. HUTCHINS, *District Engineer*

DISTRICT No. 5 is divided into 13 maintenance sections, and although at the time District No. 5 was created there were four sections without maintenance, now the entire mileage in the district is being maintained by the State Highway Department, with the exception of the Flagstaff-Angel project, which will be maintained by the Government for two years after completion. All of the maintenance being done at present is upon the Federal Aid 7 per cent system.

Along the Old Trails Highway through District No. 5 there are long stretches of road that are purely dirt roads—sand, adobe and clay in a great many instances—which through the summer season carry a 400 to 600 car traffic per day, and it is an impossibility to keep these roads in an easy riding condition without an immense outlay of money for maintenance. It has been the policy of the district to try and haul surfacing upon as much of this kind of road

as possible with the maintenance crews, but this material is sometimes miles away from the section and must be shoveled on trucks.

As for this small amount of material a mechanical loader is too expensive and trap loading would mean team and driver being idle at the pit for a greater part of the time, so very little can be done so far as building up a permanent or stable roadbed.

The maintenance crews are called upon to do a miscellaneous lot of work, from new construction, reconstruction (segregated as to cost into maintenance, betterment and reconstruction), as well as their regular run of maintenance. But all are loyal and ever ready to do their best upon all occasions, which makes it possible to keep the roads in the best possible condition under the circumstances.

In the description of the several maintenance sections, they will be catalogued consecutively from the western limits of the district at Flagstaff through to the eastern limits at the two points on the Arizona-New Mexico State line.

FLAGSTAFF STREETS

On U. S. Route 66

A F. E. 23-682 **Coconino County**

This project is a bitulithic pavement from the western city limits to the eastern city limits, and is on the State 7 per cent system of highways and was maintained by the State Highway Department until the last fiscal year. But during July of 1926, an agreement was signed between the State Highway Department and the City of Flagstaff that if the State Highway Department would repair this pavement, which was badly cracked in several places, that the maintenance would be taken over by the City of Flagstaff. This work was done, using a portable mixing plant, at a cost of approximately $1,200, thus freeing the State Highway Department of this maintenance.

U. S. Route 66

Flagstaff-Angel Highway **Coconino County**

Maintenance to start upon this project two years after compeltion

by the Government. See under heading "Construction" for a description of this project.

U. S. Route 66

Flagstaff-Winslow Highway **Coconino County**

Length 12.7 Miles **A. F. E. 324**

R. L. HOLCOMB, *Caretaker*

This section extends from the east end of the Flagstaff-Angel project, just west of Canyon Padre to the bridge across Canyon Diablo, an old county road, and had no maintenance crew working at the time District No. 5 was organized. But this road was in a very bad condition, hardly more than passable, so that in Decemb 1925, an enlarged maintenance crew consisting of the caretaker and five men, with two teams, were placed upon this road, and the road worked into a first-class condition. The crew was then reduced to the caretaker and truck driver. The equipment used is an F. W. truck, an eight-foot grader and two small drags. The project is now rough, owing to the fact that Federal Aid Project No. 81 is now being constructed for this entire length and follows more or less closely this old road.

U. S. Route 66
Flagstaff-Winslow Highway
Coconino & Navajo Counties
F. A. 74 and F. A. 22

Length 22.65 Miles **A. F. E. 322 A. & B.**

L. E. BATES, *Caretaker*

This section extends from Canyon Diablo to the west city limits of Winslow. The entire section has been constructed as Federal Aid 74 and Federal Aid 22. Federal Aid 22 was constructed complete, surfaced with six inches of selected surfacing material, but only 3.3 miles of Federal Aid 74 was so surfaced. This leaves 16.65 miles

of road constructed to Federal Aid standards as to grade and alignment, but unsurfaced and fords not paved. This grade is made of the local sandstone shale material, and in wet weather and for light traffic makes an excellent riding surface, forming a crust of an inch to two inches on top, but with dry weather and the heavy traffic of summer this crust would not stand, and this 16.65 miles went to pieces badly. An effort was made to resurface this road as a Federal Aid project, but the closest surfacing that would stand the test entailed a railroad haul of some 60 miles and the cost was prohibitive.

It was decided to wait until finances were available to pave this section. The maintenance crew has been enlarged to six men and two teams, with two F. W. D. trucks, one Ford truck, an eight-foot grader and a powered grader. A shale containing lime is being placed on the worst sections of this project. This entails a maximum haul of 10 miles and the material, although some better than the local material, the job when completed will not be satisfactory, and with the small force and long haul is rather an expensive procedure, and at best will not make a satisfactory road when completed.

U. S. Route 66

Winslow-Holbrook Highway — Navajo County

F. A. 40

Length 21.9 Miles — A. F. E. 305

AMBROSE HUNT, *Caretaker*

This section extends from the east city limits of Winslow to Joseph City, and although built throughout as a Federal Aid project, with the exception of the fords, it was surfaced under the old specifications, allowing a maximum size of two and one-half inches material to go into the surfacing. But the small maintenance crew, consisting of caretaker and three men, with two F. W. D. trucks and one Ford truck, have by very hard and diligent work practically resurfaced this whole section, to a depth of two to four inches, with the best material available.

There are two large bridges upon this section, the bridge over the

Little Colorado River, 862 feet long, and the bridge over Cottonwood Wash, 237 feet long. The flooring upon both of these bridges was in bad condition, but during 1926 a laminated floor made of three by four inch material, laid with expansion joints every 16 feet, has been placed on the Cottonwood Wash bridge and for about 75 feet of the Little Colorado bridge. The balance of the Little Colorado bridge has been recovered with the old 3 by 12 inch decking. Both floors have been covered with one-half to three-quarters of an inch of sanded asphalt, using squeegee size material rather than fine sand, which contains too much dust. That portion of the floor made up of the laminated flooring, covered with asphalt, is good, but upon that portion of the Little Colorado River bridge upon which the old 3 by 12 inch material was used, it was not possible to fasten this flooring to avoid any movement, and these planks move under extremely heavy loads, which loosens the asphalt covering, allowing this to flake off. This was thought of at the time, but money was not available to entirely cover this long bridge with the laminated flooring, but this must be done as soon as the money is available.

The old wooden hand rails have been removed and the Page wire guard fence type of hand rail placed upon the entire length of both bridges.

A cloudburst last summer washed out 50 feet of the west approach of the Cottonwood bridge. Fifty-six feet of creosoted pile bridge has been driven to replace this and 250 feet of jetty protection placed upstream from the west end. This jetty is made by driving two rows of 30-foot 56-pound rails five feet apart, the rails spaced eight feet, with six-foot hog wire fastened to both lines of rails, and rails tied together with old cable. The five-foot space is then filled with brush and rock.

Both of these bridges are narrow, one-way bridges and are very dangerous for the type of connecting road, carrying the heavy traffic of the summer months. Two very serious accidents have occurred owing to these facts within the past two months.

U. S. Route 66
Winslow-Holbrook Highway — Navajo County
Length 22.0 Miles — A. F. E. 304

JOHN DEWITT, *Caretaker*

This section extends from Joseph City to the west limit of the town of Holbrook and from the south limit of the town of Holbrook, east 11 miles.

This section is covered by three different projects, Federal Aid 40 from Joseph City to Holbrook, built under Federal Aid standards with the exception of the fords. This (as was the last section) was surfaced under the old specifications, allowing the use of too much oversize, making maintenance a very difficult problem. The section from Holbrook east for 6.6 miles is an unimproved road, although the plans are completed for this 6.6 miles under Federal Aid 78B. The last 4.4 miles is on Federal Aid 42, which is built to Federal Aid standards with the exception of the fords, and the surfacing upon this section is fairly good.

On this section is the LaRue Wash bridge, 496 feet long, which has been refloored with the laminated type of flooring, covered with one-half to three-quarters of an inch of sanded asphalt. The old wooden guard rail has been replaced with the Page wire fence type of guard rail and painted white.

Two hundred feet of jetty as described under the last section has been placed at the west end of this bridge.

A crew of a caretaker and two men, with an F. W. D. truck, a one-ton Ford truck, an eight-foot grader and two small drags are kept upon this section.

The maintenance camp for this section has been discontinued and the crew uses the yard and storage facilities at Holbrook.

U. S. Route 70
Holbrook-St. Johns Highway
Navajo & Apache Counties
Length 20.8 Miles — A. F. E. 302-A and 302-B

J. R. OVERTON, *Caretaker*

This section extends 20.8 miles east from the end of the last sec-

tion, 6.1 miles being the balance of Federal Aid project 42 built under Federal Aid standards, with the exception of the fords, and surfaced with very good surfacing materal, showing a wear of approximately one and one-half inches in four years. The next 3.7 miles of this section is Federal Aid project No. 3, through the Petrified Forest, and although one of the first projects and built narrow, the surfacing is very good and the road as a whole in very good condition. The next 11.0 miles, in Apache County, is unimproved road, but the worst places have been surfaced by the maintenance crew and the 11.0 miles as a whole is in good shape.

Very little work has been done upon this section—a fill widened here and there, and small washouts repaired, some protection work being done at the several bridges and fords.

The caretaker and truck driver, with an F. W. D. truck, an eight-foot grader and two small drags, handle this section.

U. S. Route 70

Holbrook-St. Johns Highway — Apache County

Length 19.6 Miles — A. F. E. 30

SANFORD HUNT, *Caretaker*

This section extends from the end of the previous section into the town of Concho. It is made up of seven miles of unimproved road, which is in very good condition, surfaced for the most part by the maintenance crew, and 12.6 miles of Federal Aid project No. 6, built and surfaced under the old Federal Aid specifications, which allowed a narrow width of roadway and also allowed an excess of oversize in the surfacing, but this is gradually being remedied by the maintenance crew.

The crew upon this section consists of the caretaker and truck driver, using one F. W. D. truck, an eight-foot grader, three small drags and one large road planer. No large improvement has been made upon this section, some fills widened, new pipe culverts placed, small bridges repaired and sufacing hauled.

U. S. Route 70

Holbrook-St. Johns Highway **Apache County**

Length 15.03 Miles **A. F. E. 326**

JOHN DUKE, *Caretaker*

This section extends from the town of Concho to the town of St. Johns and consists of Federal Aid 78A, 8.83 miles long, recently completed to full Federal Aid standards and State standards. The other section, 6.2 miles, is an unimproved road, but financed at the present time and plans completed for a Federal Aid, two-stage project, without surfacing.

This crew consists of the caretaker and truck driver, with an F. W. D. truck, an eight-foot grader and two small drags. It has only recently been placed uoon this section and has done nothing more than to keep the road in excellent shape as to the riding surface.

U. S. Route 70

St. Johns-Springerville Highway **Apache County**

Length 29.7 Miles **A. F. E. 300**

W. E. WILTBANK, *Caretaker*

This section extends from the town of St. Johns to the town of Springerville and is composed of Federal Aid 60, 68A and 68B, making a total of 29.7 miles, all built to Federal Aid and State standards, with the exception of the fords.

The crew of caretaker and truck driver with a Wehr grader and Ford truck, and two small drags, have kept this section in excellent shape.

Part of 68A is surfaced with a red cinder which does not show a proper compaction at the present time, although in use for about two years, and at some future date a binder will have to be added to this stretch to procure compaction.

U. S. Route 70

Springerville-St. Johns Highway — **Apache County**

Length 16 Miles — **A. F. E. 328**

HENRY S. BARRETT, *Caretaker*

This section extnds from the town of Springerville to the Arizona-New Mexico State line and is an unimproved section, very rocky and muddy. A crew of a caretaker and truck driver with an F. W. D. truck and one eight-foot grader, has recently been placed upon this section and will be augmented from time to time by a team and laborers, and by hauling surfacing and blading, this section, which has been the worst stretch of road in the district, will be gradually improved until such time as a new road can be constructed.

U. S. Route 66

Holbrook-Lupton Highway — **Navajo County**

Length 21.1 Miles — **A. F. E. 327**

GIVEN TEEL, *Caretaker*

This section extends from Holbrook to the Navajo-Apache County line and is an unimproved road made up of sandy and muddy stretches, the sandy stretches being good in wet weather and the muddy stretches being good in dry weather. A crew of a caretaker and truck driver with an F. W. D. truck, an eight-foot grader and two small drags, have recently been placed upon this section, and have it in very good shape at the present time.

U. S. Route 66

Holbrook-Lupton Highway — **Apache County**

Length 27.3 Miles — **A. F. E. 319**

E. A. ALLEN, *Caretaker*

This section, an unimproved road, extends from the Navajo-Apache County line to the town of Chambers, and for the most part is com-

posed of a sandy surface. This road when wet can be kept in an excellent conditions, smoother than pavement, but in dry weather and traffic, soon goes to pieces and impossible to hold.

As soon as the money is available, it is recommended that the experiment of oiling a portion of the Winslow-Holbrook Highway and placing calcium chloride upon a portion of the Holbrook-Lupton Highway be tried, both done as a maintenance cost reduction measure.

Two 50-foot wooden truss bridges were constructed on this section by Apache County during 1925, the State Highway Department making the necessary fills and taking them over as to maintenance.

The crew of a caretaker and truck driver, with an F. W. D. truck, an eight-foot grader and two small drags, have kept this section in remarkably good condition, considering the class of material encountered.

U. S. Route 66

Holbrook-Lupton Highway — Apache County
Length 26.7 Miles — A. F. E. 321

J. W. Mow, *Caretaker*

This section, an unimproved road, extends from the town of Chambers to the Arizona-New Mexico State line, and is composed of sandy and muddy stretches, the former being good in wet weather and the latter being good in dry weather.

The crew of a caretaker and truck driver, with an F. W. D. truck, an eight-foot grader, two small drags and one road planer, have kept this section in very good shape, but have been handicapped by the fact that no surfacing material exists upon this entire section. The only possible solution is to construct the muddy stretches, which become very nearly impassable during wet weather. The sandy stretches, although not good, can be kept in passable shape at all times.

General Maintenance and Recommendations

Some of the above stretches, as will be noted, are short. This is caused by the unimproved condition of the section. The mainte-

nance crews are gradully constructing these sections as to roadbed conditions. As soon as the entire system is built to full standards, both Federal Aid and State, these maintenance sections can be materially lengthened, thus reducing the maintenance cost.

Upon taking over the district the equipment, especially the trucks, was found in bad condition. This was the fault of no one in particular, but was caused by the maintenance sections in this part of the State being so far removed from any shop facilities. This equipment has been put in first-class condition, since the establishment of the shop at Holbrook.

PUBLICATIONS

ARIZONA HIGHWAYS

Vincent J. Keating, Editor

ARIZONA HIGHWAYS, the official organ of the Arizona Highway Department in disseminating information in reference to its activities in construction, betterment and maintenance of the state system, made its first appearance with Volume 1, Number 1, in April, 1925.

In its decision to issue a magazine devoted to the interest of good roads, the Arizona Highway Department followed the example of 22 other state highway departments, and that of the United States Bureau of Public Roads and the American Association of State Highway Officials. Several additional states have started magazines since the inauguration of ARIZONA HIGHWAYS.

The necessity of a publication of this kind, containing information for the general public in regard to Arizona's highway system, had become apparent through the scores of letters received each week by the department from every state in the Union and from Canada and Mexico, seeking data for travel or scientific purposes.

The most significant statement made by ARIZONA HIGHWAYS is that which greets the reader under the mast head on the first page of news matter: "Civilization Follows the Improved Highway."

Since its organization by the editor, under the direction of the state engineer and the chief engineer, the magazine has been in demand by citizens of this state as well as other states who seek information as to travel and other conditions of the highway system. Letters received by the department from both advertisers and readers of the publication, have commented favorably both on its appearance and subject matter. In fact, so great has been the demand that the files of several months have been exhausted.

In the center of each issue of the magazine, there appears and official condition map of the state highway system. On the other side of the page is a table showing the distance between any given city or town. On the page opposite the map is found the latest data on road conditions, compiled from the records of the district engineers. The "Engineers' Log" is another feature department. It gives the status of construction, betterment and maintenance in each district.

One of the features of the magazine which was and is of great benefit to those who travel the state highways for business or pleasure, is the series of Travelogues over the various highways, writen by the district engineers and illustrated by maps and pictures.

Among the contributors to the pages of ARIZONA HIGHWAYS are listed C. G. Morrison, senior engineer in charge of the local office of the United States Bureau of Public Roads; State Engineer W. C. Lefebvre, Chief Engineer W. W. Lane, District Engineers B. M. Atwood, T. S. O'Connell, George B. Shafer, E. M. Whitworth and W. R. Hutchins, and Chief Location Engineer C. C. Small.

A series of articles that have attracted widespread attention are those of Mr. Lane on highway financing. Another series are those of Mr. Shaffer on "The Use of Expansion Joints in Arizona." Mr. Shaffer is a recognized authority on the subject of expansion joints and his articles have been quoted in other state highway publications and in trade jounrals. W. R. Hutchins occasioned considerable favorable comment on his two tours of Arizona, "Through Arizona's Wonderland With a District Engineer" and "The Land of Opportunity," the former dealing with Northern Arizona and the latter with Southern Arizona.

The poems of Ira L. Wood on the road camps and other subjects

have been quoted by other state periodicals and newspapers. Col. J. H. McClintock, former state historian, A. H. Gardner of Tombstone, vice president of the Old Spanish Trails Highway Association, and a good-roads booster, and H. B. Watkins, general manager of the Phoenix Chamber of Commerce, are contributors.

During the 1926 State Fair, more than 35,000 persons attended the department's exhibit. Sample copies of the magazines and more than 5,000 maps, a replica of the condition map contained in ARIZONA HIGHWAYS with the table of distances on the back, were distributed at the exhibit.

In every sense ARIZONA HIGHWAYS has justified its existence. The receipts from advertising and subscriptions have equalled the cost of publication and distribution. It has furnished information in regard to Arizona's good roads that has been worth thousands of dollars to the state, a fact that can be proven by the steady increase in traffic in 1925 which was still greater in 1926, and the vast sums spent by tourists in seeing Arizona. Articles from ARIZONA HIGHWAYS quoted in other state highway publications and trade journals and the fact that it is in great demand by libraries in New York, Chicago, Baltimore, Philadelphia and other large eastern and western cities, is testimony of the inestimable value of the publication to Arizona.

ACCOUNTING DEPARTMENT

BY V. A. WOOD, *Chief Clerk*

MOST accounting is covered elsewhere in this report under the heading "Cost Accounting," by the cost accountant.

Purchases of materials, supplies and equipment are coveved elsewhere under the heading "Purchasing Department," by the purchasing agent.

Funds

Record of receipt and disbursement of funds is covered by a system of accounts which provides for daily reports of balances in funds and monthly reconciliation of fund records with the State Auditor.

Record of each charge against the "Authority for Expenditure" for each project is made under fund and cost account headings. Monthly reports are made up from ledger footings showing expenditures by funds and balancing expenditures against the "Authority for Expenditure."

Semi-annually a reconciliation is had and reported to the State Engineer, balancing expenditures by department, projects, counties and funds, against the budget, represented by "Authority for Expenditure" for each department or project.

Annually a report is made to the State Engineer covering all appropriations, expenditures and costs under fund, project or department and county headings.

Operating Costs

It will be seen by the accompanying tables that the accounting department has written during the last four fiscal periods 32,960 claims, covering 60,444 invoices for $11,292,413.31, an average of

8,240 claims, covering 15,111 invoices for $2,823,103.33 per year. It is also shown that the total operating cost of the accounting department for four years is $123,979.94, an average of $30,994.98 per year.

While the cost for the fiscal period just closed is higher than the average, it will be seen that the cost per claim and per invoice is considerably below the average. The average cost per invoice is $2.05, while the cost for the last fiscal period is $1.82.

The above data covers the cost of handling requisitions, invoices and claims through the general office records, from receipt of the requisition in the purchasing department to the mailing of the State Auditor's warrant to the payee.

Seventy-Five Per Cent Fund

The average time required to place a warrant in the hands of the payee for purchases made could be reduced about one-third if claims drawn against the 75 per cent funds were not required to be sent to the several Boards of Supervisors for approval. This results in a delay of from two to four weeks, depending on the time of meeting of the Boards of Supervisors each month.

The cost of passing invoices and claims through our records is increased by the handling of 75 per cent fund claims, one additional copy of the invoice and claim being required for the county files, and two additional handlings being required in the accounting department. To this should be added the additional cost required to keep record of fourteen 75 per cent funds under separate headings, and the necessary segregation of expenditures of funds in project records.

Pay Rolls

Pay rolls are paid by checks drawn against the State Engineer's imprest fund, the amount of which is $50,000. About 1,400 pay checks, totalling $100,000 to $110,000, are issued each month, requiring a turnover of nearly two and a half times, $4,000 being segregated within the imprest fund to pay time checks issued by the general foremen and engineers in the field.

Imprest Fund

It will readily be seen that the State Engineer's imprest fund is inadequate and should be increased to at least $100,000, in order to reduce the turnover to one and a fraction times per month, giving ample time for pay roll claims to pass from the accounting department to the offices of the Board of Directors and the State Auditor and warrants issuing from the Auditor's office to pass through the Auditor's records, the Governor's office for signature, the Board of Directors' records and to the accounting department for our record and depositing to reimburse the imprest fund.

Bonds

The highway department and the State of Arizona are adequately protected by bonds, covering all officials and employees having charge of funds, materials or equipment. The amounts of bonds are as follows:

State Engineer's official bond	$ 5,000
State Engineer's imprest fund bond	50,000
Chief Engineer	20,000
Chief Clerk	50,000
Assistant Chief Clerk	5,000
Pay Roll Clerk	5,000
Bookkeepers	2,000
Stock Clerk	2,000
Superintendent of Equipment	20,000
Storekeeper	5,000
Watchman	2,000
District Engineers, each	5,000
District Clerks	$1,000 and 2,000
Resident Engineers	2,000
General Foreman	2,000

The total amount of bonds now covering such officials and employees is $243,500.

Fire Insurance

Fire insurance sufficient to protect our investment in buildings,

stocks of supplies and equipment is carried by the department, the location of property and the amounts of policies being as follows:

Phoenix	$241,800
Tucson	17,800
Holbrook	6,500
Total	$266,100

Automobile Insurance

Fire, theft, collision and upset insurance is carried on seventeen passenger carrying automobiles operated by the department, the total amount of the "fleet policy" covering this class of insurance being $12,899.20.

Total Invoices and Claims
July 1st, 1922, to June 30th, 1926

Fiscal Year	Invoices	Claims	Amount	Average Amount Invoices	Average Amount Claim
1922-1923	11,123	5,976	$2,603,110.74	$23.41	$43.55
1923-1924	14,877	7,590	2,888,950.70	19.42	38.06
1924-1925	16,056	9,354	2,718,441.59	16.93	29.06
1925-1926	18,388	10,040	3,081,916.28	16.76	29.63
Average 4 Yrs.	60,444	32,960	11,292,413.31	76.52	140.30
Average 1 Yr.	15,111	8,240	2,823,103.33	19.13	35.07

ARIZONA HIGHWAY DEPPARTMENT

Costs—Accounting Department

July 1, 1922 to June 30, 1926

Fiscal Year	Salaries	Supplies	Total	Invoices Recorded	Average Cost	Claims Recorded	Average Cost*	Average Number Invoices Per Claim
1922-1923	$ 28,354.84	$ 565.20	$ 28,920.04	11,123	$2.60	5,976	$4.84	1.86
1923-1924	26,138.36	15.96	26,154.32	14,877	1.76	7,590	3.45	1.96
1924-1925	35,259.71	196.98	35,456.69	16,056	2.21	9,354	3.79	1.72
1925-1926	32,271.32	1,177.57	33,448.89	18,388	1.82	10,040	3.33	1.83
TOTAL	$122,024.23	$1,955.71	$123,979.94	60,444	.....	32,960	.....	.....
AVERAGE	30,506.04	488.93	30,994.98	15,111	2.05	8,240	3.76	1.83

ARIZONA HIGHWAY DEPARTMENT

RECAPITULATION

Status of Funds

July 1, 1924—June 30, 1926

	Total Receipts	Claims Registered	Claims in Transit June 30, 1926	Auditor's Balance
Apache 75%	$ 19,773.21	$ 20,608.59	$ 897.61	$ 62.23
Cochise "	239,249.93	212,823.11	2,407.27	28,834.09
Coconino "	52,204.91	41,864.14	593.55	10,934.32
Gila "	179,030.76	185,073.11	9,164.66	3,122.31
Graham "	30,689.10	34,274.97	3,673.20	87.33
Greenlee "	33,087.62	25,300.25	387.29	8,174.66
Maricopa "	343,895.56	361,491.51	29,761.13	12.165.18
Mohave "	32,215.55	23,087.60	477.71	9,605.66
Navajo "	30,805.06	27,107.73	2,446.18	6,143.51
Pima "	163.492.59	173,461.59	10,373.89	404.89
Pinal "	106,879.17	117,146.51	10.979.70	712.36
Santa Cruz "	24.350.94	23,053.38	230.39	1,527.95
Yavapai "	211,264.30	211,594.33	2,281.30	1,951.27
Yuma "	65,487.70	64,132.27	3,256.83	4,612.26
Federal Aid Road Account	1,794,830.72	1,820.733.54	46,689.36	20,786.54
State Highway Maintenance Account	904,820.56	922,990.96	26,007.86	7,837.46
25% Fund	1,498,757.62	1,672,739.25	203,971.94	29,990.31
Sacaton Prison Power Line	50,000.00	50,000.00		
Chloride Mohave County Line	40,000.00			40,000.00
St. Joseph BridgeEmergency	10,000.00	10,000.00		
Amado (Santa Cruz River) Fund	9,253.47	9,253.47		
TOTAL	$5,840,088.77	$6,006,736.31	$353,599.87	$186,952.33

ARIZONA HIGHWAY DEPARTMENT
RECAPITULATION
Net Expenditures
July 1, 1924 to June 30, 1926

County	Indirect	Engineering	Construction	Maintenance	Betterment	25%	75%	F. A	S.H.M.A	Special Appropriations	Total
Apache	$	$ 30,429.55	$ 119,425.92	$ 67,871.65	$	$ 14,466.60	$ 20,608.59	$ 133,144.04	$ 49,507.89	$	$ 217,727.12
Cochise		25,700.24	248,404.50	127,095.63	663.29	19,826.75	211,760.14	78,822.34	91,454.42		401,863.66
Coconino		13,669.54	196,552.80	70,000.37	1,21 .00	61,432.98	41,835.93	135,010.35	43,153.45		281,432.71
Gila		18,925.52	134,051.57	85,824.06	2,30 .07	18,906.83	184,429.73		37,772.66		241,109.22
Graham		42,411.36	475,137.40	64,998.24	5,58 .24	128,576.92	33,134.90	378,030.06	48,393.36		588,135.24
Greenlee		6,604.91	818.21	34,494.64	17,94 .13	7,257.11	25,286.25	731.33	26,585.20		59,859.89
Maricopa		68,050.82	669,979.38	259,042.92	3,964 92	88,730.50	360,242.67	404,390.00	147,674.87		1,001,038.04
Mohave		9,955.01	50,857.97	40,809.04		57,119.80	21,121.58	50.71	23,329.93		101,622.02
Navajo		9,523.12	51,554.10	46,396.63	2,51 .98	12,524.53	26,857.73	26,017.94	34,584.63	10,000.00†	109,984.83
Pima		33,680.25	220,184.42	82,185.73	8,103.22	5,227.44	172,399.05	123,717.10	42,810.03		344,153.62
Pinal		14,211.82	156,115.50	174,281.90	13,137.70	64,242.58	91,020.49	3,676.39	148,807.46	50,000.00†	357,746.92
Santa Cruz		2,431.11	12,730.47	60,719.15	39,943.76	18,093.28	23,053.38	677.78	64,750.05	9,250.00†	115,824.49
Yavapai		68,581.51	417,650.55	119,869.25	63,02 .33	41,345.52	211,594.33	359,354.85	56,835.94		669,130.64
Yuma		12,347.89	86,578.67	120,677.61		11,064 65	64,132.27	63,424.62	80,982.63		219,604.17
Gen. Projects A. F. E. 618-658					5,600.79	2,531.12			3,069.67		5,600.79
State Engineer's Salary	12,000.00(a)				(a)	12,000.00					12,000.00
State Engineer's Expense	2,234.13(a)				(a)	2,234.13					2,234.13
General Office General Overhaul, Co. Aid	304,593.71(a)				(a)	291,462.94	2,221.95	68.53	10,840.29		304,593.71
Warehouse and District Shops	150,939.44(b)				(b)	150,939.44					150,939.44
Dist. Engineer's Expense	23,614.09					23,614.09					23,614.09
Transfer of Funds	724,274.05					583,807.48	30,798.61	98,236.03	11,431.93		724,274.05
Refunds	74,269.69					57,355.06	521.49	15,383.13	1,006.54	3.47†	74,269.69
Interest	22.16-R*					20.50-R*		1.66-R*			22.16-R*
Total	$1,291,902.95	$356,522.65	$2,840,041.46	$1,354,266.82	$164,00 .43	$1,672,739.25	$1,521,019.09	$1,820,733.54	$922,990.96	$69,253.47	$6,006,736.31

CREDITS R*

(a) General Office	$245,665.29	(a) General Office $245,665.29
(a) General Overhaul	65,662.55	(a) General Overhaul 52,531.78
(a) County Aid	7,500.00	(a) County Aid 7,500.00
(b) Warehouse	146,994.14	(b) Warehouse 146,994.14
(b) District Shops	3,945.30	(b) District Shops 3,945.30

† Special Appropriations

St. Joseph Bridge	$10,000.00
Sacaton Prison Power Line	50,000.00
Amado Bridge	9,250.00
Amado Bridge Refunds	3.47
Total	$69,253.47

ARIZONA HIGHWAY DEPARTMENT
TWENTY-FIVE PER CENT FUND
Receipts and Disbursements
July 1, 1924 to June 30, 1926

	Receipts	Claims Registered	Claims in Transit	Auditor's Balance
Balance July 1, 1924	$ 50,470.38-R*			
Tax Apportionment, 1924-1925	162,469.82			
Tax Apportionment, 1925-1926	160.223.96			
Motor Vehicle Permits	5,000.00			
Motor Vehicle Mill Tax	51,518.22			
Gasoline Tax	321,444.70			
County Aid	53,000.00			
Transfer of Funds	634,012.07			
Refunds Deposited with Treasurer	61,559.23			
Apache County		14,466.60		
Cochise County		19,826.75		
Coconino County		61,432.98		
Gila County		18,906.83		
Graham County		128,576.92		
Greenlee County		7,257.11		
Maricopa County		88,730.50		
Mohave County		57,119.80		
Navajo County		12.524.53		
Pima County		5,227.44		
Pinal County		64,242.58		
Santa Cruz County		18,093.28		
Yavapai County		41,345.52		
Yuma County		11,064.65		
General A. F. E. 168-658		2,531.12		
General Office Accounts		305,676.57		
Warehouse and District Engineer Expenses		174,553.53		
Transfer of Funds		583,807.48		
Refunds		57,355.06		
TOTAL	$1,498.757.62	$1,672,739.25	$203,971.94	$29,990.31

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
SEVENTY-FIVE PER CENT FUND
Receipts and Disbursements
July 1, 1924 to June 30, 1926

County—	Balance July 1, 1926	Tax Approp. 1924-25	Tax Approp. 1925-26	Tfr. of Funds or Refunds	Gasoline Tax	Revenue Total	Claims Registered	Claims in Transit	Balance June 30, 1926
Apache	$ 1,427.38	$ 6,871.44	$ 6,678.05	$	$ 4,796.34	$ 19,773.21	$ 20,608.59	$ 897.61	$ 62.23
Cochise	30,784.22	84,909.53	81,109.90	1,279.12	41,167.16	239,249.93	212,823.11	2,407.27	28,834.09
Coconino	5,544.23	15,433.46	15,197.00	28.21	16,002.01	52,204.91	41,864.14	593.55	10,934.32
Gila	8,196.12	75,431.79	62,741.15	258.23	32,403.47	179,030.76	185,073.11	9,164.66	3,122.31
Graham	1,834.18	9,266.13	9,068.78	1,140.07	9,379.94	30,689.10	34,274.97	3,673.20	87.33
Greenlee	1,030.40	12,969.75	13,551.48	14.00	5,521.99	33,087.62	25,300.25	387.29	8,174.66
Maricopa	10,498.20	86,245.28	88,142.02	1,237.24	157,772.82	343,895.56	361,491.51	29,761.13	12,165.18
Mohave	3,808.05	10,106.35	9,074.03	5.67	9,221.45	32,215.55	23,087.60	477.71	9,605.66
Navajo	2,158.57	7,278.05	6,992.74		14,375.70	30,805.06	27,107.73	2,446.18	6,143.51
Pima	28,830.80	37,021.96	47,942.06	795.30	48,902.47	163,492.59	173,461.59	10,373.89	404.89
Pinal	7,671.26	28,609.50	30,878.36	26,126.02	13,594.03	106,879.17	117,146.51	10,979.70	712.36
Santa Cruz	755.40	7,614.38	7,507.96		8,473.20	24,350.94	23,053.38	230.39	1,527.95
Yavapai	40,215.10	68,443.75	70,274.92		32,330.53	211,264.30	211,594.33	2,281.30	1,951.27
Yuma	9,594.31	13,495.21	14,894.57		27,503.61	65,487.70	64,132.27	3,256.83	4,612.26
TOTAL	$152,348.22	$463,696.58	$464,053.02	$ 30,883.86	$421,444.72	$1,532,426.40	$1,521,019.09	$ 76,930.71	$ 88,338.02

ARIZONA HIGHWAY DEPARTMENT
FEDERAL ROAD ACCOUNT
Receipts and Disbursements
July 1, 1924 to June 30, 1926

	Receipts	Claims Registered	Claims in Transit	Auditor's Balance
Balance in Fund, 7-1-24	$ 374,445.36			
Federal Aid	1,317,916.06			
County Aid	50,982.71			
Transfer of Funds	36,457.09			
Refunds Deposited with State Treasurer	15,029.50			
Apache County		$ 133,144.04		
Cochise County		78,822.34		
Coconino County		135,010.35		
Gila County				
Graham County		378,030.06		
Greenlee County		731.33		
Maricopa County		404,390.00		
Mohave County		50.71		
Navajo County		26,017.94		
Pima County		123,717.10		
Pinal County		3,676.39		
Santa Cruz County		677.78		
Yavapai County		359,354.85		
Yuma County		63,424.62		
General Overhaul		68.53		
Transfer of Funds and Refunds		113,619.16		
Interest		1.66-R*		
TOTAL	$1,794,830.72	$1,820,733.54	$46,689.36	$20,786.54

Credits. *R

ARIZONA HIGHWAY DEPARTMENT

State Highway Maintenance Account

Receipts and Disbursements

July 1, 1924 to June 30, 1926

	Receipts	Claims Registered	Claims in Transit	Auditor's Balance
Balance in Fund, 7-1-24	$ 74,736.14			
Motor Vehicle Fees, 1924-1925	395,592.25			
Motor Vehicle Fees, 1925-1926	422,296.50			
Transfer of Funds	11,170.05			
Refunds	1,025.62			
Apache County		49,507.89		
Cochise County		91,454.43		
Coconino County		43,153.45		
Gila County		37,772.66		
Graham County		48,393.36		
Greenlee County		26,585.20		
Maricopa County		147,674.87		
Mohave County		23,329.93		
Navajo County		34,584.63		
Pima County		42,810.03		
Pinal County		148,807.46		
Santa Cruz County		64,750.05		
Yavapai County		56,835.94		
Yuma County		80,982.63		
General A. F. E. 618-658		3,069.67		
General Overhaul		10,840.29		
Transfer of Funds and Refunds		12,438.47		
TOTAL	$904,820.56	$922,990.96	$26,007.86	$7,837.46

ARIZONA HIGHWAY DEPARTMENT
COUNTY AID RECEIVED
July 1, 1924 to June 30, 1926

	1924-1925	1925-1926	Total	
APACHE COUNTY				
St. Johns-Springerville F. A. 68A, A. F. E. 531	$ 832.71		$ 832.71	
St. Johns-Springerville F. A. 68B, A. F. E. 532	15,400.00		15,400.00	
Holbrook-St. Johns F. A. 78B, A. F. E. 648		$ 3,500.00	3,500.00	
TOTAL APACHE COUNTY				$19,732.71
GILA COUNTY				
San Carlos Survey A. F. E. 620A			7,500.00	
Globe Paving A. F. E. 598		10,000.00	10,000.00	
TOTAL GILA COUNTY				17,500.00
GRAHAM COUNTY				
Solomonville-Duncan State Line F. A. 88-A, A.F.E. 626		7,250.00	7,250.00	
TOTAL GRAHAM COUNTY				7,250.00
MOHAVE COUNTY				
Hillside-Kingman A. F. E. 570	1,500.00		1,500.00	
TOTAL MAHAVE COUNTY				1,500.00
NAVAJO COUNTY				
Winslow-Coco Co. Line F. A. 22A, A. F. E. 501	4,000.00		4,000.00	
TOTAL NAVAJO COUNTY				4000.00
SANTA CRUZ COUNTY				
Nogales-Patagonia A. F. E. 586	10,000.00		10,000.00	
Vail-Sonoita Hihgway Sec. 2 A. F. E. 661		1,000.00	1,000.00	
TOTAL SANTA CRUZ COUNTY				11,000.00
YUMA COUNTY				
Yuma-Gila Bend Highway F. A. 82, A. F. E. 544		20,000.00	20,000.00	
TOTAL YUMA COUNTY				20,000.00
GRAND TOTAL	$39,232.71	$41,750.00	$80,982.71	$80,982.71

ARIZONA HIGHWAY DEPARTMENT
GENERAL PROJECTS
July 1, 1924 to June 30, 1926

A. F. E.	Name of Project	Engineering	Construction	Maint.	Betterment	25%	75%	F. A.	SHMA	Total
618	Mile Post Survey				4253.05	1183.38			3069.67	4253.05
658	Signing St. Hwy. Systems				1347.74	1347.74				1347.74
	TOTAL				$5600.79	$5231.12			$3096.67	$5600.79

ARIZONA HIGHWAY DEPARTMENT
APACHE COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION			FUNDS				
	Engineering	Construction	Maintenance	25%	75%	F. A.	S.H.M.A.	TOTAL
518—St. Johns-Springerville F. A. 60	$ 4.05	$ 424.25	$	$	$	$ 428.30	$	$ 428.30
531—St. Johns-Springerville F. A. 68-A	221.24	393.90		55.22		559.92		615.14
532—St. Johns-Springerville F. A. 68-B	7,648.91	61,634.19		498.31		68,784.79		69,283.10
545—Dead River Bridge F. A. 83	6,951.40			4,866.90	2,084.55			6,951.45
571—Concho-St. Johns F. A. 78-A	15353.42	56,973.58		4,402.76	4,553.21	63,371.03		72,327.00
591—Springerville-Concho	183.71			183.71				193.71
592—Holbrook-McNary	66.77			66.77				66.77
Maintenance:								
300—St. Johns-Springerville			12,953.51	917.73	3,097.40		8,938.38	12,953.51
301—Holbrook-St. Johns			15,472.17	738.73	4,001.91		10,731.53	15,472.17
302-A Holbrook-St. Johns			8,424.67	559.63	135.00		7,730.04	8,424.67
319—Adamana-Lupton			15,091.77	440.26	3,818.57		10,832.94	15,091.77
321—Adamana-Lupton			15,833.22	1,696.27	2,917.95		11,219.00	15,833.22
326—Concho-St. Johns			96.31	40.31			56.00	96.31
Total	$30,429.55	$119,425.92	$67,871.65	$14,466.60	$20,608.59	$133,144.04	$49,507.89	$217,727.12

ARIZONA HIGHWAY DEPARTMENT
COCHISE COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION				FUNDS				
	Engineering	Construction	Maintenance	Betterment	25%	75%	F. A.	S.H.M.A.	Total
541—Bisbee-Tombstone F. A. 79-A	$ 9,345.42	$ 91,622.61	$	$	$ 1,299.09	$ 28,330.59	$ 71,338.35	$	$100,968.03
564—Douglas-Safford	1,420.60-R*	96,310.78			9,387.95	85,502.23			94,890.18
579—Douglas-Safford	602.32				602.32				602.32
610—Benson-Bisbee, Sur. F. A. 79	8,202.77				6,135.20	2,067.57			8,202.77
617—Benson-Douglas Hwy. F. A. 79-B	3,810.01	11,720.48			5,957.65-R*	14,004.20	7,483.94		15,530.49
619—Tombstone-Bisbee Paving	1,412.05	21,138.33			6.85	22,543.48	.05		22,550.38
624—Bisbee-Douglas Paving F. A. 79-C	1,170.71				261.12	909.59			1,170.71
647—Douglas-Dodeo Dips		3,245.98				3,245.98			3,245.98
656—Douglas-Safford Hwy., Sec. 2	1,393.83	11,303.38			.75	12,696.46			12,697.21
656-A—Douglas-Safford Hwy, Sec. 2	22.00	2,362.23				2,384.23			2,384.23
657—Douglas-Safford Hwy, Sec. 3	1,158.98	10,700.71			.57	11,859.12			11,859.69
667—Tombstone-Bisbee, Guard Fence	2.75			438.10		440.85			440.85
670—Tucson-Benson				210.02		210.02			210.02
679—Bisbee-Tombstone Betterment				15.17				15.17	15.17
MAINTENANCE:									
456-B—Tucson-Benson			7,505.10		365.61	206.00		6,933.49	7,505.10
458—Benson-Tombstone			21,936.53		628.68	6,466.80		14,841.05	21,936.53
461—Tombstone-Nogales			17,824.93		1,122.75	841.37		15,860.81	17,824.93
462—Bisbee-Tombstone			18,475.70		1,211.38	5,800.80		11,463.52	18,475.70
464—Bisbee-Douglas Paving			9,262.06		773.10	240.39		8,248.57	9,262.06
465—Douglas-Rodeo			17,902.71		979.38	5,870.91		11,052.42	17,902.71
466—Douglas-Rodeo			18,448.05		1,421.00	4,789.46		12,237.59	18,448.05
468—Douglas-Safford			15,740.55		1,588.65	3,350.09		10,801.81	15,740.55
Total	$25,700.24	$248,404.50	$127,095.63	$663.29	$ 19,826.75	$211,760.14	$ 78,822.34	$ 91,454.43	$401,863.66

Credits R*

ARIZONA HIGHWAY DEPARTMENT
COCONINO COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION				FUNDS				
	Engineering	Construction	Maintenance	Betterment	25%	75%	F. A.	S.H.M.A.	Total
537—Winslow-Flagstaff F. A. 74	$ 9,544.28	$196,139.05	$	$	$ 53,299.45	$ 17,805.73	$134,578.15	$	$205,683.33
543—Winslow-Flagstaff F. A. 81	2,045.21				298.96	1,746.25			2,045.21
593—Flagstaff-Fredonia	878.03				878.03				878.03
630—Williams Streets F. A. 89-A	1,202.02				443.83	325.99	432.20		1,202.02
652—Branigan Lane				1,210.00				1,210.00	1,210.00
660—Angel Canyon Diablo		413.75			2.60	411.15			413.75
MAINTENANCE:									
306—Flagstaff-Williams			16,188.80		1,124.19	8,058.35		7,006.26	16,188.80
307—Flagstaff-Williams			14,464.43		1,536.25	7,956.49		4,971.69	14,464.43
308-A—Williams-Ash Fork			14,327.98		1,394.81	963.06		11,970.11	14,327.98
311-B—Seligman-Nelson			5,602.52		15.02-R*			5,617.54	5,602.52
322 B—Winslow-Coconino County Line			9,147.36		1,420.23	957.50		6,769.63	9,147.36
324—Angel Canyon Diablo			10,269.28		1,049.65	3,611.41		5,608.22	10,269.28
Total	$13,669.54	$196,552.80	$70,000.37	$1,210.00	$ 61,432.98	$ 41,835.93	$135,010.35	$ 43,153.45	$281,432.71

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
GILA COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
560—Rice-Springerville	$ 58.06	$ 55,912.60	$	$	$ 278.09	$ 55,692.57	$	$	$ 55,970.66
563—Globe-Roosevelt	38.96	40,669.92			699.48	40,009.40			40,708.88
567—Superior-Miami		1,606.74-R*			2,543.26-R*	936.52			1,606.74-R*
569—Chandler-Casa Grande					178.09	178.09-R*			
598—Globe-Roosevelt	4,632.10	25,486.63			10,202.88	19,915.85			30,118.73
620-A—San Carlos Survey	11,601.79				3,795.65	7,806.14			11,601.79
634—Globe-Miami Zoning				39.64-R*		39.64-R*			39.64-R*
639—Globe Cattle Guard		290.90				290.90			290.90
642-A—Apache Trail Survey	2,135.21				2,135.21				2,135.21
654—Rice-San Carlos River Bridge				2,347.71		2,347.71			2,347.71
659—Globe-Roosevelt Highway	9.00	13,298.26			.23	13,307.03			13,307.26
676—Miami Paving	450.40				91.55	358.85			450.40
MAINTENANCE:									
316—Prescott-Jerome					11.35	11.35-R*			
405—Globe-San Carlos			27,693.46		1,223.37	13,674.97		12,795.12	27,693.46
406—Globe-Roosevelt			33,420.97		1,976.50	19,044.29		12,400.18	33,420.97
407—Miami-Superior			24,709.63		857.69	11,274.58		12,577.36	24,709.63
Total	$18,925.52	$134,051.57	$ 85,824.06	$2,308.07	$18,906.83	$184,429.73	$	$3,772.66	$241,109.22

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
GRAHAM COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
526—Geronimo-Solomonville F. A. 63	$ 1,290.93	$ 47,998.50	$	$	$ 259.07-R*	$ 3,241.59	$ 46,306.91	$	$ 49,289.43
530—Geronimo-Solomonville F. A. 67	12,950.14	206,040.03			3,385.59		215,604.58		218,990.17
540—Solomon-Duncan F. A. 77	10,238.29	173,733.59			104,654.68		79,317.20		183,971.88
575—Safford-Bowie	725.21	4,558.74			4.00	5,279.95			5,283.95
576—Safford-Bowie Highway					531.65-R*	531.65			
600—San Carlos Bridge Repairs				2,838.16	147.19			2,690.97	2,838.16
605—Black Rock Wash				393.89				393.89	393.89
606—San Carlos Bridge				872.97	105.90			767.07	872.97
608—Paint S. C. and Gila Bridges				1,483.22	806.15			677.07	1,483.22
613—Canal Cross F. A. 63		46.95				46.95			46.95
620-B—San Carlos Reloc. Survey	11,303.62				8,732.61	2.571.01			11,303.62
626—Solomon-Duncan St. Line F. A. 88-A	5,903.17	39,940.55			8,827.86	214.49	36,801.37		45,843.72
674—Ashurst Bridge		2,819.04				2,819.04			2,819.04
MAINTENANCE:									
402-B—Clifton-Solomonville			4,124.27		425.39-R*	231.00		4,318.66	4,124.27
404—Globe-San Carlos			28,186.72		88.78	7,780.92		20,317.02	28,186.72
410—Geronimo-Solomonville			23,412.80		1,849.85	8,588.30		12,974.65	23,412.80
411—Solomonville-Duncan			9,274.45		1,190.42	1,830.00		6,254.03	9,274.45
Total	$ 42,411.36	$475,137.40	$64.998.24	$5,588.24	$128,576.92	$ 33,134.90	$378,030.06	$48,393.36	$588,135.24

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
GREENLEE COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION				FUNDS				
	Engineering	Construction	Maintenance	Betterment	25%	75%	F. A.	S.H.M.A.	Total
580—Mule Creek Road	$.....	$.....	$.....	$17,942.13	$ 6,614.74	$ 11,327.39	$.....	$.....	$17,942.13
627—Solomon-Duncan St. Line Sur.F.A. 88-B	5,644.79	.....	.....	.....	1 304.67	4,874.77	534.65-R*	.....	5,644.79
672—Safford-Duncan Highway F. A. 88-B	960.12	818.21	.....	.....	.....	512.35	1,265.98	.....	1,778.33
MAINTENANCE:									
401—Clifton Mule Creek	.....	.....	15,954.75	.....	180.90	6,820.10	.....	8,953.75	15,954.75
402-A—Clifton-Solomonville	.....	.....	15,514.82	.....	1,600.21-R*	992.95	.....	16,122.08	15,514.82
412—Solomonville-Duncan St. Line	.....	.....	3,025.07	.....	757.01	758.69	.....	1,509.37	3,025.07
Total	$6,604.91	$ 818.21	$34,494.64	$17,942.13	$ 7,257.11	$ 25,286.25	$ 731.33	$ 26,585.20	$59,859.89

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
MARICOPA COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
516—Gila Bend-Piedra F. A. 56	$	$ 2,384.19	$	$	$ 2,384.19	$	$	$	$ 2,384.19
517—Wickenburg-Hot Spgs Jct. F. A. 59	11.15	599.70			790.77-R*		1,401.62		610.85
527—Gillespie Dam-Hass. F. A. 64-A	1,934.07	661.51-R*			694.22	286.00	292.34		1,272.56
528—Mesa Sup. Paving F. A. 65	141.87				130.79		11.08		141.87
533—Piedra Stanvix F. A. 69	499.96	36,190.37			5,777.99-R*		42,468.32		36,690.33
535—Phoenixx, Yuma, Buckeye, Hassayampa F. A. 71	16,475.00	292,052.10			6,888.92-R*		315,416.02		308,527.10
539—Nada-Hot Springs Jct. F. A. 76	2,096.53	12,997.05			420.43		14,673.15		15,093.58
553—Chandler-Casa Grande	1,906.79	35,279.14			4,894.19	32,291.74			37,185.93
557—Mesa Sup. Surfacing		592.73				592.73			592.73
559—Nada-Beardsley	3,942.35	30,570.93			1,032.96	33,480.32			34,513.28
566—Gillespie Dam-Hassayampa		368.12			1,197.78-R*	1,565.90			368.12
568—Mormon Flats	917.40	42,316.47			43,233.87				43,233.87
572—Phoenix-Wickenburg F. A. 84-A	2,110.17	15,383.37			415.90		17,077.64		17,493.54
581—Phoenix-Buckeye Highway	803.92				803.92				803.92
582—Tempe Bridge Repairs	42.75	6,638.20			1,773.28	4,907.67			6,680.95
596—Phoenix-Maricopa Survey	467.57				467.57				467.57
597—Phoenix-Mesa Survey	487.19				487.19				487.19
601—Gillespie Dam Bridge F. A. 64-B	13,321.95	12,319.15			1,750.28	11,111.84	12,778.98		25,641.10
607—Apache Trail	19,428.86	167,745.81			21,728.78	165,445.89			187,174.67
607-A—Apache Trail Bridges		11,379.65			2,194.00	9,185.65			11,379.65
615—Hassayampa Bridge Repairs								263.75	263.75
616—Gila River Crossing				700.00	700.00				700.00
632—Hassayampa River Bridge	324.20				13.05	40.30	270.85		324.20
637—Bixby Cattle Guard									
642-B—Apache Trail Survey	2,610.86				2,610.86				2,610.86
643—Hassayampa River Bridge Repairs		3,823.91			62.32	3,761.59			3,823.91
645—New River Bridge				3,001.17	132.32-R*	100.00		3,033.49	3,001.17
675—Phoenix-Buckeye, Agua F. R. Brge	528.23				528.23				528.23

ARIZONA HIGHWAY DEPARTMENT
MARICOPA COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
678—Prescott-Phoeni. Hgwy F. A. 84-B									
MAINTENANCE:									
353—Piedra-Gillespie Dam			43,117.20		1,288.52	19,667.38		22,161.30	43,117.20
354—Maricopa Paving and Bridges			62,353.01		4,632.05	23,768.16		33,952.80	62,353.01
355—Agua Fria Crossing			539.46			314.72		224.74	539.46
356-A—Mesa-Superior			7,243.81		441.19	98.32		6,704.30	7,243.81
359—Apache Trail			24,147.21		821.38	13,203.11		10,122.72	24,147.21
360—Apache Trail			18,448.62		1,079.79	10,882.65		6,486.18	18,448.62
361-A—Wickenburg-Hot Springs Jct.			12,496.27		533.32	327.25		11,635.70	12,496.27
364—Hassayampa-Gila Bend			31,049.35		1,732.87	15,969.31		13,347.17	31,049.35
365—Maricopa-Hot Springs			30,182.02		3,110.89	13,266.14		13,804.99	30,182.02
368—County Line Piedra			22,357.38		2,290.67	277.50		19,789.21	22,357.38
370—Morristown Castle-Hotsprings			79.06		79.06				79.06
373-A—Chandler-Casa Grande			5,341.86		423.38			4,918.48	5,341.86
374—Gillespie Dam Crossing			1,567.67		337.63			1,230.04	1,567.67
375—Phx,, Tempe, Gila Bend, Buckeye			120.00			120.00			120.00
465—Douglas-Rodeo					421.50	421.50-R*			
Total	$68,050.82	$669,979.38	$259,042.92	$3,964.92	$ 88,730.50	$360,242.67	$404,390.00	$147,674.87	$1,001,038.04

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
MOHAVE COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
508—Topock-Oatman F. A. 39	$	$ 128.83-R*	$	$ 128.83-R*	$	$	$	$ 128.83-R*
542—Ash Fork-Kingman F. A. 80	1,072.02	70.85		1,128.50	14.37			1,142.87
570—Hillside-Kingman	505.68	50,915.95		51,421.63				51,421.63
603—Oatman-Topock F. A. 85	5,628.04			799.64	4,828.40			5,628.04
663—Ash Fork-Kingman F. A. 80-D	2,749.27				2,698.56	50.71		2,749.27
MAINTENANCE								
311-C—Seligman-Nelson			3,951.07	13.23			3,937.84	3,951.07
314—Kingman-Oatman			14,554.99	686.51	4,571.15		9,297.33	14,554.99
315—Oatman-Topock			16,301.10	1,767.38	5,997.46		8,536.26	16,301.10
325—Peach Spring-Kingman			6,001.88	1,431.74	3,011.64		1,558.50	6,001.88
Total	$ 9,955.01	$50,857.97	$40,809.04	$57,119.80	$21,127.58	$ 50.71	$23,329.93	$101,622.02

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
NAVAJO COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	St. Josephs B., Fund	Total
501—Winslow-Coco. Co. Line F. A. 22	$1,566.81	$12,910.73	$	$	$ 4,128.80	$ 463.21	$ 9,885.53	$	$	$ 14,477.54
509—Holbrook-Winslow Sec. 1 F. A. 40	10.05	10.60-R*			.55-R*					.55-R*
511—Holbrook-Winslow Sec. 2 F. A. 40	11.50	6.34			17.84					17.84
561—Rice-Springerville	20.80				20.80					20.80
584—St. Josephs Bridge, Holbrook-Winslow, Sec. 3 F. A. 40 Reo	3,278.98	19,328.88			205.82		12,402.04		10,000.00	22,607.86
612—Winslow City Limits F. A. 40	3.45	6,426.95			3.45			6,426.95		6,430.40
623—Winslow Bridge				2,510.98		311.72		2,199.26		2,510.98
633—Holbrook-Winslow Bridge F. A. 40	1,429.62	2,806.98			323.05	606.63	3,306.92			4,236.60
648—Holbrook-St. Johns F. A. 78-B	3,150.31	540.80				3,267.66	423.45			3,691.11
662—District 5, Yards	51.60	9,544.02			2,507.60	7,088.02				9,595.62
MAINTENANCE										
302-B—Holbrook-St. Johns			6,893.06		458.08			6,434.98		6,893.06
304—Holbrook-St. Johns			18,444.21		2,065.98	7,870.73		8,507.50		18,444.21
305—Holbrook-Winslow			19,727.47		2,602.91	7,249.76		9,874.80		19,727.47
322-A—Winslow-Coco. County Line			1,331.89		190.75			1,141.14		1,331.89
Total	$9,523.12	$51,554.10	$46,396.63	$2,510.98	$12,524.53	$26,857.73	$26,017.94	$34,584.63	$10,000.00	$109,984.83

Credits R*

ARIZONA HIGHWAY DEPARTMENT
PIMA COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
505—Tucson-Nogales Brs. F. A. 25-B	$ 184.42	$ 9,352.32	$.....	$.....	$9,179.36-R*	$ 4,563.68	$ 14,152.42	$.....	$ 9,536.74
538—Tucson-Nogales Brs. F. A. 75	2,264.99	12,359.49	.....	.....	456.36	530.12	13,638.00	.....	14,624.48
550—Tucson-Florence	.....	69.07-R*	.....	.....	.....	69.07-R*	.....	.....	69.07-R*
577—Tucson-Nogales F. A. 86-A	23,676.83	130,983.29	.....	.....	2,623.60	56,109.84	95,926.68	.....	154,660.12
585—Vail-Empire Ranch	.....	.....	.....	4,162.55	484.55	3,088.99	.....	589.01	4,162.55
614—Tucson Shop Improvements	.....	3,782.47	.....	.....	3,782.47	.....	.....	.....	3,782.47
640—Tucson-Vail	4,669.07	.....	.....	.....	254.72	4,414.35	.....	.....	4,669.07
644—Tucson-Sonoita	2,884.94	63,775.92	.....	.....	.....	66,660.86	.....	.....	66,660.86
644-A—Tucson-Sonoita	.....	.....	.....	3,682.17	.....	3,682.17	.....	.....	3,682.17
664—Tucson-Nogales Highway	.....	.....	.....	.....	.....	.....	.....	.....	.....
665—Tucson-Benson Guard Fence	.....	.....	.....	258.50	.....	258.50	.....	.....	258.50
MAINTENANCE									
451-B—Tucson-Florence	.....	.....	22,031.43	.....	2,005.03	12,306.17	.....	7,720.23	22,031.43
454—Tucson-Benson	.....	.....	19,812.34	.....	1,476.81	13,283.94	.....	5,051.59	19,812.34
455—Tucson-Nogales Paving	.....	.....	3,152.02	.....	422.41	2,035.16	.....	694.45	3,152.02
456-A—Tucson-Benson	.....	.....	16,185.19	.....	780.16	874.01	.....	14,531.02	16,185.19
459-A—Tucson-Nogales	.....	.....	6,868.34	.....	399.49	414.39	.....	6,054.46	6,868.34
467—Tucson-Rillito Bridge	.....	.....	1,258.20	.....	69.00	283.98	.....	905.22	1,258.20
469—Tucson-Nogales Highway	.....	.....	12,878.21	.....	1,652.20	3,961.96	.....	7,264.05	12,878.21
Total	$33,680.25	$220,184.42	$82,185.73	$ 8,103.22	$5,227.44	$172,399.05	$123,717.10	$42,810.03	$344,153.62

Credits: R*

ARIZONA HIGHWAY DEPARTMENT
PINAL COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION				FUNDS					
	Engineering	Construction	Maintenance	Betterment	25%	75%	F. A.	S.H.M.A.	Sacaton Prison Power Line	Total
502—Florence-Superior F. A. 23	$ 57.61	$ 2,690.38	$	$	$ 928.40-R*	$	$ 3,676.39	$	$	$ 2,747.99
556—Superior-Globe					445.78-R*	445.78				
569—Chandler-Casa Grande	6,443.35	103,296.20			50,532.78	59,206.77				109,739.55
573—Sacaton Pris Power Line	1,640.50	48,359.50							50,000.00	50,000.00
620-C—San Carlos Reloc. Survey	4,556.28				884.08	3,672.20				4,556.28
641—Florence-Superior Highway				13,137.70	437.52			12,700.18		13,137.70
642-C—Apache Trail Survey	284.25				284.25					284.25
655—Florence-Chandler	1,011.46	1,769.42			2,780.88					2,780.88
680—Florence-Chandler Sec.	218.37				218.37					218.37
MAINTENANCE										
356-B—Mesa, Superior and Apache Trail			25,046.48		1,525.70			23,520.78		25,046.48
358—Mesa-Superior Paving			597.47		100.43			497.04		597.47
367—Florence-Superior			36,960.95		1,951.59	7,724.43		27,284.93		36,960.95
373-B—Chandler-Casa Grande			20,158.00		1,597.72	359.55		18,200.73		20,158.00
369—Superior-Miami			35,794.43		1,516.95	8,484.31		25,793.17		35,794.43
451-A—Tucson-Florence			1,965.91		282.70			1,683.21		1,965.91
452—Tucson-Florence			25,762.12		1,412.89	7,130.53		17,218.70		25,762.12
453—Tucson-Florence			27,996.54		1,894.40	4,193.42		21,908.72		27,996.54
454—Tucson-Benson					196.50	196.50-R*				
Total	$14,211.82	$156,115.50	$174,281.90	$13,137.70	$ 64,242.58	$91,020.49	$ 3,676.39	$148,807.46	$ 50,000.00	$357,746.92

Credits R*

ARIZONA HIGHWAY DEPARTMENT
SANTA CRUZ COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Amado Bridge	Total
529—Tucson-Nogales Bridges F. A. 66	$ 231.10-R*	$ 131.00	$	$	$ 777.88-R*	$	$ 677.78	$	$	$ 100.10-R*
578—Structure Adjacent to F. A. 66	613.66	3,499.11			338.38	3,774.39				4,112.77
586—Nogales-Patagonia	399.57			15,116.65	11,146.49	4,369.73				15,516.22
594—Nogales-Patagonia Reconstruction				24,414.65	1,667.67	643.25		22,103.73		24,414.65
621—Amado Bridge	1,632.30	8,517.37			899.67				9,250.00	10,149.67
661—Vail-Sonoita Sec. 2	8.00	582.99			590.99					590.99
666—Tombstone-Nogales Guard Fence				107.15				107.15		107.15
668—Tucson-Nogales Cattle Guard										
669—Tucson-Nogales Highway	8.68			305.31				313.99		313.99
MAINTENANCE										
459-B—Tucson-Nogales			20,290.05		1,307.58	1,119.71		17,862.76		20,290.05
462—Tombstone-Nogales			19,371.85		1,571.92	5,989.26		11,810.67		19,371.85
470—Tombstone-Nogales			21,057.25		1,348.46	7,157.04		12,551.75		21,057.25
Total	$2,431.11	$12,730.47	$60,719.15	$39,943.76	$ 18,093.28	$ 23,053.38	$ 677.78	$ 64,750.05	$9,250.00	$115,824.49

Credits R*

ARIZONA HIGHWAY DEPARTMENT
YAVAPAI COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
507—Prescott-Jerome F. A. 36-B	$ 1,529.33	$ 13,424.31	$	$	$ 429.99	$ 1,619.32	$ 12,904.33	$	$ 14,953.64
520—Prescott-Ash Fork F. A. 61		644.72			643.72		1.00		644.72
521—Prescott-Ash Fork F. A. 62	4.28	2,126.03			1,211.91		918.40		2,130.31
522—Prescott-Ash Fork F. A. 62-B	109.15	3.00			109.15		3.00		112.15
523—Prescott-Ash Fork F. A. 62	48.63-R*				48.63-R*				48.63-R*
525—Prescott-Ash Fork F. A. 62		38.24					38.24		38.24
536—Prescott, Phoenix, White Spar, Congress Jct. F. A. 72-A	17,489.31	171,358.86			3,058.44		186,789.73		188,848.17
574—Hillside-Kingman	320.27	1,397.96				1,718.23			1,718.23
587—Prescott-Jer'e Underpass F. A. 19B	2,300.98	10,984.66			421.12	11,317.44	1,547.08		13,285.64
589—Prescott-Phoenix F. A. 72-B	28,758.23	198,864.54			2,405.34	69,465.84	155,753.59		227,622.77
590—Prescott-Ash Fork F. A. 62-B	2,278.34	14,511.12			722.65	15,644.48	422.33		16,789.46
595—Prescott-Jerome F. A. 36		3,250.24			3,250.24				3,250.24
599—Hell Canyon Bridge				380.78				380.78	380.78
602—Two Cattle Guards		404.38				404.38			404.38
604—Ash Fork West Survey	5,746.17	450.00			6,196.17				6,196.17
609—Hillside-Kingman Extension	1,314.00				1,314.00				1,314.00
611—Page Highway Guard		192.49			76.00	116.49			192.49
622—Prescott-Jerome Resurfacing F. A. 19-A	1,246.34			59,807.73	9,740.63	51,313.44			61,054.07
635—Prescott-Granite Dells Survey	4,022.97				1,494.89	2,528.08			4,022.97
636—Prescott-Jerome Underpass F.A. 36B	29.65				29.65				29.65
649—Ash Fork Project F. A. 89-B	1,420.97					443.82	977.15		1,420.97
650—Fill 2 Miles East Ash Fork				217.50		217.50			217.50
651—Fill 2 Miles West Ash Fork				180.00		180.00			180.00
653—Caliche Pit				2,443.32	36.80	2,344.97		61.55	2,443.32
677—Prescott-Phx. Hwy. F. A. 84-C	2,060.15				2,060.15				2,060.15

ARIZONA HIGHWAY DEPARTMENT
YAVAPAI COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	Betterment	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
MAINTENANCE									
308-B—Williams Ash Fork			2,420.78		$ 269.52	$ 100.00	$	$ 2,060.26	$ 2,429.78
310—Ash Fork-Seligman			17,182.84		2,263.95	9,488.34		5,430.55	17,182.84
311-A—Seligman-Nelson			14,834.10		39.85-R*	1,267.48		13,606.47	14,834.10
316—Prescott-Jerome			12,612.83		106.73-R*	8,885.91		3,833.65	12,612.83
317—Prescott-Jerome			14,040.07		1,032.56	8,704.14		4,303.37	14,040.07
318—Prescott-Ash Fork			14,313.09		935.08-R*	10,924.62		4,323.55	14,313.09
320—Prescott-Ash Fork			14,986.26		2,783.22	8,702.45		3,500.59	14,986.26
361-B—Wickenburg-Congress Jct.			16,401.05		686.63	47.70		15,666.72	16,401.05
372—Congress Jct.-White Spar			10,763.52		2,361.53	5,624.90		2,777.09	10,763.52
376—Yarnell-Congress Jct.			2,305.71		879.56	534.80		891.36	2,305.71
Total	$68,581.51	$417,650.55	$119,869.25	$63,029.33	$41,345.52	$211,594.33	$359,354.85	$56,835.94	$669,130.64

Credits R*

ARIZONA HIGHWAY DEPARTMENT
YUMA COUNTY
July 1, 1924 to June 30, 1926

A. F. E. Name of Project	DISTRIBUTION Engineering	Construction	Maintenance	FUNDS 25%	75%	F. A.	S.H.M.A.	Total
514—Welton-Aztec F. A. 55	$ 61.70	$ 63.86	$	$ 61.70	$	$ 63.86	$	$ 125.56
515—Aztec Co. Line F. A. 55	690.83	36,230.43		86.96		36,834.30		36,921.26
544—Yuma-Gila Bend F. A. 82-B	8,258.36	25,836.13		107.24	8,037.95	25,949.30		34,094.49
562—Antelope Hill Bridge	3.70	1,417.39		776.55	644.54			1,421.09
565—Ligurta Blaisdale	5.75			5.75				5.75
588—Yuma Streets	2,149.91	22,891.96		35.48	25,006.39			25,041.87
625—Phoenix-Yuma Overpass F. A. 55	748.88			548.98	77.15	122.75		748.88
673—Yuma-Gila Bend	428.76	138.90		71.25	42.00	454.41		567.66
MAINTENANCE								
351—Yuma-Welton			55,524.68	4,494.33	18,005.08		33,025.27	55,524.68
352—Welton-Mohawk			38,969.55	1,678.99	10,879.80		26,410.76	38,969.55
368-A—Aztec-Piedra			2,564.55	10.59			2,553.96	2,564.55
370—Mohawk County Line			22,060.83	3,186.83	1,439.36		17,434.64	22,060.83
371—Parker-Bouse			1,558.00				1,558.00	1,558.00
Total	$ 12,347.89	$ 86,578.67	$120,677.61	$ 11,064.65	$ 64,132.27	$ 63,424.62	$ 80,982.63	$219,604.17

Credits R*

ARIZONA HIGHWAY DEPARTMENT
GENERAL OFFICE ACCOUNTS
July 1, 1924 to June 30, 1926

	1924-1925	1925-1926	Total
Account 14—Transfer of Funds	$325,568.84	$398.705.21	$724,274.05
Account 15—Acct. Rec. Refunds	39,040.87	35,228.82	74,269.69
Account 24—General Overhaul		65,662.55	65,662.55
A.F.E. 33—Stock Room			
33—Stock	6,335.00	4.923,43	
113—Salaries	2,301.98	3,131.30	
120—Traveling Expenses	461.91	73.45	
121—Postage	1,202.41	1,109.87	
123—Freight and Express	1.41		
	10,302.71	9,238.05	19,540.76
A.F.E. 40—Plant Accounts			
40—Land	1,674.03		
41—Administration Bldg.		1,170.73	
42—Warehouse Bldg.			
43—Sheds			
44—Machine Shop			
45—Paint Shop			
46—Spur Track			
47—Paving			
48—Fences			
49—Tucson Real Estate			
50—Ashfork Real Estate			
55—Plant Machinery			
60—Furniture	92.20	861.95	
61—Fixtures and Partitions	1,317.69	2,071.18	
62—Office Eqquipment Transit Levels	1,838.72	7,962.52	
63—Office Machinery	14.03		
64—Miami-Super'r Prison Cmp	386.00-R*		
	4,550.67	12,066.38	16,617.05
A.F.E. 101—State Engineer			
101—Salaries	6,000.00	6,000.00	
119—State Engineer's Expense	752.44	1,522.34	
130—Auto Expense, gas, oil, rent	172.60	4,078.96	
135—Engineer's office Supplies		143.22	
	6,925.04	11,744.52	18,669.56

Note. Credits—R*

GENERAL OFFICE ACCOUNTS
July 1, 1924-June 30, 1926

		1924-1925	1925-1926	Total
A.F.E. 102	General Engineering			
102	Salaries	$13,221.33	$20,387.10	
120	Traveling Expenses	112.49	1,185.47	
130	Auto expense, gas, oil, rental		1,189.58	
135	Office Supplies		1,066.76	
142	Membership Dues		15.00	
145	Repairs to Transits Levels		858.82	
		13,333.82	24,702.73	38,036.55
A.F.E. 106	Office Engineering			
106	Salaries	12,798.78	7,027.01	
120	Traveling Expenses	186.99	54.95	
128	Blue Prints, Photo Supplies	33.78-R*	82.06	
130	Auto expense, gas, oil, rental	227.82	1,807.74	
135	Office Supplies	4,158.20	1,079.84	
140	Rental, Office Equipment	33.00		
146	Repairs office mch., furn.		23.00	
		17.371.01	10,074.60	27,445.61
A.F.E. 107	Laboratory			
107	Salaries	3,174.44	2,805.26	
120	Traveling Expense	464.46	72.53	
130	Auto expense, gas, oil, rental	.20	103.18	
133	Laboratory Materials	1,167.76	907.58	
135	Office Supplies		64.76R*	
138	Miscellaneous Charges	73.50	561.25	
145	Repairs Office Mch.		16.85	
		4,880.36	4,401.89	9,282.25
A.F.E. 111	Purchasing Department			
111	Salaries	2,505.02	5,941.94	
120	Traveling Expense	271.86	160.08	
121	Postage		127.44	
130	Auto expense, gas, oil, rental	193.32	65.90	
137	Acct. Books and Supplies		434.84	
		2,970.20	6,730.20	9,700.40
A.F.E. 112	Accounting Department			
112	Salaries	35,259.71	32,271.32	
120	Traveling Expense	271.86	224.91	
130	Auto expense, gas, oil, rental	193.32	789.88	
137	Acct. Books and Supplies	197.00	1,455.16	
140	Rental Office Equipment	50.00	15.00	
145	Repairs Office Machinery		33.75	
		35,971.89	34.790.02	70,761.91

Note. Credits—R*

GENERAL OFFICE ACCOUNTS
July 1, 1924-June 30, 1926

		1924-1925	1925-1926	Total
A.F.E. 127	"Arizona Highways' Magazine			
127	Printing Magazine	$ 558.74	$ 1,127.96	$ 1,686.70
A.F.E. 136	General Office Expense			
114	Salaries	558.71	3,759.42	
121	Postage		20.00	
122	Telephone—Telegraph	2,643.82	3,253.86	
125	Printing and Adv,, general	20.00	76.85	
126	Printing Reports	2,385.74		
129	Magazines, Newspapers.....	70.42	263.30	
130	Auto Exp., gas, oil, rentals	6.067.67	7.90	
131	Light and Fuel	143.70	649.70	
132	Ice and Water	348.77	116.66	
134	Bonding & Ins. Premiums	64.79	508.55	
136	General Office Supplies.....	2,553.90	796.62	
138	Miscellaneous Supplies	4,056.62	2,762.55	
140	Rental Paid General Office Equipment		12.00	
142	Membership Dues		221.60	
144	Building Repairs, Labor, Material	254.97	1,542.67	
145	Repairs of Furniture and Fixtures	374.45	314.05	
146	Repair of Office Machin'y	43.46	3,00	
148	Depreciation,. Fixtures and Partitions		28.75	
		19,587.02	14,337.48	33,924.50
	Total General Office Accounts			$245,665.29
	District Engineer's Expense			
A.F.E. 151-155	District No. 1.....	1,802.78	2,641.68	
152-157	District No. 2.....	4,307.00	2,181.85	
153	District No. 3.....	1,450.61	1,615.06	
154	District No. 4.....	6,326.48	1,515.37	
158	District No. 5.....		1,773.25	
		13,886.87	9,727.22	23,614.09
A.F.E. 156	Tucson Whse. and Shops..	16,508.59	12,030.67	28,539.26
A.F.E. 159	Holbrook Yards		3,945.30	3,945.30
Acct. No. 180	County Aid		7,500.00	7,500.00
Acct. No. 188	Interest	20.50-R*		20.50-R*
		20.50-R*	7,500.00	7,479.50
	GRAND TOTAL			$1,173,449.73

Note. Credits—R*

Warehouse and Shop
July 1, 1924-June 30, 1926

	1924-1925	1925-1926	Total
Salaries and General Expense			
076 Superintendent's Salary	$ 2,875.00	$ 3,250.00	$
077 Shop Foreman's Salary	1,287.50	2,639.00	
078 Yard Foreman's Salary	1,750.00	1,887.50	
079 Accounting Salaries	6,018.98	8,136.27	
080 Dray, labor, gas, oil	1,588.48	1,562.50	
081 Postage, Tel. & Tel.	23.47		
082 Misc. Lbr., Watchman, etc.	9,548.99	8,309.05	
083 Auto expense, gas and oil	.56	1,598.71	
084 Truck expense	109.30		
085 Ice, water, light, power, furnace	3,073.53	6,070.95	
	$ 26,275.81	$ 33,453.98	$ 59,729.79
Incidental—			
086 Inuries, doctor, hospital, drugs..	1,651.10	613.15	
087 Injury compensation	1,223.95	445.50	
088 Overhead account, Dr. and Cr.	14,387.07-R*	1,446.04-R*	
	$ 11,512.02-R*	$ 387.39-R*	
Traveling Expense—			
089 Traveling expense	665.66	791.58	1,457.24
Equipment—			
093 Epuipment purchase and repairs	60,289.59	183,571.27	
095 Equipmetn, rental to jobs	131,428.02-R*	184,529.06-R*	
096 Equipment, rental to outside	1,713.83-R*	5,061.21-R*	
097 Equipment sales	8,674.05-R*	11,686.00-R*	
098 Depreciation	1,051.60-R*		
	$ 82,577.91-R*	$ 17,705.00-R*	$100,282.91-R*
Warehouse Stock—			
090 Purchases, frt. and costs	170,273.31	166,085.76	
0100 Closed	7.74-R*		
0101 Warehouse Labor	14,412.98	16,823.67	
0102 Stock Repairs		19,747.76	
0103 Sales to Jobs	70,061.96-R*	97,935.91-R*	
0104 Sales to Jobs Outside	11,506.10-R*	8,592.60-R*	
0105 Reclaimed Dept. Labor	3,661.54	4,079.36	
0108 Live Stock	6,480.09-R*	4,760.93-R*	
	$100,291.94-R*	$ 95,447.11-R*	$195,738.05
Shop Accounts—			
0109 Direct Labor	72,664.25	99,858.10	
0111 Shop and Building	8,900.08	17,612.96	
	$ 81,564.00	$117,471.06	$199,035.39
0112 Shop Operating (Dept.)	260.30	11,551.08	
0113 Shop Sales to Jobs	31,764.27-R*	207,878.18-R*	
0114 Shop Sales to Outside	1,358.22-R*	3,683.71-R*	
0115 Shop Machinery Cost		2,026.01	
0116 Shop Machinery Repairs		5,522.72	
	$ 32,862.19-R*	$192,462.08-R*	$225,324.27-R*
Total	$ 81,845.62	$ 36,609.26	$118,454.88

Note: Credits-R*

COST ACCOUNTING

BY IRA L. WOOD, *Cost Accountant*

COST ACCOUNTING for the Arizona Highway Department is divided into two classifications: Construction and maintenance. Construction cost accounting serves two purposes: One for a ready check during construction of all units of the job, as the cost report will show if any of the units are running higher than the estimate, and if so what class of work on that unit tends to make the high cost; the other purpose is to furnish a record for estimating the cost of future work.

There are many different systems of keeping construction costs, but the principle is virtually the same in each system. The value of the cost obtained depends wholly upon the timekeeper's ability and knowldge of construction, for the office must depend upon the timekeeper or cashier for the proper distribution of invoices and labor.

The Arizona Highway Department uses the following account numbers in its system of keeping construction costs on its State Force work. The numbers between the general headings are used for listing the various materials and different classes of work performed:

200-215—Engineering Reconnoissance Survey.
216-235—Engineering Preliminary.
236-250—Bridge Engineering.
251-270—Engineering, Construction and Inspection.
271-285—Mess House Operation.
286-311—Corral Operation.
311-325—Motor Vehicles.
326-350—Steam and Gas Shovels.
351-375—Compressor Operation.
376-395—Hand Drilling.
396-410—Blacksmith Shop Operation.

411-430—Roller Operation.
431-445—Field Superintendency.
446-470—Camp Construction.
471-480—Transportation of Equipment.
481-495—Moving Camp.
495-515—Camp Maintenance.
516-530—Temporary Construction.
531-540—Equipment, Rental and Repairs.
541-560—Right-of-Way.
561-575—Clearing and Grubbing.
591-620—Roadway Excavation.
621-650—Structural Excavation.
651-679—Borrow Excavation.
680-720—Concrete.
721-735—Crusher Operation.
736-755—C. M. Pipe Culverts.
756-775—Cattle Guards.
776-800—Rip Rapping.
801-825—Ditches and Channel Changes.
826-850—Surfacing.
851-860—Guard Fence.
900-930—Materials and Supplies.
1001-1024—Steel Bridges.
1025-1050—Gunite.

Feature Sheet Carried

In the field a feature sheet is carried for each account opened, and all labor and direct charges are posted direct to these feature sheets. The material and supply account is kept in a small ledger, and the materials and supplies used during the month are charged out at the end of the month into the accounts where used, and posted on the feature sheets. A document register is kept in camp which shows the distribution and amount of each invoice and payroll. At the end of the month the timekeeper closes his camp records, checking the total of the feature sheets plus the inventory, against the total amount of the document register, before sending the feature sheets into the office.

In the Phoenix office the unit costs are worked out, after "re-capping" the feature sheets in the following manner: The amount of the feature sheet showing the truck costs is divided by the truck days, giving a truck day cost, and is then charged into the various construction units by the number of truck days shown against those units. The feature sheets, covering caterpillar, corral, and other accounts of this kind, are worked out in the same manner. The mess account is then closed, and the loss or gain is transferred to superintendency. The overhead, such as superintendency, camp maintenance, and like accounts, is then prorated to the various construction units, such as excavation, borrow, concrete, etc., by the amount of labor in those units.

The following is a copy of a typical construction cost report:

ARIZONA HIGHWAY DEPARTMENT

AFE 656—Douglas-Safford—Cost Report

June 30, 1926

		Unit		Unit Cost	Amount
541	Right-of-Way Fencing**	6,764	Lin. Ft.	.0475	$ 321.47
	Right-of-Way Expenditures for Titles				44.12
561	Clearing and Grubbing				22.48
621	Excavation Structural	732	Cu. Yd.	.8607	630.10
651	Excavation Borrow*	46,483	Cu. Yd.	.2761	12,838.19
680	Wooden Toe Walls for Dips				2,077.86
736	C. M. Pipe				95.40
756	Cattle Guards				1,111.96
2-801	Dykes and Levees	81	Cu. Yd.	.326	26.41
826	Surfacing	90.6	Cu. Yd.	.5917	53.61
	Sub-Total				$ 17,221.60
	Engineering				1,495.54
	Materials				1,281.12
	Sub-Total				$ 19,998.26
	656A Bridge				4,754.91
	TOTAL				$ 24,753.17

** Setting back old fence.

* Includes 49,771 Lin. Ft. blade Sec. 47 Cu. Yd. per Sta.

Maintenance

Maintenance cost is kept by the following list of account numbers:
050—District Engineer's Expense.
051—District Shop Operation.
052—Surface Work.
053—Shoulders and Ditches.
054—Structures.
055—Zoning.
056—Signs.
057—Repairs to Equipment (except motive equipment).
058—Equipment Rental (except motive equipment).
059—Large Trucks.
060—Caterpillars.
061—Power Graders.
062—Teams.
063—Gasoline.
064—Oil.
065—Miscellaneous M. and S. and Expense.
066—Small Trucks.

Charging of Payrolls

Every payroll is charged into one or more of these accounts, as to the class of work it covers. The distribution of payrolls is made in the District Engineer's office, from form No. 34, which the maintenance foreman turns in with the payroll. This form shows the class of work performed by each man for that payroll period. The various distributions, covering the entire amount of the payroll, are then worked out and written on the back of the payroll to be posted in the office ledger under that project. The invoices are charged direct to the class of work or material that it pertains to.

At the end of each month, after the office ledger has been closed, the totals of each project are taken off, on form No. 6, the outstanding invoices of the project are added and the inventory deducted. The cost is then worked into the following maintenance units: "Surface work," covering the upkeep of the road's surface; "shoulders and ditches," covering all upkeep of the roadbed; "struc-

tures," repairs to structures and keeping their channels free of obstructions; "zoning" or striping of pavement, and "road signs."

To arrive at the maintenance cost of each of these units this procedure is followed: The large trucks, caterpillars, power graders, and small truck charges are worked out by information furnished to the office on form No. 45 by the foreman of each project. This form is kept for each individual piece of motive equipment and shows the amount of gas and oil used for the period, also the numbers of days worked on each class of maintenance work. The oil and gas used is then added to the amount of money charged to that piece of equipment, and the total divided ino a day cost and charged into each unit of maintenance, as shown by the days worked on form No. 45. The remaining open accounts are then pro-rated into surface work, shoulders and ditches, structures, zoning, and signs, by the amount of labor that has been charged into each of these maintenance units. Following this procedure each month gives the total cost of each of the maintenance units on the different projects, and the maintenance report turned over to the engineers is the total to date from the beginning of the fiscal year.

Traffic Census

The traffic census is then worked into this report, using the amount charged to the units surface work and shoulders and ditches, to determine the maintenance cost per mile per vehicle. This cost is then compared by ratio to the same class of cost on an 82-mile paving project, with the idea that it will help determine when any project should be paved.

The following is a copy of the maintenance cost report that is turned over to the State Engineer, and District Engineers:

ARIZONA HIGHWAY DEPARTMENT

Maintenance Cost Report From July 1, 1925 to June 30, 1926

AFE	Project	County	Miles	Cost To Date Surface	Cost to Date Shl & Ditch	Cost to Dte. Struc. & Misc.	Cost to Date Total	Surfacing and Road Bed	Monthly Cost Per Mi.	Number Vehicles Per Month	Maint Cst Per Mile Per Veh'e	Ratio to Pvg.
306	Flag-Williams	Coconino	17.5	7,393.51	885.10	22.61	8,301.22	8,278.61	39.42	6,780	.0058	10-1
307	Flag-Williams	Coconino	17.5	8,487.58	324.25	.....	8,811.83	8,811.83	41.96	6,090	.0069	12-1
308	Williams-Ash Fork	Yavapai	19.0	6,676.99	2,921.50	319.38	9,917.87	9,598.49	42.10	6,480	.0070	12-1
310	Ash Fork-Seligman	Yavapai	25.0	8,439.00	820.93	236.51	9,496.44	9,259.93	30.87	4,800	.0064	11-1
311	Selig-Nelson Moh.,	Coc., Yav	38.5	11,538.60	2,070.61	266.93	13,876.14	13,609.21	29.46	4,410	.0067	11-1
314	Kingman-Oatman	Mohave	28.8	7,612.39	533.88	71.03	8,217.30	8,146.27	23.57	4,590	.0051	9-1
315	Oatman-Topock	Mohave	25.0	8,004.85	233.96	856.31	9,095.12	8,238.81	27.46	5,610	.0049	8-1
316	Prescott-Jerome	Yavapai	13.5	3,336.95	3,059.69	404.30	6,800.94	6,396.64	39.49	5,430	.0073	12-1
317	Prescott-Jerome	Yavapai	19.2	6,617.79	1,151.94	116.45	7,886.18	7,769.73	33.72	14,190	.0024	4-1
318	Prescott-Ash Fork	Yavapai	22.5	6,911.72	527.07	201.28	7,640.07	7,438.79	27.55	5,460	.0050	8-1
320	Prescott-Ash Fork	Yavapai	23.5	6,261.18	1,395.72	127.04	7,783.94	7,656.90	27.15	2,880	.0094	16-1
325	Peach Spring-Kingman	Mohave	52.0	4,832.90	1,832.86	903.94	6,839.70	5.935.76	19.02	4,620	.0041	7-1

Note: Surfacing and roabed does not include structures and miscellaneous.

ARIZONA HIGHWAY DEPARTMENT

Maintenance Cost Report From July 1, 1925 to June 30, 1926

AFE	Project	County	Miles	Cost To Date Surface	Cost to Date Shl & Ditch	Cost to Dte. Struc. & Misc.	Cost to Date Total	Surfacing and Road Bed	Monthly Cost Per Mi.	Number Vehicles Per Month	Maint Cst Per Mile Per Veh'e	Ratio to Pvg.
351	Yuma-Wellton	Yuma	38.5	28,420.04	3,138.60	425.36	32,011.00	31,558.64	68.31	8,230	.0094	16-1
352	Wellton-Mohawk	Yuma	23.0	28,940.23	2,877.82	.....	31,818.05	31,818.05	124.29	6,510	.0191	32-1
353	Piedra-Gillespie	Maricopa	24.5	24,608.05	5,057.68	1,312.68	30,978.44	29,665.76	100.90	8,520	.0118	20-1
354	Mari Co. Pv. & Brgs.	Maricopa	82.9	14,177.99	15,729.27	5,007.53	34,914.79	29,907.26	30.06	52,530	.0006	1-1
361	Wick-Hot Springs	Yavapai	26.7	14,773.93	1,433.39	291.19	16,498.51	16,207.32	50.58	7,860	.0064	11-1
364	Hassay-Gila Bend	Maricopa	25.2	16,315.67	2,970.39	147.54	19,433.60	19,286.06	63.78	8,670	.0074	12-1
365	Marinette-H. Spg. J.	Maricopa	21.6	18,889.50	2,095.80	115.64	21,100.94	20,985.30	80.96	5,490	.0147	25-1
368	County Line-Piedra	Maricopa	21.8	10,727.88	3,766.01	.....	14,493.89	14,493.89	55.40	6,900	.0080	13-1
370	Mohawk-County Line	Maricopa	26.5	21,772.47	1,009.74	124.40	22,906.61	22,782.21	85.97	7,560	.0114	19-1
372	Cong Jct-White Spar	Yavapai	18.84	8,643.83	1,822.42	971.86	11,438.11	10,466.25	46.29	7,140	.0065	11-1
373	Chandler-Casa Grand	Maricopa	25.3	25,845.69	442.06	168.33	26,456.08	26,287.75	115.45	8,670	.0133	22-1
374	Gillespie Dam Cross.	Maricopa	.....	.....	.....	.....	1,567.67	.....	.....	.....	.....	.....
375	Px.-Gld-Tempe-Buck	Maricopa	.....	.....	.....	.....	120.00	.....	.....	.....	.....	.....
376	Yarnell-Cong Jct.	Yavapai	9.038	2,063.56	808.15	.....	2,871.71	2,871.71	79.43	4,020	.0198	33-1

Note: Surfacing and Roadbed does not include structures and miscellaneous.

ARIZONA HIGHWAY DEPARTMENT

Maintenance Cost Report From July 1, 1925 to June 30, 1926

AFE	Project	County	Miles	Cost To Date Surface	Cost to Date Shl & Ditch	Cost to Dte. Struc. & Misc.	Cost to Date Total	Surfacing and Road Bed	Monthly Cost Per Mi.	Number Vehicles Per Month	Maint Cst Per Mile Per Veh'e	Ratio to Pvg.
356 and												
358	Mesa-Superior	Maricopa-Pinal	31.3	16,357.92	1,655.92	1,100.87	19,114.71	18,013.84	47.96	10,740	.0045	8-1
359	Apache Trail	Maricopa	20.0	10,623.23	754.97	800.58	12,178.78	11,378.20	47.41	3,030	.0156	26-1
360	Apache Trail	Maricopa	21.5	7,326.19	1,825.01	151.17	9,302.37	9,151.20	35.47	2,070	.0171	29-1
367	Florence-Superior	Pinal	25.6	15,840.60	2,308.17	457.98	18,606.75	18,148.77	59.08	11,370	.0052	9-1
369	Superior-Miami	Pinal	15.5	14,552.05	2,607.54	685.65	17,845.24	17,159.59	92.26	17,910	.0052	9-1
401	Clifton-Mule Creek	Greenlee	18.1	3,319.89	1,666.40	22.03	5,008.32	4,986.29	45.91	Closed 12-31-25		9-1
402	Clifton-Solomon	Graham	30.0	6,594.70	3,846.77	47.07	10,488.54	10,441.47	29.00	1,830	.0158	26-1
404	San Carlos-Geron.	Graham	32.8	9,409.30	1,190.19	3,984.16	14,583.65	10,599.49	26.93	5,430	.0050	8-1
405	Globe-San Carlos	Gila	28.6	15,941.02	379.13	277.75	16,597.90	16,320.15	47.55	9,780	.0049	8-1
406	Globe-Roosevelt	Gila	33.0	14,313.71	1,102.67	176.27	15,592.65	15,416.38	38.93	40,020	.0010	2-1
407	Miami-Superior	Gila	9.5	9,437.78	2,386.80	36.25	11,860.83	11,824.58	103.72	20,280	.0051	9-1
410	Geron-Solomon.	Graham	34.7	9,772.90	6,357.40	3,288.16	19,418.46	16,130.30	38.74	16,020	.0024	6-1
411	Solomon-Duncan	Graham	12.1	8,728.91	822.06	99.93	9,550.90	9,450.97	65.09	2,640	.0247	41-1
412	Solom-Dunc. St. Line	Greenlee	20.0	2,958.96	519.96	93.46	3,572.37	3,478.91	34.80	2,640	.0132	22-1

Note: Surfacing and Roadbed does not include structures and miscellaneous.

ARIZONA HIGHWAY DEPARTMENT

Maintenance Cost Report From July 1, 1925 to June 30, 1926

AFE	Project	County	Miles	Cost To Date Surface	Cost to Date Shl & Ditch	Cost to Dte. Struc. & Misc.	Cost to Date Total	Surfacing and Road Bed	Monthly Cost Per Mi.	Number Vehicles Per Month	Maint Cst Per Mile Per Veh'e	Ratio to Pvg.
451	Tucson-Florence	Pima-Pinal	23.2	11,165.81	1,701.46	403.17	13,270.44	12,867.27	46.22	13,530	.0034	6-1
452	Tucson-Florence	Pinal	21.3	13,236.81	519.19	687.85	14,443.85	13,756.00	53.82	6,870	.0078	13-1
453	Tucson-Florence	Pinal	22.0	12,512.00	1,825.34	1,314.11	15,651.45	14,337.34	54.31	7,350	.0074	12-1
454-455	Tucson-Benson-Nogales	Pima	27.9	9,409.05	549.55	1,638.45	11,597.05	9,958.60	29.74	15,900	.0019	3-1
456	Tucson-Benson	Cochise-Pima	31.6	9,916.87	224.78	3,455.54	13,597.19	10,141.65	26.74	6,510	.0041	7-1
458	Benson-Tombstone	Cochise	22.0	9,401.86	1,017.51	109.79	10,529.16	10,419.37	39.47	8,520	.0046	8-1
459	Tucson-Nogales	Pima-S. Cruz	38.3	10,174.27	1,169.33	1,973.68	13,317.28	11,343.60	24.68	5,520	.0045	8-1
461	Tombstone-Nogales	Cochise	24.0	6,564.60	730.31	18.84	7,313.75	7,294.91	25.33	4,170	.0061	10-1
462	Tombstone-Nogales	S. Cruz	27.0	8,400.33	1,112.50	558.97	10,071.80	9,512.83	29.36	2,940	.0100	17-1
463	Bisbee-Tombstone	Cochise	26.3	8,600.05	853.05	.....	9,453.10	9,453.10	29.95	7,410	.0040	7-1
464	Bisbee-Tombstone	Cochise	24.0	2,600.26	1,712.07	398.06	4,710.39	4,312.33	14.97	14,580	.0010	2-1
465	Douglas-Rodeo	Cochise	23.0	8,162.03	986.47	.....	9,148.50	9,148.50	33.15	3,060	.0108	18-1
466	Douglas-Rodeo	Cochise	25.0	7,173.95	1,067.96	225.94	8,467.85	8,241.91	27.47	3,360	.0082	14-1
468	Douglas-Safford	Cochise	30.0	10,691.70	1,035.18	234.42	11,961.30	11,726.88	32.57	4,530	.0072	12-1
469	Tucson-Nogales	Pima	22.0	9,820.77	455.88	47.23	10,323.88	10,276.65	38.93	8,670	.0045	8-1
470	Tombstone-Nogales	S. Cruz	22.0	15,088.73	1,912.70	1,605.24	18,606.67	17,001.43	64.40	5,580	.0115	19-1

Note: Surfacing and roadbed does not include Structures and Miscellaneous.

ARIZONA HIGHWAY DEPARTMENT

Maintenance Cost Report From July 1, 1925 to June 30, 1926

AFE	Project	County	Miles	Cost To Date Surface	Cost to Date Shl & Ditch	Cost to Dte. Struc. & Misc.	Cost to Date Total	Surfacing and Road Bed	Monthly Cost Per Mi.	Number Vehicles Per Month	Maint Cst Per Mile Per Veh'e	Ratio to Pvg.
300	St. Johns-Springerville	Coco	20.0	5,223.89	1,520.89	.....	6,744.78	6,744.78	28.10	2,970	.0095	16-1
301	Holbrook-St. Johns	Apache	20.0	6,367.79	1,456.85	989.17	8,813.81	7,824.64	32.60	1,980	.0165	28-1
302	Holbrook-St. Johns	Nav.-Apache	20.0	6,545.65	1,818.96	716.92	9,081.53	8,364.61	34.85	2,250	.0155	26-1
304	Holbrook-St. Johns	Navajo	22.0	8,861.40	1,114.79	1,054.87	11,031.06	9,976.19	37.79	3,120	.0121	20-1
305	Holbrook-Winslow	Navajo	21.5	9,715.19	254.54	234.71	10,204.44	9,969.73	38.64	6,330	.0061	10-1
319	Adamana-Lupton	Apache	28.5	6,424.90	662.40	2,923.41	10,010.71	7,087.30	20.72	3,000	.0069	12-1
321	Adamana-Lupton	Apache	28.5	6,143.51	1,223.16	758.31	8,124.98	7,366.67	21.54	3,840	.0056	9-1
322	Winslow-Coconino Navajo Co. Line and	Coconino	23.1	9,865.54	339.53	.....	10,205.07	10,205.07	36.81	6,030	.0061	10-1
324	Angel-Canyon Diablo	Coco	12.2	8,579.57	2,139.95	355.27	11,074.79	10,719.52	73.22	5,802	.0126	21-1
326	Concho-St. Johns	Apache	15.0	96.31	.....	.....	96.31					

Note: Surfacing and Roadbed does not include Structures and Miscellaneous.

PURCHASING DEPARTMENT

A. E. STELZER, *Purchasing Agent*

THE purpose of the Purchasing Department is to furnish for the offices of the Highway Department, its maintenance districts, warehouses, shops, and construction jobs, the necessary materials, supplies and equipment at the best prices.

The method of operation can be briefly stated: Beginning with the writing of requisitions in the field when there is created a need for material, supplies or equipment, the requisition is approved by the District Engineer, or in cases involving unusually large sums, the approval of the Chief Engineer or the State Engineer is secured. If the item required is on hand in the Warehouse the order is filled from stock. If the Warehouse cannot fill the order, the requisition is stamped and returned to this office. If it is required at a point other than at Phoenix, the purchase, if possible, is made in the county where the work is being done. It is the constant effort of this Department, as far as circumsances permit, to make all purchases in the county providing the funds for the work; however, because there are few places in the state where the same service can be had as in Phoenix, it necessarily follows a larger number of purchases are made in Phoenix than elsewhere. This is also due to the large amount of material, supplies and equipment purchased for the Warehouse either for stock or to place it in condition for use in the field. Purchases are made on a three fold basis: Price, Quality and Service. With this is combined the element of Faith. With possibly no exception the salesmen who come to this department are men of high calibre and represent responsible houses, and up to the present it has never been necessary to impose a penalty for failure to deliver as promised. All transactions are based on the understanding that misrepresentation or intentional failure to perform as promised terminates all relations with the Purchasing Department.

The organization consists of the Purchasing Agent, an Assistant, and a Stenographer.

In July, 1925 we installed an Underwood Fan-Fold Billing Machine using Continuous Manifold forms. With this machine, and this style of form, we were able to increase the number of copies of each purchase order to six, using the additional copies to install a better system of recording purchases. The original copy is mailed, or handed, to the Vendor; the second is a continuous, consecutive, chronological office file; the third is given to the Accounting Department; the fourth is sent to the man in the field who requisitioned the article; the fifth is sent to the District Engineer's office, and the sixth copy is kept in this office and filed under the name of the Vendor. The requisitions are filed consecutively under the A.F.E., or Project, number. We have, therefore, a three-fold record; requisitions from the field, numerically; a chronological record, and a file by vendors. In addition to this record, we have an individual Kardex record of every different kind of item bought, large or small, showing the date, name of vendor, for whom purchased, A. F. E. number, Purchase Order Number, quality, price, discount and amount of the purchase. This last record is valuable as it gives us a ready comparison of prices of like articles bought from different merchants and also enables us to compute the amount or quantity required within a given time. A monthly report is made showing the amount of purchases and where purchases are made. A copy is given to the State Engineer and another copy to the Governor.

During the fiscal year beginning July 1, 1924, there were written 9,546 Purchase Orders, representing an outlay of $528,677.93. During the fiscal year beginning July 1, 1925, there were written 11,312 Purchase Orders, covering purchases amounting to $710,600.47. During the period of July 1, 1926 to date, December 11, 1926, there were written 6,142 Purchase Orders representing $421,831.52. The above figures do not include Field Emergency purchases. The practice of wriing Emergency Purchase Orders was discontinued in January, 1926. In such cases where it is necessary to make a purchase in the field an invoice is attached to the requisition and a Purchase Order in confirmation is written.

GENERAL OFFICE STOCK ROOM

E. H. DOTY, *Stock Clerk*

THE stock-room is situated in the basement of the general office and has grown in four years from a small room of 400 square feet of floor space, and 175 feet of shelving, to a floor space of 2,740 square feet, with 2,499 feet of shelving, 1,223 feet of which is used for stationery, forms and engineering equipment, and the balance of 1,276 feet is used as a repository for the office, warehouse and camp records.

The office furniture and equipment are under the direct charge of the stock-room.

Requisitions are made on the purchasing agent for all supplies of the general office and stock-room.

All disbursements of supplies are made by purchase orders from the purchasing department for all field requisitions. Other disbursements are made on call by the employes of the Phoenix plant and upon order of the chiefs of the different departments.

The force employed to attend to the duties of the stock-room consist of a stock clerk, a boy to assist the stock clerk and a clerk-stenographer.

Duties of Stock Clerk

The duties of the stock clerk are to requisition all purchases of stock, general office equipment and other items that may be required, to attend to the upkeep of equipment and furniture and obtain replacements when necessary; to pass on and make recommendations when necessary on all field requisitions and orders from the general office, and have general supervision of all activities of the stock-room. It is the further duty of the stock clerk to act as custodian of the office, field and warehouse records, and see that they are filed in such a way as to be accessible.

The assistant fills all orders, sees that the proper postage is affixed when sent by mail, runs the mimeograph, keeps the stock in good physical condition, cuts and pads scratch paper, binds office records and books of construction, and makes minor repairs to engineering equipment.

The clerk-stenographer keeps a perpetual inventory, enters under separate headings the data pertaining to transits, levels, typewriters, etc., cuts all general office stencils, and sends out for approval the monthly statements of disbursements. The clerk-stenographer also must check all invoices against the purchase orders, and typewrite and file all correspondence and data of the stock-room.

Amount of Equipment

The stock and office furniture and equipment amount approximately to sixty-three thousand six hundred and eighty-nine and 67/100 ($63,689.67) dollars, apportioned as follows:

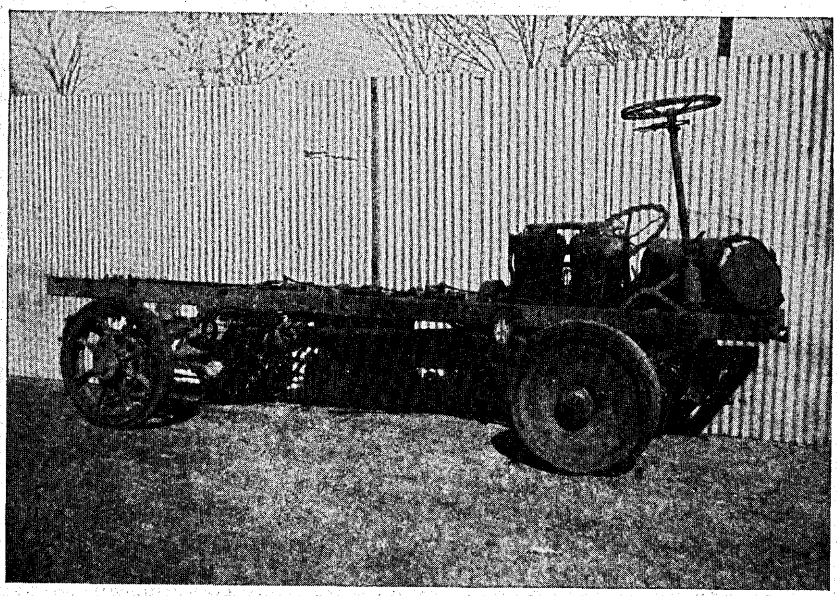
Office equipment and furniture	$31,896.38
54 Transits and levels	12,548.00
53 Typewriters	3,241.85
14 Adding machines	2,122.50
1 Checkwriter	287.50
11 Calculators	2,525.00
Other engineering equipment, such as tapes, level rods, line rods, stadia rods, etc.	3,000.00
Miscellaneous stationery, forms, binders, etc.	9,000.44

Disbursements

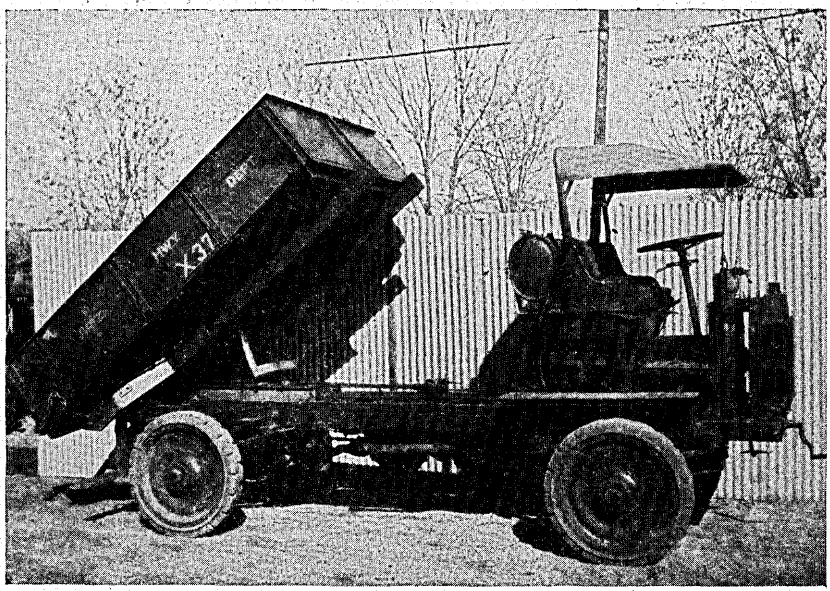
Disbursements for two years:

Total field requisitions	1,372
Number of items in above	6,870
Office items drawn	5,820
Number of envelopes used—field and office	117,124

The mail matter prepared in the two years comprises 80,505 pieces of mail, divided as follows: 78,669 pieces of first class mail, of which 650 were registered; 1,840 parcel post, 804 insured and 45 pieces sent C. O. D. The total postage for the two years was $2,444.50.



Before



After

EQUIPMENT, WAREHOUSES AND SHOPS

C. R. JONES, *Superintendent of Equipment*

THE equipment used by the Arizona Highway Department was purchased from all parts of the United States, making it necessary to have a central warehouse from which to disburse quantities of repair parts, supplies, and equipment, so as to keep the different pieces of equipment and machinery in continuous operation. For without proper repair parts in stock, many pieces of equipment when in need of repairs would have been compelled to stand idle for several weeks, awaiting parts from points as far East as New York before repairs could have started, and in the meantime the highways would be deteriorating through the shortage of equipment and lack of proper maintenance, causing a loss of many thousands of dollars; or the alternative for the State Highway Department to have many thousands of dollars invested in additional road building equipment and machinery available for emergencies at all time to overcome this great loss of money by deterioration.

Organization

In charge of the warehouses, shops and equipment throughout the State, is a superintendent and his assistant, with the necessary help, including bookkeepers, stenographer, inventory clerks, disbursing clerks, shipping clerks, receiving clerks, the yard force to handle loading and unloading of supplies and equipment being received and shipped to and from different camps located at different points throughout the entire State, and any other necessary work that might come up around an instiution of this size.

The Phoenix shop of the Arizona Highway Department is one of the most complete shops in the Southwest with different departments,

including carpenter shop, top and upholstering department, acetylene welding, sheet metal works, radiator shop for building and repairing radiators, brass foundry, electrical department, paint shop, blacksmith shop, where all kinds and classes of both heavy and light work is done; spring furnace, machine shop, with facilities for taking care of all kinds of machinery work, and also cylinder grinding and reaming; mechanical department for repairing light cars, trucks, engines of all descriptions as well as machinery of every description; salvage department, where all parts from trucks and various equipment are segregated, classified, and final inspection given, thus saving many thousands of dollars for the State.

Stock, How Purchased and Disbursed

About 95 per cent of all motor equipment was acquired by the Arizona Highway Department, requisitioning the United States Department of Agriculture for equipment, supplies, etc., subject to the Highway Department reimbursing the Government all freight and loading charges, which has amounted to approximately $400 per truck. Most of this equipment, before using, had to have a general overhauling, costing between $1,200 and $2,000 per truck. The balance of equipment and stock on hand was purchased by the warehouse, after first ascertaining what quantities, qualities and classes were and would become needed and used most economically for the highway work, by issuing requisition at different times to the purchasing department to purchase certain supplies and equipment.

This department has on hand, in warehouse and in use, approximately $1,320,000 invested in equipment and supplies which is subject to disbursement by the heads of different departments making requisition to the superintendent of equipment, who in turn orders all such requisitions filled and shipped.

All equipment, material and labor furnished by warehouse is charged directly to the different projects and camps.

Equipment Rentals and Repairs

Practically all equipment rentals are based on a report issued by the Associated Contractors of America, Inc., with the exception of

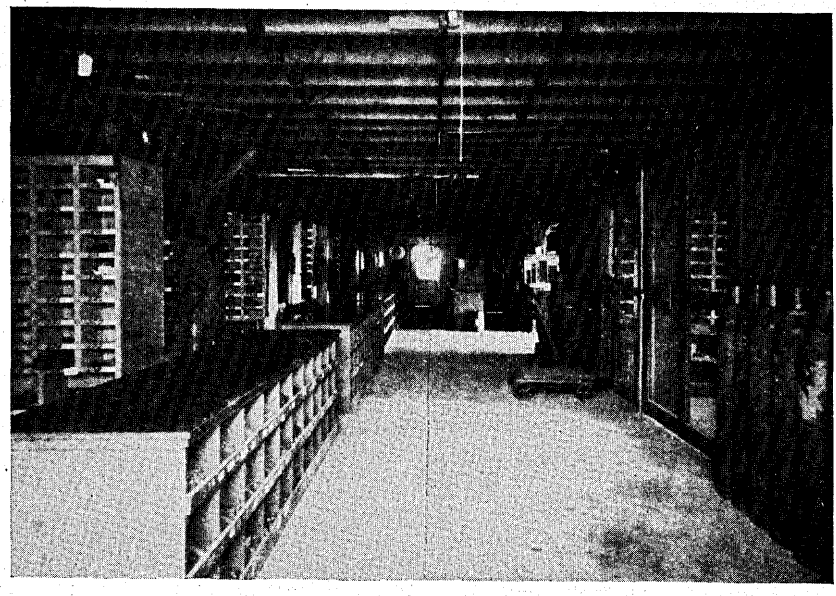
certain cases, where the charge is a trifle lower or higher, as the charges are all based on the percentage of time different pieces of equipment are used by the Highway Department, as for example: the more use a piece of equipment receives the smaller the rental charge, and vice versa.

All equipment which is acquired from the United States Department of Agriculture is first repaired and charged to the warehouse, and is then ready to be requisitioned by different projects. Rentals start from the time of delivery of equipment to different projects, which must, as long as they are using equipment, keep up all repairs and return the equipment to the warehouse in as good condition as when received. In case equipment is not returned to warehouse in good condition, they are then repaired by warehouse shops and the project is then charged for the repairs.

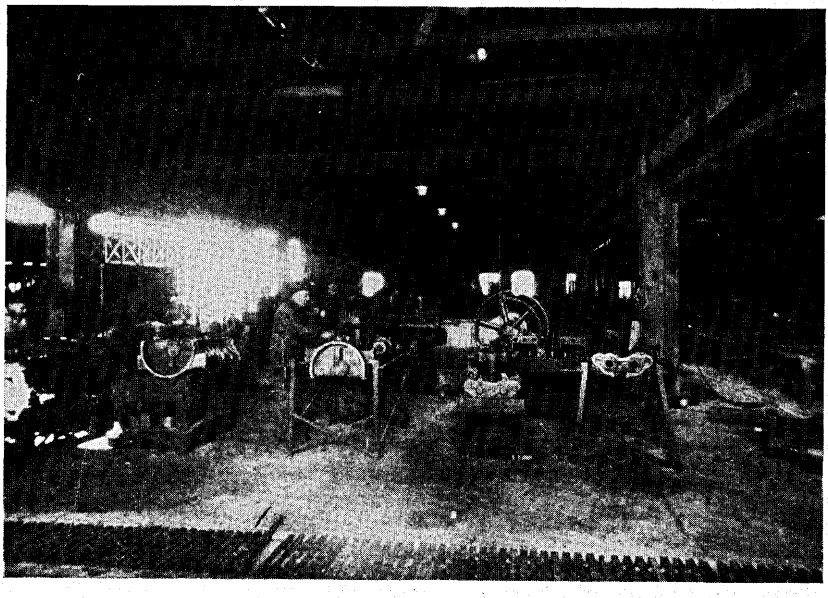
Sub-Warehouses and Shops

The Highway Department has warehouses and shops in Phoenix, Tucson, Ash Fork and Holbrook. Since bringing under control of the central warehouse and shops at Phoenix, all the different sub-warehouses and shops, it has simplified all transactions and made it possible to know State-wide conditions as they actually exist, and to keep an inventory and cost sheet by having installed the shop order and card index system as was used in the Phoenix warehouse.

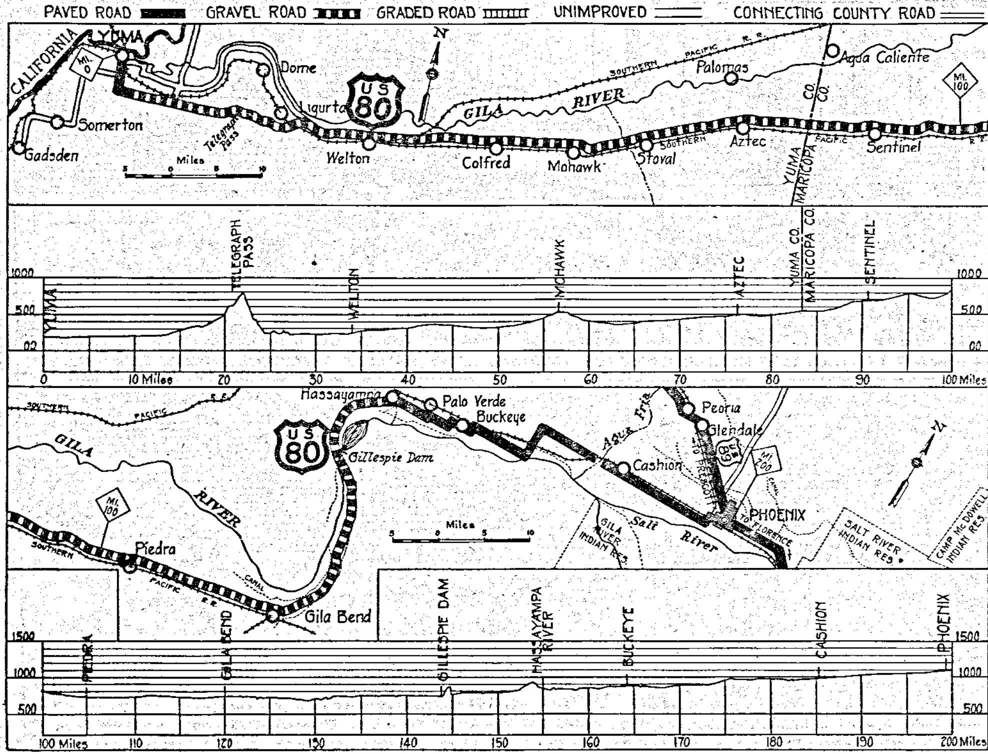
Since installing the new steam heating system in the warehouse and shops, the cost of heating the different departments has been reduced considerably through a saving in fuel, insurance and loss of time.



In the Warehouse



Scene in Phoenix Shop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CONNECTING COUNTY ROAD
CALIFORNIA
YUMA
MI. 0
Dome
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Ligurta
Somerton
Telegraph Pass
Gadsden
Welton
Colfred
Mohawk
Stoval
Aztec
GILA RIVER
SOUTHERN PACIFIC R.R.
Palomas
Agua Caliente
YUMA CO.
MARICOPA CO.
Sentinel
MI. 100
Miles
TELEGRAPH PASS
WELTON
MOHAWK
AZTEC
YUMA CO.
MARICOPA CO.
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Palo Verde
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Cashion
Peoria
Glendale
TO PRESCOTT
MI. 200
PHOENIX
TO FLORENCE
Salt River
GILA RIVER INDIAN RES.
SALT RIVER INDIAN RES.
CAMP McDOWELL INDIAN RES.
CANAL
Piedra
Gila Bend
PIEDRA
GILA BEND
GILLESPIE DAM
HASSAYAMPA RIVER
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1500
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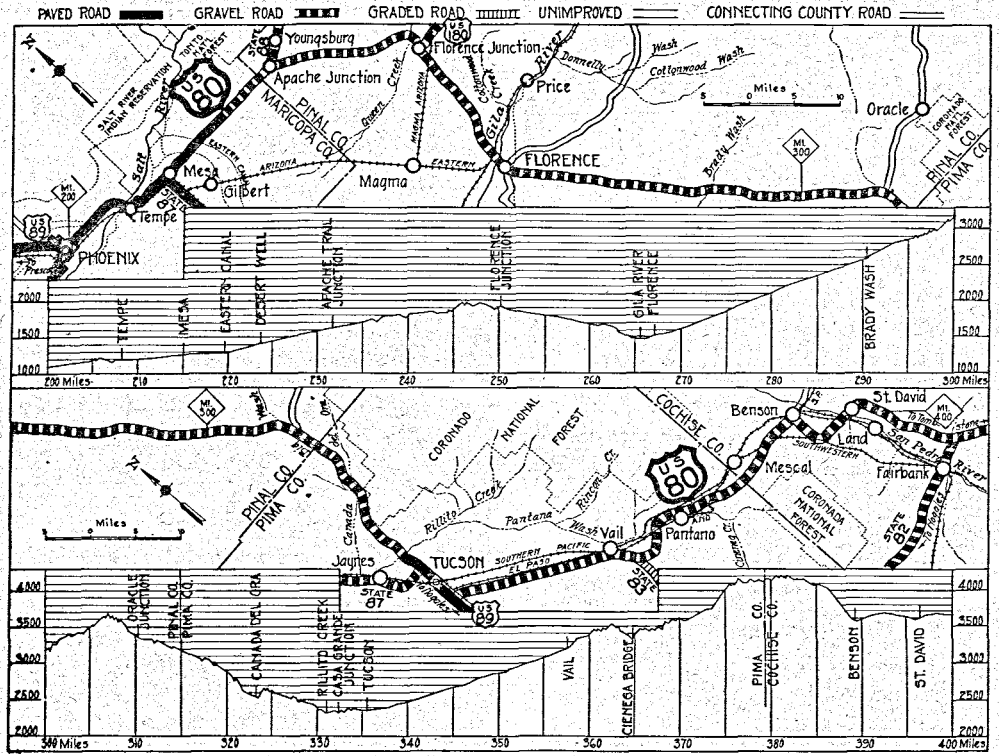
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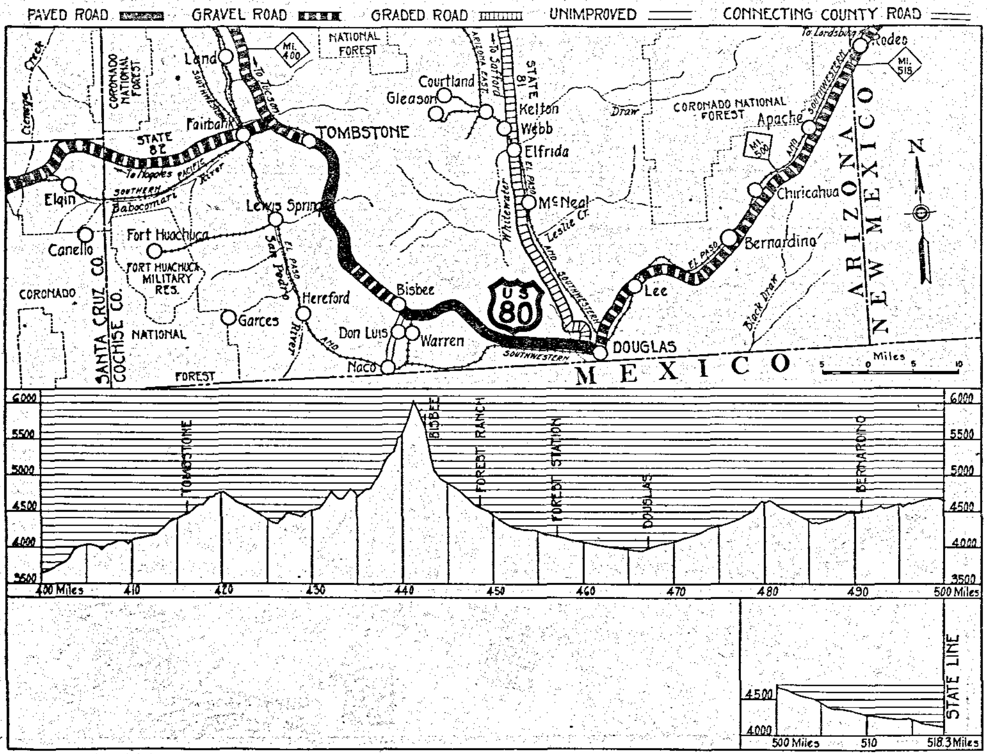
Youngsburg
Apache Junction
Florence Junction
Price
Oracle
Mesa
Gilbert
Tempe
Magma
FLORENCE
PHOENIX
PINAL CO.
MARICOPA CO.
PIMA CO.
COCHISE CO.
Benson
St. David
Mescal
Fairbank
Pantano
Vail
Jaynes
TUCSON
Miles
TEMPE
MESA
EASTERN CANAL
DESERT WELL
APACHE TRAIL JUNCTION
FLORENCE JUNCTION
GILA RIVER FLORENCE
BRADY WASH
ORACLE JUNCTION
CANADA DEL ORA
RILLITO CREEK
CASA GRANDE JUNCTION
TUCSON
VAIL
CIENEGA BRIDGE
PIMA
COCHISE CO.
BENSON
ST. DAVID


PAVED ROAD
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CONNECTING COUNTY ROAD
To Lordsburg
Rodeo
MI. 518
MI. 400
MI. 500
NATIONAL FOREST
CORONADO NATIONAL FOREST
Land
To Tucson
Courtland
Gleason
Kelton
Webb
Elfrida
STATE 81
To Safford
ARIZONA EAST
Draw
Apache
Fairbank
TOMBSTONE
STATE 82
To Nogales
SOUTHERN PACIFIC
Babocomari River
Elgin
Canello
Lewis Springs
Fort Huachuca
FORT HUACHUCA MILITARY RES.
San Pedro River
EL PASO AND SOUTHWESTERN
Whitewater
McNeal
Leslie Cr.
Chiricahua
Bernardino
Lee
Black Draw
CORONADO
SANTA CRUZ CO.
COCHISE CO.
NATIONAL
FOREST
Garces
Hereford
Bisbee
Don Luis
Warren
Naco
DOUGLAS
US 80
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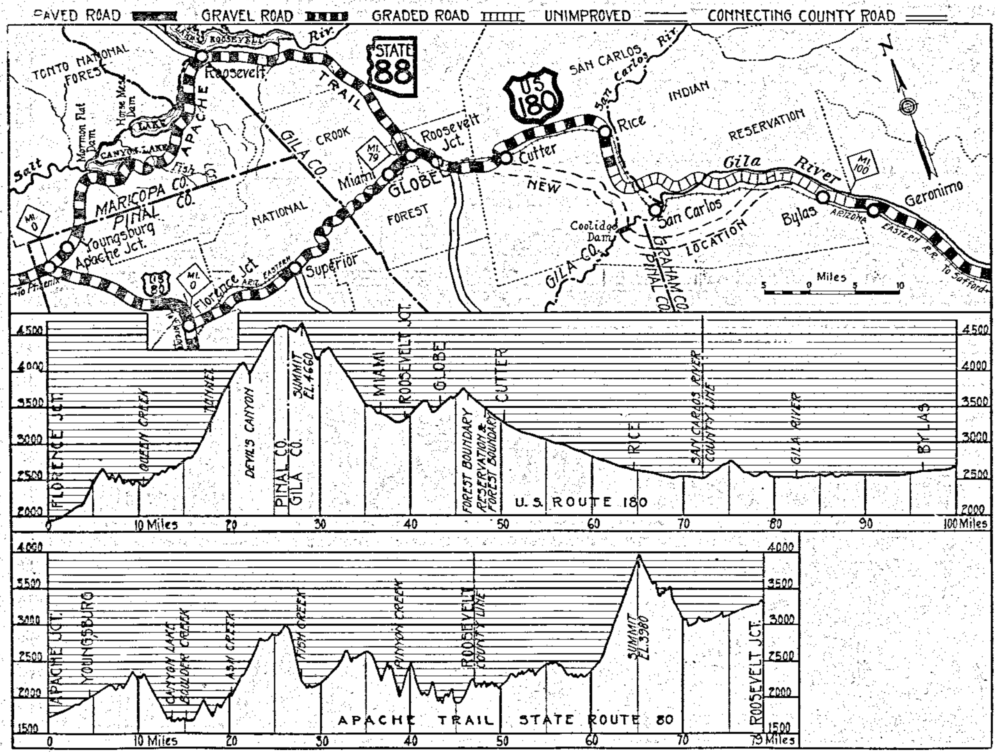

PAVED ROAD
GRAVEL ROAD
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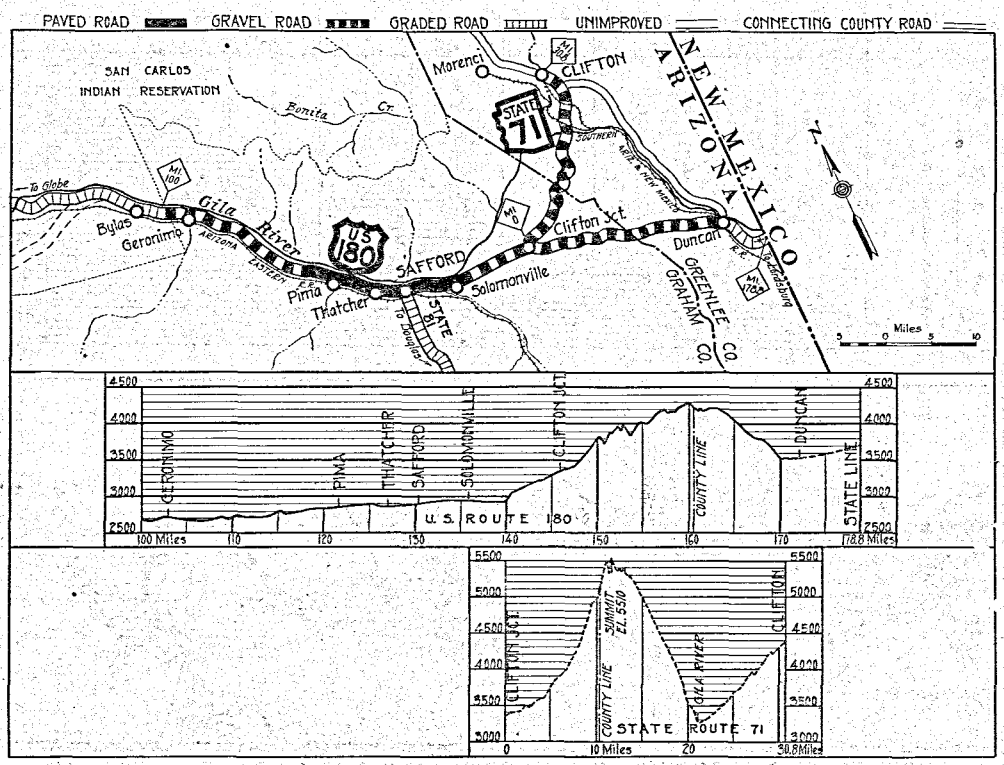
UNIMPROVED
CONNECTING COUNTY ROAD
TONTO NATIONAL FOREST
Roosevelt
STATE 88
APACHE TRAIL
Mormon Flat Dam
Horse Mesa Dam
CANYON LAKE
Fish
Salt
MARICOPA CO.
PINAL CO.
Youngsburg
Apache Jct.
To Phoenix
US 80
Florence Jct.
Superior
GILA CO.
CROOK NATIONAL FOREST
Miami
GLOBE
Roosevelt Jct.
US 180
Cutter
SAN CARLOS
San Carlos Riv.
INDIAN RESERVATION
Rice
NEW LOCATION
Coolidge Dam
San Carlos
GRAHAM CO.
Gila River
Bylas
Geronimo
To Safford
Miles
U.S. ROUTE 180
FLORENCE JCT.
QUEEN CREEK
TUNNEL
DEVIL'S CANYON
PINAL CO.
GILA CO.
SUMMIT EL. 4660
MIAMI
ROOSEVELT JCT.
GLOBE
CUTTER
FOREST BOUNDARY
RESERVATION & FOREST BOUNDARY
RICE
SAN CARLOS RIVER
COUNTY LINE
GILA RIVER
BYLAS
10 Miles
100 Miles
APACHE TRAIL STATE ROUTE 80
APACHE JCT.
YOUNGSBURG
CANYON LAKE
BOULDER CREEK
LASH CREEK
FISH CREEK
PINYON CREEK
ROOSEVELT
COUNTY LINE
SUMMIT EL. 3980
ROOSEVELT JCT.
79 Miles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UNIMPROVED
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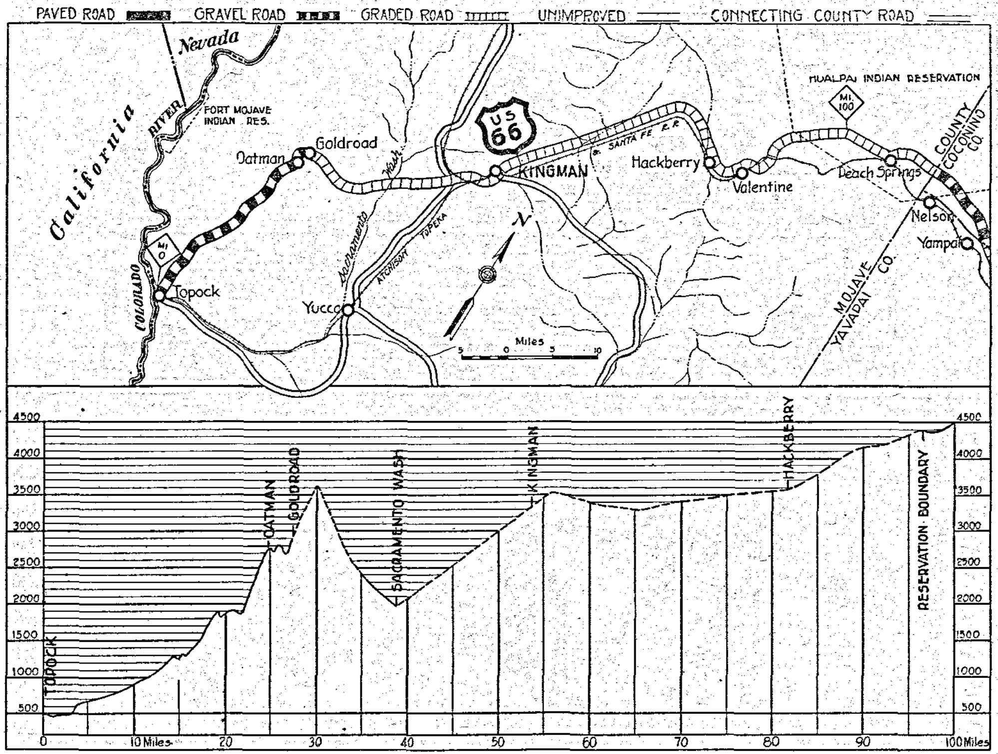
SAN CARLOS INDIAN RESERVATION
Bonita Cr.
Morenci
CLIFTON
STATE 71
Southern Pacific & New Mexico
NEW MEXICO
ARIZONA
To Globe
Bylas
Geronimo
Gila River
Arizona Eastern R.R.
US 180
SAFFORD
Pima
Thatcher
To Pinaleno
Solomonville
Clifton Jct
Duncan
Greenlee Co.
Graham Co.
Miles
GERONIMO
PIMA
THATCHER
SAFFORD
SOLOMONVILLE
CLIFTON JCT.
COUNTY LINE
DUNCAN
STATE LINE
U.S. ROUTE 180
100 Miles
178.8 Miles
SUMMIT EL. 5510
GILA RIVER
STATE ROUTE 71
10 Miles
20
30.8 Miles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CONNECTING COUNTY ROAD
Nevada
California
RIVER
COLORADO
FORT MOJAVE INDIAN RES.
Goldroad
Oatman
US 66
KINGMAN
SANTA FE R.R.
Hackberry
Valentine
HUALPAI INDIAN RESERVATION
MI. 100
Peach Springs
COUNTY
COCONINO CO.
Nelson
Yampai
MI. 0
Topock
Yucca
Sacramento Wash
ATCHISON TOPEKA
N
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5 0 5 10
MOJAVE CO.
YAVAPAI CO.
4500
4000
3500
3000
2500
2000
1500
1000
500
TOPOCK
OATMAN
GOLDROAD
SACRAMENTO WASH
KINGMAN
HACKBERRY
RESERVATION BOUNDARY
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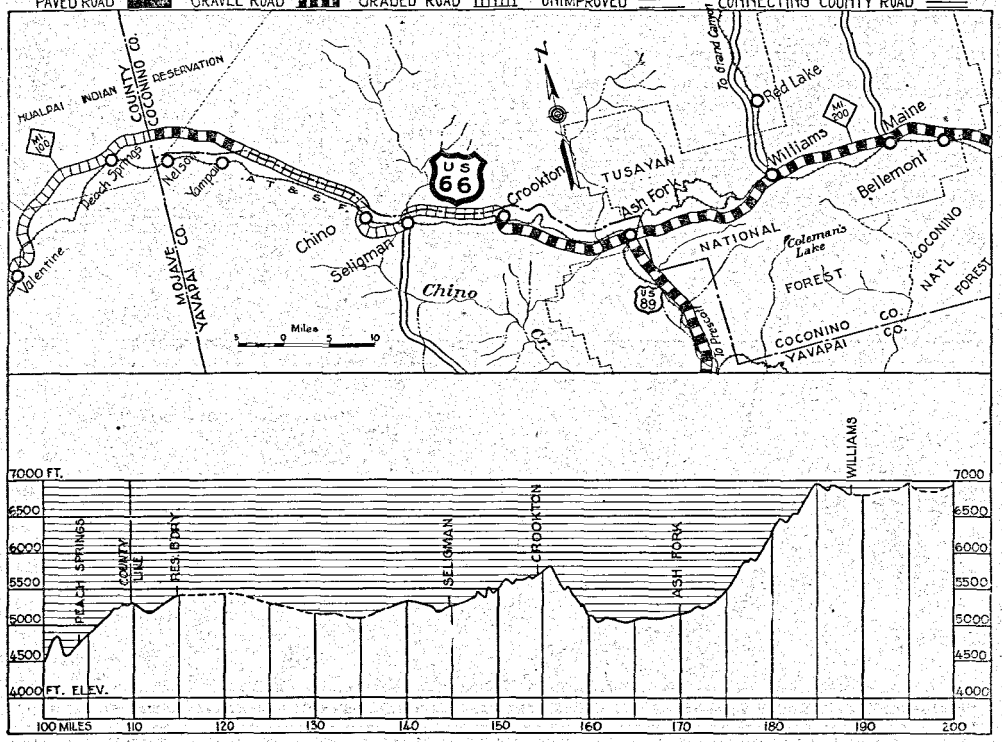
100 Miles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CONNECTING COUNTY ROAD
HUALPAI INDIAN RESERVATION
COCONINO CO.
COUNTY
Beach Springs
Nelson
Vampire
A. T. & S. F.
Valentine
MOJAVE CO.
YAVAPAI CO.
Chino
Seligman
US 66
Crookton
TUSAYAN
Ash Fork
To Grand Canyon
Red Lake
Williams
Maine
Bellemont
NATIONAL
Coleman's Lake
FOREST
COCONINO NAT'L FOREST
US 89
To Prescott
COCONINO CO.
YAVAPAI CO.
Miles
7000 FT.
6500
6000
5500
5000
4500
4000 FT. ELEV.
BEACH SPRINGS
COUNTY LINE
RES. 8 DAY
SELIGMAN
CROOKTON
ASH FORK
WILLIAMS
100 MILES
110
120
130
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150
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170
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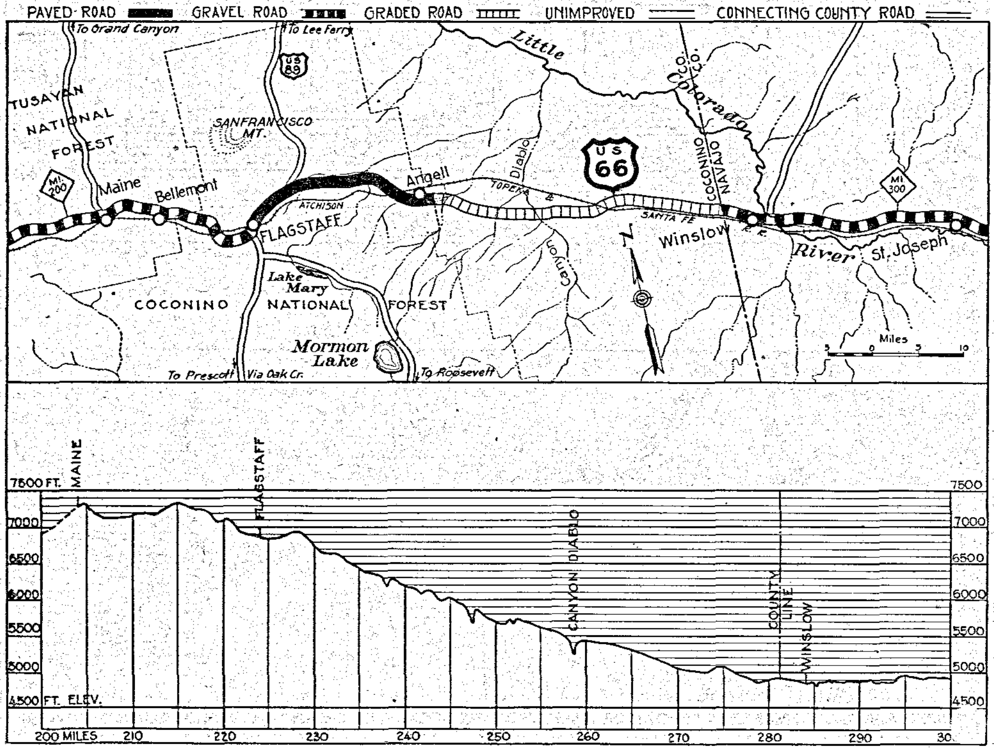
190
200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UNIMPROVED
CONNECTING COUNTY ROAD
To Grand Canyon
To Lee Ferry
US 89
TUSAYAN NATIONAL FOREST
SAN FRANCISCO MT.
Little Colorado River
Coco. Co.
US 66
Diablo
Canyon
COCONINO NAVAJO
MI 200
MI 300
Maine
Bellemont
FLAGSTAFF
Angell
ATCHISON TOPEKA & SANTA FE R.R.
Winslow
St. Joseph
Lake Mary
COCONINO NATIONAL FOREST
Mormon Lake
To Prescott
Via Oak Cr.
To Roosevelt
Miles
5 0 5 10
MAINE
FLAGSTAFF
CANYON DIABLO
COUNTY LINE
WINSLOW
7500 FT.
7000
6500
6000
5500
5000
4500 FT. ELEV.
200 MILES
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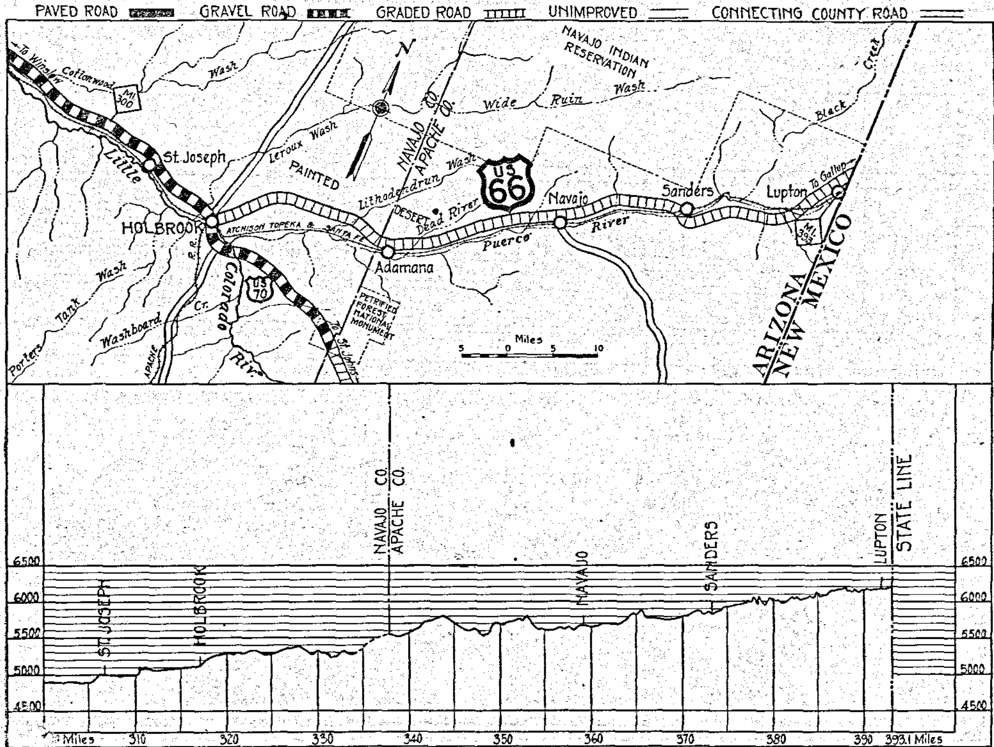
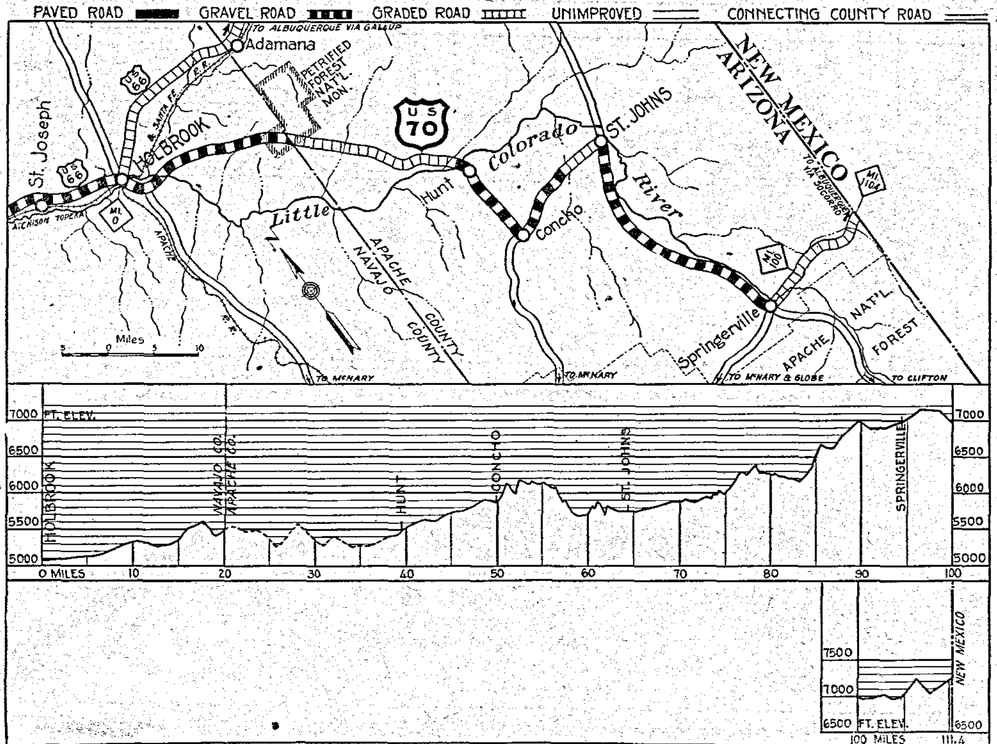
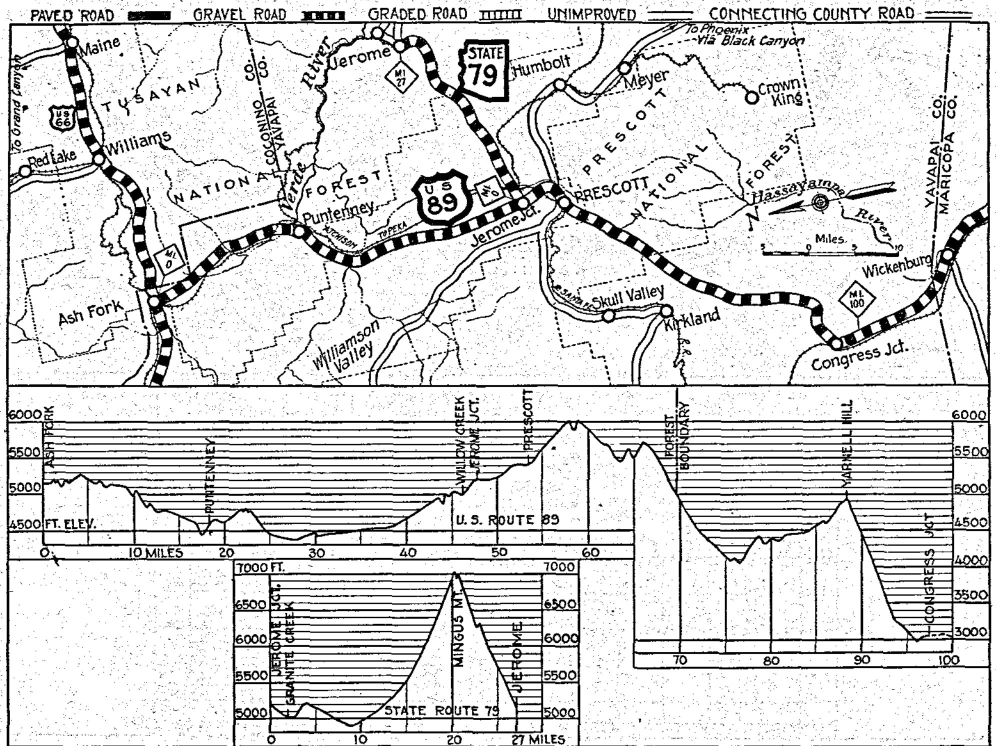
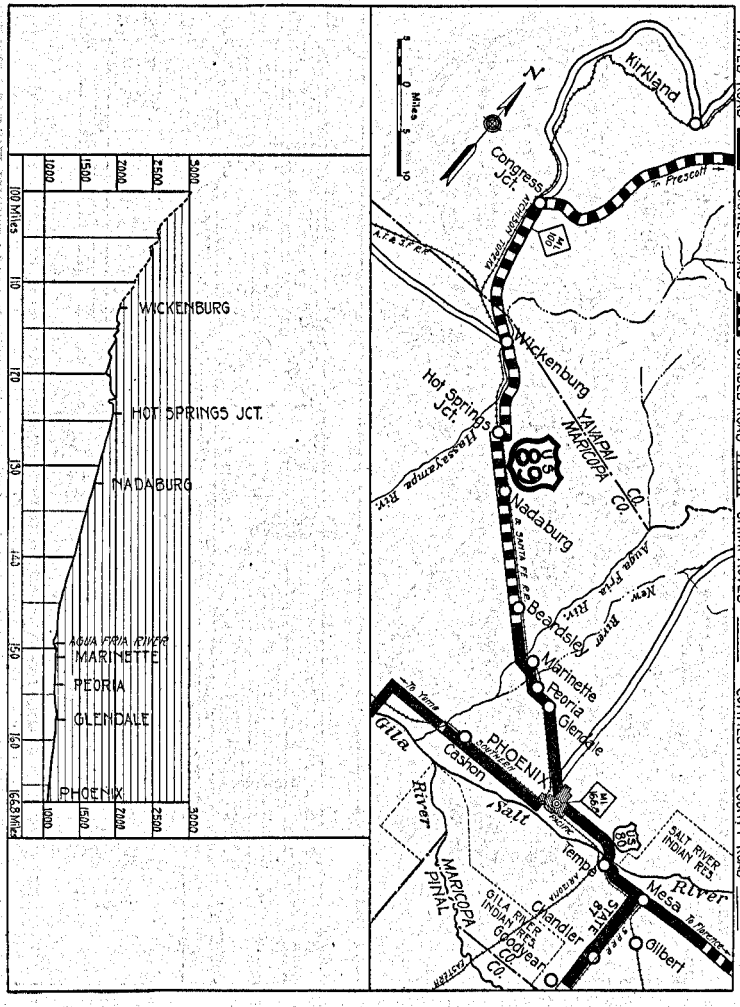
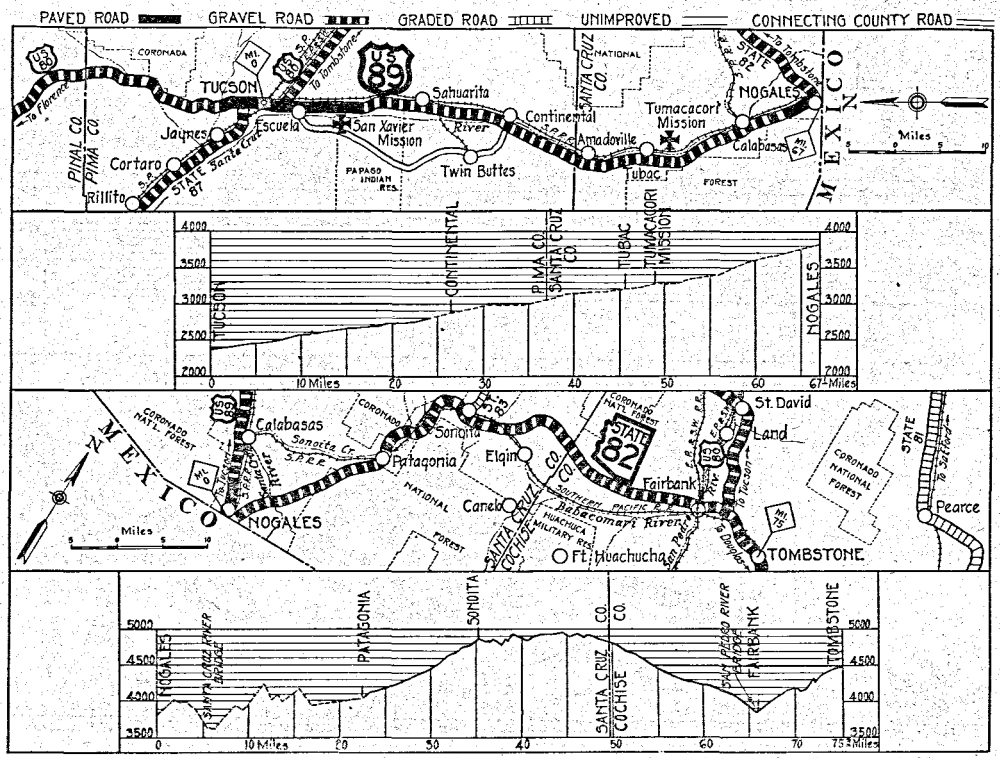
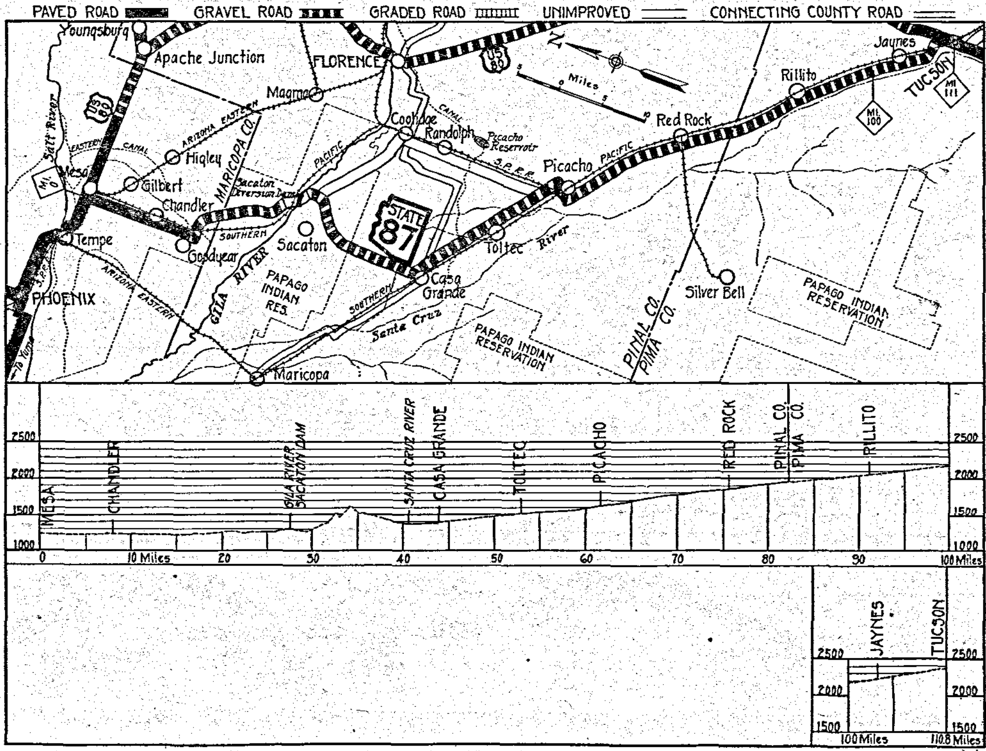

PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
NAVAJO INDIAN RESERVATION
To Winslow
Cottonwood
MI 300
Wash
Wide Ruin Wash
Black Creek
St. Joseph
Little
Leroux Wash
PAINTED
DESERT
NAVAJO CO.
APACHE CO.
Lithodendron Wash
Dead River
US 66
Navajo
Sanders
Lupton
To Gallup
MI 393
HOLBROOK
ATCHISON TOPEKA & SANTA FE
R.R.
Adamana
Puerco
River
Colorado
Cr.
US 70
Tank
Wash
Porters
Washboard
Apache
Riv.
To St. Johns
PETRIFIED FOREST NATIONAL MONUMENT
Miles
5 0 5 10
ARIZONA
NEW MEXICO
ST. JOSEPH
HOLBROOK
NAVAJO CO.
APACHE CO.
NAVAJO
SANDERS
LUPTON
STATE LINE
6500
6000
5500
5000
4500
Miles
310
320
330
340
350
360
370
380
390
393.1 Miles

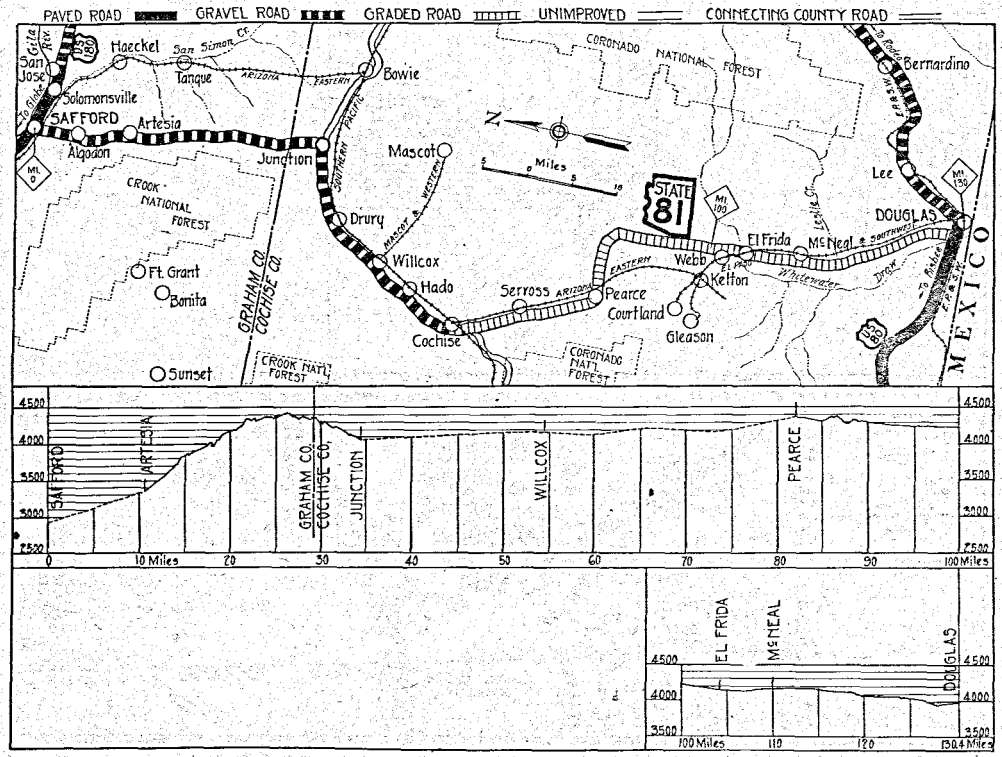

PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
TO ALBUQUERQUE VIA GALLUP
Adamana
PETRIFIED FOREST NAT'L. MON.
US 66
US 70
HOLBROOK
St. Joseph
ATCHISON TOPEKA & SANTA FE R.R.
MI. 0
Little Colorado River
Hunt
Concho
ST. JOHNS
NEW MEXICO
ARIZONA
TO ALBUQUERQUE VIA SOCORRO
MI. 104
MI. 100
Springerville
APACHE NAT'L. FOREST
APACHE COUNTY
NAVAJO COUNTY
Miles
TO McNARY
TO McNARY
TO McNARY & GLOBE
TO CLIFTON
FT. ELEV.
HOLBROOK
NAVAJO CO.
APACHE CO.
HUNT
CONCHO
ST. JOHNS
SPRINGERVILLE
7000
6500
6000
5500
5000
0 MILES
10
20
30
40
50
60
70
80
90
100
7500
NEW MEXICO
100 MILES
111.4

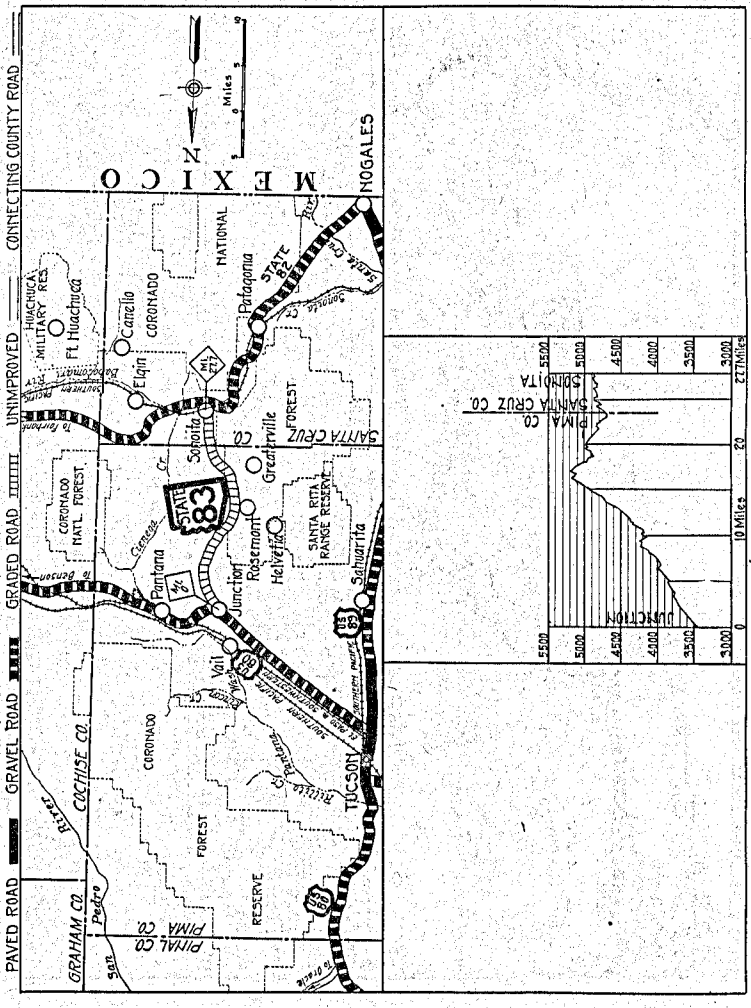

PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
Maine
To Grand Canyon
TUSAYAN
US 66
Williams
Red Lake
NATIONAL
FOREST
COCONINO CO.
YAVAPAI CO.
Verde River
Jerome
MI 27
STATE 79
Humbolt
To Phoenix Via Black Canyon
Meyer
Crown King
PRESCOTT
NATIONAL
FOREST
PRESCOTT
US 89
Punteney
Jerome Jct.
Ash Fork
Williamson Valley
Skull Valley
Kirkland
Hassayampa River
Miles
Wickenburg
MI 100
Congress Jct.
YAVAPAI CO.
MARICOPA CO.
FT. ELEV.
ASH FORK
PUNTENNEY
WILLOW CREEK
JEROME JCT.
PRESCOTT
FOREST BOUNDARY
YARNELL HILL
CONGRESS JCT
U. S. ROUTE 89
10 MILES
JEROME JCT.
GRANITE CREEK
MINGUS MT.
JEROME
STATE ROUTE 79
27 MILES


PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
Kirkland
Congress Jct.
To Prescott
Wickenburg
Hot Springs Jct.
Nadaburg
Beardsley
Marinette
Peoria
Glendale
PHOENIX
Tempe
Mesa
Chandler
Gilbert
Casten
Salt River
Gila River
MARICOPA
PINAL
YAVAPAI
MARICOPA CO.
GILA RIVER INDIAN RES.
SALT RIVER INDIAN RES.
A.T. & S.F. R.R.
WICKENBURG
HOT SPRINGS JCT.
NADABURG
AGUA FRIA RIVER
MARINETTE
PEORIA
GLENDALE
PHOENIX
100 Miles
166.5 Miles


PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
TUCSON
Sahuarita
Continental
Tumacacori Mission
NOGALES
Jaynes
Escuela
San Xavier Mission
Amadeville
Calabasas
Cortaro
Rillito
Twin Buttes
Tubac
PAPAGO INDIAN RES.
FOREST
MEXICO
Miles
TUCSON
CONTINENTAL
PIMA CO.
SANTA CRUZ CO.
TUBAC
TUMACACORI MISSION
NOGALES
10 Miles
67 Miles
Calabasas
Sonoita
Patagonia
Elgin
Canelo
Fairbank
St. David
Land
Pearce
TOMBSTONE
Ft. Huachuca
Babocomari River
NOGALES
PATAGONIA
SONOITA
SANTA CRUZ CO.
COCHISE CO.
FAIRBANK
TOMBSTONE
75 Miles


PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
Youngsburg
Apache Junction
FLORENCE
Magma
Coolidge
Randolph
Picacho Reservoir
Higley
Gilbert
Chandler
Mesa
Tempe
PHOENIX
Goodyear
Sacaton
Sacaton Diversion Dam
STATE 87
US 80
Picacho
Red Rock
Rillito
Jaynes
TUCSON
Toltec
Casa Grande
Silver Bell
Maricopa
PAPAGO INDIAN RES.
PAPAGO INDIAN RESERVATION
PINAL CO.
PIMA CO.
MARICOPA CO.
GILA RIVER
Santa Cruz River
Salt River
ARIZONA EASTERN
SOUTHERN PACIFIC
S.P.R.R.
EASTERN CANAL
To Yuma
Miles
MI. 0
MI. 100
MI. 111
MESA
CHANDLER
GILA RIVER SACATON DAM
SANTA CRUZ RIVER
CASA GRANDE
TOLTEC
PICACHO
RED ROCK
PINAL CO. PIMA CO.
RILLITO
JAYNES
TUCSON
2500
2000
1500
1000
0
10 Miles
20
30
40
50
60
70
80
90
100 Miles
110.8 Miles


PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
San Jose
Haeckel
San Simon Cr.
Tanque
Arizona Eastern
Bowie
Solomonsville
SAFFORD
Artesia
Algodon
Junction
Southern Pacific
Mascot
Drury
Mascot & Western
Willcox
Hado
Ft. Grant
Bonita
Graham Co.
Cochise Co.
Sunset
Crook Natl. Forest
Cochise
Serross
Arizona Eastern
Pearce
Courtland
Gleason
Coronado Natl. Forest
Coronado National Forest
Bernardino
Lee
DOUGLAS
El Frida
McNeal & Southwest
Webb
Kelton
Whitewater Draw
Leslie Cr.
STATE 81
MEXICO
Miles
4500
4000
3500
3000
2500
SAFFORD
ARTESIA
GRAHAM CO.
COCHISE CO.
JUNCTION
WILLCOX
PEARCE
0
10 Miles
20
30
40
50
60
70
80
90
100 Miles
EL FRIDA
McNEAL
DOUGLAS
100 Miles
110
120
130.4 Miles


PAVED ROAD
GRAVEL ROAD
GRADED ROAD
UNIMPROVED
CONNECTING COUNTY ROAD
MEXICO
NOGALES
N
0 5 10 Miles
HUACHUCA MILITARY RES.
Ft. Huachuca
Camelia
Elgin
CORONADO NATIONAL FOREST
Patagonia
STATE PARK
Sonoita
Greaterville
SANTA CRUZ CO.
CORONADO NATL. FOREST
STATE 83
Cienega Cr.
Pantano
Rosemont
Helvetia
SANTA RITA RANGE RESERVE
Sahuarita
Junction
Vail
TUCSON
Rillito
Pantano Cr.
COCHISE CO.
CORONADO FOREST
RESERVE
GRAHAM CO.
PIMA CO.
San Pedro River
PIMA CO.
SANTA CRUZ CO.
SONOITA
JUNCTION
10 Miles
20
27 Miles
5500
5000
4500
4000
3500
3000

INDEX

INDEX

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—P—

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