FOURTH BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR

OF THE

STATE OF ARIZONA

For the Period
July 1, 1918 to December 31, 1920

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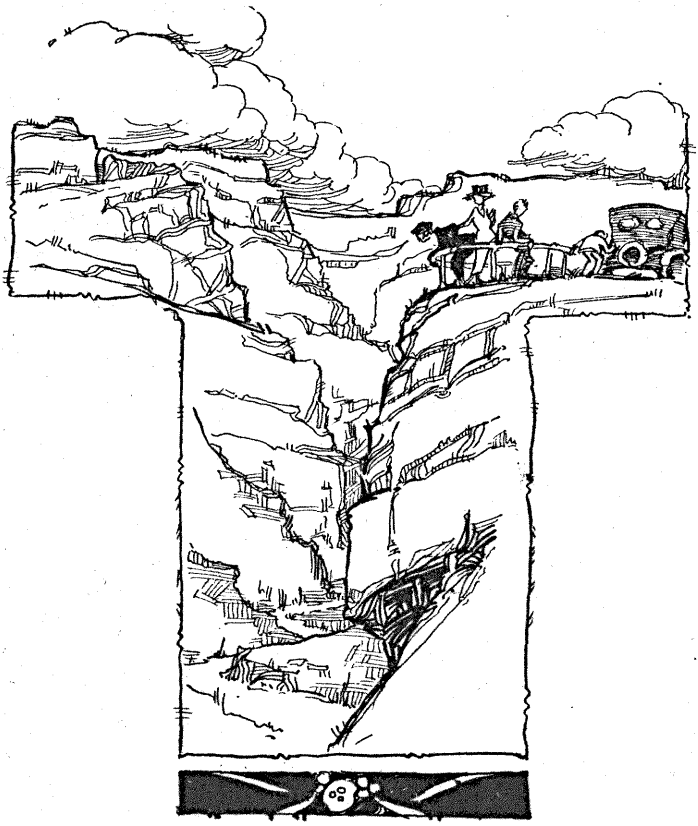


PRINTED AT
THE REPUBLICAN PRINT SHOP
PHOENIX, ARIZONA

Phoenix, Arizona,
January 22, 1921.

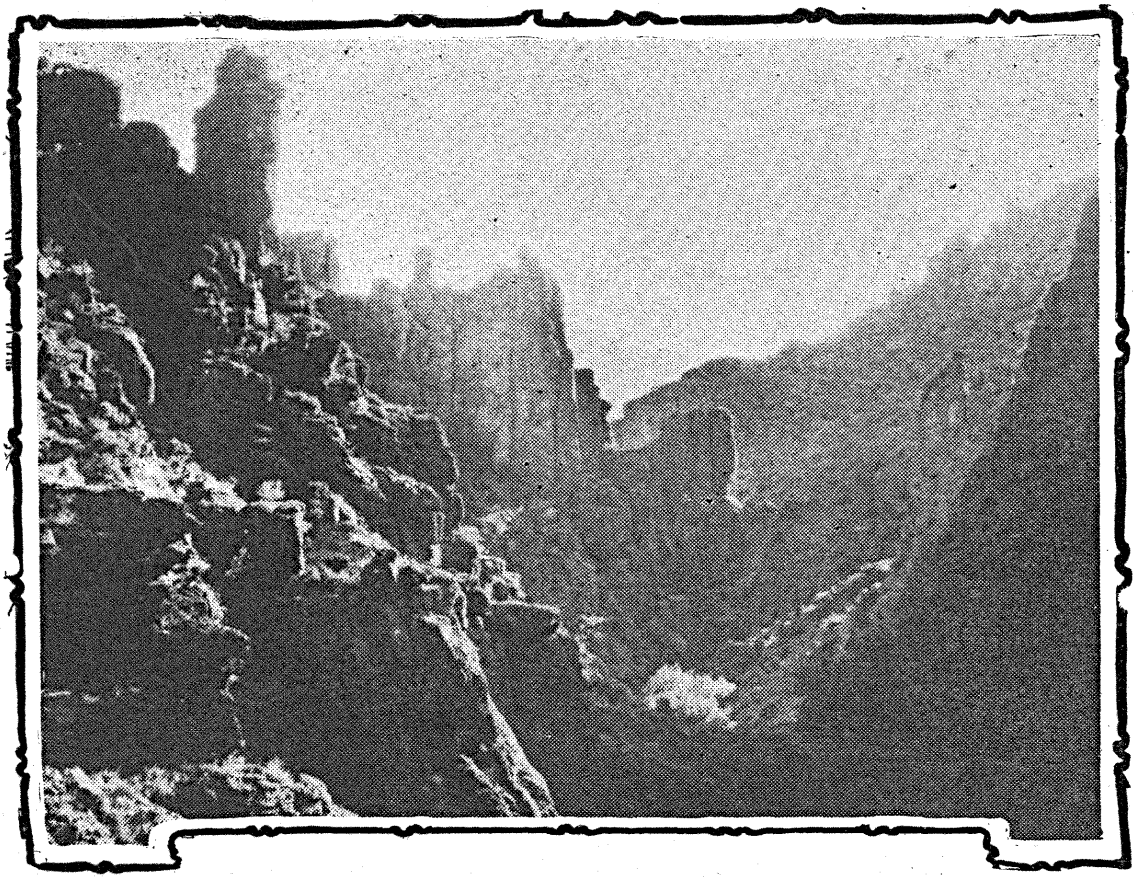
Honorable Thomas E. Campbell,
Governor of Arizona,
Phoenix, Arizona.

Dear Sir:

I am transmitting you herewith a report of the activities of the State Highway Department during the period July 1, 1918, to December 31, 1920.

Respectfully yours,

THOS. MADDOCK,
State Engineer.



ON THE ROUTE OF THE SUPERIOR-MIAMI HIGHWAY
FEDERAL AID PROJECT NO. 16

STATE HIGHWAY DEPARTMENT

DECEMBER 31, 1920

THOS. MADDOCK.....State Engineer
F. N. HOLMQUIST.....Assistant State Engineer
W. R. INGHRAM.....Chief Clerk
W. J. JAMIESON.....Office Engineer
C. C. SMALL.....Chief Locating Engineer
E. A. WOLFE.....Chief Construction Engineer
MERRILL BUTLER.....Bridge Engineer
E. C. MOORE.....Purchasing Agent
J. H. ALLEN.....Superintendent of Equipment
R. M. HANSEN.....Testing Engineer
S. R. STANIFORTH.....Traveling Auditor
T. P. JOHNSON.....Accountant

Field Engineers

H. D. Alexander
Jas. Bone
J. M. Brown
D. M. Bunker
R. A. Davis
E. C. Dietrich
I. P. Frazier
W. C. Goetz
F. N. Grant
F. A. Greene
H. Hagen
A. F. Harter
Fred Hauk
A. W. Jenkins
George Lukesh
T. S. O'Connell
Jas. A. Parker
W. B. Piper
George Porter
J. M. Shepherd
E. O. Slater
Logan Stillwell
F. G. Twitchell
A. W. Van Fleet
W. W. Van Frank
W. B. Weast
H. B. Wright
John H. Zeitler

General Foremen

Floyd Allen
C. R. Bone
J. B. Chadwick
Ed. J. Enneking
Ernest Hall
John Hughes
A. A. Lillard
T. F. McGrath
J. W. McIntosh
Chas. O'Conner
B. J. Pearce
Ben Price
Dale Ralston
H. W. Smith
O. M. Terry
J. P. Walthall
G. H. Webb
Bert Witcher

The following men resigned positions with the Department:

Ben Gallagher left the Department to enter the contracting business.

Earl H. Parker left the Department to accept a more remunerative position with the Yavapai County Highway Commission.

C. W. Miller left the Department to enter the contracting business.

W. B. West left the Department to accept the position of County Highway Engineer of Navajo County.

R. N. Genin left the Department to accept the position of City Engineer of Globe.

C. Makutcheon left the Department to accept a position with the City of Globe.

INTRODUCTORY REMARKS

In the absence of any statutory provision for an annual report by the State Engineer, I am submitting to you a general report on the operation of this Department for the period ending December 31st, 1920, in order that the information may be up to date for yourself and the Legislature.

We have eliminated detail similar to that shown in previous reports as it would require several volumes to thoroughly explain the roads and bridges constructed in your administration. These have been greater than the total previously constructed since the creation of a Territorial or State Highway Department.

Magnitude of Department

In order that you may appreciate the comparative size of this Department, which has grown tremendously during your administration, your attention is called to the fact that the Arizona Highway Department is the largest employer of engineers in Arizona. It is conducting the largest truck transportation operations in the State. It is the largest single consumer of explosives. It puchases more supplies for its various camps than are bought by the State Purchasing Agent for all the State institutions. In addition to handling the engineering on many contracts, State forces, under the direct supervision of this Department, constitute the largest contracting force in the State.

Funds Handled

The funds paid through this Department and equipment received in the past year by us amount to a value greater than that expended by every State, County, City, School and Road District, combined, in this State in 1914.

This Department last year handled more funds and employed more men and women than all the other State Departments combined.

Management Centralized — Specialists in Charge of Work

During your administration many changes have taken place in regard to the conduct of this Department. The object has been to centralize management and to place specialists in charge of each branch of our work rather than to divide the State into districts under Division Engineers.

During your administration this Department has created the office of Traveling Auditor and placed all bookkeeping and time-keeping under the control of the Chief Clerk in order to secure the same system of accounts on all State jobs.

The office of Chief Locating Engineer has been established in order to place this important function in the hands of men who are specialists in this line.

The office of Bridge Engineer has been created, resulting in this Department now making all the plans for its own bridges instead of securing outside help, as formerly, by a payment of a percentage of the cost of a bridge to the engineer for plans and specifications, etc.

The office of Construction Engineer has been created in order that best construction methods may be carried from one part of the State to another and equipment distributed where most needed on our various jobs.

The office of Superintendent of Equipment has been established and between two and three million dollars' worth of Federal equipment and material received which has been distributed throughout the State.

The office of Engineer of Tests has been established and a State Laboratory is now testing the various road materials as required by the Bureau of Public Roads.

There has been a central Purchasing Department established, Central Storage and Repair Shops have been organized.

Standard Plans and Specifications Prepared

State standard road sections, bridge and culvert designs and specifications have been established and approved by the United States Bureau of Public Roads.

Competition in Purchases

The practice of securing bids before buying has been inaugurated and most of State purchases are made from Arizona instead of Los Angeles firms. The State has established the practice—which has been largely followed by the Counties—of securing competition in the purchase of corrugated pipe by eliminating specifications which provided for the purchase of these important articles from one manufacturer only. In order to eliminate royalties, patented bridge designs and patented pavements have likewise been compelled to compete with unpatented articles.

First Paved Road Built

Under your administration the first paved road built by the State was completed and the first mountain work so heavy as to necessitate a tunnel has been commenced.

The custom of fully advising County and Highway Engineers of the result of bids received for State work has been started and the Counties have been tendered the services of various State employees, as for instance, the Bridge, Testing and Locating Engineers' services at cost.

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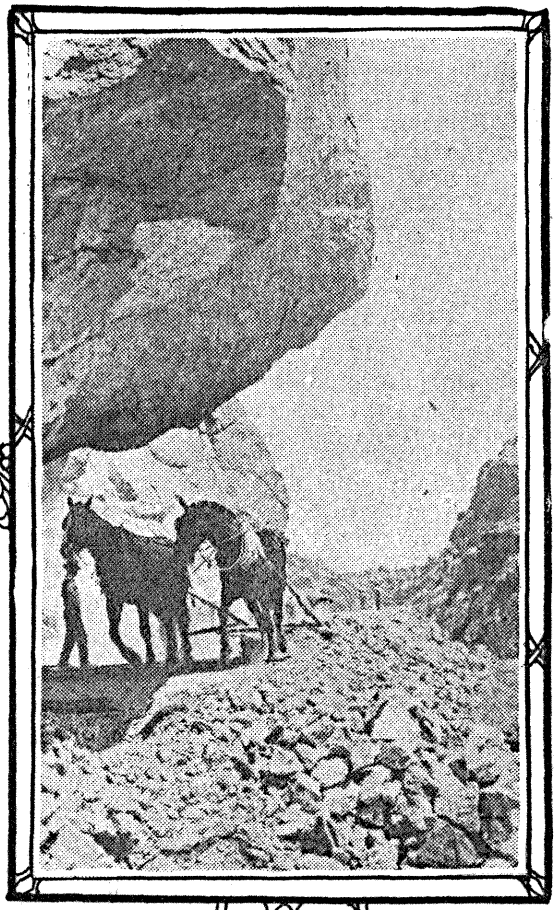


HALF-MOON TUNNEL ON MIAMI-SUPERIOR ROAD

POLICIES

This Department has been importuned by citizens of nearly every County in the State to start construction with State or Federal funds on many projects off the through lines of communication. We have found that the citizens of every locality are united in the opinion that through roads only should be built by State and Federal funds in the other counties of the State, even while soliciting the use of these funds on some local road. On this account we are convinced that the large majority of the citizens of Arizona favor the continuation of our policy of spending State and Federal funds which are received from the taxpayers in general only for the construction of those through roads which are used by all citizens in general.

Permanent Work

We have, with few exceptions, confined our expenditures to the construction of first-class roads and bridges in the belief that it was better to build well what was built at all so that every dollar of State money expended would be a permanent investment. We have avoided the taking over and the subsequent maintaining of many roads which will no doubt some day become State highways, knowing that the expenditure of our funds on this work would greatly reduce the amount of improved road which we were able to build, also because we could not secure Federal Aid on road maintenance, and needed all of our available State funds to match Federal Aid on road construction.

Maintenance

We realize the importance of maintenance work and that this will increase as our construction increases our road mileage. On this account we contemplate the appointment of a Chief Maintenance Engineer in the near future. At the present time there are approximately 335 miles of State road which must be maintained by the State under the present law, as against 1600 miles in the proposed State primary system, which consists of two roads east and west

across the State and an additional one from Phoenix to Rodeo by the way of Florence, Tucson, Benson, Tombstone, Bisbee and Douglas; also a road from Tucson to Nogales, and a connecting road from Phoenix to Prescott and Ash Fork. Maintenance costs at present in the United States are approximately $300.00 per mile. This primary system alone, therefore, will require approximately one-half million dollars annually for maintenance. At the present time we are spending about $100,000 a year for maintenance. This does not, of course, include the repair of structures destroyed by floods.

Strengthen Weak Links

We have not been striving to secure the most mile construction, but rather to improve the poorest lengths of our through lines so that Arizona's portion of the National Highways would be more quickly placed in position to better compete with the other through highways across the United States. We realize that there will be a tremendous revenue secured by the citizens of our State in their providing for the needs of the travelers across our State; also that the first good route across the United States will receive so great an amount of advertising that it will for a long time carry a large portion of the National traffic; that in addition, the business built up by this traffic will assist in the paying of taxes to further improve the State highways. On this account we feel that the expenditure of Arizona funds for through highways is justified.

Where it has been impossible to improve the entire length of road in a County after first building the poorest links, it is the policy of this Department to improve the portions of the highways which in addition to being of equal benefit to through traffic serve the greatest local traffic as well.

Contracts

The State law was changed January 1st, 1919, permitting the letting of contracts on State road work, since which time the majority of the State work has been advertised for bids.

Where the same type of construction prevailed no work has been let except to the lowest bidder when he could secure the proper bonds. It is the policy of the State Highway Department to contract large bridges, large paving jobs and heavy rock work. State forces are continued to be employed on work involving hauling, as the State has a large number of trucks, etc.; on small bridges which are built in conjunction with State grading and on light work in general which would be extremely hard to classify and expensive to inspect. In

case satisfactory bids are not received, however, the Department performs all classes of construction.

Insurance

Early in 1919 the Department cancelled all liability insurance. Prior to this large premiums had been paid with practically no return to injured employees.

In our opinion the State work is so large and widely scattered that the State can carry its own insurance, paying the necessary liabilities out of the saving in premiums. This system avoids court costs and lawyer fees to both State and employees and permits the adjustment of the matter by the Legislature so that the entire cost to the State is received by the injured, the public in general thus bearing the expenses of the inevitable accidents which occur on construction work.

Subsequent to our action a court decision was made which indicates that the State may not be sued. If this is correct, it cannot sustain loss, so insurance to refund this loss is worthless.

The insurance premiums would have approximated $30,000.00 per year during the last two years had we continued to pay them. All injured employees are carried on our payrolls, their doctor and hospital bills paid, and they are returned to work on their recovery.

Imprest Fund

The State Engineer's imprest fund has been used mostly to comply with the semi-monthly payday bill in the payment of payrolls. In addition it has been used to discount bills whenever possible. The saving on approximately 100,000 barrels of cement at 5c each alone amounted to $5,000.00.

As the average monthly expenditures of this Department run over $300,000.00, approximately one-half of which is Federal Aid, and this requires approximately three months to receive, the present imprest fund is wholly inadequate to operate this Department.

Eight-Hour Day

The office employees of this Department are working eight hours a day in place of the customary seven. It is our belief that as the average taxpayer who provides us with funds works at least eight hours per day, the employees of the Departments which spend the taxpayers' money should do likewise.

Nepotism

Nepotism is not permitted in this Department.

No persons are permitted to work under the direction of their relatives.

Bonds

Every employee in this Department who handles money or who is in responsible charge of work is under surety bond. These range from $50,000.00 each for the State Engineer and Chief Clerk to as low as $1,000.00 for inspectors on small jobs.

Contractors' Surety

All contractors are under surety bond to pay for labor and material; also to complete their contracts.

Promotion

It has been our desire, whenever possible, to promote present employees rather than secure outside help, not only as a reward for hard work but to improve the general morale of the Department and encourage the other employees to better services.

POLITICS

The question of politics has no place in a State Report. However, as critics of the present State Highway Department and advocates of changes assume that this Department is political, we desire to assure you that it is not.

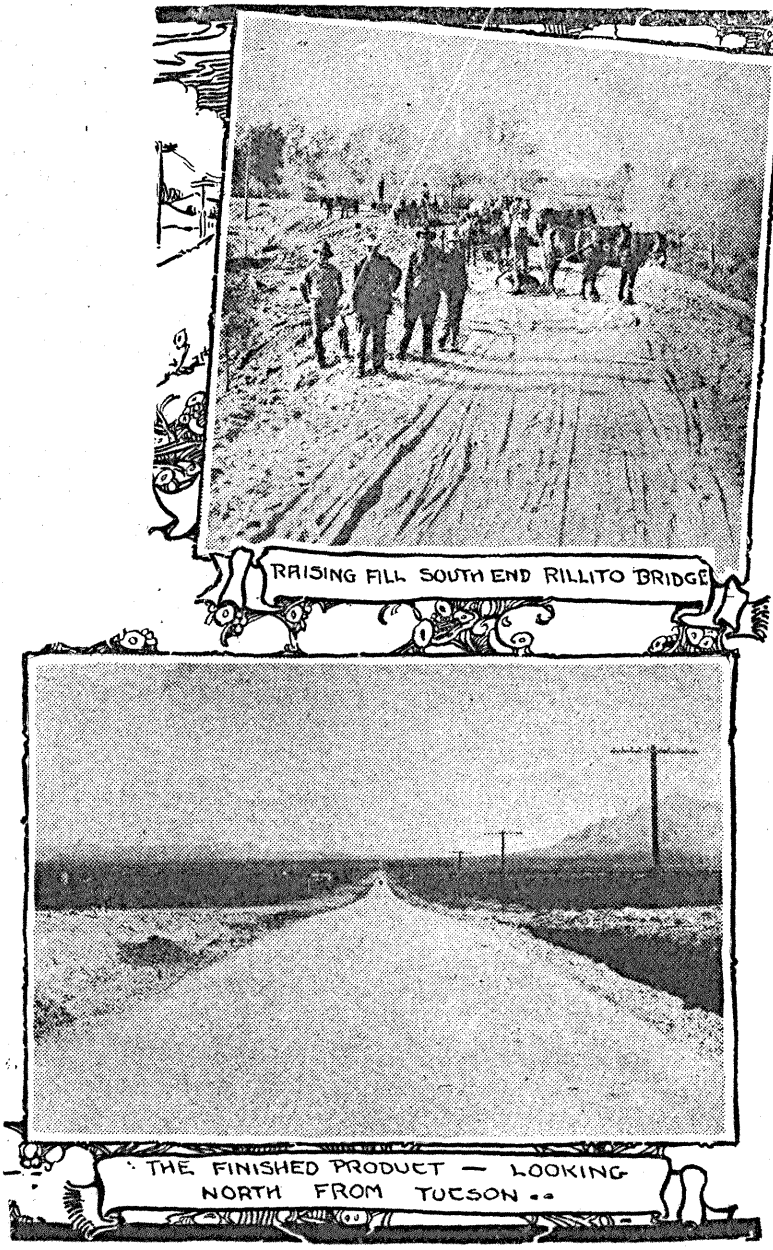
None of the employees of this Department have been assessed any part of their salary, directly or indirectly, as a contribution to the Republican Party.

In the approximate two years which the writer has served as State Engineer, he has not himself, nor his Office Engineer, Chief Clerk, nor any other person with his authority, even asked the politics of an applicant requesting employment in the State Highway Department. In accordance with the provision of the Federal Road Act that "preference shall be given, other conditions being equal, to honorably discharged soldiers, sailors and marines, but no other discrimination among citizens of the United States shall be made,"—we have given preference to ex-service men.

This Department in making purchases does not take into consideration the politics of merchants but merely the prices of their goods to the State.

We have many men in important positions of the opposite political faith. They have never even been requested to support your administration politically. We therefore feel that we have been neutral as far as politics is concerned and that this neutrality has warranted a return of the same from our employees.

We have made no suggestions or objections to how our employees voted. However, where employees in our Department, after receiving our neutral treatment, have seen fit to openly work for and solicit votes for the opponents of this administration, we have felt that they were not properly reciprocating our actions and have severed their connection with the State, on the principle of the Scriptural passage: "They that take the sword shall perish with the sword."



VIEWS ON TUCSON-FLORENCE PAVING
FEDERAL AID PROJECT NO. 9

RECOMMENDATIONS

Matching Federal Aid

The best information which we can secure on the authority of our representatives in Congress indicates that the Government will appropriate additional funds for the continuation of Federal Aid, during the present session of Congress.

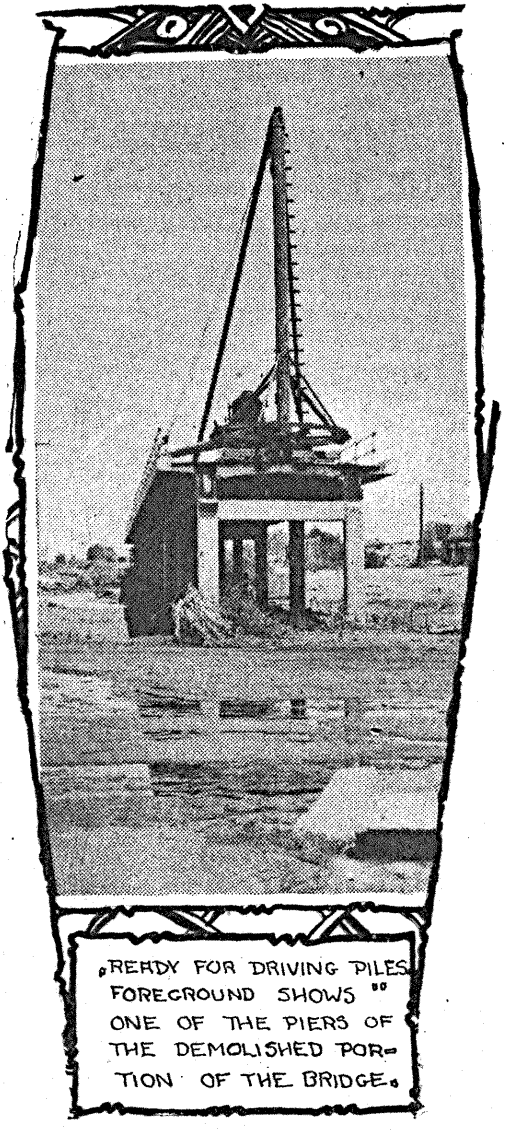
State funds should be appropriated to permit the matching of Arizona's portion of such Federal Aid. It has been only with great difficulty that the sums previously allotted Arizona have been matched in such manner that the distribution would be fair to the various sections of the State. The County bond issues and even the State funds which will be available under the present law on July 1st, 1921, are necessary to meet the present Federal Aid allotted this State, if we continue the practice of applying for Federal Aid only on direct routes of general benefit.

Budget

I would respectfully suggest that the Highway Department should be consulted before special appropriations for various road projects are passed by the Legislature. The appropriation for the Williams-Clarkdale Road, the Superior-Miami and the Arrowhead Trail were all insufficient to more than start this work.

Engineers for Engineering

In case the Legislature sees fit to change the organization of the present Highway Department, I sincerely hope that they will include a provision in any new law which will require that those placed in authority possess an engineering knowledge of construction work. I have had a great deal of experience in handling road affairs with Boards of Supervisors, Highway Commissions and City Councils. While appreciating the enthusiasm, integrity and good intention of the average layman office holder, I believe the possession of engineering knowledge to be a decided advantage in the economic handling of funds and in addition that engineering training is the most likely to produce men with the least bias in calculating the economical results to be secured by the most people for the least expenditure.



VIEW OF AQUA FRIA BRIDGE AT COLDWATER

UNEXPENDED APPROPRIATIONS

Williams - Clarkdale

We have to report that the $25,000.00 appropriation for the construction of the Williams-Clarkdale Road has not been expended. Our survey indicated that this road would cost over $1,000,000.00. The Highway Commission of Coconino County allotted also $25,000.00 of their bond issue to this work. By matching this total of $50 000.00 with Federal Aid, we would have secured $100,000.00, but this was the total possible, as the Highway Commission of Yavapai County apparently was not interested in this construction. We took up the possible construction of this road with the Forest Department, but they had no funds available. We doubt if we could receive Federal Aid on this road unless we could show the Government the possibility of its completion. Apparently the funds to be received from Coconino County were contingent upon securing Federal Aid. This brings the available funds to the original $25,000.00, which we feel is useless to expend on such a large project.

Parker Bridge

The $30,000.00 appropriation for the Colorado River Bridge at Parker has not been expended, because of the failure on the part of the State of California to appropriate a like sum, Arizona's appropriation being contingent upon the State of California and the Federal Government making like appropriations.

Arrowhead Bridge

We have not expended the $40,000.00 contingent appropriation for the bridge across the Colorado River on the Arrowhead Trail in Mohave County, as we have not yet been able to build a road to the bridge site and shall not be able to do so with the funds available. The bridge site is inaccessible until such a road is built. Furthermore, $80,000.00 is but half of the amount needed.

Electric Power Line

We have not expended the $50,000.00 appropriation for the Sacaton-Power Line. The bill making this appropriation assumed that a contract between the State of Arizona and the Salt River Valley Water Users' Association, successors to the Reclamation Service in control of the Roosevelt Dam Project, was still in force. After considerable delay we secured the opinion from the Attorney General that while this contract might be enforced in court, a lawsuit might show that the State had slept on its rights. Information from the Water Users' Association indicated that we should not be able to receive power for much more than half of the year. An investigation also showed that the investment for an auxiliary plant to produce this power when the same could not be secured from the Water Users' Association would require a considerable investment, the funds for which were not available; that the total cost of the auxiliary plant and power line would be greater than the services warranted; that in addition the power line would be too small to provide for the needs of the numerous pumping stations which had been established on its route during the last few years. In view of these circumstances and after a discussion of these matters with numerous parties interested, including the Town Council and the Chamber of Commerce of Florence, it was unanimously decided that this expenditure would be a waste of public funds.

Lee's Ferry and Oak Creek Bridge

The appropriation for the approaches to Lee's Ferry, north of Flagstaff, and the appropriation for the construction of the Oak Creek Bridge near Cornville, Yavapai County, of $10,000.00 each are unexpended because the counties have not provided an equal amount as required by the law.

FEDERAL AID

It should be said at the outset that no Federal Aid has been lost or will be lost to Arizona. This statement is made without qualification, knowing that statements, rumors and fears to the contrary have been expressed.

The total amount of Federal Aid allotted to Arizona under the provisions of existing appropriations amounted to $3,767,794.65; of this amount, $3,244,720.49 has been covered by Project Statements, a Project Statement being the preliminary application for Federal Aid. Project Agreements have been entered into between the Federal Bureau of Public Roads and the State Engineer covering $2,759,011.26. A Project Agreement definitely ties up the money. There remains $1,008,783.39 to be covered by Project Agreements between now and the first of July, 1922. Plans, specifications and estimates have already been submitted for a part of this. Others have been held up pending the receipt of funds from the sale of bonds in some of the Counties of Arizona. Except for the present poor market for bonds every dollar of money available would have been covered by Project Agreements long ago.

Federal Legislation

The Federal Aid Road Act, sometimes referred to as the Bankhead Bill, approved July 11, 1916, authorized the Secretary of Agriculture to co-operate with the States, through their respective State Highway Departments, in the construction of rural post roads, and provided that no money apportioned under the Act to any State should be expended in that State until its Legislature had assented to the provisions of the Act. The Secretary of Agriculture and the State Highway Department of each State were empowered to determine what roads should be constructed in the respective States, and the character and method of construction, and stipulated that all roads constructed under the provisions of the Act should be free from tolls of all kinds. The term "Rural Post Road," according to the terms of the Act, should be construed to mean any public road over which the United States mails now are or may hereafter be transported. The Act appropri-

ated $75,000,000.00 as Federal Aid for highway construction. So much of the appropriation apportioned to any State for any fiscal year remaining unexpended at the close thereof is available for expenditure in that State until the close of the succeeding fiscal year. Any amount apportioned to any State and remaining unexpended at the end of the period during which it is available for expenditure shall be reapportioned to all the States in the same manner as if it were being apportioned for the first time. The Act also provides that the Secretary of Agriculture shall approve only such projects as may be substantial in character, and the funds authorized are to be applied only to such improvements. The limit of Federal Aid to be paid for any work is fixed at $10,000.00 per mile, exclusive of the cost of bridges of more than 20 feet clear span. The construction work and labor for each State shall be done in accordance with the State laws, and under the direct supervision of the State Highway Department, subject to the inspection and approval of the Secretary of Agriculture, and in accordance with the rules and regulations made pursuant to the Act. The States are made responsible for the proper maintenance of roads built under the provisions of the Federal Aid Road Act, and if such maintenance is not properly done, the Secretary of Agriculture "Shall thereafter refuse to approve any project for road construction in such State . . . . . until it has been put into condition of proper maintenance." The Secretary of Agriculture is authorized by the bill to make rules and regulations for carrying out the provisions of the Act.

The Post Office Appropriation Bill, passed in March, 1919, amended the Federal Aid Road Act in several important particulars. The definition of a Rural Post Road was changed so as to include any public road the major portion of which is now used or *CAN* be used, or forms a connecting link not to exceed ten miles in length of any road or roads now or hereafter to be used for the transportation of United States mails. The limitation of payments as Federal Aid were also increased from $10,000.00 per mile to $20,000.00 per mile. $200,000,000.00 was appropriated to be apportioned to the States as Federal Aid. This Act also authorized the Secretary of War in his discretion to transfer to the Secretary of Agriculture all available war material, equipment and supplies not needed for the purposes of the War Department, but suitable for use in the improvement of highways, and that the same be distributed among the Highway Departments of the several States to be used on roads constructed in whole or in part by Federal Aid, such distribution to be made upon a value basis of distribution the same as provided by the Federal Aid Road Act.

Federal Funds Available

Reduced to figures, the State of Arizona shall receive approximately 1.4% of the total appropriation of money, and the same percent of the excess war material available for distribution. The following table sets forth the amount of money available for Arizona under the provisions of the two Acts:

Fiscal Years Ending July 1st	Amount	When Available	Must be covered by Project Agreements by
1917	$ 68,513.52	July 1, 1916	July 1, 1918
1918	137,027.04	" 1, 1917	" 1, 1919
1919	205,540.58	" 1, 1918	" 1, 1920
1919	685,043.47	March, 1919	" 1, 1920
1920	1,301,582.79	July 1, 1919	" 1, 1921
1921	1,370,087.15	" 1, 1920	" 1, 1922
TOTAL	$3,767,794.55		

The Federal Aid Road Act was assented to by an Act of the Arizona Legislature approved March 8, 1917. The State Engineer, with the approval of the State Board of Control, was authorized to enter into all contracts and agreements with the United States Government relative to the survey, construction and maintenance of roads under the provisions of said Act. The Act also declares, "For the construction and maintenance of rural post roads the good faith of the State is hereby pledged to make available funds sufficient to equal the sums apportioned to the State or by or under the United States Government during each of five years for which Federal funds are appropriated by Section 3 of said Act and to maintain the roads constructed with the aid of funds so appropriated, and to make adequate provisions for carrying out such maintenance."

Project Agreements entered into with the Secretary of Agriculture prior to January 6, 1919, (the date on which the present administration took office) totaled $100,499.98, making it necessary to submit plans, specifications and estimates, and to enter into Project Agreements covering $995,624.73 between that time and July 1, 1920, and to have additional amounts of $1,301,582.79 by July 1, 1921, and $1,370,087.15 by July 1, 1922. While we have until July 1, 1922, to cover the last allotment, all money coming to us as Federal Aid would become available on or before July 1, 1920, and in our program of receiving and distributing it to various projects, the entire amount was considered as one appropriation, no consideration being given to the different fiscal years, except to see to it that the various amounts were covered within the specified time limits, and none lost to the State.

State Funds Available

The situation which confronted the State Highway Department in March, 1919, was therefore as follows:

1.—Funds available for the fiscal year ending July 1, 1919, were not sufficient to carry on work then under way until the beginning of the new fiscal year, July 1, 1919.

2.—Funds to become available July 1, 1919, consisted of the following:

FUNDS AT THE DISPOSAL OF THE STATE ENGINEER

1.	State Engineer's Salary	$ 3,000.00
2.	25% Portion State Road Tax Fund (Estimated)	213,806.18
3.	Receipts from Automobile Licenses (Estimated)	160,000.00
4.	Prison Fund	60,000.00
5.	Appropriation for Federal Aid Projects	200,000.00
6.	Appropriation for a Road from Superior to Miami	100 000.00
7.	Appropriation for Williams-Clarkdale Road	25,000.00
8.	Cost of survey for same (estimated)	10,000.00
9.	Appropriation for Gila River Bridge, Globe-Solomonville Highway	65,000.00
	TOTAL	$836,806.18

FUNDS TO BE SPENT JOINTLY BY THE STATE ENGINEER AND BOARDS OF SUPERVISORS

10.	75% Portion State Road Tax Fund	$641,418.57
11.	Appropriation for Approaches to Lee's Ferry, and Grading Buckskin Hill	10,000.00
12.	Appropriation for Bridge across Colorado River, within the County of Mohave	40 000.00
13.	Appropriation for Arizona Section of the Arrowhead Trail	50,000.00
	TOTAL	$741,418.57

14. Besides the above a special appropriation of $30,000.00 was made for the construction of a bridge across the Colorado River near Parker, conditioned on like amounts being appropriated by the State of California and the United States Government ..... $ 30,000.00

15. Estimated Receipts for the Fiscal Year 1920-1921 from the State Road Tax Fund, Auto Licenses and Prison Fund	1,209,824.75
GRAND TOTAL	$2,818,049.50

Of the above, the following items could not be included in funds available to match Federal Aid:

Item No. 1	$ 3,000.00
Items Nos. 7 and 8: The $25,000.00 appropriation for construction being only about 2½% of the amount necessary to construct a highway directly from Williams to Clarkdale	35,000.00
Item No. 11: Federal Aid not available for an isolated piece of work such as this	10,000.00
Items Nos. 12 and 13: This bridge site is inaccessible until a road is constructed to it, and the appropriation for the Arrowhead Trail is insufficient to construct such a road	90,000.00
Item No. 14: The State of California has not made the required appropriation	30,000.00
TOTAL	$168,000.00

This leaves $2 650,049.50 to go into construction work on Federal Aid Projects, and to pay for maintenance, surveys, freight and loading charges on Federal equipment, yard and storage facilities, preparing plans and general office expenses. These were estimated as follows for the two-year period:

Maintenance	$180,000.00
Surveys	150,000.00
Freight and Loading Charges on Federal Equipment	400,000.00
Yard and Storage Facilities	50,000.00
Preparing Plans	75,000.00
General Office Expense	50,000.00
TOTAL	$905,000.00

There was therefore available $1,745,049.50, which under the most favorable circumstances might be matched with Federal Aid. Furthermore it was not within the realm of possibility to make necessary surveys, prepare plans, specifications and estimates, and secure approval of the Bureau of Public Roads by July 1, 1919, for any considerable part of this work, and it would be necessary to forego Fed-

eral Aid on a considerable part of this amount, in order to keep construction work going. The Federal Aid Road Act also limits to $20,000.00 per mile the amount which the Government may pay as Federal Aid, making it necessary in cases of heavy, or otherwise expensive work for the State to pay more than one-half the cost of such work. The amount of money in sight to be used on Federal Aid Projects was actually considerably less than $1,500,000.00 with which to match $3,667,294.67 of Federal Aid.

Counties Asked to Co-operate

It was apparent that in order to secure for Arizona its full apportionment of Federal Aid, money other than State funds would be needed. To secure this, the Boards of Supervisors of all the Counties were asked to co-operate with the State Highway Department in road construction and thus secure the benefits of Federal Aid. A tentative distribution of Federal Aid shown in the accompanying table was made and submitted to the meeting of all Boards of Supervisors of the State held in Phoenix, September 21, 1919:

Apache	$150,000.00	Mohave	$150,000.00
Cochise	400,000.00	Navajo	150,000.00
Coconino	150,000.00	Pima	300,000.00
Gila	400,000.00	Pinal	300,000.00
Graham	150,000.00	Santa Cruz	100,000.00
Greenlee	150,000.00	Yavapai	400,000.00
Maricopa	500,000.00	Yuma	250,000.00

The Supervisors were asked to criticise this distribution and to suggest changes, but as no criticisms or suggestions were made, we have been guided in allotting Federal Aid by this distribution.

While the Counties were no better prepared than the State to immediately pay out such large sums of money, they had the advantage of being able to issue bonds, when authorized by the people at a bond election.

Bonds Authorized by Counties

Some of the Counties were already considering bond issues, and others desiring to receive their share of Federal Aid immediately started proceedings to call bond elections. Since that time the following bond issues have been authorized by Counties:

Apache	$ 150,000.00
Coconino	150,000.00
Graham	250,000.00
Greenlee	200,000.00
Maricopa	8,500,000.00
Mohave	300,000.00
Navajo	150,000.00
Pima	1,500,000.00
Pinal	1,000,000.00
Santa Cruz	100.000.00
Yavapai	1,500,000.00
Yuma	1,200,000.00

The apportionments to Cochise and Gila Counties could be met with their 75% Fund, and the proceeds of previous bond issues, so no new bond issues were needed in those Counties. At any rate, sufficient funds are assured to match all Federal Aid available for Arizona under existing appropriations.

Department Enlarged

The State Highway Department, at the beginning of the two-year period, was organized to handle only about $1,000,000.00 worth of work annually, and this under such regulations as the State Engineer might prescribe. With the advent of Federal Aid the annual expenditures jumped to a total of approximately $4,000,000.00, and all work on which Federal Aid was received was subject to regulations of the United States Bureau of Public Roads, as well as those of the State Highway Department. The requirements of the Bureau of Public Roads also more than doubled the amount of work necessary in the preparation of plans and specifications, and required so much time that it was not possible to proceed with construction as promptly and rapidly as would otherwise have been the case. It was, of course, necessary to make arrangements with the several Boards of Supervisors relating to the 75% portion of the State Road Tax Fund, and with the County Highway Commissions relating to their funds. This necessitated relations with fourteen Boards of Supervisors, each consisting of three members, and thirteen County Highway Commissions, each consisting of five members,—besides several city and town councils through which the State highways pass and which participate in Federal Aid. The difficulties, disadvantages and delays of this system are so obvious as to need no comment. However, we were confronted by facts and not by theories, so we proceeded promptly to make the best of a difficult situation.

The following table shows the results of our efforts as of December 31, 1920:

PROJECTS FOR WHICH PROJECT AGREEMENTS HAVE BEEN EXECUTED OR APPROVAL RECOMMENDED BY THE DISTRICT ENGINEER, UNITED STATES BUREAU OF PUBLIC ROADS

F. A. No.	Name of Project	Estimated Cost	Federal Aid
1	Florence Bridge	$ 131,602.13	$ 65,789.14
2	Phoenix-Tempe	93,142.83	46,571.41
3	Holbrook-St. Johns	57,139.54	28,569.77
5	Oatman-Goldroad	85,750.18	42,875.09
6	Holbrook-St. Johns, Sec. 4	30,607.83	15,303.91
7	Mesa-Superior, Sec. 2-B	153,436.25	76,718.12
8	Tempe-Mesa	222,967.25	111,483.62
9	Tucson-Florence, Sec. A	116,018.00	58,009.00
10	Marinette Bridge	60,277.58	30,138.79
11	Bisbee-Douglas, Sec. 2	297,081.15	148,540.57
12	Prescott-Jerome, Sec. 1	133,054.11	39,220.00
13	Clifton-Franklin	183,241.46	91,620.73
14	Douglas-Rodeo, Secs. A & C	112,213.38	56,106.69
15	Globe-Geronimo	195,928.21	97,964.09
16	Superior-Miami	1,177,398.51	413,318.50
17	Prescott-Jerome, Sec. 2	210,347.27	100,000.00
18	Benson-Vail	304,436.70	152,218.33
19	Prescott-Jerome, Sec. 4	83,839.85	41,919.92
21	Flagstaff Paving	68,826.23	25,139.46
23	Florence-Superior	478,178.65	239,089.32
24	Flagstaff-Williams	202,588.37	101,294.18
26	Yuma-Welton	237,860.04	118,930.02
28	Ray-Superior	188,899.84	90,000.00
29	Tucson-Nogales	400,564.41	180,504.02
31	Wickenburg Bridge	78,895.85	39,447.92
33	Phoenix-Glendale	122,314.31	61,157.15
37	Williams-Ashfork	35,707.76	17,853.88
38	Douglas-Rodeo	160,603.52	80,301.76
39	Topock-Oatman	177,430.35	88,715.17
41	Phoenix-Yuma	200,421.41	100,210.70
	TOTAL	$6,000,772.97	$2,759,011.26

PROJECTS FOR WHICH PLANS, SPECIFICATIONS AND ESTIMATES HAVE BEEN SUBMITTED TO, BUT NOT YET APPROVED BY THE UNITED STATES BUREAU OF PUBLIC ROADS

F. A. No.	Name of Project	Estimated Cost	Federal Aid
20	Winslow Paving	$ 62,773.20	$ 22,003.53
25	Bridges on Tucson-Nogales Highway	48,690.40	24,345.20
27	Nogales-Fairbank	95,400.76	47,700.38
	TOTAL	$ 206,864.36	$ 94,049.11
	GRAND TOTAL	$6,207,637.33	$2,853,060.37

It can be seen from the above that a total of $2,853.060.37 of our apportionment of $3,767,794.65 has been, or will very soon be, covered by Project Agreements. The work for providing for the remaining $914,734.28 has progressed to such an extent that it seems reasonable to expect that it will all be covered before the end of the present fiscal year.

In our program of financing different projects, and of matching Federal Aid, we have necessarily been guided by the fact that Federal Aid appropriations were made over a limited period of time,—the last appropriation being available July 1, 1920.

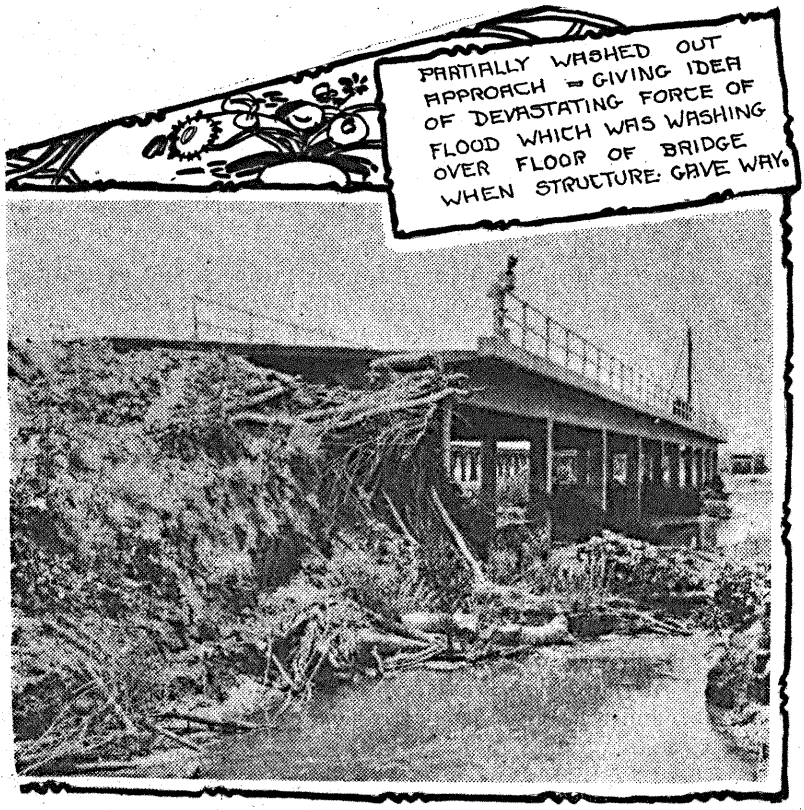
At the time your administration assumed office, all correspondence and business matters with the Bureau of Public Roads were handled through the office of the Bureau of Public Roads at Albuquerque, New Mexico. This required considerable time and resulted in consequent delays. We took up the matter of securing a representative of the Bureau of Public Roads located in Phoenix, with the result that the Bureau of Public Roads now maintains an office here, with Mr. J. W. Moore, Senior Highway Engineer, in charge. All applications for Federal Aid, as well as practically all other matters, are taken up directly with Mr. Moore. The present arrangement is much more satisfactory in every respect than the previous one to this Department, and we believe is equally advantageous to the Bureau of Public Roads.

As to the advantages of Federal Aid: We believe that there are many, but the following merit particular mention:

1. A higher standard of work results. All plans and specifications must be approved by the Bureau of Public Roads, and the work is at all times subject to its inspection and approval.

2. Proper maintenance of the work is insured. The States are required to maintain all work in a satisfactory manner. Should a State fail to do this, further Federal Aid would be withheld.

3. A definite program of highway construction must be submitted. This will result in co-ordination of work by adjoining States and in a system of trans-continental and interstate highways, and at the same time meet the needs of each State.



VIEW OF AUGA-FRIA BRIDGE
AT COLDWATER
AFTER FLOOD OF THANKSGIVING, 1919

PROJECTS BY COUNTIES

APACHE COUNTY

Federal Aid Project No. 6—Holbrook-St. Johns, Section 4:

This project originally contemplated the construction of 12.6 miles of highway from a point about 2.1 miles northwest of Hunt to Concho. Project Statement was submitted in 1918 and approval secured. Funds available, however, were not sufficient to complete the entire project, so a contract has been entered into with Tanner Brothers for the northerly 3 miles, and construction work is now in progress.

The portion of the project now under contract will cost approximately $16,049.81, or $5,349.94 per mile.

Apache County has voted bonds to the extent of $150,000.00; $140,000.00 is proposed to be spent on the road from the Navajo County line through Apache County to the New Mexico line, via Hunt, Concho, St. Johns and Springerville. It is expected that this bond issue will be sold early in 1921, and these funds, together with an equal amount of Federal Aid, will be spent on the improvement of this highway.

Construction engineering work on this project is in charge of F. N. Grant. Location was made by Engineer J. M. Shepherd.

COCHISE COUNTY

Federal Aid Project No. 11—Bisbee-Douglas Highway:

Consists of 8.5 miles of concrete paving 18 feet wide and 6 inches thick, and extends from Forest Station to Forest Ranch on the road between Bisbee and Douglas.

Rising prices in 1919 prohibited the Highway Commission of Cochise County from completing the 25 miles of paving between these

two cities. In order to complete this very important highway, this Department secured Federal Aid for the unfinished portion of this road, and together with the Board of Supervisors of Cochise County let the contract in two sections. Bids were received for this work November 17, 1919, the best bids being $2.69 per square yard for Section A and $2.75 for Section B, the State to furnish cement, making a total cost for the project of $299 747.53. These bids were rejected as being too high and new bids asked to be opened January 3, 1920. On the eastern portion George Oswald's bid of $2.09 per square yard, exclusive of cement, was accepted and bid of McPeak & Dillon of $2.40 per square yard, exclusive of cement, for the western portion was accepted. The State furnished the cement for this construction, which made the respective sections cost $2.86 and $3.17 per square yard, or a total cost for the project of $267,225.31. This road was constructed in the early part of 1920.

Personnel: W. C. Goetz, Resident Engineer; N. Davenport, Chief Inspector; J. H. Martin, Inspector; Earl Maxwell, Inspector; C. L. Burton, Inspector; M. H. Calderwood, Tester; L. H. Thompson, Instrumentman.

Federal Aid Project No. 18—Benson-Vail Highway:

Consists of the construction of 27.8 miles of highway between Benson and Vail on the Borderland Highway. Included in this project is a bridge across Cienaga Creek and the Southern Pacific Railroad with an overhead crossing, the total length of which is 278 feet with a main span of 146 feet, and a bridge across Mescal Wash of two 30-foot spans.

In general the work is light and over good material for surfacing. The project is divided into six sections, known as Sections "A," "B," "C," "D," "E" and "F." Section "A" extends from a point near Vail to Cienaga Creek; Section "B" extends from Cienaga Creek to a point east of Mescal Wash; Section "C" from the end of Section "B" to Cochise County line; Section "D" from Cochise County line approximately 4.0 miles toward Benson; Section "E" consists of 6.0 miles from the end of Section "D" to the town of Benson; Section "F" consists of the bridge crossing Cienaga Creek and the Southern Pacific Railroad.

Sections "A" and "B" are being constructed with State forces under supervision of Engineer A. W. Jenkins. Section "C" is being constructed under contract by Goodman & Merrill,—the principal item of which is approximately 20,000 cubic yards excavation at $0.65 per cubic yard. Class "A" concrete costs $27.00 per cubic yard, and Class "B" concrete $22.00 per cubic yard, the State furnishing ce-

ment and reinforcing steel, as well as corrugated iron pipe for culverts; Section "D" is completed, having been built under contract by Goodman & Merrill. Excavation on this section cost $0.50 per cubic yard and all classes of concrete $15.00 per cubic yard. Section "E" is being built under contract by Eckerman & Chambers. On a portion of this section the excavated material was suitable for surfacing. This class of excavation cost $0.90 per cubic yard. On the remainder of this section it was necessary to borrow other material for surfacing. For this part of the work the roadway excavation cost $0.60 per cubic yard, borrow excavation $0.50 per cubic yard, and borrow for surfacing, $0.75 per cubic yard. Section "F," being the bridge across Cienega Creek and the Southern Pacific Railroad, is being built under contract by English & Pierce for a lump sum of $27,840.00, the State furnishing cement and reinforcing steel at an additional cost of $10,724.27. The structure is now nearing completion. The bridge across Mescal Wash is being built under contract by de Waard and Cobham at a cost of $18.00 per cubic yard for concrete, the State furnishing cement and reinforcing steel. The total cost of this bridge will be $16,438.00.

Bids were requested for the construction of Section "B," but only one bid was received, which amounted to $155,288.43. The estimate of the State Highway Department was $78,096.72 and in view of the great difference between these figures the bid was rejected.

This work is now nearing completion at a cost approximately equal to the State estimate. On this section alone more than seventy-five thousand ($75,000.00) dollars will be saved by doing the work with State forces instead of by contract.

The total cost of the project will be approximately $300,000.00.

Sections "C," "D" and "E" are under the direct supervision of Engineer A. W. Van Fleet of the State Highway Department. The highway was located by Engineer W. W. Van Frank. The road will be open to traffic as soon as the bridge across Cienaga Creek is completed, which will be about March 1st, 1921. Portions of the highway are already in use, and the entire project will be completed early in March. Sections "A," "B," "C" and "F" are being paid for from the proceeds of the Pima County bond issue and Federal Aid. Sections "D" and "E" are being paid for with the Cochise County portion of the State Road Tax Fund and Federal Aid.

Federal Aid Projects Nos. 14 and 38—Douglas-Rodeo Highway:

This project was started by the Highway Commission of Cochise County, which was unable to complete this road on account of shortage of funds.

Section "B" and part of Section "A" were completed before the Arizona Highway Department could secure Federal Aid for this construction. Following the death of Mr. J. C. Ryan, Engineer for the County Highway Commission of Cochise County, the remaining portions of Sections "A" and "C" were constructed under the direction of W. C. Goetz.

Robt. McKay, of Tucson, was awarded contract for grading; Thos. Tate and Son, the bridges on Section "A," and Chas. D. Golden, the bridges on Section "C." The concrete work on Section "C" had previously been constructed by Redmond Toohey and the Silver Creek bridge by the El Paso Bridge & Iron Co.

On Sections "A" and "C" the Arizona Highway Department secured Federal Aid based on the contracts previously let by the Highway Commission of Cochise County, funds to match Federal Aid for this construction having been provided by the sale of bonds in Cochise County and the Arizona Highway Department 25% Fund.

On October 14th, 1920, bids were received on Section "2" of the Douglas-Rodeo Highway from Bernardino to the New Mexico State line, known as Federal Aid Project No. 38. Contract was let to Dan LaRoe, the principal items being excavation at $0.67 per cubic yard, gravel surfacing at $1.75 per cubic yard and concrete at $20.00 per cubic yard, exclusive of cement and reinforcing steel, which were furnished by the State. This section will cost approximately $145,000.00. The funds for this section were provided by the Cochise County portion of the State Road Tax Fund, plus Federal Aid for an equal amount. This section is 26.4 miles in length and should be completed by the first of April, 1921. Its completion will mean the securing of a first-class highway from Tucson to the New Mexico line via Benson, Tombstone, Bisbee and Douglas.

Work on this section is in charge of W. C. Goetz, with Geo. M. Lukesh, Resident Engineer. Location was made by J. M. Shepherd.

Tombstone-Bisbee Highway Improvements:

In response to the request of numerous citizens of Tombstone and Bisbee who objected to the narrowness and resulting danger of parts of the Tombstone-Bisbee Road which was constructed several years ago, this Department, the latter part of 1920, widened the roadway at some seven points. TNT secured from the Government was used in this operation, while the drilling was done with air compressors and jackhammers shipped in from the Vail-Empire work.

This improvement both of the width and the vision of this road greatly lessened the danger and was secured at the small cost of $3500.00.

See also Pima County, Vail-Empire Ranch Highway.

COCONINO COUNTY

Federal Aid No. 21—Paving within the Town of Flagstaff:

Consists of paving the State Highway through the Town of Flagstaff and the construction of a reinforced concrete bridge 32 feet long across the Rio de Flag.

The work is being done under contract by Warren Brothers Co., and consists of an asphaltic concrete base 4 inches thick with a bitulithic wearing surface 2 inches thick.

The cost of the pavement is $3.43 per square yard. The work is being paid for by the Town of Flagstaff and Federal Aid. Engineering work is being handled by J. B. Wright, City Engineer of Flagstaff, who represents the State Highway Department on this job. Plans and specifications were prepared by the State Highway Department. Total cost of the job will be approximately $81,186.33.

The contractor was forced to close down construction work early in the Winter of 1920-21 because of cold weather. This entire project should be finished early in the Spring of 1921.

Federal Aid Project No. 24—Flagsstaff-Williams Highway, Sections "A" and "B":

That portion of the Flagstaff-Williams Highway known as Federal Aid Project No. 24, Sections "A" and "B," embraces 15 miles. The greater portion of the work consists of improving the present roadway between Flagstaff and Maine.

The estimated cost is $202,588.00, or approximately $13,500.00 per mile. This highway is one of the connecting links between the Towns of Flagstaff and Williams, the only incorporated towns in Coconino County. It is a State Highway on the through route from Coast to Coast on the Old Trails National Highway. The route lies through the Coconino and Tusayan National Forests and is mostly through timber interspersed with open valley lands heavily grassed. These lands are being homesteaded and are becoming valuable farming ground. For miles north and south of the route there is fine grazing, much of which is also heavily timbered. The elevation at Maine is 7,267; the highest elevation overcome is 7,329 and the elevation at Flagstaff is 6,896. These points are connected by rolling grades and easy curvature.

Funds available for this construction are provided through the Coconino County bond issue and Federal Aid.

This project was approved by the District Engineer of the Bureau of Public Roads, July 19, 1920. Bids were called for by the Coconino County Highway Commission. None were received. At a second bidding only one bid was received, that of the Arizona Highway Department for cost plus $10.00. This bid was accepted and construction with State forces commenced on Section "A" on August 10th and continued through the month of October, when inclement weather caused the work to be discontinued for the winter. Practically all of the grading on Section "A" was completed and about one-half of the surfacing was done. In addition, on Section "B," where the old roadway needed further attention, a contract was let to John Turley, the total of his work amounting to $3,321.00. The State also did a small amount of work on Section "B" amounting to $4,916.00. The major item upon this work is surfacing, practically one-half of the cost of the project being chargeable to this item. This part of the work was conducted with a ¾-yard gas shovel installed at a cinder pit and a fleet of 13 Kelly-Springfield 3-ton and 3 F. W. D. 2-ton trucks, one 12-ton roller and one 120-H.P. caterpillar. The average truck haul was 2 miles, and 600 lin. ft. of surfacing 19 feet wide and 6 inches thick was the averageday's work.

The personnel upon this location and construction was: E. A. Wolfe, Engineer in charge; F. N. Grant, Locating and Resident Engineer; H. W. Smith, General Foreman of Surfacing; Chas. O'Conner, General Foreman in charge of grading.

Project 2, R. C.,

consisted of surfacing a portion of the Old Trails Highway between Williams and Maine. The sub-grade had been constructed during 1917-18. Approximately 9 miles of road were surfaced, mostly with cinders, but some with gravel from Pittman Valley.

In this work a gas shovel was used for loading cinders which were hauled in 13 Government trucks. This work was paid for with the Coconino County portion of the State Road Tax Fund.

H. W. Smith was General Foreman in charge of this work.

Federal Aid Project No. 35— Flagstaff-Winslow Highway:

Contemplates the improvement of that portion of the Old Trails Highway extending from the city limits of Flagstaff easterly three miles. This work will be paid for from the proceeds of a bond issue in Coconino County and Federal Aid.

Construction will probably be done during the working season of 1921.

Federal Aid Project No. 37— Williams-Ashfork Highway:

Contemplates the construction of that portion of Williams-Ashfork Highway known as Ashfork Hill. A new location has been made which will reduce the maximum grade to 6% and the road will be adequately drained and surfaced.

Location work was under the general supervision of Engineer Ed. Wolfe, with F. N. Grant in direct charge of survey party.

Estimated total cost, $35,707.76. The present grade is approximately 18% and is practically impassable in wet weather.

GILA COUNTY

Federal Aid Project No. 15— Globe-Geronimo Highway:

This highway is 56 miles in length and almost the entire portion of it lies within the San Carlos Indian Reservation.

State forces began the construction of this work in May, 1919. Application was made for Federal Aid to the Bureau of Public Roads for the construction of this entire project on July 21st, 1919, but this was refused in the belief that there was no possibility of this road through the Indian Reservation becoming a post road. The Boards of Supervisors of Gila and Graham Counties, supplemented by the individual solicitation of many of the taxpayers of these Counties, secured from our congressional delegation their interest in endeavoring to secure a change in the ruling of the Bureau. In addition, Governor Thos E. Campbell made a personal appeal in behalf of this project, and as a result of this endeavor, on May 7th, 1920, the Bureau approved the plans and specifications for the construction of the uncompleted portion of this highway, since which date the Federal Government has co-operated in the financing of this construction.

All of the bridges on this highway participate in Federal Aid, their construction having been purposely delayed until Federal Aid could be secured.

This highway is completed in Gila County to a point where the high water of the proposed San Carlos Dam will necessitate a change in the present location.

The concrete bridges on this portion of the highway were contracted to A. W. Daniels at a cost of $16.00 per cubic yard. The

total cost of the bridges will be approximately $19,000.00 plus cement and steel, which are furnished by the State.

Personnel: Jas. Parker, Locating Engineer; H. Hagan, Resident Engineer; R. M. Genin, Inspector; Geo. Porter, Inspector; H. A. Alderton, Inspector; John Hughes, General Foreman.

Federal Aid Project No. 16— Superior-Miami Highway:

Consists of the construction of a highway from Superior to Miami, a distance of 20.78 miles by way of Queen Creek Canyon. This work is by far the heaviest so far undertaken by the State Highway Department.

The heaviest portion of this work, known as Section "C," consists of 1.75 miles of roadway at an estimated cost of approximately $300,000.00, or $170,000.00 per mile. The principal items of work in this section are: Approximately 95,500 cubic yards excavation at $2.10 per cubic yard; 4,500 cubic yards excavation in tunnel at $6.00 per cubic yard; 8,600 cubic yards dry rubble retaining wall at $4.00 per cubic yard, besides other large items for surfacing, drainage structures, ditches, channel changes, etc. While the remaining sections are not nearly so heavy as this one, they are all unusually heavy, averaging more than $40,000.00 per mile.

Included in the project is a reinforced concrete arch bridge across Queen Creek of 125 ft. span, which is already completed, and a reinforced concrete bridge across Devil's Canyon of 70 ft. span, besides numerous other smaller bridges and culverts.

At the present time work has been completed from Superior to and beyond the tunnel, a distance of 2.98 miles, and the tunnel heading large enough to permit passage of a single automobile is now completed. This portion of the work has been in charge of Engineer F. G. Twitchell, with Engineer H. B. Wright on construction.

Section "F" is being constructed under contract by John Hoopes. This section consists of 3.871 miles, beginning about 3 miles from Miami. This work is reached from Miami by way of a road previously constructed by Gila County. This work is in charge of Engineer H. Hagan, of the State Highway Department.

From Hoopes' contract a pilot road has been constructed by State forces under supervision of General Foreman C. R. Bone. This pilot road was constructed for a distance of 7 miles to a point just west of Devil's Canyon. From this point for a distance of approximately one mile the road has been constructed full width to a point

approximately 2200 feet from the work done from the Superior end. As soon as this 2200 feet is completed the road will be open from Superior to Miami. However, a great deal of work will remain to put the road in first-class condition; the bridges will have to be built across Devil's Canyon and Pinto Creek, and other small water courses, and the pilot road will have to be widened from approximately 10 feet to 22 feet.

The opening of this road will shorten the distance between Phoenix and Globe from 113 miles to 95 miles. The distance from Superior to Miami by present road is approximately 100 miles, and will be reduced to 21 miles. The maximum gradient of this highway will be 6% as compared with 10% by way of the Apache Trail, and the rise and fall will be reduced by over 2500 feet. The map and profiles accompanying this report show the general location of this highway with respect to other connecting highways, and also with respect to the Apache Trail.

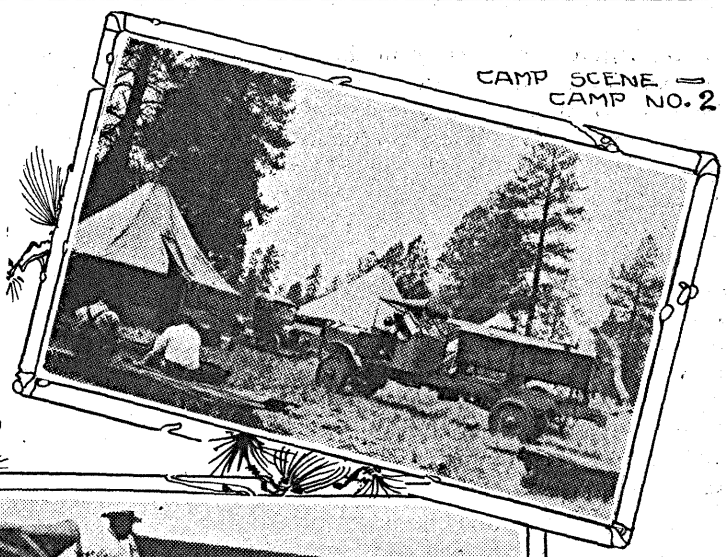
It is expected that the 2200-foot gap will be completed by March 1st, 1921. The completion of the entire project depends upon the amount of funds available. After the 2200-foot gap has been completed, the other work can be pushed vigorously, as all parts will be accessible.

The original survey of this line was made by Engineer Earl Parker. On account of the extremely difficult country which the road traverses but one general location was available, while the most minute adjustment of location was necessary in order to secure the greatest economy. The original plans contemplated three tunnels, but owing to the condition of the rock formation two of these tunnels were eliminated. A large amount of TNT secured from the Federal Government has been used on this project, one shot alone using approximately 8000 pounds. This shot was used at the site of one of the proposed tunnels and resulted in moving 12,000 cubic yards of solid rock at a cost of $0.20 per cubic yard. The estimated cost of the tunnel at this site was $6,600.00.

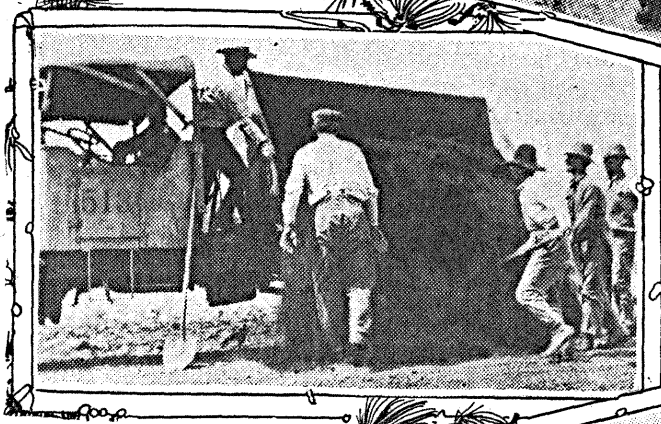
The work already done and now in progress was financed with a special appropriation of $100,000.00 made by the last Legislature specifically for this road, $34,000.00 from the Gila County portion of the State Road Tax Fund, the Prison Fund of $60,000.00 per year for two years, and Federal Aid. On account of the limitation of Federal Aid to $20,000.00 per mile, funds so far received from this source have been very limited.

Globe-Roosevelt Highway:

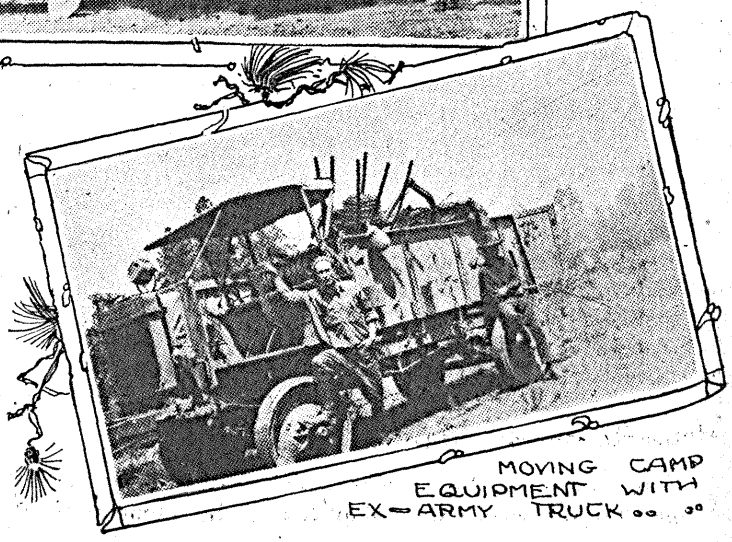
The portion of the Globe-Roosevelt Road from the Pinal Creek Bridge into Roosevelt was completed in the summer of 1919. This



CAMP SCENE — CAMP NO. 2



DUMPING CINDER SURFACING ON GRADE.



MOVING CAMP EQUIPMENT WITH EX-ARMY TRUCK

VIEWS OF FLAGSTAFF-WILLIAMS PROJECT

was a reconstruction of the road built in Territorial days, but has been a great improvement on the original. In addition to forming a portion of the well-known Apache Trail, this road is used by people in the upper Tonto districts who have no other means of communication with the outside world.

This highway, in conjunction with the County road now being improved between Roosevelt and Pine and the proposed highway from Pine to Camp Verde by the way of Fossil Creek and the well-known El Capitan Highway from Globe to Winkleman and from Winkleman to Oracle and Tucson, may constitute the first real north-and-south highway in the State of Arizona, especially if nothing is done about the construction of the highway between Phoenix and Prescott, in the immediate future.

GRAHAM COUNTY

Federal Aid Project No. 15— Globe-Geronimo Highway, Sections "C" and "D":

Section "C" consists of the construction of an extension to the old steel bridge across the Gila River near San Carlos. A description of the bridge will be found in the chapter under Bridges. Section "D" consists of the construction of approximately five miles of standard highway extending from Geronimo in a westerly direction to a point which will be the high-water elevation of the San Carlos Reservoir according to the best information available.

The estimated cost of this project is approximately $64,000.00. In addition to this work the old road which lies within the limits of the proposed San Carlos Reservoir has been surfaced and put in shape as a temporary road. It is our opinion that a permanent road would not be justified in view of the possibility of the San Carlos Dam being built, while sufficient funds were not available to construct the road on a permanent location.

Location of this highway was made by Jas. A. Parker.

John Hughes is General Foreman of this State work.

Federal Aid Project No. 34— Geronimo-Solomonville Highway:

Contemplates the improvement of the highway between Geronimo and Solomonville. This highway will be graded, drained and surfaced with gravel or other suitable local material.

The work will be paid for from the proceeds of a bond issue in Graham County and Federal Aid.

Actual construction on this project has been delayed on account of the inability of Graham County to market their bonds.

Preliminary engineering work was in charge of Jas. A. Parker, Locating Engineer, with a field party under J. M. Shepherd.

GREENLEE COUNTY

Federal Aid Project No. 13— Clifton-Franklin Highway:

Consists of three distinct parts or contracts. Contract No. 1 consists of the construction of three miles of road up Ward Canyon from Clifton to the top of the mesa, joining a road which had previously been constructed from Clifton to Duncan.

Contract No. 2 consists of the construction of bridges and paved fords between the end of the Ward Canyon work and Duncan.

Contract No. 3 consists of the construction of a reinforced concrete bridge 65 feet long across Railroad Wash near Franklin.

The remaining portions of the road had been improved by Greenlee County and were in good condition. The work included in this project thus completes a first-class highway from Clifton to the State line near Franklin.

Contract No. 1 was let to Webster, Webster and Kirby, the lower 80 stations at a price of $0.60 per cubic yard for excavation, and the remaining portion at $1.30 per cubic yard for excavation and $0.85 per cubic yard for borrow in both cases.

Contract No. 2 was let to Webster, Webster & Kirby, the principal item of construction being 2390 cubic yards of Class "A" concrete at $14.00 per cubic yard, the State furnishing cement and reinforcing steel, as well as corrugated iron pipe for culverts.

Contract No. 3 was let to Cotey and Black for the sum of $7,750.00, the State furnishing cement and reinforcing steel.

The total cost of the entire project when completed will be approximately $145,000.00. Work is now in progress and will be completed during the early part of 1921. Funds for this construction were secured by matching a portion of the Greenlee County bond issue with Federal Aid.

Mr. S. C. Redd, Engineer for the Greenlee County Highway Commission, also acted for the Arizona Highway Department in looking after this construction. Logan Stillwell is Inspector, and L. Robert, Assistant Engineer.

MARICOPA COUNTY

Federal Aid Project No. 2—Phoenix Tempe Highway:

Consists of 3.86 miles of concrete paving on the highway between Phoenix and Tempe. The pavement is 18 feet wide and 5 inches thick, with 3-foot shoulders on each side. In the construction of this job it was necessary to widen the roadway and to extend some of the culverts and raise the headwalls.

The total cost of this job was $138,207.79, of which $84,243.75 was for paving, $41,983.46 for grading, $6,429.04 for extensions to bridges and culverts, $242.44 for ditching and $5,309.10 for guard fences, right-of-way, etc. The item of grading included the construction of a temporary road alongside the permanent road over which material had to be brought in, the opening up of other temporary roads to accommodate traffic while the main road was closed, and the heavy cut necessary to eliminate the dangerous grade just north of the Tempe bridge, which was not contemplated in the original project submitted to the Government.

Expenditures on this project prior to January 1st, 1919, when your administration began, totaled $61,780.65, at which time practically no pavement had been laid. The cost per square yard of paving was $2.22. This is one of the least expensive pavings laid in Arizona in the last two years.

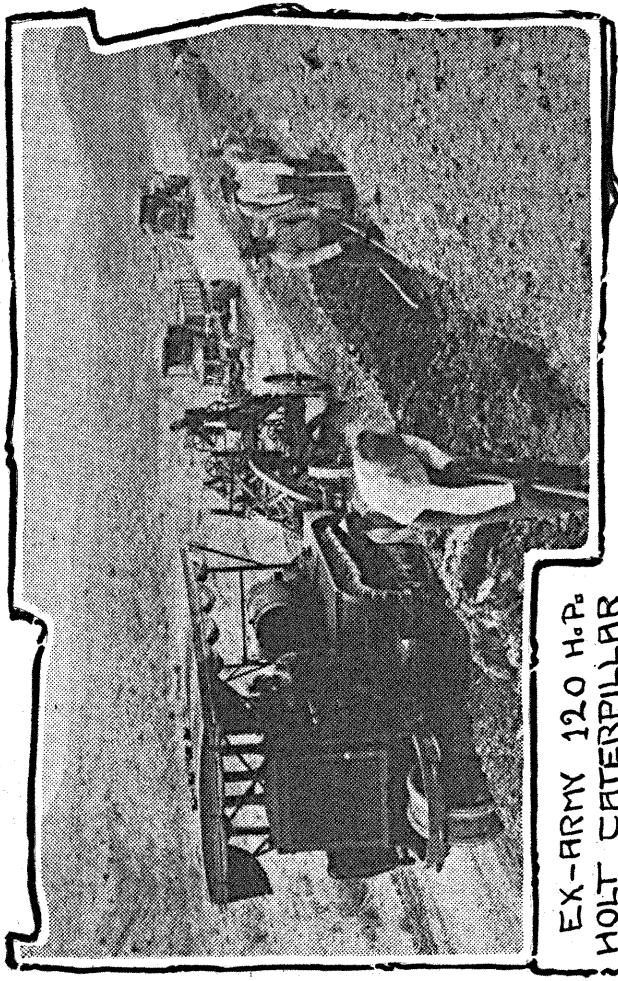
Personnel: A. L. Trippell; W. H. Barnum, M. Kisselburg, Engineers and Inspectors; B. J. Pearce, General Foreman.

Federal Aid Project No. 8—Tempe-Mesa Highway:

Consists of paving the State Highway from the end of the Phoenix-Tempe project to Mesa, a distance of 6.793 miles; and of reconstructing two old bridges and constructing two new bridges across irrigation canals, besides small drainage structures.

The portion of the highway lying within the corporate limits of Tempe is paved with 2″ bitulithic on a 5″ concrete base. This pavement is 30 feet wide on Mill Avenue, and 20 feet wide on Second Street and Eighth Street. This work was paid for by the Town of Tempe and Federal Aid.

The portion of the highway from Tempe to Mesa is paved with concrete, the pavement being 18 feet wide and 6 inches thick, with 5-foot shoulders on each side. This work was paid for with the Maricopa County portion of the State Road Tax Fund and an equal amount of Federal Aid.



EX-ARMY 120 H.P. HOLT CATERPILLAR GRADER - AND EX-ARMY TRUCKS HAULING SURFACING MATERIAL.

The bitulithic pavement in the Town of Tempe was laid under contract by the Southwestern Contracting Co. for $1.95 per square yard, the State furnishing Portland cement at an additional cost of $0.47 per square yard, making a total cost per square yard for this pavement of $2.42.

The concrete pavement was laid under contract by McElrath & Shumway for $1.54 per square yard, the State furnishing Portland cement at an additional cost of $0.80 per square yard, making a total cost of $2.34 per square yard.

The total cost of the work within the Town of Tempe was $41,504.44, and of the remaining portion, $163,421.68.

Original plans for this work contemplated paving the highway directly west from Mesa to an intersection with Mill Avenue; thence north on Mill Avenue to Second Street; thence west to the end of the Phoenix-Tempe project. At the request of a large majority of the citizens of Tempe this route was changed to go by way of the Creamery Road and Eighth Street.

Personnel: J. M. Brown, Resident Engineer; Logan Stillwell, Assistant Engineer; J. H. Sonntag and E. W. Graves, Inspectors.

Federal Aid Project No. 10—Marinette Bridge:

This bridge, across the Agua Fria River, consists of five concrete arches having a total length of 497 feet with a 20-foot roadway. The arches are of single ring design, with solid spandrel walls and cantilever deck slab. The foundations for these arches were carried down 22 feet below the stream bed, being 12 feet below sign of any previous scour.

This bridge is being paid for out of the Maricopa County portion of the State Road Tax Fund, plus an equal amount of Federal Aid. This bridge is 125 feet below the railroad bridge across the Agua Fria River and on the road between Phoenix and Wickenburg. Previous to its construction, traffic in this direction was frequently held up for days during floods in the river. The cost of the bridge complete will be approximately $73,000.00.

Federal Aid Project No. 30—Phoenix-Tempe Highway:

Contemplates the paving of three miles of the Phoenix-Tempe Highway lying between the city limits of Phoenix and the present concrete pavement.

Application for Federal Aid has been submitted and approval secured. The estimated cost of the work is $95,500.00, based on the unit contract prices being paid by Maricopa County, but the paved

section will be 18 feet wide like the remainder of the Phoenix-Tempe and Tempe-Mesa Road, instead of 16 feet as is provided on most of the Maricopa County program.

This stretch of highway is included in the Maricopa County program and will be financed with funds secured from the sale of bonds recently authorized.

Federal Aid Project No. 31—Wickenburg Bridge:

Consists of the construction of a steel bridge across the Hassayampa River at Wickenburg, Ariz. This work will be paid for with funds from the Maricopa County portion of the State Road Tax Fund and an equal amount of Federal Aid. A more complete description of the work will be found in the chapter under Bridges.

Work is now in progress, in charge of Engineer John H. Zeitler. The foundation work is being done by State forces. The steel trusses will be built under contract by the Allied Contractors, Inc., of Omaha, Nebraska, at a cost of $26,097.00. The concrete floor of the bridge will be constructed by State forces.

Federal Aid Project No. 32—Arlington Bridge:

Contemplated the construction of a reinforced concrete bridge across the Hassayampa River near Arlington. On account of the extremely high cost of such a bridge and the facilities for building a pile bridge, application for Federal Aid was canceled and a pile bridge constructed.

This bridge cost $10,530.00. The annual cost of maintenance is estimated at $877.50. The life of the bridge is estimated at 10 years. Assuming that the going rate of interest is 6%, the annual cost of the bridge, including interest on the first cost, maintenance and sinking fund to replace the structure at the end of 10 years, would be $2,341.17.

The estimated cost of a concrete bridge at this place was $54,756.00 and estimated annual cost of maintenance, $175.00. Assuming the life of such a bridge to be 100 years, the annual cost as before would be $3,401.19. This is a saving in annual cost of $1,060.02 in favor of the wooden bridge or a total capitalized cost of $17,667.00.

Federal Aid Project No. 33—Phoenix-Glendale Highway:

Contemplates the improvement of the highway between Phoenix and Glendale. The principal item of work will be 7.06 miles of paving 18 feet wide.

Bids for this work were received on the 9th day of October, 1920, but were rejected as being too high. The estimated total cost of this work is $250,000.00.

This project is included in the program voted on at the recent bond election in Maricopa County. A project statement and plans, specifications and estimate have been submitted to the Federal Government and approved by the Secretary of Agriculture so that Federal Aid will be available to assist in defraying the cost of this construction.

MOHAVE COUNTY

Federal Aid Project No. 5—Oatman-Goldroad Highway:

Consists of the construction of 2.186 miles of highway between Oatman and Goldroad. The project is a link on the Old Trails National Highway. Contract for this job was let to Alvey & Larson, who are now at work and expect to complete same by February 15th, 1921. While the original plans did not contemplate construction to the Town of Oatman, a modified project agreement with the U. S. Bureau of Public Roads has been requested to extend the work into the town and complete the project.

Personnel: Earl Parker, Locating Engineer; T. S. O'Connell, Resident Engineer on Construction; H. A. Alderton, Instrumentman.

Federal Aid Project No. 39—Topock-Oatman Highway:

Consists of the improvement of 23 miles of highway extending from the bridge across the Colorado River at Topock toward Oatman. Federal Aid has been secured on the basis of total estimated cost of $177,430.35, or $7,714.36 per mile. Funds available were not sufficient to complete the construction work entirely to Oatman, but an existing road will make this connection of 3.25 miles. This road will be surfaced with gravel or other local material. Construction work is now in progress and will be completed by early spring.

Personnel: T. S. O'Connell, Locating Engineer; R. A. Davis, T. A. Green and Fred Hauk, Assistant Engineers, Chas. O'Conner and Floyd Allen, General Foremen.

NAVAJO COUNTY

Federal Aid Project No. 3— Holbrook-St. Johns, Section 3:

Consists of the construction of 3.718 miles of road on the route of the Old Trails National Highway, and is that portion of the highway lying within the Petrified Forest.

Contract for grading and construction of bridges and culverts was let to John Turley for the sum of $10,946.10. Contract for surfacing was let to P. E. Richards for the sum of $10,468.80. Turley's contract was completed August 19th, 1920, and surfacing is now being done.

Changes in the original survey for this stretch of road practically eliminated the curvature, shortened the distance one-half mile, and decreased the cost of construction by reducing the quantities of material in cuts and fills. The estimate based on the first survey was $37,130.00, and the cost of this job complete will be less than $28,000.00. This change demonstrates the value of thorough engineering investigation.

Personnel: Earl Parker in charge of survey; Engineers: F. N. Grant and G. T. West on Construction.

Federal Aid Project No. 20— Paving within the Town of Winslow:

Consists of paving the State Highway through the Town of Winslow, a distance of 0.946 miles. Plans call for the use of a 4½" bituminous concrete base with 1½" bituminous wearing surface.

The work will be paid for by the Town of Winslow and Federal Aid. This project has been approved but the plans and specifications are still under consideration by the Bureau of Public Roads.

Federal Aid Project No. 22— Winslow-Coconino County Line Highway:

Contemplates the construction of 2.75 miles of highway from Winslow west to the Coconino County line, at an estimated cost of approximately $26,500.00.

Project Statement has been submitted and approved, but work has not yet been started. Funds will be provided from the proceeds of bond issue in Navajo County and Federal Aid.

Preliminary engineering work has been in charge of F. N. Grant.

PIMA COUNTY

Federal Aid Project No. 9—Tucson-Florence Highway:

Consists of 3.8 miles of concrete paving 18 feet wide and 6 inches thick, beginning at the northern city limits of Tucson and running to the south end of the bridge across Rillito Creek.

This project cost a total of $120,562.25, $58,009.00 of which was paid by the Federal Government and the remainder from Pima County's portion of the State Road Tax Fund. This paving cost $1.47 per square yard, exclusive of cement, and constitutes the best bid received for paving construction in the State of Arizona during the last two-year period. The contract was let to the West Coast Construction Co.

Arrangements were made with the City Council of the City of Tucson to secure paving of the city streets from the center of Tucson to the beginning of this highway. This road carries an extremely heavy traffic, as it is the main road from Tucson to Oracle, Winkleman and Globe, as well as Florence and Phoenix. Prior to this paving it was the worst stretch of this important highway. Permanent drainage structures installed on this paving have a carrying capacity twenty-five times greater than the former waterways.

Personnel: E. C. Dietrich, Resident Engineer; E. M. Whitworth, Inspector; E. W. James, Instrumentman.

Federal Aid Project No. 29—Tucson-Nogales Highway:

Consists of paving 8.85 miles of this highway, beginning with the city limits of Tucson. The large amount of traffic over this highway and consequent high cost of maintenance of the present gravel surface make it necessary to provide a permanent pavement for this portion of the highway. Bids were received for the construction of this job on the 4th day of September, 1920, but were rejected on recommendation of the Pima County Highway Commission. The price per square yard for cement concrete was $1.85 and for bituminous, $2.495, the State to furnish Portland cement or asphaltic cement.

Funds for this work will be provided by Pima County from the proceeds of their bond issue and Federal Aid.

Federal Aid Project No. 25— Bridges on Tucson-Nogales Highway:

Consists of the construction of four bridges and one large box culvert on the highway between Tucson and Nogales. Work previously done by the State Highway Department in Santa Cruz County

and by Pima County practically completed the grading and bridge work on this highway excepting at these five crossings. Four of these crossings are in Pima County in the vicinity of Continental, the other being in Santa Cruz County, approximately 14 miles from Nogales.

Bridge No. 1 has a length of 86 feet; No. 2, 86 feet; No. 3, 24 feet; No. 4, 24 feet; No. 5, 8x12-foot box culvert.

It is expected to have this work done during the spring of 1921.

Vail-Empire Ranch Highway:

The road from Tombstone to Fairbanks was completed in September, 1919. It was the desire of this Department to continue the construction of this road toward Huachuca until the completion of the surveys of the Benson-Vail Road permitted a transfer of these State forces to this latter road. Following the objection of the Board of Supervisors of Cochise County to the use of State forces in that County, this Department transferred the organization working on the Tombstone-Fairbanks road to the Vail-Empire Ranch Highway in Pima County, where the construction of a splendid highway has resulted. State 75% Funds apportioned to Pima County were used on the first part of this construction and when these were exhausted funds from the Pima County bond issue were used. Twenty miles of one of the finest highways in the State of Arizona have been completed on this project.

This work was under the general supervision of A. W. Jenkins.

PINAL COUNTY

Federal Aid Project No. 1—Florence Bridge:

Consists of an extension consisting of 15 50-foot spans to the old bridge, which consisted of 14 50-foot spans. It also included the construction of an approach to the south end of the bridge one mile long, surfacing the bridge and approaches, and the construction of two deflectors and a channel changer to keep the water in the north channel of the river and under the bridge. Subsequent work not included in the Federal Aid Project consisted of the construction of six deflectors to protect the north bank of the river above the bridge.

Paving was laid on this bridge at cost of $6,060.36 by State forces, —bid for $7,559.00 having previously been rejected.

The work done during the past two years has been in charge of Engineer J. M. Brown, with J. P. Walthall, General Foreman.

Prison labor was used.

A more detailed account of this bridge is contained in the article on Bridges.

Federal Aid Project No. 7— Mesa-Superior Highway—Section 2-B:

Consists of 11.71 miles of highway between Mesa and Superior and is on the route of the State Highway between Phoenix and Tucson, and Phoenix and Globe. Included in this project is an arch bridge of 120-foot span across Queen Creek, besides three other bridges having a span of more than 20 feet.

Work was started in March, 1919, using State forces on all work, except the Queen Creek bridge, which was built under contract by the Topeka Bridge & Construction Co. The project was finished May 6th, 1920, at a total cost of $182,491.30. The roadway is surfaced with selected local material.

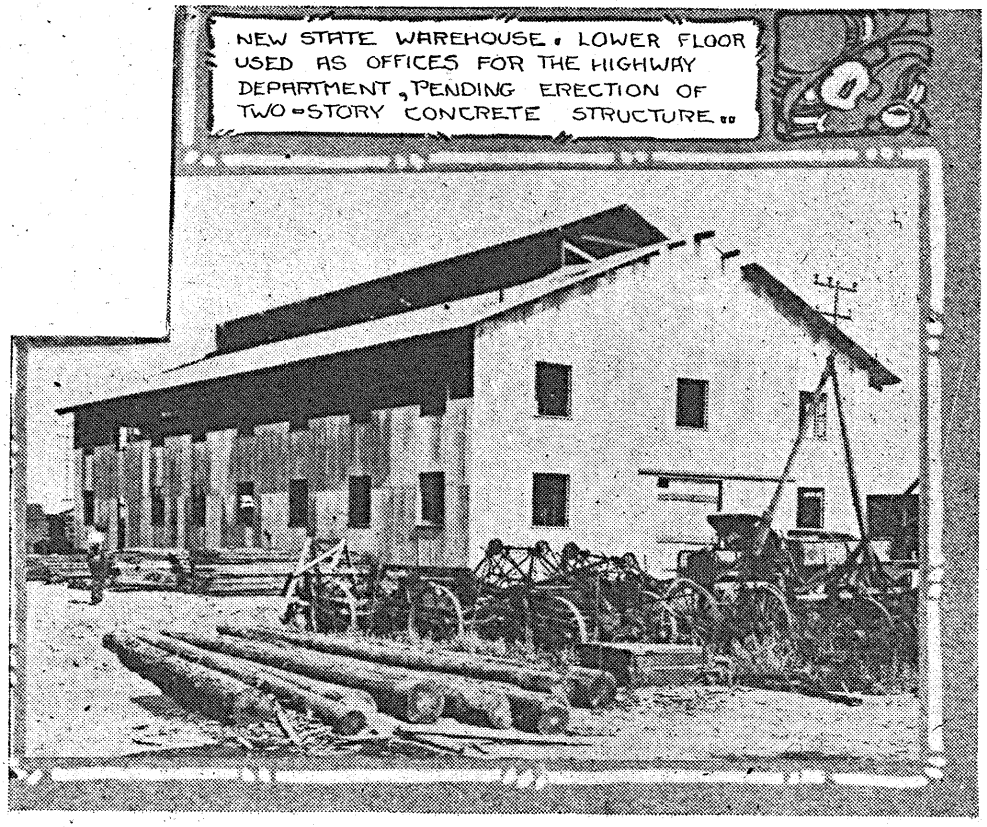
The Queen Creek bridge was let by contract for $14,000.00 plus cement and steel, which were furnished by the State at a cost of $4,016.80.

The original plans contemplated the construction of an additional 120-foot span bridge across an overflow channel of Queen Creek. This bridge was eliminated by raising the grade of the present roadway three feet to provide additional head room and the construction of a rock fill across the overflow channel at a cost of $7,000.00, which resulted in a saving of $11,000.00. Very heavy rains in Queen Creek drainage area in the summer of 1920 demonstrated that this bridge as constructed is of ample capacity.

Personnel: Ben Gallagher, Resident Engineer; Jas. Bone, Inspector, Queen Creek bridge; T. F. McGrath, General Foreman; A. A. Lillard, General Foreman.

Federal Aid Project No. 23— Florence-Superior Highway:

Consists of the construction of 30.78 miles of highway from the north end of the Florence Bridge to the Town of Superior. The highway runs almost due north from the Florence Bridge to the end of Section 2-B of the Mesa-Superior Highway; thence in an easterly direction to Superior. This highway, in connection with the Mesa-Superior Highway, provides a road from Florence to Superior, Florence to Mesa and Mesa to Superior. Included in the project is a reinforced concrete bridge 154.5 feet in length crossing Queen Creek. That portion of the highway from Florence north 14.79 miles is generally light construction so far as grading is concerned, but owing to the nature of the soil all will have to be surfaced. Surfacing will have


NEW STATE WAREHOUSE. LOWER FLOOR USED AS OFFICES FOR THE HIGHWAY DEPARTMENT, PENDING ERECTION OF TWO-STORY CONCRETE STRUCTURE.

to be hauled a considerable distance and the road will be rather expensive for that kind of construction, costing about $5,800.00 per mile. The remainder of the road into Superior is over comparatively rough ground requiring considerable rock excavation, making that portion also above the average in cost.

The project is divided into six sections,—Section "A" being 9.597 miles on the Florence end; Section "B" being 5.1989 miles in length and extending from the north end of Section "A" to the end of Section 2-B of the Mesa-Superior Highway. This section is also practically complete. Section "C" extends from the end of Section "B" easterly 2.098 miles toward Superior. This section is also practically complete. Section "D" consists of 8.664 miles extending from the end of Section "C" to the Queen Creek Bridge, across Gonzalez Pass. Section "E" is the bridge across Queen Creek. Section "F" is 5.193 miles in length, constituting the remaining portion of the highway, and extends from the Queen Creek Bridge to Superior. Sections "A," "B" and "C" are being constructed with State forces. Section "D" is being constructed under contract by Maurice Ryan, the principal items of which are excavation and borrow at the unit price of $1.65 per cubic yard. The bridge across Queen Creek has been constructed under contract by English and Pierce, the principal items being Class A concrete at $30.00 per cubic yard and Class B concrete at $17.00 per cubic yard. So far no work has been done on Section "F."

The estimated cost of the project is $456,882.72, or approximateley $14,856.53 per mile, exclusive of the bridge across Queen Creek, which will cost approximately $21,384.18. Funds for this construction are being provided by proceeds of the Pinal County bond issue and Federal Aid. The preliminary survey was made by Engineer Earl Parker. The location survey was made by Engineer Ben Gallagher. Sections "A," "B" and "C" are under the direct supervision of Engineer D. M. Bunker. Sections "D" and "E" are under the direct supervision of Engineer W. W. Van Frank. Sections "A" and "D" will be completed in the early spring of 1921, provided funds from the sale of bonds are forthcoming as provided under existing contract. Sections "B," "C" and "E" are already practically completed. The construction of Section "F" is contingent upon further funds being made available.

Federal Aid Project No. 28—Ray-Superior Highway:

Contemplates the construction of 7.52 miles of highway from Superior towards Ray, using $100,000.00 secured from the sale of bonds in Pinal County and $90,000.00 Federal Aid. The route of this highway will be on an entirely different location than the present road between Ray and Superior. Funds available or authorized are not

sufficient to complete the entire road from Superior to Ray, so arrangements have been made to construct 7.52 miles on the Superior end, using the old road temporarily from this point on to Ray. The location work has been done by W. W. Lane, County Engineer of Pinal County, who represented the State Highway Department in this work.

Bids were received for this job on the 6th day of October, 1920, but were rejected as being too high. Owing to the status of the funds in Pinal County new bids will not be asked for until these matters have been straightened out. Pinal County is now building a highway from Ray to Kelvin and from Kelvin to Hayden which, together with this project and other projects west of Superior, will make a direct route from Phoenix to Hayden which is already connected with a highway to Globe and another highway up the San Pedro River via Mammoth and Oracle to Tucson.

SANTA CRUZ COUNTY

Federal Aid Project No. 27— Nogales-Fairbank Highway:

Contemplates the improvement of the highway between Nogales and Fairbanks. The necessary location work has been done by the State Highway Department under the direct charge of W. W. Van Frank as Locating Engineer.

There is available for the work approximately $100,000.00, secured from the sale of bonds in Santa Cruz County,, and an equal amount of Federal Aid. Construction work to be done with these funds extends from Sonoita to the Cochise County line. It is expected to build this road with State forces now employed on the construction of Section "B" of the Benson-Vail Highway and will start as soon as that work is completed and approval of plans, ,specifications and estimate by the Bureau of Public Roads secured.

YAVAPAI COUNTY

Federal Aid Projects Nos. 12, 17, 19 and 36— Prescott-Jerome Highways:

Constitutes 25.43 miles of the total length of 32.5 miles between Prescott and Jerome. This highway was under construction on January 1st, 1919,—approximately one mile having been constructed to that date. The preliminary survey of this road was made in 1917 by

Earl Parker under authorization of the Board of Supervisors of Yavapai County. A location survey was made by F. R. Goodman and in the fall of 1918 construction was commenced under his supervision at the south end of Yeager Canyon with State forces. In March of 1919 Engineer Goodman was succeeded by Engineer E. A. Wolfe—the work through Yeager Canyon section continuing with State forces.

In March, 1919, an engineering party in charge of W. J. Jamieson commenced a location survey between Jerome and Mingus Pass. Upon completion of that part of the survey between Jerome and Walnut Springs; approximately two miles, known as Federal Aid Project No. 12, was compiled and submitted to the Bureau of Public Roads. Upon approval of this project by the Government and the granting of Federal Aid, bids were called for; the low bidder being the Miller Construction Company, of San Bernardino, California, at a unit price for excavation of $1.34 per cubic yard, two other bids being received for $1.55 and $1.89 per cubic yard, respectively. The work on the two miles out of Jerome was heavier than anything before attempted by the State of Arizona and cost $123,785.15, a rate of approximately $62,000.00 per mile.

On January 30th, 1920, the District Engineer, of the Bureau of Public Roads, approved Federal Aid Project No. 17, being that portion of the new location between Walnut Springs and Mingus Pass. An endeavor was made to let this by contract, but only one bid was received, which was withdrawn at the end of the ten-day limit while the advisability of accepting this contract was still under consideration. State forces completed this five-mile section with the exception of approximately one-fourth mile, which was let to Henry Galbraith in June, 1920. The grading of this portion of the road was completed after the road was thrown open to traffic.

The remaining portion of this road from the mouth of Yeager Canyon across Lonesome Valley, known as Federal Aid Project No. 19, was constructed by State forces with large caterpillar tractors, recently received from the Government. Shortage of funds and cold weather closed down this construction work in late November, 1920, but only after construction had progressed so far as to insure traffic over the road during the winter of 1920-21. At present maintenance forces are keeping open this road, completing a portion of the surfacing, and in addition, the Western Building and Construction Co. are proceeding with the building of a 65-foot concrete bridge across Granite Creek. Approximately $200,000.00 will be needed to complete this highway from the city limits of Prescott to Jerome, which includes an additional bridge crossing Granite Creek.

This road was completed just in time to take care of the passenger traffic between Jerome and Prescott, which had up to that time been carried by the narrow gauge railroad from Jerome Junction to

Jerome, and which was abandoned in the summer of 1920. This highway cuts the distance from 67 miles to 32.5 miles, and the running time from five hours to one and one-half hours.

This is one of the most scenic highways in the State of Arizona, that portion through the Dells near Prescott furnishing views of a most unique granite formation, while from Mingus Pass, where the road attains its highest elevation of 7,020 feet, the Verde Valley and contiguous territory presents itself to view; at this point it is also possible to gain easy access to the summit of Mingus Mountain, it being some two miles distant and 700 feet higher. From this mountain it is possible to view the country for many miles and this panorama is excelled only at the Grand Canyon of Arizona. Many mining claims lie adjacent to the new highway and prospects that heretofore lay inactive on account of the lack of highway facilities will eventually be in process of development.

The personnel upon the location and construction between the dates of March, 1919, and January 1, 1921, were:

E. A. Wolfe, Engineer in Charge; W. J. Jamieson, Locating and Construction Engineer; F. N. Grant, Resident Engineer; W. B. Piper, Resident Engineer; R. A. Davis, Resident Engineer; Chas. O'Conner, Floyd Allen and Ben Price, General Foremen.

YUMA COUNTY

Federal Aid Project No. 4— Agua Caliente-Antelope Hill Bridge:

Project Statement was submitted in 1918 for approximately 50 miles of road from a point near Agua Caliente to the Antelope Hill Bridge. The greater portion of this route followed the bottom lands along the Gila River and was on light, silty soil which would have required expensive surfacing. The floods of Thanksgiving, 1919, and those of the latter part of February, 1920, submerged a large part of the located line and demonstrated beyond question that this location was not feasible.

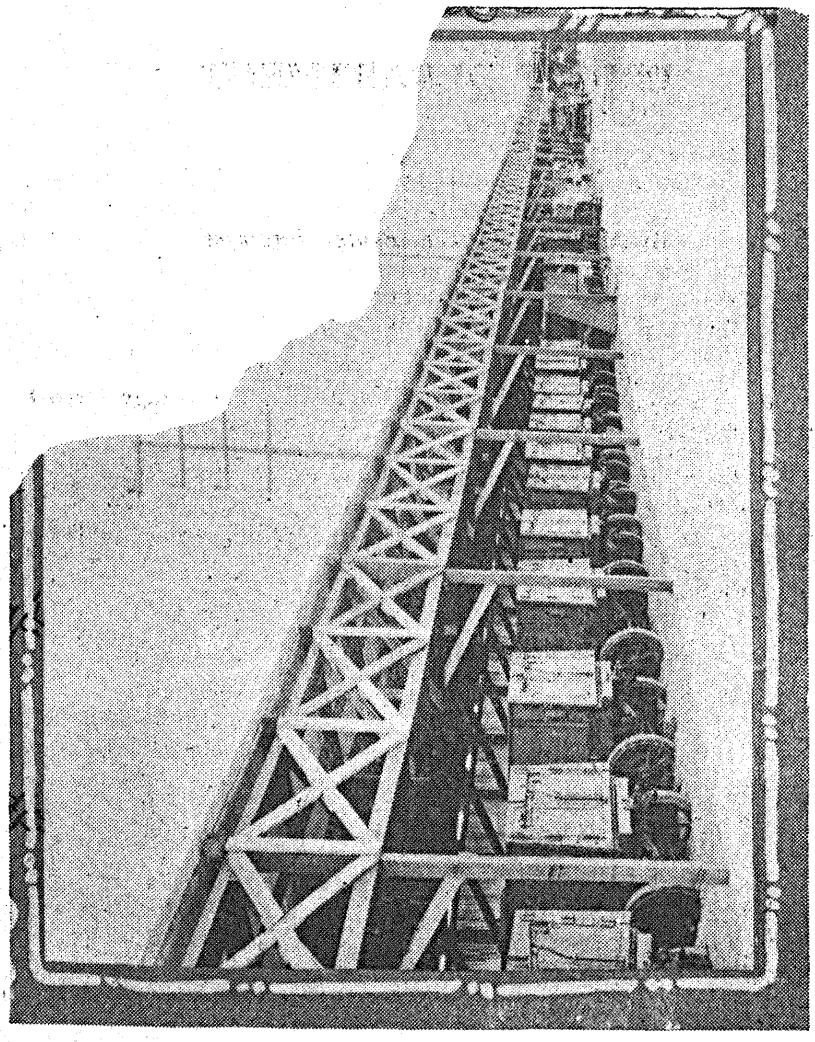
Further data regarding the river crossing is contained in the article on Bridge Failures.

Present plans contemplate the construction of this highway on an entirely new location on the south side of the Gila River, crossing at a point in the vicinity of the Gillespie Dam.

Federal Aid Project No. 26—Yuma-Welton Highway:

Is on the main State Highway between Yuma and Phoenix and consists of 18.63 miles of highway construction. Four miles of the highway between Yuma and Welton has previously been improved by Yuma County and this project will complete the improvement between these two cities. A portion of this work has already been done, using the Yuma County portion of the State Road Tax Fund, but as this fund is exhausted, work has been discontinued. Funds for the completion of the project will be provided by proceeds from the sale of bonds in Yuma County and Federal Aid. These bonds were authorized on the 27th day of October, 1919, but as the purchasers of the bonds have failed to make the necessary payments these funds are not available at this time. The work in general is light, so far as the grading is concerned, but rather expensive for surfacing. In the construction of this project 120-HP caterpillars, received by the State Highway Department from the Federal Government, were used to pull a string of 5-ton trailers hauling surfacing.

The highway was located by Engineer Claude Miller and the work so far has been constructed under the direct supervision of William C. Lacey, County Engineer of Yuma County, who represented the State Highway Department on this work. The date of completion of the project depends upon the date funds will become available.



TRUCK STORAGE SHEDS AT STATE YARD—PHOENIX

BRIDGE DEPARTMENT

By MERRILL BUTLER, *Bridge Engineer*

The following report covers the activities of the Bridge Department from July 1, 1918, to December 31, 1920.

Mr. R. V. Leeson had charge of bridge design from July 1, 1918, to September, 1919, with title of Consulting Engineer. The writer has supervised the work since that time. For the present purpose, the activities of the Department have been grouped under the following headings:

1. New construction other than standard structures.
2. Repairs and extensions to existing structures.
3. Standard structures.
4. Bridge failures other than Tempe.
5. Tempe Bridge.
6. Miscellaneous duties.

1. NEW CONSTRUCTION

Location	Type of Structure	Length	Act'l or Est. cost not inc. engineering	Status of Work	Remarks
Emerald Gulch -	1 span reinforced concrete arch	.....	$17,375.19	Completed	Mentioned in Report 1916-1918
Continental - - -	3 reinforced concrete girder spans	97.5′	15,890.13	Completed	Mentioned in Report 1916-1918
Clifton Bridge & approaches - - -	2 span reinforced concrete arch	277′	60,191.16	Completed	Mentioned in Report 1916-1918
Queen Creek Br. Mesa-Superior -	Reinforced concrete arch	136′	18,879.95	Completed	Topeka Br. & Constr. Co. ½ paid by Fed. Gov.
Deflectors at Florence - - - -	6 wooden deflectors	.....	1,847.06	Completed	State forces
Deflectors San Carlos Bridge - -	3 30′ wooden deflectors and 1 brush deflector	.....	1,153.00	Completed	State forces
Canal Bridge Tempe-Mesa - - -	2 span slab	24′	1,070.81	Completed	Abutments in place. ½ cost paid by Fed. Gov.
Canal Bridge Tempe-Mesa - - -	2 span slab	29.4′	1,443.19	Completed	Abutments in place. ½ cost paid by Fed. Gov.
Canal Bridge Tempe-Mesa - - -	1 span slab	14′	1,408.94	Completed	½ cost paid by Fed. Gov.

Location	Type of Structure	Length	Act'l or Est cost not inc. Engineering	Status of Work	Remarks
Canal Bridge Tempe-Mesa - - -	1 span slab	16′	2,165.24	Completed	½ cost paid by Fed. Gov.
Cottonwood - - -	2 reinforced concrete arch spans	316′	39,547.67	Completed	Topeka Br. & Constr. Co.
Agua Fria at Marinette - - - -	5 span reinforced concrete arch	497′	75,000.00	Under construction	State forces; ½ cost paid by Fed. Government
Gillespie Dam Br.	Concrete girders	.....	109,000.00	Dam under construction Bridge not yet designed	Foundations part of Gillespie Dam
Cienega Creek - -	Reinforced concrete arch and girder spans	278′	38,204.00	Under construction	½ cost paid by Fed. Gov.
Flagstaff Bridge	2 16′ slab spans	32′	4,074.65	Completed	½ cost paid by Fed. Gov.
Florence Br. Pav.	3245 sq.yds.paving	.....	6,060.36	Completed	1645 sq. yds. 2″, 1600 sq. Yds. 3″ asphalt concrete laid by State force
Queen Crk. Florence-Superior - -	4 concrete girder spans	154′	19,608.93	Completed	State standards; ½ cost paid by Fed. Gov.
Railroad Wash -	2 concrete girder spans	66′	9,640.00	Under construction	State standards; ½ cost paid by Fed. Gov.
Mescal Wash - -	2 concrete girder spans	67.5′	15,093.35	Under construction	State standards; ½ cost paid by Fed. Gov.

NEW CONSTRUCTION *(Continued)*

Location	Type of Structure	Length	Act'l or Est. cost not inc. engineering	Status of Work	Remarks
Queen Creek Superior-Miami - -	Reinforced concrete arch and retaining walls	190′	27,467.40	Under construction	½ cost paid by Fed. Gov.
Devil's Canyon -	Reinforced concrete arch	108′	20 530.00	Plans complete	½ cost paid by Fed. Gov.
Pinto Creek - - -	Reinforced concrete culvert	14′x116′	11,265.70	Plans complete	½ cost paid by Fed. Gov.
Sonoita River - -	4 reinforced concrete girder spans	125′	17,800.00	Plans complete	State standards; ½ cost paid by Fed. Gov.
Granite Creek - -	2 concrete girder spans	87.50′	10,877.40	Under construction	½ cost paid by Fed. Gov.
Wickenburg - - -	3 100′ steel spans	303′	71,723.50	Under construction	½ cost paid by Fed. Gov.
Arlington - - - -	Wooden pile trestle	354′	11,000.00	Under construction	State forces
Prescott-Jerome -	2 plain concrete arches	42′ ea.	11,355.58	Completed	State forces
5 Bridges on Tucson-Nogales Hwy.	Reinforced conc.	.....	50,000.00	Proj. Statement to Fed. Government	
		TOTAL	$669,673.21		

2. REPAIRS AND EXTENSIONS

Location	Type of Structure	Length	Act'l or Est cost not inc. Engineering	Status of Work	Remarks
Florence Bridge -	See discussion	.....	2,299.31	Completed	
Florence Br. Ext.	" "	.....	107,795.51	"	Mentioned in 1916-1918 Report. Includes earth-fill approaches
Milky Wash, Beaver Dam - -	Maintenance	.....	2,010.89	"	
Fairbanks - - - -	"	.....	16.00	"	
Mesa Canal, Grand Ave. Division - -	.....	.....	4.10	"	
Chevalan Creek -	.....	.....	49.00	"	
Sapori Wash - -	.....	.....	1,011.73	"	Mentioned in report 1916-18
Canoa Wash - -	.....	.....	660.39	"	
Antelope Hill Ext.	See discussion	.....	20,274.78	See discussion	$44,168.95 total cost of Extension
San Carlos Br. -	" "	.....	39,186.70	Under construction	½ cost paid by Fed. Gov.
Agua Fria at Cashion - - - - -	" "	.....	60,000.00	" "	State forces
Tempe Bridge -	" "	.....	70,856.29	" "	State forces
	Total.....$304,164.70				

3. STANDARD STRUCTURES

Standard plans for various types of reinforced concrete bridges, abutments, and culverts were prepared during the summer of 1919. Approval by the Federal authorities was secured in February, 1920. Since the completion of the original set additions have been made from time to time as the need arose. The appended table will serve to indicate the variety and wide usefulness of standard plans and the amount of construction and approximate cost for these structures. In addition, many standard features are incorporated in special designs. The department contemplates adding to the present list by preparing plans for additional reinforced concrete box culverts, reinforced concrete double box culverts, plain concrete arch culverts and reinforced concrete arch culverts.

Table Showing Standard Structures Built or Planned With Estimated Cost

Type of structure	Total No.	Total Cu. Yds. Conc.	Total Lbs. Steel	Total Estimated Cost
Slab bridges	77	7,042	312,422	$170,358.00
3 Girder deck	10	2,124	147,179	62,916.00
Arch culverts	5	440	12,622	13,158.00
Box culverts	92	1,638	31,043	39,901.00
Pipe culverts	407	2,161	.....	43,570.00
Slab culverts	49	2,094	31,578	45,393.00
Fords or dips	107	7,548	.....	119,063.00
TOTALS	747	23,047	534,844	$494,359.00

List of Standard Plans

1. Slab bridges (spans 6′ to 24′) inclusive.
2. High and low hand rails.
3. Three girder deck bridges (spans 22′ to 40′ inclusive). NOTE: The slab spans become uneconomical for spans of greater than about 24′. For greater spans, the three girder deck is the more economical up to about 50′.
4. Gravity abutments, 10′ to 18′ in height.
5. Reinforced concrete abutments, 10′ to 24′ in height.
6. Concrete headwalls for 12″ to 48″ culverts.

7. Slab culverts 4x3′ to 7x7′.
8. Gravity piers 8′ to 30′ in height. Piers for continuous slabs 6′ to 18′ in height.
9. Reinforced concrete box culverts 1′ 3″ x 1′ 3″ to 5′ x 5′.
10. Reinforced concrete arch culverts 14′ x 9′.
11. Rubble masonry headwalls for pipe culverts.
12. Gravel and concrete fords or dips.

Bridge Failures Other Than Tempe

Floods have necessitated important repairs, extensions, rebuilding or abandonment during the period reported on at the following locations:

1. *San Carlos Bridge across the Gila River,* built by the U. S. Government in the fall of 1913. The south bank was washed away for a distance of 500 feet in 1915. The bridge proper was uninjured but left isolated by lack of facilities to confine the stream, permitting the Gila to change its course and wash around the approach. The new extension of four 126′ steel truss spans will probably be ready for service about the first of February, 1921. That is, the usefulness of this particular bridge has been lost to the community for a period of something over five years because of erratic stream action. Necessity for stream control is, therefore, emphasized in conjunction with bridge construction and maintenance.

2. *Florence Bridge across the Gila River* was built during the year 1909-10, and consisted of fourteen 50-foot spans. The south bank began to erode upstream from the bridge site and some small efforts were made to control the channel, but nothing of sufficient scope to achieve any marked result. A heavy flood in the winter of 1915-16 cut away about 1200 feet of the south approach and left the main discharge of the Gila passing through this gap. However, an overflow channel north of the main channel and passing under the bridge was scoured out to such an extent that it appeared to be the most feasible channel in which to confine the river. With this idea in view 15 additional spans were constructed on the north end of the old structure; and a system of deflectors and channel changers installed to deflect the current into the north channel, and brnig it under the bridge. A new approach was constructed to the bridge from the south extending over the new river bottom.

No floods of great magnitude have occurred since the completion of the fill, but several rises of considerable volume have served to test the work. One of these demonstrated the necessity of raising the south approach, in order to prevent the water from over-topping it during exceptionally high water. This has since been done, and it is believed that the bridge is reasonably safe from damage, except in case of unprecedented floods. However, the nature of the topography and soil is such that no amount of work would render it absolutely safe from damage by high water.

The State has recently installed six deflectors along the north bank of the river just above the bridge, where an irrigation ditch was in serious danger of being entirely washed away. This action was necessary in order to protect the same, as well as the north abutment.

3. *Antelope Hill Bridge across the Gila.* This bridge originally consisted of ten 65-foot spans. It was built during part of 1914 and 1915 and crosses the Gila River about nine miles northeast of Wellton. The north approach was washed out for a distance of 300 feet early in 1916. The Legislature appropriated $50,000 in 1917 and five 65-foot spans were added on the north during 1918; thereby increasing the waterway about 50% and permitting the bridge to be used until the flood of the week following Thanksgiving, 1919. At this time about 500 feet of the north approach were washed away; the third and fourth piers from the north end settled about three-tenths of a foot and shifted donwstream approximately the same amount.

The flood of February, 1920, cut back the north approach nearly 300 feet more, took out the north abutment and one span, shifted the most northerly pier and the next one to it about a foot downstream and caused between two and three-tenths settlement in each of them. The two remaining piers of the extension both moved downstream and settled from one to three-tenths of a foot.

The road from the bridge across the valley was badly washed and several channels of considerable magnitude formed with each flood. One in particular at a distance of approximately one mile from the bridge has cut back within 2,000 feet of the road. Another channel formed three miles north of the bridge and the whole situation has been one that would justify only temporary construction. Or, to sum up the situation, Antelope Hill Bridge is located at a point where it is impossible to

control the river and keep it under the bridge at any reasonable cost; foundation conditions are bad and a permanent extension would necessarily be long and costly with the strong possibility that the same situation would again develop in a few years. The foregoing, together with the apparent need for expensive repairs to two of the existing piers, should militate against anything except some form of temporary construction.

4. *Agua Fria Bridge at Coldwater.* Construction of this bridge was started in December, 1915. In less than a month a heavy flood occurred which formed a new channel to the west and on the opposite side of an island which extended about a quarter of a mile upstream from the bridge site. Nevertheless, the original plans were carried out; the bridge constructed over the dry bed and a fill placed across the new channel. This west approach was washed away during the winter of 1916-17 and in March, 1917, the Legislature appropriated $22,000 to rebuild the same.

It was apparent from the conditions existing that in order to make this approach withstand even an ordinary flood it would be necessary to divert the river back under the bridge. Channel changers and some miscellaneous work accomplished this purpose sufficiently to prevent any damage until the Thanksgiving, 1919, flood, which far exceeded anything recorded for this location. Seven spans and both approaches were washed away; a considerable portion of the Arizona Eastern Railway Bridge was wrecked and the entire topography of the river changed. Subsequent floods carried out five additional spans.

The bridge consisted of 37 bays of two-girder reinforced concrete construction supported on concrete column bents 32'-6" apart. Each bent in turn rested on eight wooden piles grouped in fours under each column footing. These latter which had not washed out were found to be entirely exposed after the water had receded, due to the lowering of the stream bed. The remaining portion of the old bridge is, therefore, entirely supported by the piles, which have a maximum length of fifteen feet—by no means sufficient. As a possible protection additional piles 35 feet long were driven below the footings of old piers in the hope that they may decrease the scour and thus increase the chance of this work surviving an ordinary flood.

The Agua Fria River at this point is approximately one mile from bank to bank,—the space between the banks being all subject to overflow, and over which the river wanders at will.

In order to provide a permanent crossing at this location which would be free from danger of floods, it would be necessary to build a bridge about one mile long, with foundations 30 or 40 feet below the river bed. The cost of such a structure would, of course, be prohibitive. Hence it was decided to construct a timber pile trestle. Money for this was provided from the Emergency Fund authorized in Chapter 152 Session Laws of 1919. The work has now been practically completed, and the bridge has been opened to traffic. While it is not expected that this entire structure (which consists of eighty-one bays, each 19′-6″ long) will withstand any maximum flood which may come down the Agua Fria; it is very improbable that a considerable portion will be destroyed at any one time. Furthermore, the time and cost of replacing damaged sections will not be as serious as would be the case for a concrete bridge. A considerable amount of the railroad trestle was taken out by the floods but much of the damage resulted from the fact that when a portion of the deck was caught by the current, the steel rails holding together pulled otherwise stable sections of the deck with them and thereby caused much loss which might not have otherwise occurred.

The location and foundation conditions are both extraordinarily poor, but the bridge is on a main highway, a road of great economic importance, and in a section where no better site can be found within a reasonable distance.

Two possible solutions are herein outlined which may be feasible when the necessity for further permanent construction arises.

1. That the Arizona Eastern Railroad and the State build a joint bridge of a type to be determined after a thorough study of the foundation conditions, or
2. A concrete highway viaduct supported on concrete piles, having at least forty feet of penetration.

It should be remembered that the past year has been one of high material and labor costs; that the present pile trestle should have several years of life, by which time it is reasonable to expect a substantial decrease in the cost of building and in consequence that the wooden structure will pay for itself because of future lesser expense of a concrete bridge, plus the saving of interest and sinking fund charges.

5. *Wickenburg Bridge across the Hassayampa* was built by Maricopa County in 1914 and consisted of four concrete truss

spans. Total length of bridge, 195'-4". Two westerly spans washed out during the fall of 1916, and were replaced by a steel truss. The Thanksgiving flood of 1919 wrecked this structure entirely. Except at the westerly abutment, the foundations were all placed on sand and had inadequate depth to withstand the scour during the high water. This stream carries considerable large drift, and, if the reports of eye witnesses are correct, the bridge was constructed with insufficient headroom. The largest flood experienced during twenty years occurred in August, 1920, and served to demonstrate the utter inadequacy of this bridge. This Department has begun the construction of a 3-span, 303-foot over all bridge with steel trusses and concrete floor. The length will be greater by more than fifty per cent and the headroom will be nearly double that of the former structure.

Previous efforts to construct and maintain this bridge have cost the taxpayers of Maricopa County something over $20,000, together with a part-time loss of use. This Department contemplates an additional expenditure of about $70,000, making a total of over $90,000. A properly designed bridge in the first place would have cost about $30,000 or, in other words, would have saved $60,000 and much inconvenience.

Tempe Bridge: Repairs

The second pier from the north end of this bridge settled about 4½ inches shortly after the Thanksgiving, 1919, floods. Traffic was maintained, except during high water, until the second drop, which occurred February 13, 1920, and amounted to about ½". Two tons was then named as the maximum load permitted to cross. On March 2, 1⅛" additional deflection necessitated closing the bridge and on the following day a sudden drop of nearly 5" was recorded. Emergency measures to insure the stability of the structure were completed and the bridge opened to pedestrian traffic March 4. Material and equipment for sinking caissons and underpinning the defective pier had been in process of assembling for some time and the belated arrival of timber permitted permanent repair work to start late in the month; the Governor having declared that an emergency existed and set aside $45,000.00 for the repairs on March 25.

Serious cracks in the superstructure made necessary extensive repairs over three piers at the south end. This work was completed, the false work to support the sunken arches erected, and the bridge opened to vehicular traffic on May 11, 1920. Since that time the retaining wall at the south approach has been underpinned, the crown

expansion joints renewed, sheetpile cofferdam driven and at this time the sunken pier is underpinned and the false work removed. Considerable repairs are yet needed on the handrail, floor and spandrel columns.

It may be pertinent to call attention at this time to the existence of other very serious cracks in the arch rings and floor system. The bridge was originally designed for a live load of 100 pounds per square foot, plus a 15-ton traction engine. The present State requirements are 150 pounds per square foot of roadway surface, or two 15-ton trucks. The bridge as built is a more or less indeterminate structure, but an analysis of stresses calls the sufficiency of the floor system and arch rings seriously in question.

Besides the one undergoing repair, five additional piers must be considered as of doubtful capacity to sustain the loads to which they are subjected.

In view of the extreme economic value of the Tempe Bridge—about 2500 vehicles per day use this structure at an estimated saving of $1.00 each over the longer route—it is the recommendation of this Department that the Legislature be informed of the unsatisfactory condition of this bridge, the liability of serious accident which may require restricting traffic or closing the bridge altogether and the possibility of requests for maintenance funds during the next two years.

The general scheme of repair would be to follow the procedure at the sunken pier for underpinning operations; the placing of additional arch rings of reinforced concrete or steel; and necessary strengthening alterations in the floor system to provide for temperature variation and to transfer the loads to the new arch rings. Work would have to be carried on without stopping traffic; a condition which would increase the cost to the State by many thousands of dollars.

The original cost of the Tempe Bridge was $151,250.71 and it will probably require somewhere in the neighborhood of $450,000.00 at present prices to build a new bridge adequate to carry present day traffic. The expenditure of about one-half of this latter amount should serve to increase the life of the bridge for several years over that now estimated, which is about five at best.

Miscellaneous Duties

Plans have recently been prepared for County bridges of an aggregate value of nearly $70,000.00. This work is done for the Counties of the State for the actual cost of preparing the plans and specifications.

Steel cutting lists, cement and corrugated pipe requisitions are arranged for all State furnished material. This first item involves over 500,000 pounds of reinforcing steel ordered and to be cut to length in the Phoenix yard and then sent to the various jobs.

Standard drainage structures on all road projects are examined as to economical selection and general sufficiency.

Preliminary estimates on proposed structures and some routine duties not easily susceptible of classification have also been handled.

One assistant engineer and one foreman have been loaned and are at present aiding the United States Public Health Service in their work of enlarging the Tucson hospital.

STATE YARD AND SHOP AT PHOENIX

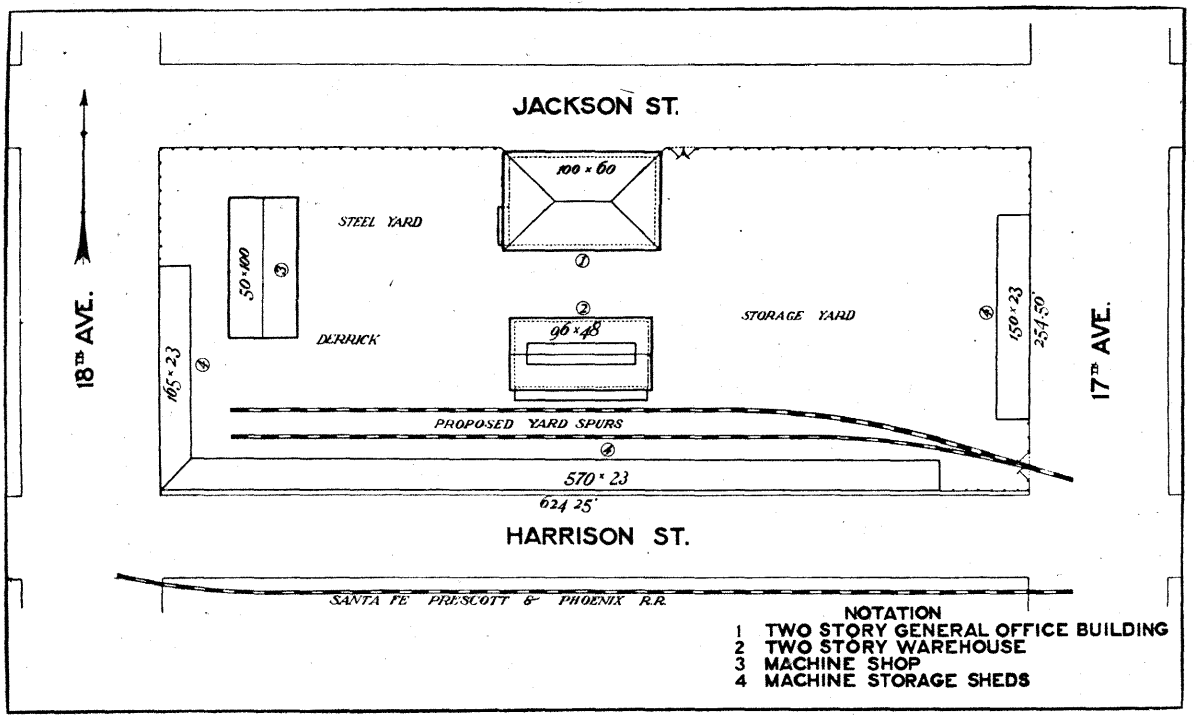
The accompanying map shows the location, size and lay-out of the Phoenix yard to serve the entire Highway Department. Of the buildings indicated, the two-story warehouse and truck sheds are completed, the machine shop is in use but is yet to be fitted with a traveling crane designed to have sufficient capacity to handle all truck and miscellaneous repair work for the entire organization.

One spur track is contemplated in the near future, with provision for one additional track.

The basement and first floor of a two-story general office building have been completed but construction has been stopped on account of lack of funds. This building is of the utmost necessity to provide adequate office space for the administration of the Highway Department and to release the ground floor of the warehouse, which is now being used as an office instead of for storage purposes.

This yard fills a long felt want for some central distributing point where supplies can be collected and sent to all parts of the State. Due to the condition of the steel market and the impossibility of securing deliveries within three or four months, the ability to store and cut large quantities of steel reinforcing has alone enabled much construction work to be carried on at a considerable saving of time and money.

The following table gives the status of the project:



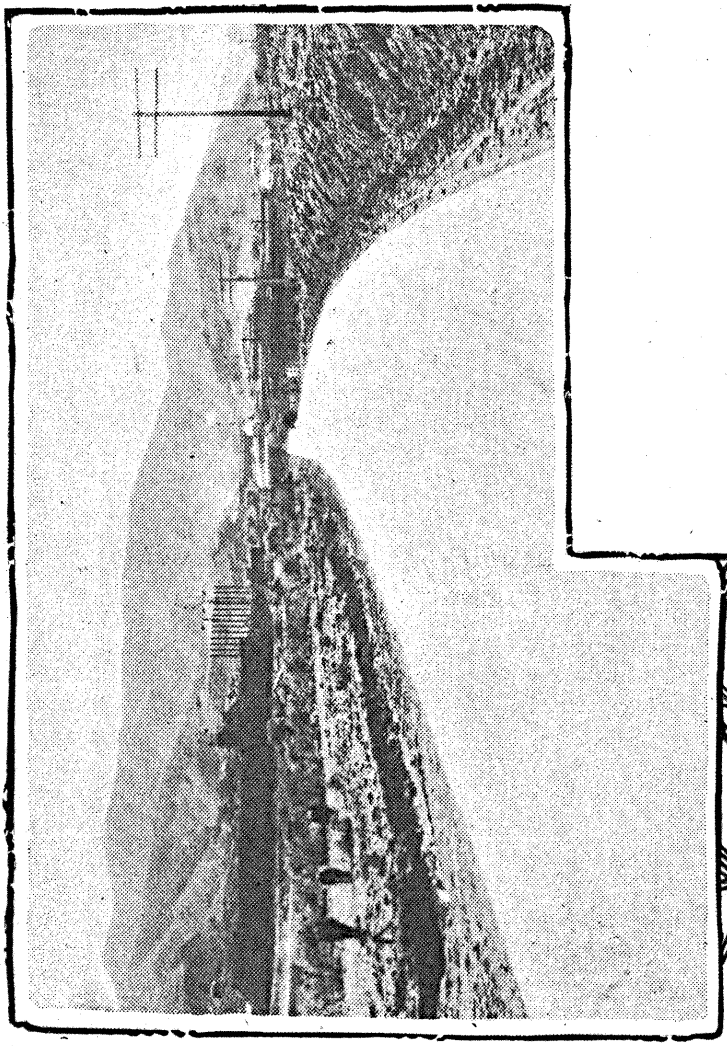
SKETCH SHOWING LAY-OUT OF STATE YARD AT PHOENIX

Land bought in May, 1919			$12,324.10
Warehouse:	Labor	$6,811.29	
	Material	7,957.07	14,768.36
Office building:	Labor	5,007.50	
	Material	5,805.34	10,812.84
Machine shop:	Labor	5,109.24	
	Material	2,322.54	7,431.78
Auto sheds:	Labor	4,861.82	
	Material	3,774.76	8,636.58
Grounds:	Labor	658.15	
	Material	1,096.89	1,755.04
Material and Supplies on hand			8,907.27
Total			$64,635.97

Much second-hand material and corrugated iron from the Government was used in the building construction, thereby effecting a considerable saving to the State in the matter of purchases of supplies in the open market.

Estimated Cost of Proposed Improvements

To complete office building	$45,000.00
To install railroad spur	2,100.00
To install crane in machine shop	900.00
To grade driveways, etc	2,000.00
Total	$50,000.00



CONCRETE HIGHWAY APPROACHING LOWELL.

SURVEYS

In addition to the actual highways for which funds will be available in the near future, the Highway Department has in the last two years practically completed the surveys for the entire primary system of the State of Arizona. This has been done in order that the funds now being spent may be used on highways whose location will fit into the entire State system, and also to provide the information necessary to secure legislative appropriations consistent with the needs of the construction.

Holbrook-Gallup Route

In this regard the State has completed a survey in Apache County from the County line of Navajo near Adamana to the New Mexico State line near Lupton. This survey was made at the request of the Old Trails Highway Association of California, Arizona and New Mexico. We are in receipt of information from the New Mexico Highway Department that the first through highway to reach the Arizona border will be near Rodeo. The second west of Gallup near Lupton. By April the Arizona highway should be complete into Rodeo, but we have no funds in prospect with which to connect through Apache County toward Gallup. This northern route will reduce the distance from Holbrook to Albuquerque about one hundred miles over the present route, by the way of St. Johns, Springerville, Magdalena and Socorro.

Holbrook-Gallup Secondary to Springerville Route

While the construction of a first-class highway parallel to the Santa Fe railroad through Apache County must necessarily be secondary to the construction of the Holbrook-Springerville road, due to the fact that this latter road serves the majority of the people of Apache County, work should be done on the Holbrook-Gallup route in order to make available the through road being built across Navajo, Coconino, Yavapai and Mohave Counties in this State.

In expectation of the early sale of the Apache County bonds this Department made a complete survey for the construction of a road

involving approximately $280,000.00 in Apache County; this sum being composed of $140,000.00 of Apache County's fund, plus an equal amount of Federal Aid. A portion of this work is now under construction, State Road Funds and Federal Aid being used until bonds can be sold.

Winslow-Holbrook

A survey was also completed from Winslow to Holbrook in order to secure the information necessary to submit plans and specifications to the Federal Government in accordance with the requirements of the Bureau of Public Roads. Some $60,000.00 of the bond issue of Navajo County which has already been sold will be used to match with Federal funds to improve this highway.

Nogales-Fairbank

A survey for a road from Nogales to Fairbank has been completed. This entire highway cannot be built with the funds now available, but that part proposed to be built by Santa Cruz County's bond issue and Federal Aid will be that which should receive first consideration. This highway will meet the extension of the Vail-Empire Ranch Highway recently reconstructed in Pima County with Pima County bond funds.

Williams-Clarkdale

The survey for the Williams-Clarkdale Road, under the provisions of Chapter 142 of the Session Laws of 1919, indicated that it was inadvisable to start construction on this highway until additional funds could be secured. It also indicated, in our opinion, that the State can quickest secure a north and south highway by acting in conjunction with the Highway Commission of Yavapai County, whose bond issue provides for the construction of a road from Ashfork to Prescott. This road will be at a much lower altitude than the Williams-Clarkdale, cheaper to build, and more easily kept open in the winter time.

In our opinion neither the State nor the Federal Government should, at this time, attempt the construction of two parallel roads as expensive as the ones from Prescott to Ashfork and from Williams to Clarkdale.

We believe that the east and west highway in Coconino County is much more essential to the people than is the north and south highway and that its improvement will be all that the present valuation of Coconino County can bear.

The resources of Yavapai County are much better able to construct and maintain this north and south highway within Yavapai County, where also commercial interests will be better served at the present time.

Globe-Roosevelt via Pinal Creek

The State, at the request of the Board of Supervisors of Gila County, has completed a survey for the construction of a road from Globe to Roosevelt by the way of Pinal Creek and the Salt River near Livingston Bridge. This survey indicates that it is not advisable to expend additional State funds on the construction of the road across the mountain between Globe and Roosevelt, where it will be impossible to utilize much of the present construction if grades are to be reduced and curvature decreased.

The road from Roosevelt to Globe by the way of Livingston would be somewhat longer than the present route, but the distance can be covered much quicker in an automobile on account of the elimination of the grades. The road would be much safer and the truck loads can be greatly increased on its light grades over those carried on the present highway. This road will also greatly reduce the distance from Globe to the northern part of Gila County by way of the recently constructed Livingston Bridge.

Arrowhead Trail

In accordance with the provision of Chapter 145, Session Laws of 1919, a survey has been made from Kingman northward to the Utah State line, a distance of 186 miles. This road, in addition to crossing the Grand Canyon of the Colorado, rises from an elevation of some 1100 feet to over 5000 feet elevation.

Anyone familiar with the mountainous road construction in Arizona realized that the $50,000.00 appropriated for the construction of this road was insignificant in comparison with the cost of this highway.

The Department has estimated that it will require an eventual expenditure of $1,700,000.00 for 88 miles of this construction between the Old Trails Highway and the Utah line, utilizing the roads now at each end which are in existence. This estimate is based on an 18′ roadway on a 20′ subgrade according to Federal Aid Standards. However, a small fraction of this amount will be sufficient to construct a narrower road to the Colorado River, making accessible important dam sites the utilization of which pertains vitally to early reclamation and hydro-electric development in this State.

Under these circumstances, it is believed advisable to construct a temporary road or trail by the easiest route from Kingman to the Colorado River in order to permit the construction of the bridge, which construction is partially financed by the passage of Chapter 49 of the Session Laws of 1919.

In doing this temporary construction it is proposed to increase the grades over the State standard of six per cent but to endeavor to see that all of the work done on the temporary road will become of permanent value in the construction of a subsequent first-class highway. An endeavor was made to commence construction on this type of road in the summer of 1920, but inability to secure labor at any reasonable price, in conjunction with the arrival of warm weather, caused the stoppage of this work.

It will be necessary for the Legislature to take some action to secure any type of highway construction between Kingman and Utah on this highway, which will be practically the only Arizona connection between the southern part of Mohave County—in fact, the entire State of Arizona—with the portion of the State north of the Colorado, which is commonly known as the "strip." It is believed by many people that if the rest of the State of Arizona cannot make some feasible connection with this part of our State, in justice to the present inhabitants and future settlers of this region, they should permit this part of Arizona to become a portion of the State of Utah.

Phoenix-Yuma via Gillespie Dam

The survey for a complete highway from Phoenix to Yuma has been made. In view of the floods of the winter of 1919-1920 and the desire of the Yuma County Highway Commission to connect with both Phoenix and Ajo, also in realization of the necessity for a highway from the Capital of the State to Ajo, this survey was run on the south side of the Gila River from Yuma to Gila Bend, thence in a northerly direction through the area proposed to be irrigated from the Gillespie Dam, now under construction, and thence to Arlington. This road would be approximately two miles longer than the present route from Phoenix to Yuma.

It is proposed to cross the Gila River on the apron of the Gillespie Dam until at some future date the superstructure of a bridge can be erected on the same. This superstructure can be built for approximately $125,000.00, while as a general proposition we doubt that any bridge crossing of the Gila River from its junction with the Salt to its confluence with the Colorado, can be secured for less than between three and four hundred thousand dollars.

While some difference of opinion in regard to the proper location of a highway from Yuma to Phoenix exists, no loss of time should be permitted in the discussion of this route when both ends of this highway, approximately fifty miles in length, will be identical whichever route is adopted.

Phoenix-Prescott

This Department has had a reconnaissance survey made by Mr. C. C. Small, our Chief Locating Engineer, from the Arizona Canal to the Yavapai County line in order to secure an estimate of the cost of construction in Maricopa County necessary to connect with the proposed Yavapai construction. This forty miles of construction is estimated to cost $490,000.00 for an 18′ gravelled road or $750,000.00 for a 9′ hard surfaced paving.

Mesa-Superior and Roosevelt

A reconnaissance has also been run from the Eastern Canal to the Pinal County line and an estimate made of $185,000.00 for a 9′ paving on the same.

Buckeye-Hassayampa Paving

A reconnaissance from Buckeye to Hassayampa indicates that $150,000.00 will be necessary for a 9′ paving on this road. In suggesting 9′ pavings this Department realizes that they are not wide enough for main line traffic, but advocates them on certain highways because they can be subsequently widened. They will greatly increase the load carrying capacity of vehicles, allowing the lighter ones to turn out. They will also protect the natural surface from going to dust in extremely dry weather and into mud in wet weather, as the 9′ strip of paving will receive nearly all of the wear of the traffic.

Benson-Dragoon

At the request of the Board of Supervisors a survey was made from Benson to Dragoon paralleling the Southern Pacific Railroad. This work was in charge of W. W. Van Frank, Locating Engineer. Data is available for preparing working plans and specifications.

Clifton-Mule Creek

A reconnaissance survey has been made from Clifton to Mule Creek by the way of Black Jack Gap in Greenlee County in order to ascertain the cost of connecting our State System with that of New Mexico beween Silver City and Mogollon.

Present information indicates that New Mexico will not immediately improve the road from Lordsburg toward Franklin, which is necessary in order to provide a connection with the central Arizona highway. On this account, the Mule Creek Road would not only make a valuable through highway connecting with the New Mexico System, but in addition would develop a considerable local traffic in and out of Clifton.

A rough estimate indicates a 12′ road would cost $193,000.00 and a 20′ road $511,000.00 for a distance of about twenty miles. This reconnaissance was made by Mr. F. G. Twitchell.

Apache Trail

A reconnaissance survey has been made from mile post 14, east of Mesa, to mile post 60, on the Apache Trail. This indicates that replacing of the present wooden bridges, which are in a dangerous condition, by steel structures, would cost $24.200; that new bridges at Boulder Creek and Pine Creek and nine new small structures would cost $66,600.00; that $42,000.00 would be needed for culverts; $115,000.00 for grading and ditching, and that $50,000.00 would be required to raise the grade on miles 57 and 58, which are submerged during heavy floods in the Salt River.

The expenditure of this approximate $300,000.00 on the Apache Trail would be necessary in order to put this well-known highway into as good condition as it was several years ago, with the additional installation of drainage structures to avoid the surfacing material being washed away. It would not provide for the widening of this highway, the reducing of the grades or the lengthening of the radius of the curves. However, it would make this road a first-class tourist highway.

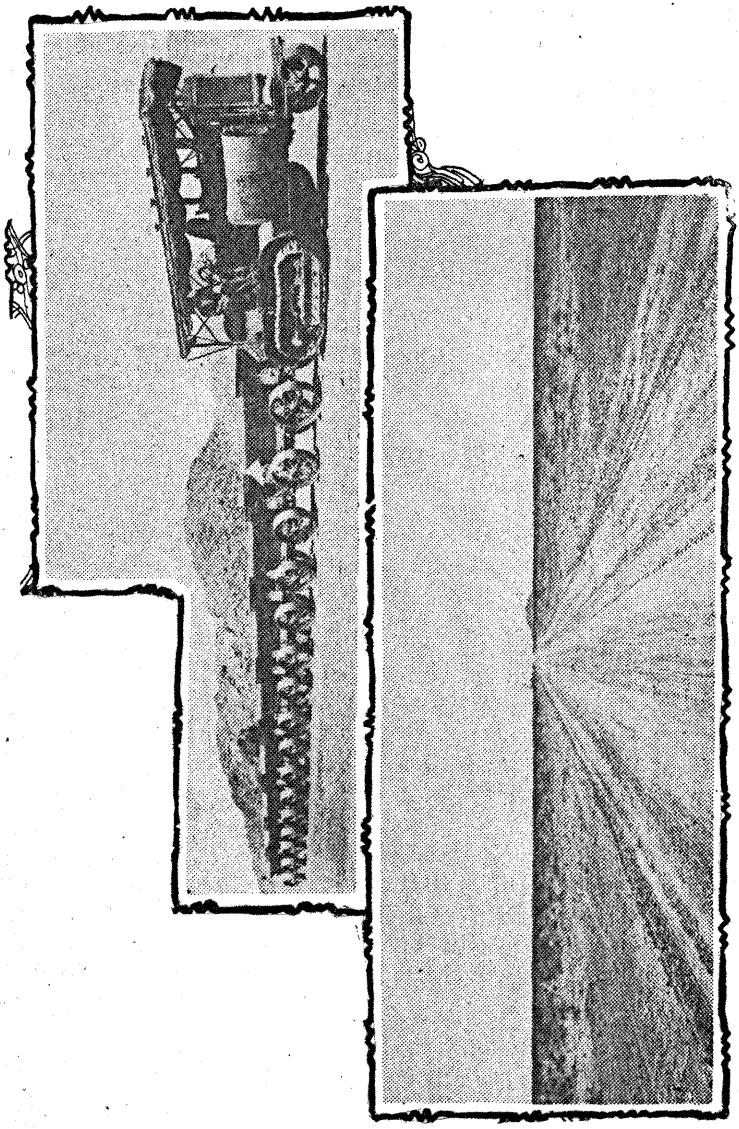
This reconnaissance was made by F. G. Twitchell.

CEMENT PIPE MANUFACTURE

The State Highway Department has recommenced the manufacture of concrete pipe at the State Prison. Several cars of cement have been shipped to the Prison and the pipe is manufactured for road construction between Florence and the junction of the Mesa-Superior Highway. It is also intended to manufacture pipe at the Prison to take care of the drainage on the road from Florence toward Tucson, some 20 miles of which were surveyed during 1920.

The cost of installing drainage will be a good portion of the expense necessary on this latter highway construction and the manufacture of this concrete pipe at the Prison will greatly decrease the cost of the necessary culverts. This is equally true where highway work is within a truck hauling distance of the Prison. The concrete pipes are not only cheaper than the corrugated iron, but where they are properly installed and covered with sufficient material, they are much more durable than corrugated iron.

These pipes can be manufactured and stored at the Prison at odd times when other duties do not require the labor of the prisoners, so that the only cost to the State should be some slight supervision and the cost of the cement.



VIEWS ON YUMA-WELTON PROJECT

FEDERAL EQUIPMENT

We desire to report that between two and three million dollars' worth of Federal equipment has been received by this Department. As the acceptance or rejection of this equipment on the part of the State of Arizona had to be determined by wire and no appropriation was available to pay for the cost of loading and unloading; the freight and storage on this equipment, as well as the purchase of our warehouse site and the construction of the necessary building, have all been paid for from current road funds, which has greatly depleted the same. We feel that while there might be some question about our authority in assuming the responsibility of the acceptance of this equipment at greatly reduced prices from the Government, our action was justified and would be approved by the majority of the taxpayers of the State. We are, therefore, asking the Legislature to reimburse the State Road Tax Fund for all sums expended in securing and protecting this equipment, except those which have been paid by the various Counties of the State.

This Department had hardly received its first equipment from the Government before the inquiry was made by letter and by Government inspectors as to our method of protecting the same from the weather conditions.

We early realized that the receipt of this very necessary equipment was contingent upon the arrangements made by this State as well as the rest of the States of the Union for the handling of this equipment so that no just criticism could induce Congress to stop its distribution. On this account, after advertising through the Board of Control, this Department purchased half a block of land, the site being determined upon accessibility to railroad connections, the State Capitol and the Street Railway system. Six thousand ($6,000.00) dollars was paid for this half block. In anticipation of future growth this Department subsequently purchased an additional one-half block for $6,200.00, securing property which has already increased greatly in value and which should be sufficient to provide for the needs of the Highway Department for many years to come. This property has been fenced and in part covered with buildings to house Federal equipment. All of the corrugated iron possible to secure from the Government was used in the construction of these warehouses, the remaining portion having to be bought.

The large increase in the force of the State Highway Department necessary in the handling of Federal Aid did not permit this Department being housed in the State Capitol, except in piecemeal. For a considerable length of time this Department was using the cellar of the recently constructed addition to the Capitol, the Senate Chamber, together with some of the committee rooms adjoining and the bungalow on the west side of the Capitol grounds. In order to better supervise this Department, our offices and drafting forces were moved to the warehouse built on purchased State property. The floor elevation of this warehouse is such that it will facilitate the loading and unloading of freight from trucks and from cars on a spur which it is proposed to eventually build from the railroad.

In securing material to fill the foundation for this warehouse excavation was made for a future office building, the foundation of which was subsequentlty started and the construction carried on to the first floor. This building could not be completed because of lack of funds. In the meantime the testing engineer is occupying a portion of this basement with the highway laboratory.

In addition to receiving much Federal equipment, spare parts also have been obtained by the Arizona Highway Department; in order to reduce the inevitable cost of repairs on automobiles, trucks, tractors and road-building equipment in general, this Department has established a repair shop where mechanics are constantly occupied in keeping State equipment in first-class condition.

The Department is still short considerable machinery for the proper handling of repairs, but is doing all possible with funds available.

In addition to the equipment already received, we can expect to secure additional equipment from the Government. It is understood that there is a possibility of our securing three-quarter ton trucks, which not only the State but the Counties need very badly.

We also hope to receive some mobile repair units, which would be almost invaluable for highway construction, as these were built with the idea of having mobile machine shops for use in various sections of the army where conditions were frequently the same as in our construction camps.

We hope to receive some small five- and ten-ton tractors, which we can use not only on State work but to distribute to Counties. Also several car loads of truck parts and also some light railroad cars and track to use in conjunction with the locomotives already received.

This latter railroad equipment would be a splendid asset in the construction of paving or in building roads across desert sands where it is almost impossible to use any other form of transportation.

LYMAN DAM

This Department, at the request of the State Loan Board, investigated the construction of the Lyman Dam, which was being built with State funds in the fall of 1919.

New plans and specifications for its construction were drawn up and estimates of the cost prepared, the contract for this construction being later let by the Loan Board in conjunction with the Lyman Water Company.

This Department likewise made surveys and investigations into the feasibility of the Walnut Dam construction under the provisions of the State's acceptance of the Cary Act.

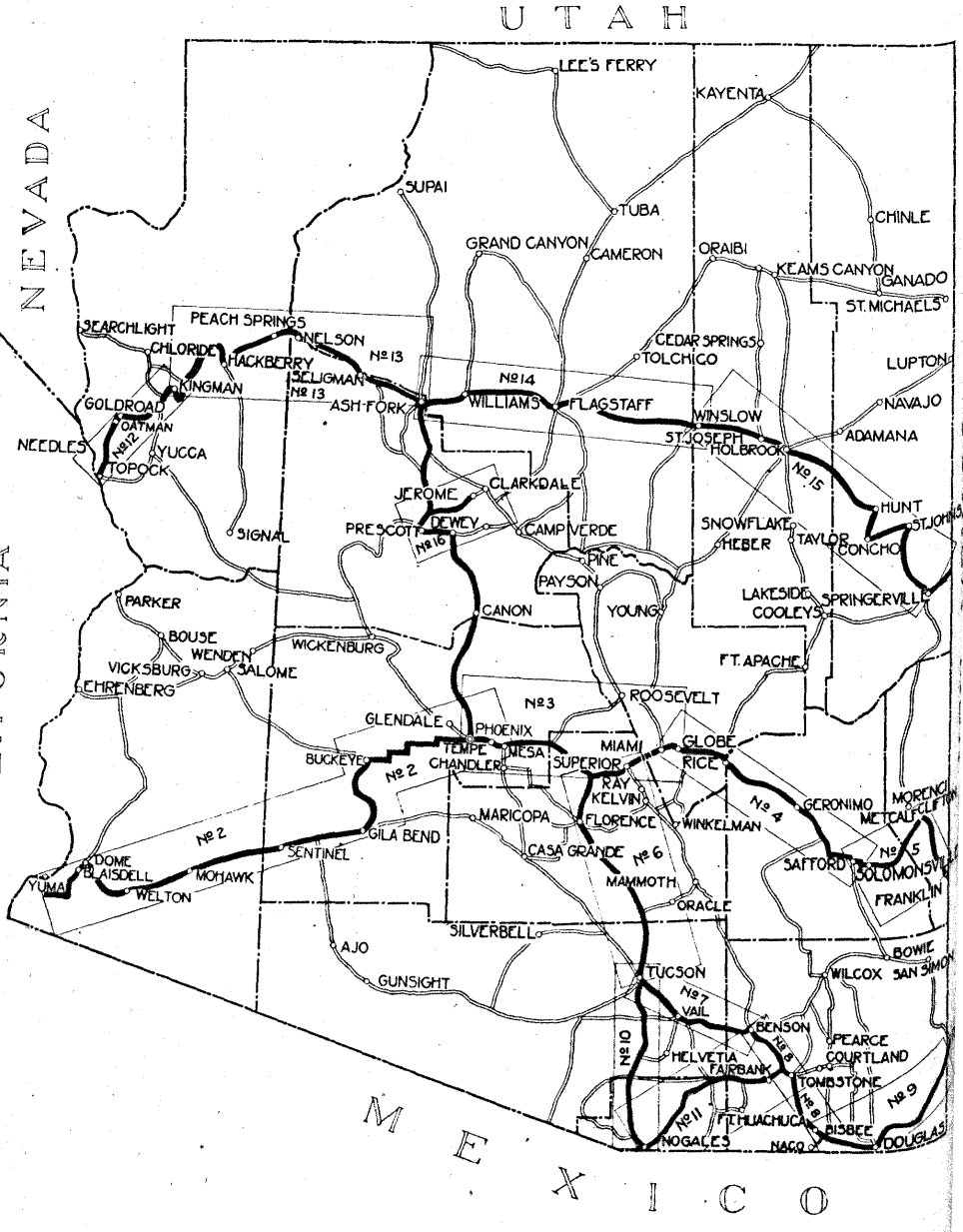
The personnel of the Highway Department is so extensive that it is usually possible to find engineers in our employ thoroughly competent to design any specialized form of construction. Their temporary connection with this kind of work cost the other State Departments a great deal less than if it were necessary to organize forces to perform the same.

SILVER CREEK CONCRETE BRIDGE BUILT BY EL PASO BRIDGE CO. UNDER DIRECTION J. C. RYAN ..

MAPS

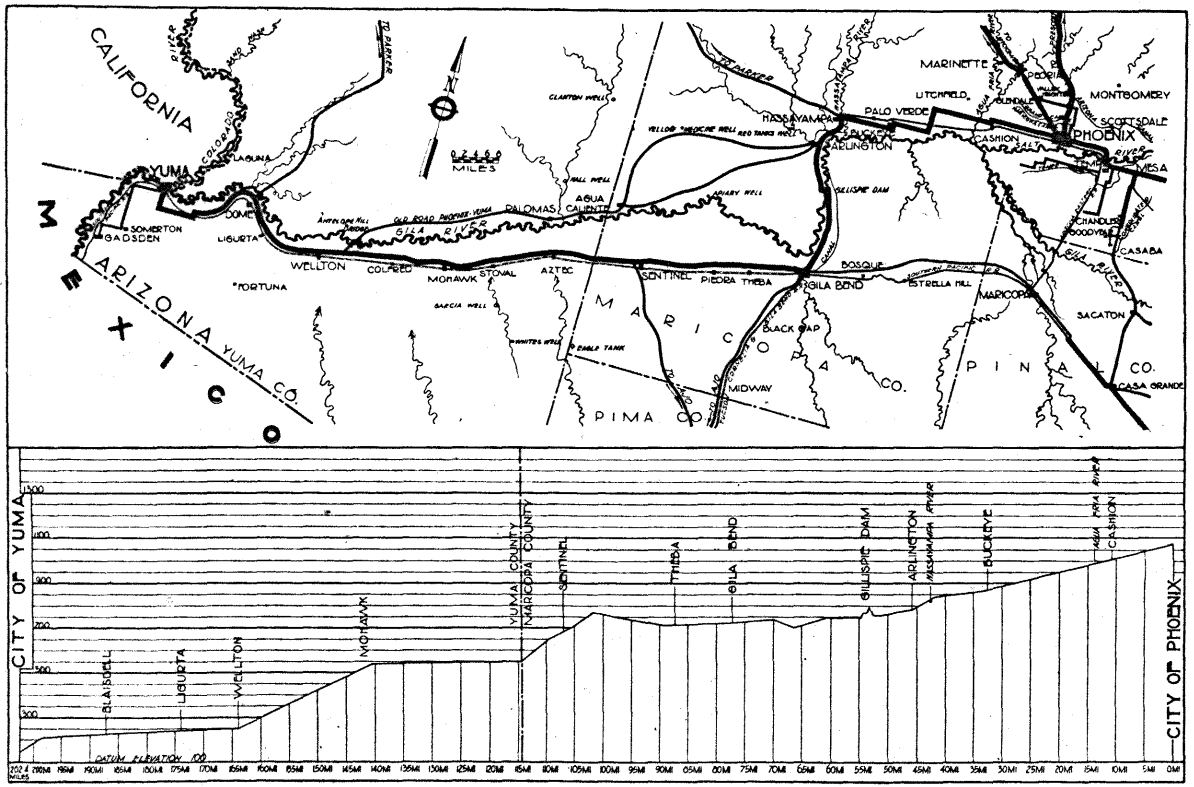
The highway maps shown on the following pages cover the primary system and are the first effort of the Department to furnish the public with detail maps of the State Highways. We have endeavored to show principal connecting roads and such other features as might be of value to persons using the highways or making a study of them.

The difficulties incident to preparing such a set of maps can be appreciated only by persons who have undertaken a like task. We do not pretend that everything has been shown that should be shown or that no errors have been made. However, the demand for a comprehensive road map of the State has been so general that we decided to make a start, hoping that people interested may be benefited and also advise the Department of omissions or errors so that corrections may be made in future issues.

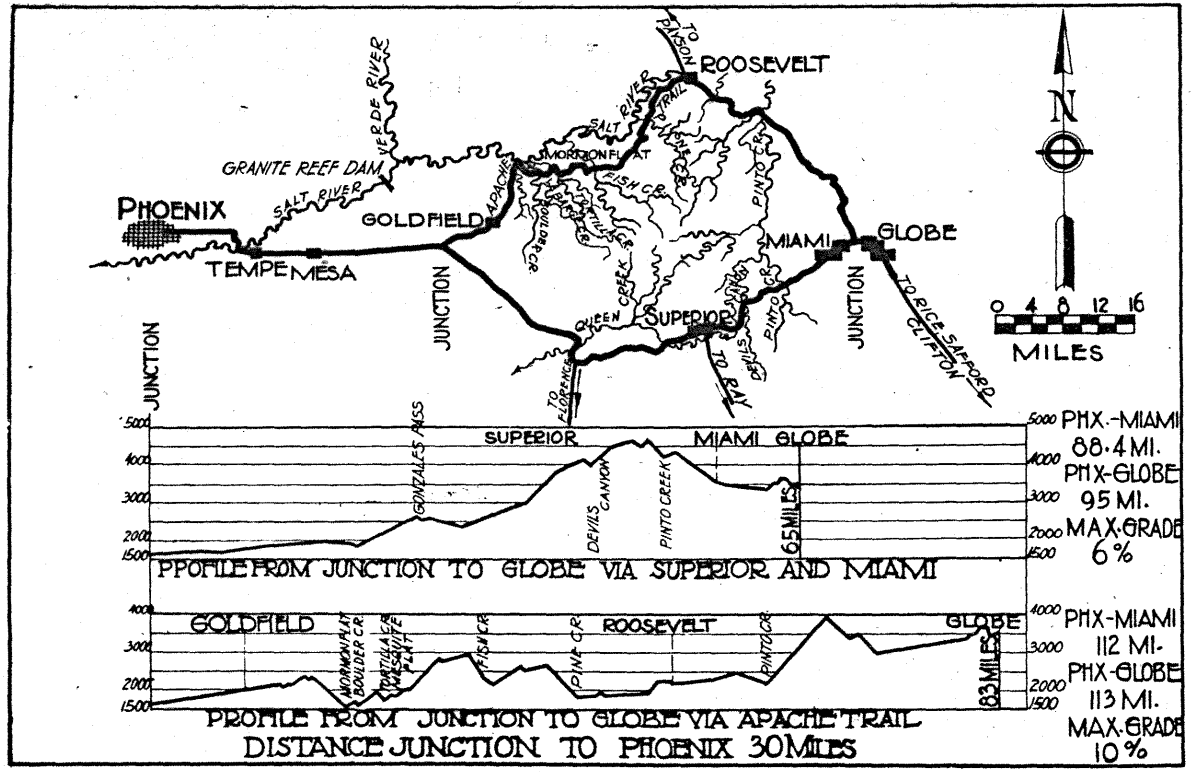


Map No. 1

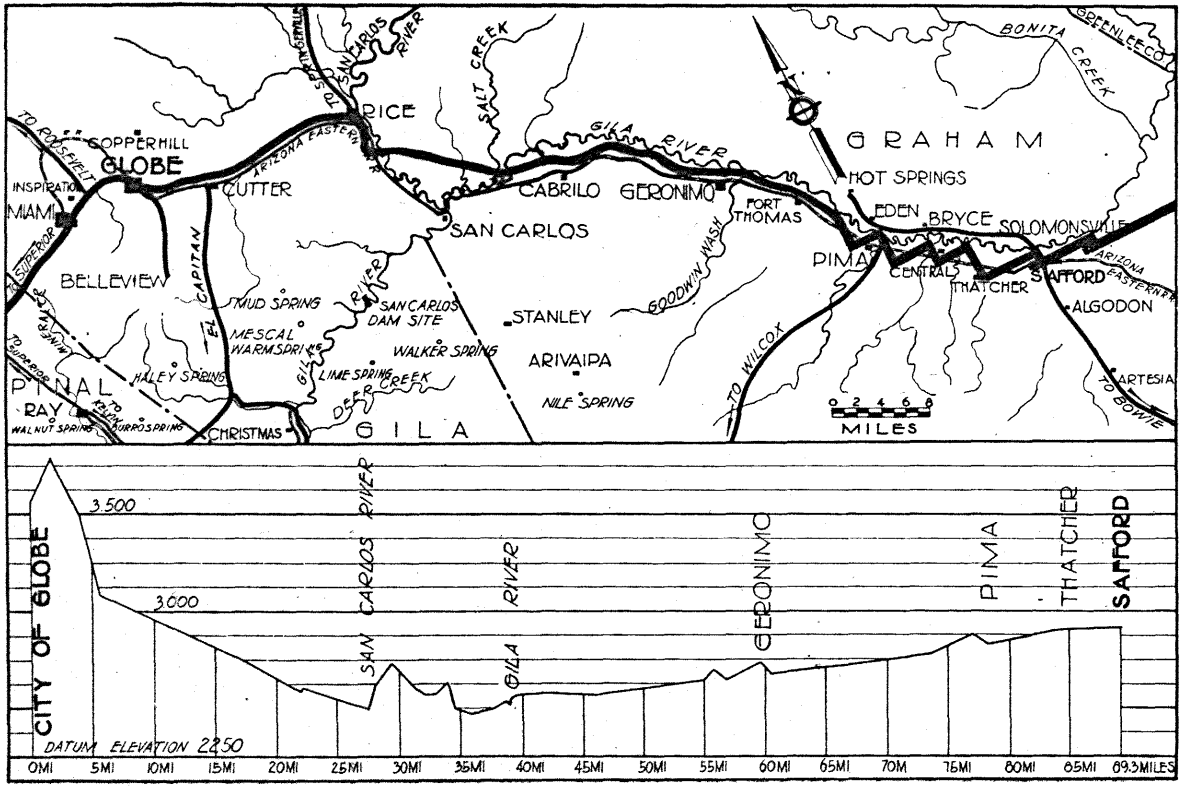
KEY MAP



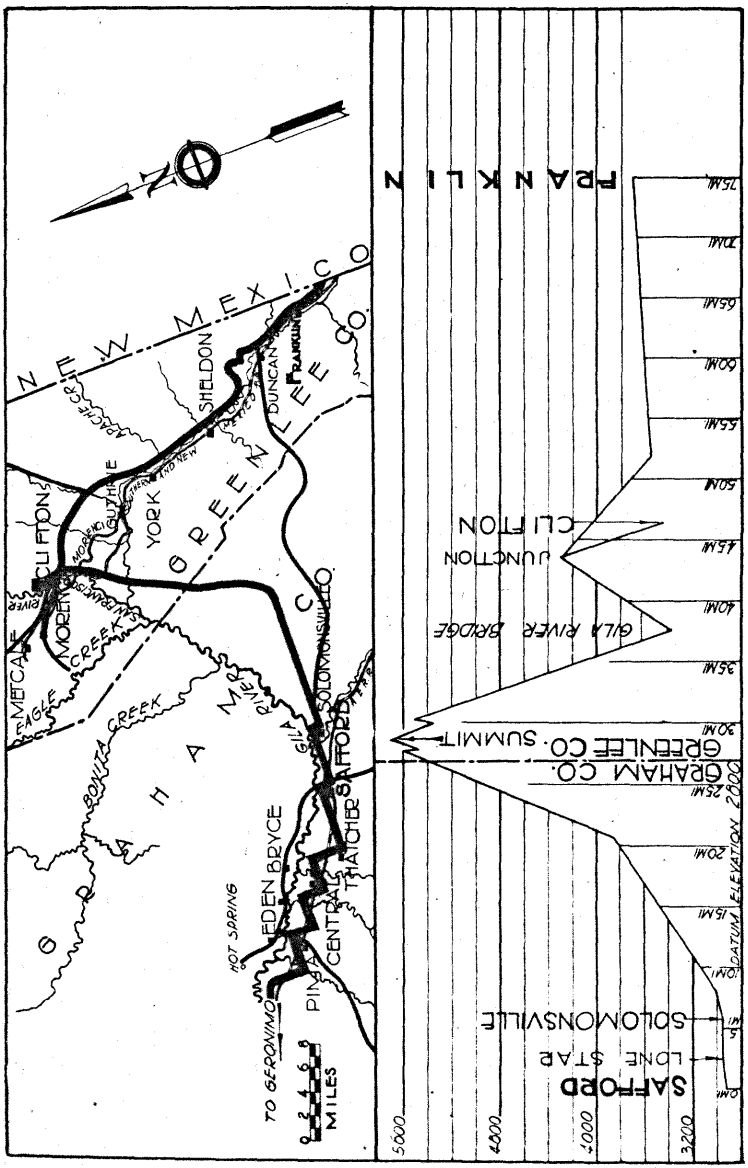
Map No. 2 YUMA-PHOENIX



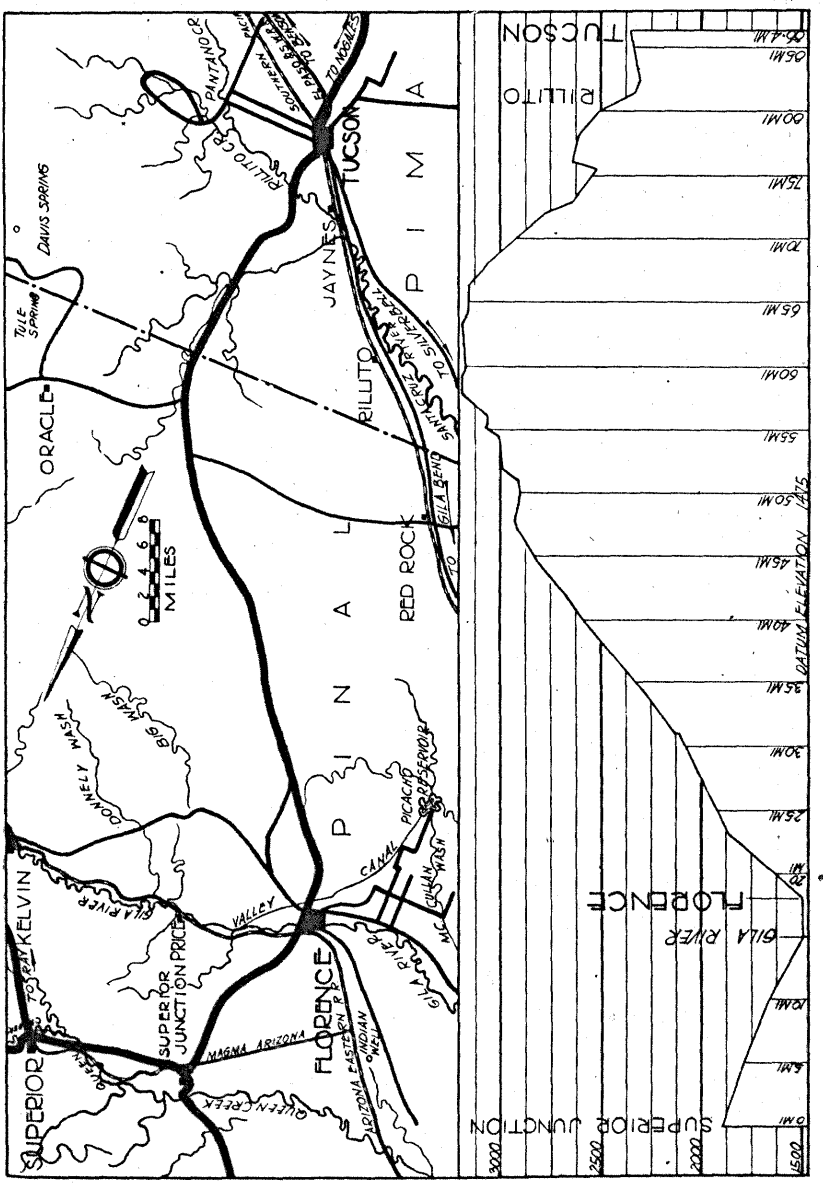
Map No. 3 PHOENIX-SUPERIOR-MIAMI-GLOBE



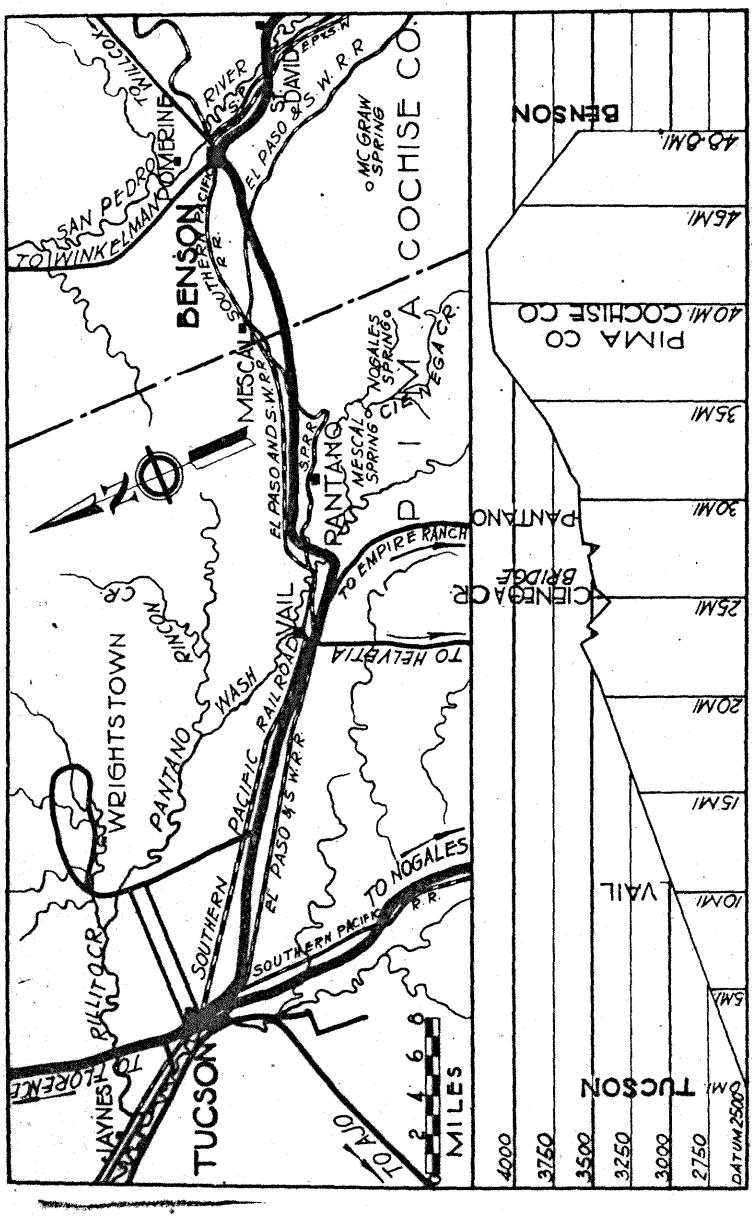
Map No. 4 GLOBE-SAFFORD



Map No. 5 SAFFORD-CLIFTON-FRANKLIN

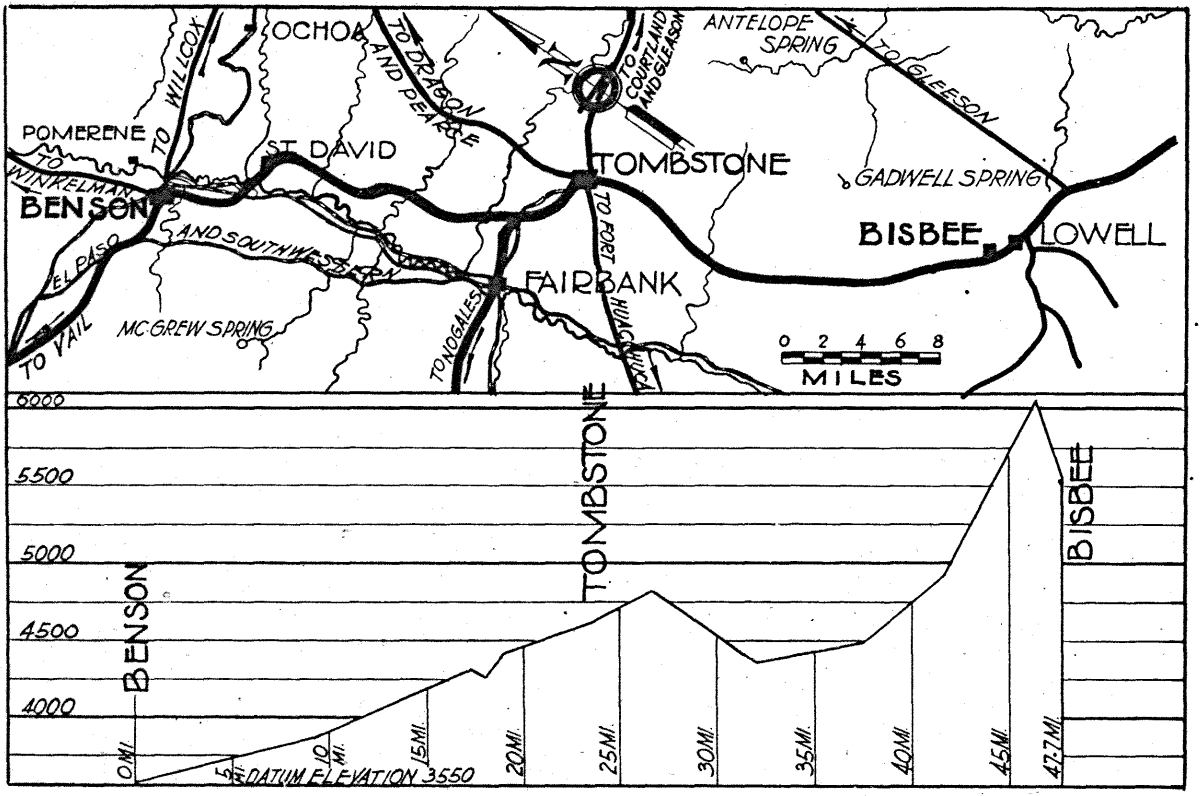


Map No. 6 JUNCTION-FLORENCE-TUCSON

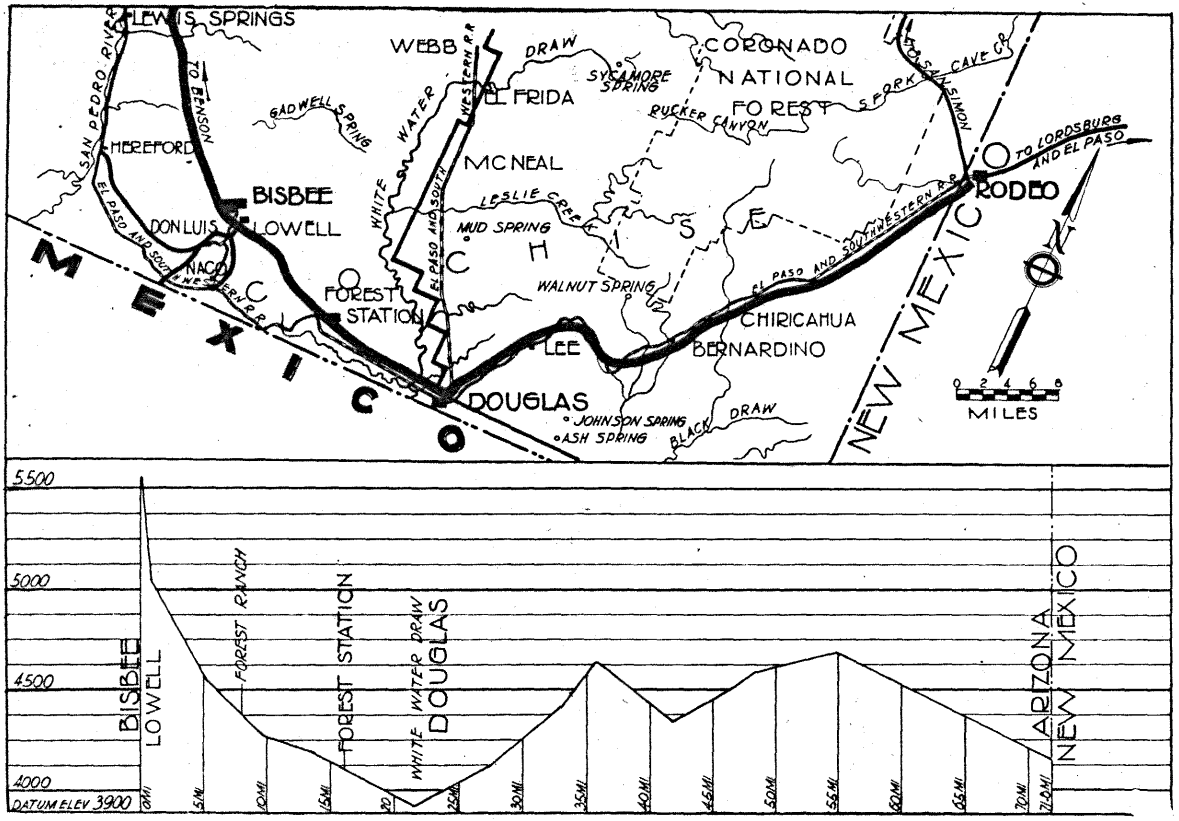


TUCSON-BENSON

Map No. 7

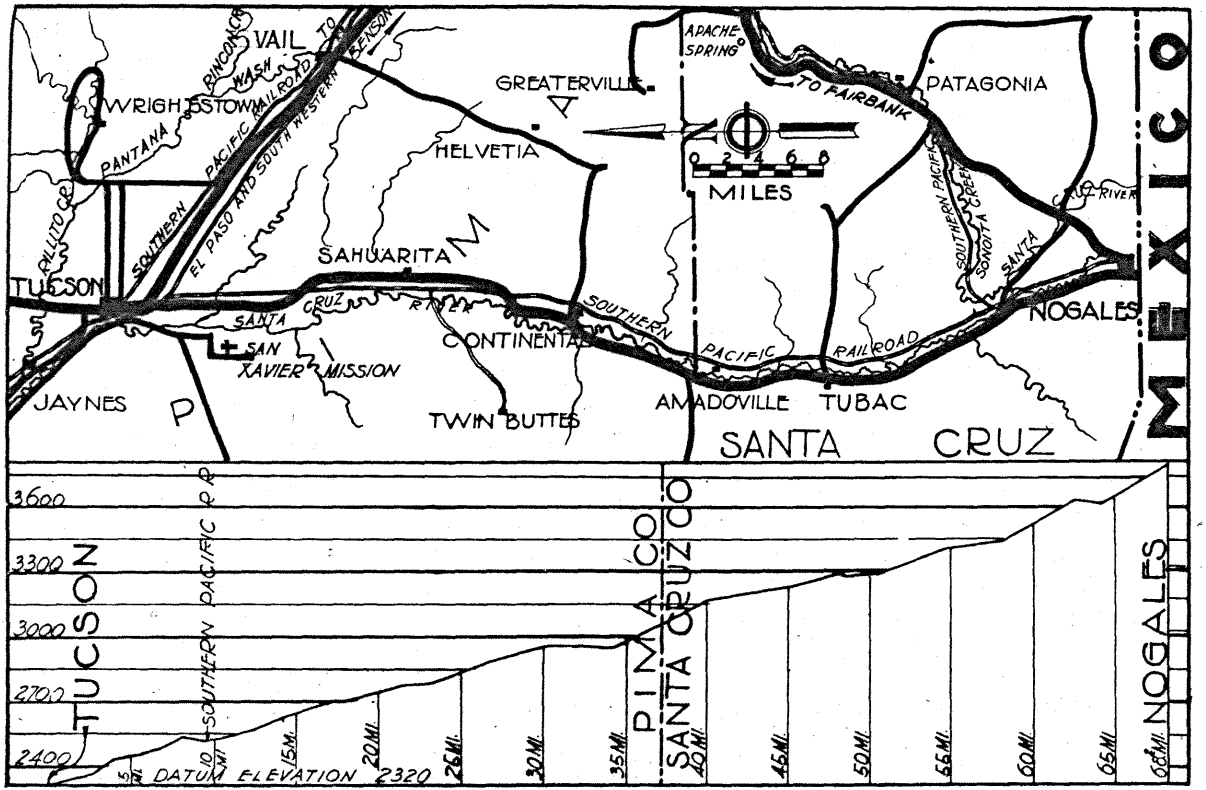


Map No. 8 BENSON-TOMBSTONE-BISBEE

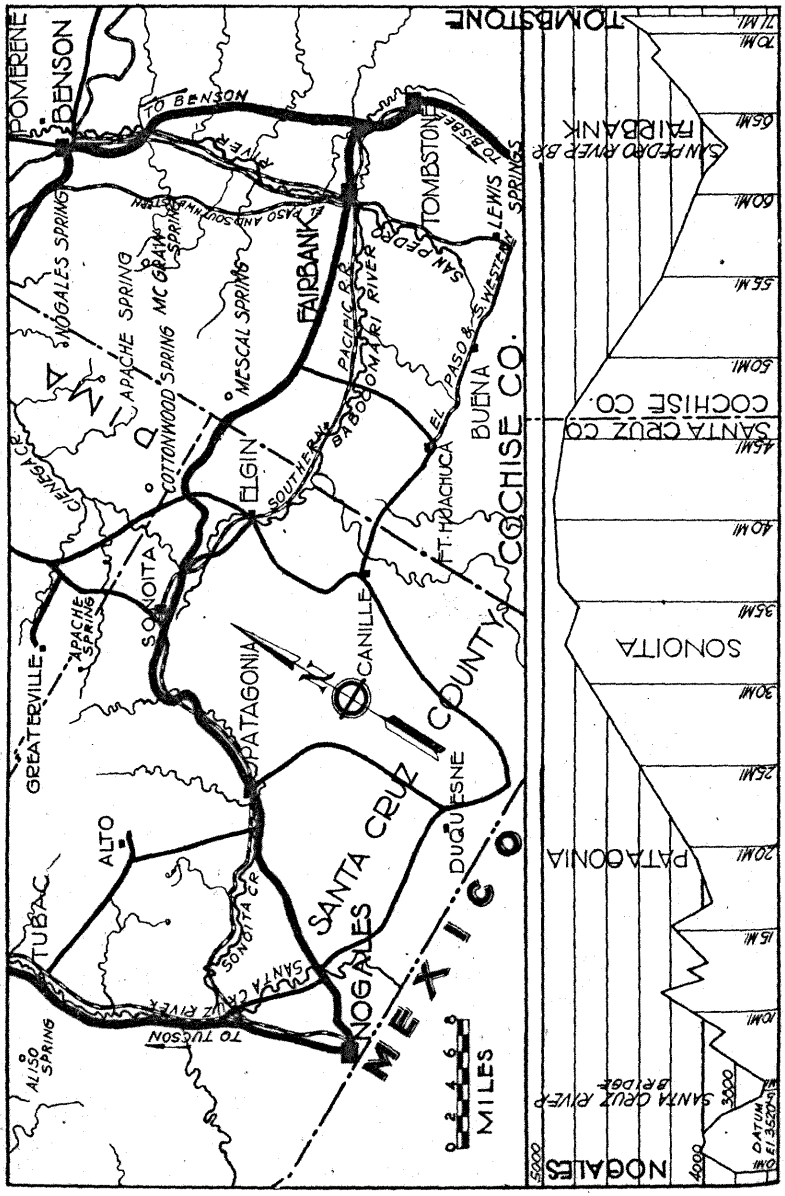


Map No. 9

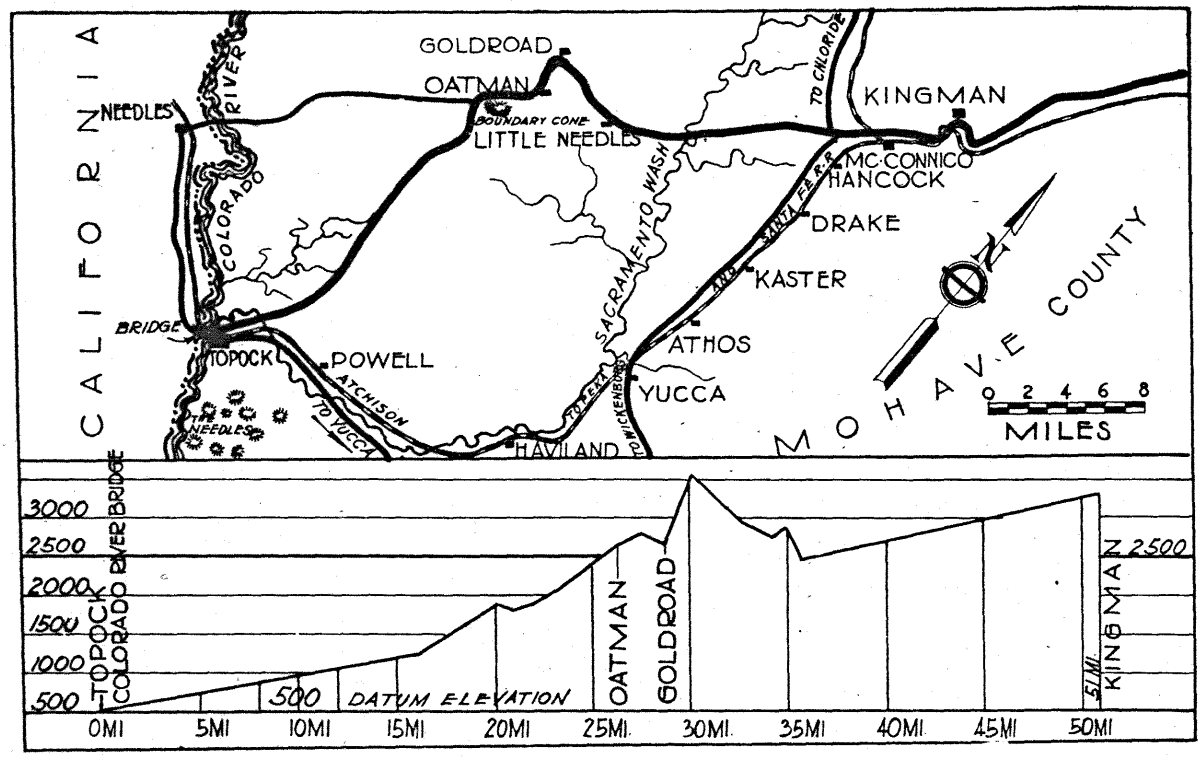
BISBEE-DOUGLAS-RODEO



Map No. 10 TUCSON-NOGALES

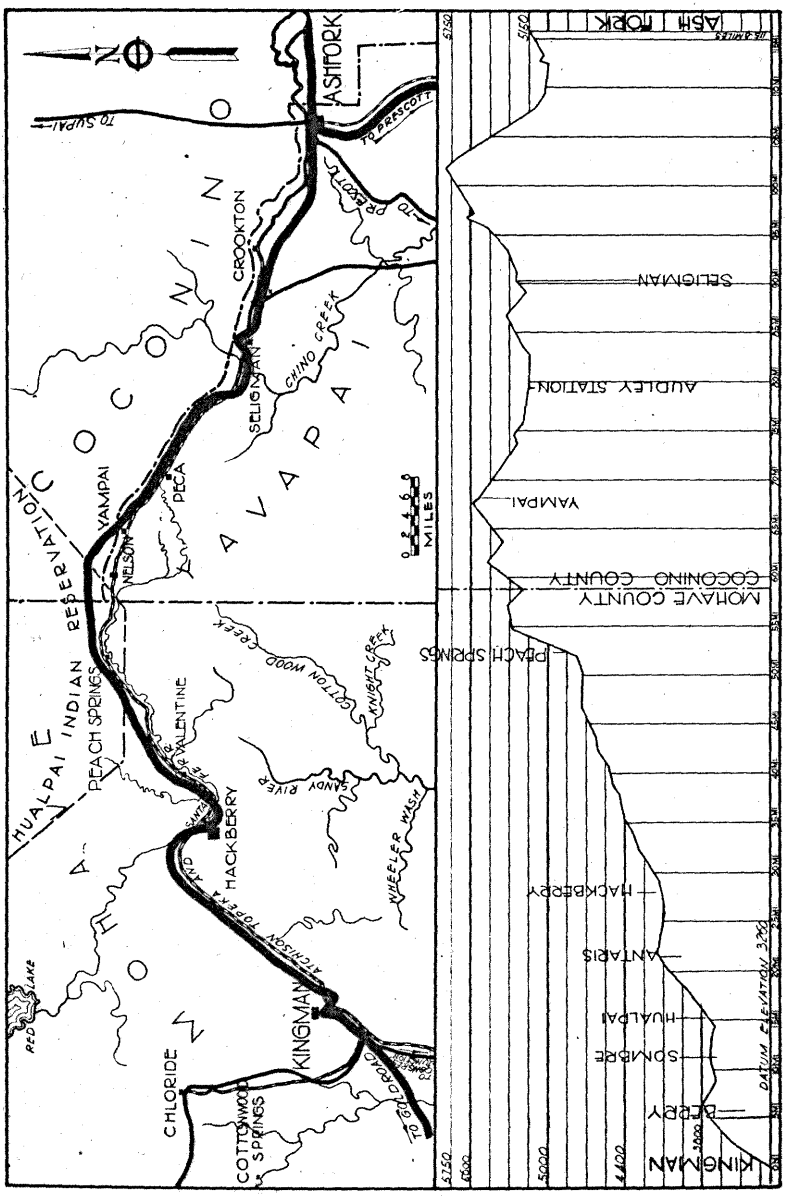


Map No. 11 TOMBSTONE-NOGALES

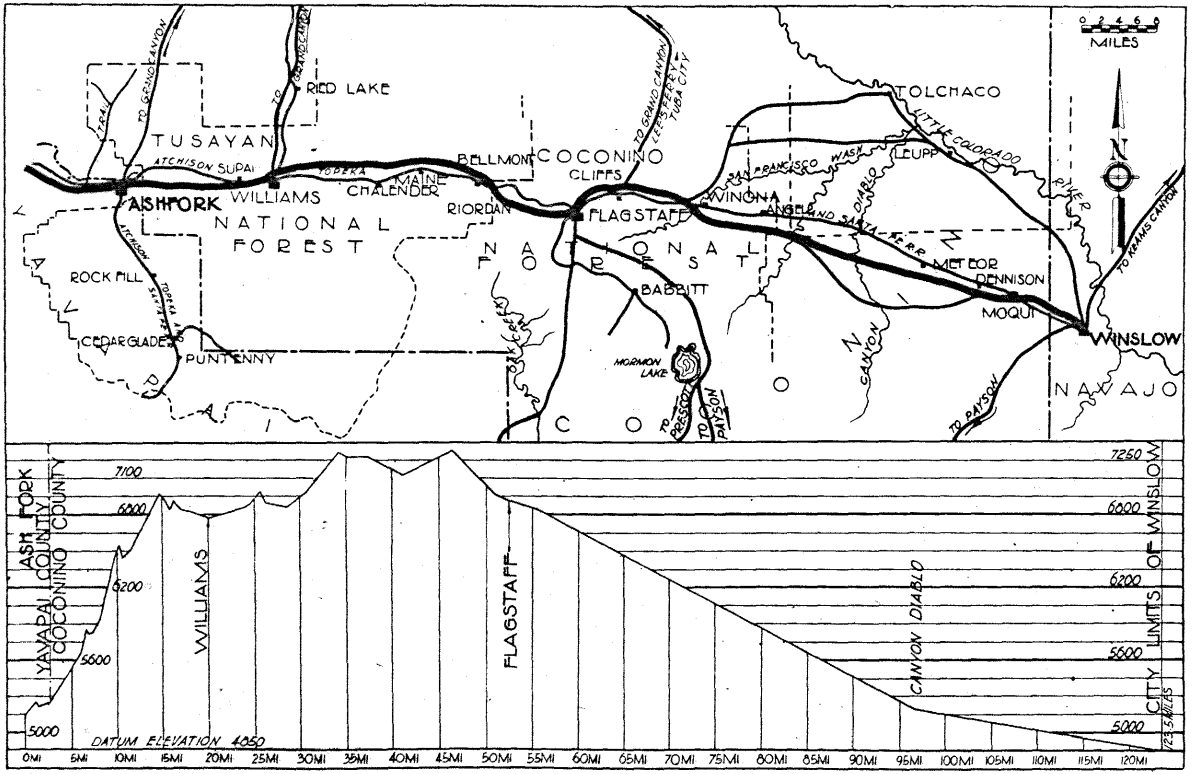


Map No. 12

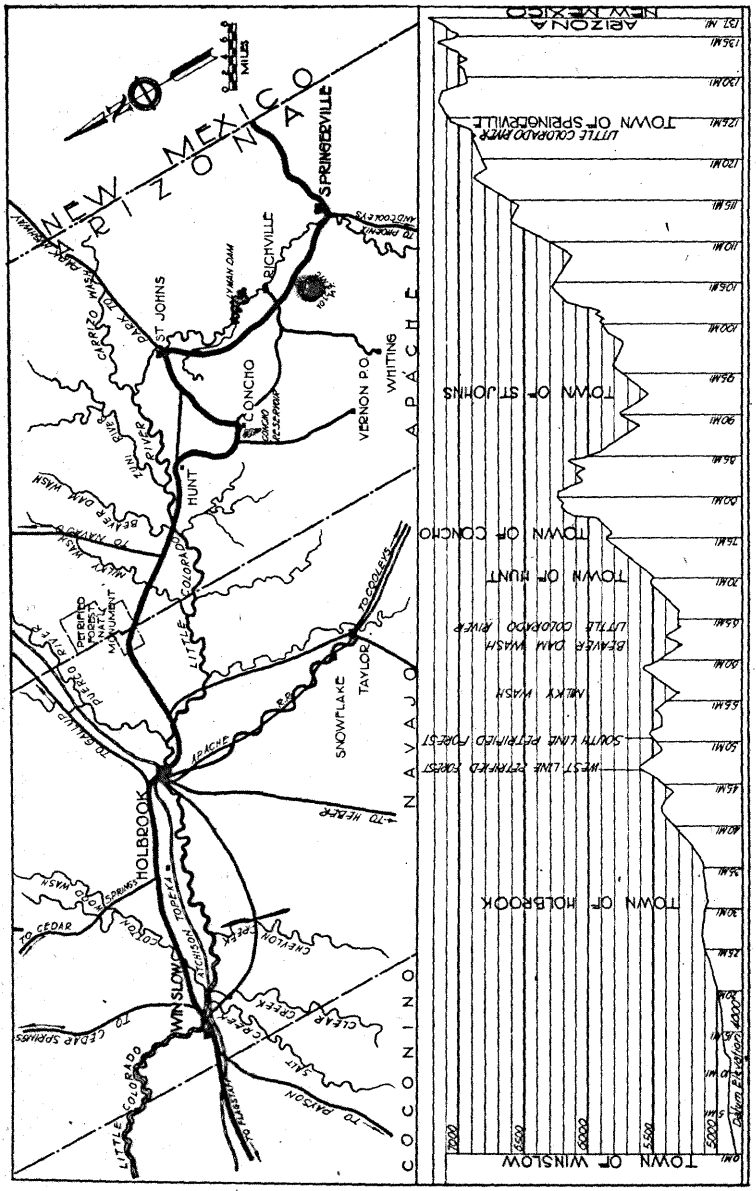
TOPOCK-KINGMAN



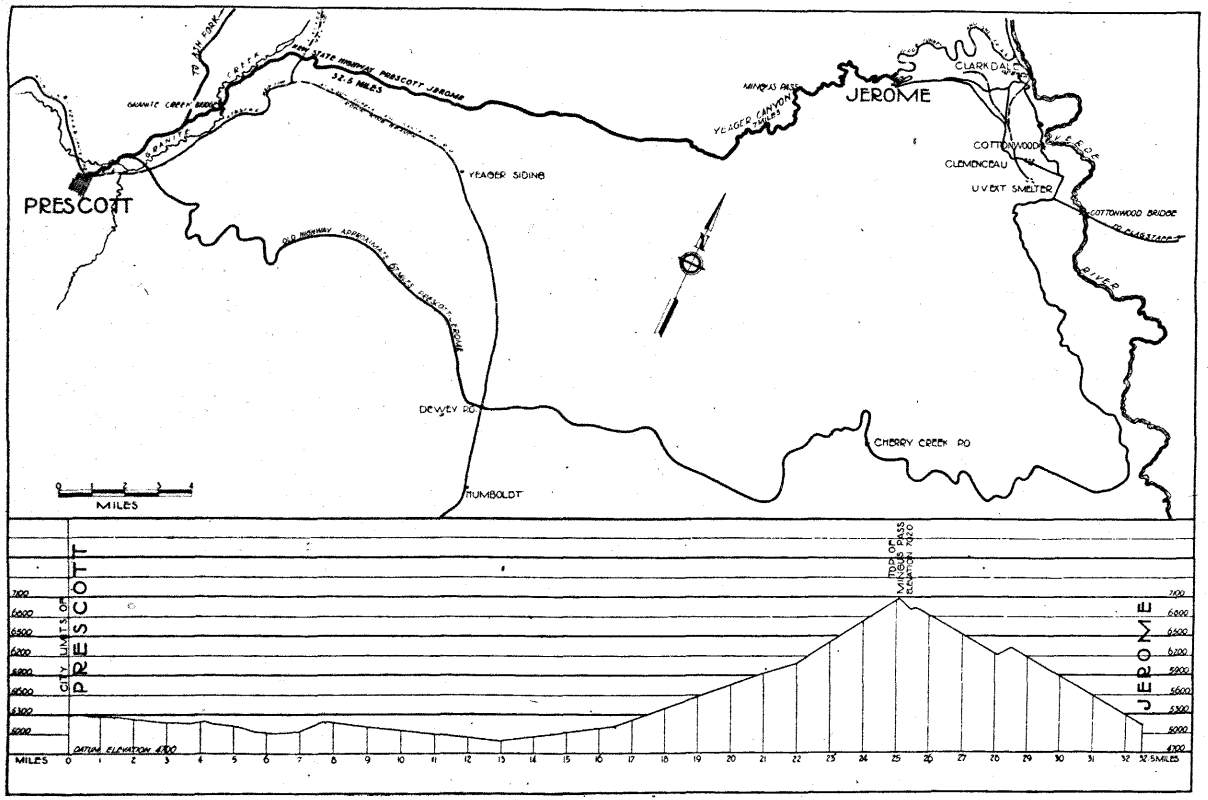
Map No. 13 KINGMAN-ASH FORK



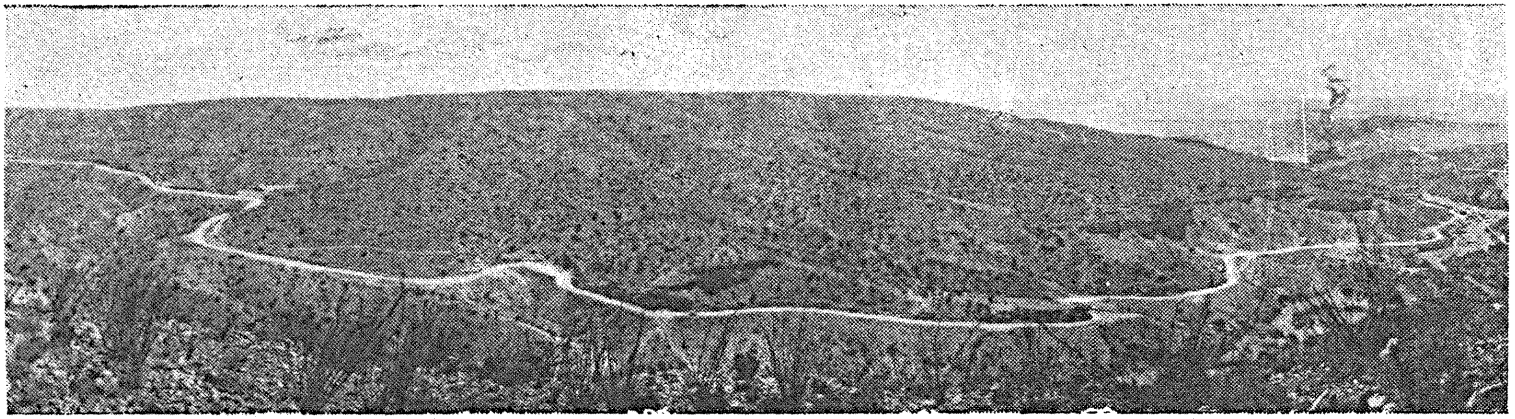
Map No. 14 ASH FORK-WINSLOW


NEW MEXICO
ARIZONA
SPRINGERVILLE
RICHVILLE
ST JOHNS
CONCHO
VERNON P.O.
WHITING
HUNT
HOLBROOK
WINSLOW
SNOWFLAKE
TAYLOR
PETRIFIED FOREST NAT'L MONUMENT
APACHE
NAVAJO
COCONINO
TOWN OF SPRINGERVILLE
TOWN OF ST JOHNS
TOWN OF CONCHO
TOWN OF HUNT
TOWN OF HOLBROOK
TOWN OF WINSLOW
WINSLOW-SPRINGERVILLE-STATE LINE

Map No. 15



Map No. 16 PRESCOTT-JEROME



BIRDS-EYE VIEW OF CLIFTON-FRANKLIN HIGHWAY IN WARD'S CANYON—FEDERAL AID PROJECT NO. 13

REPORT OF ACCOUNTING DEPARTMENT

By W. R. INGHRAM, *Chief Clerk*

The Accounting Department, under the direct supervision of the Chief Clerk, is divided into branches, namely—Purchasing, Claim, Equipment and Auditing.

With the growth of the Arizona Highway Department, the Accounting System has been improved to meet present requirements.

In State Construction Camps, cost accounting records are kept. This is necessary to get segregation of costs. As the system used in construction camps requires study, we have adopted the policy of first using men in the capacity of timekeeper and student bookkeeper. With this plan, the department is, at all times prepared to fill vacancies from its employees. With the report system as used by Construction Camps, the General Office is in close touch with all projects. Camp records are opened and audited by the Traveling Auditor.

Contract Payments

Contract payments are based on 90% of monthly estimates. On acceptance of completed contract, final payment is made in compliance with provision of contract. Extra work in connection with contracts, is based on cost plus ten per cent.

Salaries and Wages

Payrolls are prepared semi-monthly. On receipt by the General Office, they are paid from the State Engineer's Imprest Fund.

Traveling Expense

Traveling expenses are allowed employees. Such expense is limited to actual travel and living while outside Phoenix, or such other point as employee may have as his residence.

Purchases

As far as possible, all purchases are made thru the Purchasing Branch of the Department. The authority of engineers in charge of

parties and those in charge of camps being limited to emergency purchases made necessary to avoid delay to the work.

The Purchasing Branch keeps posted as to quotations and by grouping the purchases for projects, gets the best values at all times. Purchases are made by requisition, which are made in quadruplicate. The original is sent to the vendor, duplicate and triplicate are sent to receiving project and the fourth copy is kept on file in the Purchasing Branch after being registered.

Invoices

Invoices are requested in triplicate or quadruplicate, depending on the fund from which payment will be made. Invoices are first passed through the purchasing Branch where they are entered against requisitions, they are then entered in invoice register under vendors' name and forwarded to receiving project for approval and entry in field records.

Funds

The State Road Tax Fund for the last two years was approximately the same as the two years previous; the total money expended was approximately three times as much. To accomplish this it has been necessary to borrow from different funds available for this Department and from the Boards of Supervisors and County Highway Commissions, while awaiting receipt of Federal Aid. This has caused much extra work in our Accounting Department.

Red Tape

The following is given as an example of the time and detail involved in paying a claim from the 75% Fund:

Mr. John Doe who is engineer or general foreman in charge of a construction camp, needs some material to repair a piece of damaged equipment. He issues a requisition for the purchase of the necessary material from a nearby store conducted by John Smith, and the material is secured. John Smith makes out four bills and sends them to John Doe. John Doe approves the bill, makes a record in his books and sends the bill to the State Engineer at Phoenix.

The Chief Clerk at the State Engineer's Office has the claim put in proper shape, approved by the State Engineer and sends it to the Board of Supervisors of the County in which the work is being done, for their approval. The bill is kept there, awaiting a meeting of the Board which may not occur for a month. When the Board meets, the chairman or clerk signs on the dotted line provided for the purpose

and returns the bill to the State Engineer. The Chief Clerk makes a record of approval by the Board of Supervisors and sends it to the Board of Directors of State Institutions for approval. The claim is examined there computations checked, the Secretary signs on another dotted line provided for that purpose, a record is made and the claim is then sent to the State Auditor. The Auditor's Office examines it, checks the computations and issues a warrant. The warrant is then sent to the Governor for his signature. After it is signed by the Governor, it is returned to the Auditor who, in turn, sends it to the Board of Directors of State Institutions,where a record is made. It is then transmitted to the State Engineer, who sends it to John Smith who receives it from 30 to 90 days from the date of presenting the bill.

Recommendation

The steps outlined were undoubtedly intended to be a check on all transactions but as a matter of fact they are not. The approval by the Board of Supervisors and the Board of Directors of State Institutions is purely a matter of form and only adds to the time required to pay bills. A bill legitimately incurred must be paid. The only safe guard against unnecessary expenditures is the limitation of authority to make purchases. Authority to make purchases in this Department is limited to the Purchasing Agent for ordinary purposes and to the engineer or general foreman for emergency purposes. The check of the Auditor should be sufficient to eliminate errors. Irregularities or dishonesty can be guarded against by giving the State Auditor or State Examiner authority to examine the records of the Highway Department. We, therefore, recommend that legislation be enacted providing for the payment of claims against the Highway Department when same have been approved by the State Engineer and State Auditor and extending the authority of the State Auditor or State Examiner to make an examination of the records of the State Engineer at any time as now provided in the examination of county officials.

TABLE SHOWING ACTUAL DISBURSEMENTS PLUS CLAIMS APPROVED BUT NOT PAID FOR THE PERIOD JAN. 1, 1919, TO NOV. 30, 1920

Project	Fund	Constr.	Eng.	Maint.	Total	Total All Funds	Total For County
APACHE COUNTY—							
Holbrook-Lupton (Survey)	25		$ 2,973.93		$ 2,973.93	$ 2,973.93	
Holbrook-St. Johns	25	$ 18.00	4,973.05	$ 121.10	5,112.15		
	75	3,804.49		2,850.60	6,655.09	11,767.24	
St. Johns-N. Mex. Line (Survey)	25		1,907.88		1,907.88	1,907.88	$ 16,649.05
COCHISE COUNTY—							
Benson-Cochise	25		$ 117.59		$ 117.59		
	75		1,428.43		1,428.43	1,546.02	
Benson-Vail—Sec. D	25		2,130.71		2,130.71		
	75	$ 17,869.40	2,451.24		20,320.64	22,451.35	
Benson-Vail—Sec. E	25	19,138.97	3,524.79		22,663.76		
	75		1,920.23		1,920.23	24,583.99	
Bisbee-Douglas—Secs. A & B	25	13,399.78	1,540.85	17.10	14,957.73		
	75	254,082.71	5,874.69	404.51	260,361.91	275,319.64	
Bisbee-Tombstone	25		649.00	6,969.92	7,618.92		
	75		962.92	7,126.91	8,089.83		
Bisbee-Tombstone (Emerald Gulch Bridge	75	17,375.19			17,375.19	33,083.94	
Douglas-Rodeo—Sec A.	25	40,655.72	2,848.56		43,504.28	43,504.28	
Douglas-Rodeo—Sec. C	25	12,994.71	346.44	456.00	13,797.15		
	75	6,545.32	1,897.14		8,442.46	22,239.61	
Douglas-Rodeo—Sec. 2	25		17.20		17.20		
	75	7,438.45	2,103.11		9,541.56	9,558.76	
Nogales-Fairbank	25		1,710.81		1,710.81	1,710.81	
Tombstone-Fairbank	25	128.00	1,509.28	53.98	1,691.26		
	75	66,228.54	5,244.49		71,473.03	73,164.29	$ 507,162.69
COCONINO COUNTY—							
Flagstaff-Williams	25		$ 1,996.17	$ 2,579.33	$ 4,575.50		
	75	$ 40,060.09	1,458.50	3,403.29	44,921.88	49,497.38	
Flagstaff-Williams—Secs. A & B.	25	43,630.24	1,209.89		44,840.13	44,840.13	
Flagstaff-Winslow	25	7,517.85	1,654.71	39.91	9,212.47	9,212.47	
Williams-Ashfork	25		2,755.05		2,755.05		
	75		430.55		430.55	3,186.60	
Williams-Clarkdale Specific	Appr.		12,726.37		12,725.37		
	25		21.95		21.95	12,747.32	$ 119,452.90
GILA COUNTY—							
Globe-Geronimo	25	$ 20,214.45	$ 8,462.86		$ 28,677.31		
	75	192,925.07	4,646.24	$ 1,495.37	199,076.68	$ 227,753.99	
Globe-Ray	25		59.26		59.26	59.26	
Globe-Roosevelt	25		7,029.77	2,308.05	9,337.82		
	75	31,491.98	3,556.03	17,543.35	52,591.36	61,929.18	
Superior-Miami—Sec. F	25		344.43		344.43		
	75	31,889.07	2,051.82		33,940.89	34,285.32	
Superior-Miami Survey	25		2,664.63		2,664.63	2,664.63	$ 326,692.38
GRAHAM COUNTY—							
Clifton-Solomonville	25	$ 27,919.73	$ [illegible]		$ 29,341.23		
	75			$ 671.15	671.15	30,012.38	
Geronimo-Solomonville	25	33.09	662.45	73.48	769.02		
	75	13,597.98	1,314.19	3,720.31	18,632.48	19,401.50	
Globe-Geronimo—Sec. D	25	15,342.99	2,250.43		17,593.42		
	75	6,671.77	1,765.35	354.25	8,791.37	26,384.79	
San Carlos Bridge Specific	Appr.	10,752.99	3,143.15		13,896.14		
	25		5.63		5.63	13,901.77	$ 89,700.44
GREENLEE COUNTY—							
Clifton-Franklin—Contact No. 1 Highway	Comm.	$ 65,248.08	$ 5,428.86		$ 70,676.94		
	25	125.35	209.55		334.90	71,011.84	
	Hwy. Com.	17,987.73	2,787.08		20,774.81		
Clifton-Franklin—Cont. No. 2	25	18,232.11	641.18		18,873.29	39,648.10	
Clifton-Franklin—Cont. No. 3	25	1,170.92	112.13		1,283.05	1,283.05	
Clifton-Solomonville Spec.	App.	23,930.45	157.26		24,087.71		
	25	41,458.88	3,316.46	$ 2,408.44	47,183.78		
	75	48,243.54	231.57	6,173.63	54,648.74	125,920.23	
Clifton-Solomonville—Sec. 2-A Spec.	App.	13,103.20	699.22		13,802.42	13,802.42	$ 251,665.64
MARICOPA COUNTY—							
Agua Fria Bridge (Includes approaches) Spe	App.	$ 64,109.69			$ 64,109.69		
	25	5,095.84	$ 255.97	$ 7,837.94	13,189.75		
	75	17,380.43		1,552.03	18,932.46	96,231.90	
Arlington Bridge	75	428.37			428.37	428.37	
Arlington-Caliente	25		5,594.13	101.67	5,695.80		
	75		407.37		407.37	6,103.17	
Marinette Bridge	25	16,964.38	18.00		16,982.38		
	75	52,055.79	2,205.81		54,261.60	71,243.98	
Mesa-Florence (Higley Route)	25		83.82		83.82		
	75			56.00	56.00	139.82	
Phoenix-Glendale	25		803.93	1,346.68	2,150.61		
	75		275.00	214.32	489.32	2,639.93	
Phoenix-Tempe—Sec. 1	25		744.73	1,227.33	1,972.06		
	75			2,154.39	2,154.39	4,126.45	
Phoenix-Tempe (Paving)	25	57,576.74	1,247.07		58,823.81		
	75	71,884.87	425.19	454.76	72,764.82	131,588.63	
Tempe Bridge Repairs Spec.	App.	70,360.08	496.21		70,856.29	70,856.29	
Tempe-Mesa—Sec. 1 (Paving)	25	44,384.70	6,265.20		50,649.90		
	75	995.86	44.81		1,040.67	51,690.57	
Tempe-Mesa—Sec. 2 (Paving)	25	61,771.15	3,728.14		65,499.29		
	75	116,630.86	333.38		116,964.24	182,463.53	
Wickenburg Bridge	25		125.48		125.48	125.48	$ 617,648.12
MOHAVE COUNTY—							
Arrowhead Trail—Sec. 1 Spec.	App.	$ 12,757.76	$ 21,794.04		$ 34,551.80		
	25		4,102.62		4,102.62		
	75		137.90		137.90	38,792.32	
Arrowhead Trail—Sec. 2 Spec.	App.		15,515.79		15,515.79		
	25		203.87		203.87	15,719.66	
Kingman-Goldroads	25		1,101.85	$ 1,171.53	2,273.38		
	75			1,738.12	1,738.12	4,011.50	
Nelson-Kingman	25		3,397.70		3,397.70		
	75		25.15		25.15	3,422.85	
Oatman-Goldroads	25		3,404.82	17.24	3,422.06		
	75	29,012.87	2,767.16	1,495.51	33,275.54	36,697.60	
Topock Bridge	75			482.68	482.68	482.68	
Topock-Oatman	25		6,521.67		6,521.67		
	75		687.99		687.99	7,209.66	$ 104,336.27
NAVAJO COUNTY—							
Holbrook-St. Johns	25			$ 40.00	$ 40.00		
	75			848.40	848.40	$ 888.40	
Holbrook-St. Johns—Sec. 3 (Petrified F Forest)	25	$ 12.00	$ 3,233.42		3,245.42		
	75	16,142.74	1,729.88		17,872.62	21,118.04	
Holbrook-Winslow	25		478.39	2.70	481.09		
	75		[illegible]	67.00	1,331.54	1,812.63	$ 23,819.07
PIMA COUNTY—							
Benson-Vail—Secs. A & B	25	$ 84,174.79	$ 1,683.52	$ 299.53	$ 86,157.84		
	75	10.72	3,433.26	1,117.26	4,560.64	$ 90,718.48	
Benson-Vail—Sec. C	25	7,320.40	667.37		7,987.77		
	75	2,152.00	8.00		2,160.00	10,147.77	
Benson-Vail—Sec. F (Cienega Bridge)	25	13,025.56	752.43		13,777.99	13,777.99	
Tucson-Florence—Sec. 1	25			3,859.23	3,859.23		
	75			6,178.68	6,178.68	10,037.91	
Tucson-Florence (Paving)	25	94,553.09	7,594.41		102,147.50		
	75	44,229.76	3,810.38		48,040.14	150,187.64	
Tucson-Nogales	25			568.25	568.25		
	75	71.93	144.40	6,209.00	6,425.33	6,993.58	
Tucson-Nogales (Continental Bridge)	25	3,479.58	282.83		3,762.41		
	75	2,606.78	254.40	124.00	2,985.18	7,747.59	
Tucson-Nogales (Paving)	25	1,055.22	254.65		1,309.87	1,309.87	
Tucson-Vail	25			1,591.38	1,591.38		
	75			5,754.45	5,754.45	7,345.83	
Vail-Empire Ranch	25	162,704.74	2,149.24		164,853.98		
	75	35,094.30	108.15		35,202.45	200,056.43	$ 498,319.08
PINAL COUNTY—							
Florence Bridge (Approaches and Extension)	25	$ 4,067.29	$ 605.98	$ 839.02	$ 5,512.29		
	75	17,907.51		1,136.76	19,044.27	$ 24,556.56	
Florence-Superior—Secs. A, B, C	25	49,830.60	4,933.84		54,764.44		
	75	43,615.63	13.81		43,629.44	98,393.88	
Florence-Superior—Sec. D (Ryan Contract)	25	1,482.96	1,820.12		3,303.08		
	Hwy. Com.	56,629.68			56,629.68	59,932.76	
Florence-Superior—Sec. E (Queen Creek Bridge)	25	649.04	110.29		759.33		
	Hwy. Com.	10,793.88			10,793.88	11,553.21	
Florence-Superior—Sec. F.	25		966.67		966.67	966.67	
Tucson-Florence	25		4,687.90	2,179.04	6,866.94		
	75			1,030.79	1,030.79	7,897.73	
Mesa-Florence (Higley Route)	25			1,101.56	1,101.56		
	75			423.12	423.12	1,524.68	
Mesa-Superior—Sec. 2-A	25	8,652.15	1,873.06	2,015.22	12,540.43		
	75		145.00		145.00	12,685.43	
Mesa-Superior—Sec. 2-B	25	93,585.96	5,540.09		99,126.05		
	75	83,355.65	9.60		83,365.25	182,491.30	
Mesa-Superior (Queen Creek Bridge)	25	15,434.52	714.77		16,149.29		
	75	1,034.17			1,034.17	17,183.46	
Ray-Superior	25		26.57		26.57	26.57	
Superior-Miami Spec.	App.	97,907.02	1,532.79		99,439.81		
	25	223,008.97	13,266.64		236,275.61		
	75	8,478.31	254.40		8,732.71	344,448.13	$ 781,666.28
SANTA CRUZ COUNTY—							
Canoa Wash Bridge	25	$ 429.10			$ 429.10	$ 429.10	
Nogales-Fairbank	25		$ 4,043.82		4,043.82		
	75		68.75	$ [illegible]	[illegible]	4,199.03	
Sopori Wash Bridge	25	961.32			961.32	961.32	
Tucson-Nogales	25			[illegible]	[illegible]		
	75		30.00	[illegible]	[illegible]	[illegible]	
Vail-Sonoita	25		1,024.77		1,024.77	1,024.77	$ [illegible]
YAVAPAI COUNTY—							
Ashfork-Nelson	25		$ 4,027.64		$ 4,027.64		
	75		307.03		307.03	$ 4,334.67	
Cottonwood Bridge	25	$ 24,665.09	1,369.78	$ 14.70	26,049.57		
	75	13,430.64	862.85		14,293.49	40,343.16	
Phoenix-Prescott (Senator Mt. Division)	25			1,276.82	1,276.82		
	75			3,169.29	3,169.29	4,446.11	
Prescott-Flagstaff	25		131.16	1,025.00	1,156.16		
	75			4,343.28	4,343.28	5,499.44	
Prescott-Jerome	25	190,677.70	16,736.37		207,414.07		
	75	375,120.79	10,556.07		385,676.86	[illegible]	$ [illegible]
YUMA COUNTY—							
Welton-Maricopa Co. Line	25		$ 1,366.29		$ 1,366.29		
	75		263.15		263.15	$ 1,629.44	
Yuma-Welton	25	$ 30,189.33	6,241.87		36,431.20		
	75	43,999.66			43,999.66	79,430.86	
Antelope Hill Bridge	25	[illegible]	257.01		[illegible]	[illegible]	$ [illegible]
Grand Total All Counties		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

NOTE—Engineering includes costs of Supervision, Inspection, and Tests of Materials. Engineering costs are shown for projects on which construction work has not started.
Maintenance includes costs of minor improvements and betterments handled by maintenance forces.

GENERAL OR INDIRECT CHARGES

Item	General Account	Amount	General	S. R. T. Funds	Total
State Engineer's Salary	State Engineer's Salary	$ 5,750.00			
State Engineer's Expense	State Engineer's Expense	4,747.71	$ 10,497.71		$ 10,497.71
State and Federal Equipment	General Equipment and Repair*	172,261.03		172,261.03	
U. S. Govt. Shipping Charges	Federal Equipment	9,498.65			
Freight	" "	94,276.34			
Labor	" "	4,550.33			
Expense	" "	1,872.91			
Storage	" "	820.36		111,018.59	
Storage Yard	Property and Improvements	12,324.10			
Buildings	" " "	52,311.87		64,635.97	
Engineering Office Salaries	Expense General Office	89,817.95			
Accounting Office Salaries	" " "	49,882.28			
Engineering Office Supp. & Exp.	" " "	21,547.08			
Accounting Office Supp. & Exp.	" " "	8,044.01		169,291.32	
Expense	General Expense	7,758.89			
Bonds	" "	2,659.79			
Storage and Rent of Equipment	" "	2,905.58			
Legal Expense	" "	260.20		13,584.46	
Plant and Production	Screening Plant	21,116.62		21,116.62	$ 552,207.99
		$ [illegible]	$ [illegible]	$ [illegible]	$ [illegible]

*Includes Equipment Purchased and Repairs to State and Federal Equipment.

Grand Total allocated to all projects in all Counties	[illegible]
Grand Total General or Indirect Charges	[illegible]
Grand Total All Disbursements	$ [illegible]

ARIZONA HIGHWAY DEPARTMENT

Financial Statement for the Period January 1st, 1919, Ending November 30th, 1920

	Total	S. E. Salary	S. E. Expense	Gila Bridge Greenlee	Williams-Clarkdale	Arrowhead Trail	San Carlos Bridge	Agua Fria Bridge	Tempe Bridge	Parker Colo. River Bridge	Arrowhead Colo. River Bridge	Sacaton Power Line	Lee's Ferry	Oak Creek Bridge	Superior-Miami	Prison	S. R. T. Fund General	Apache	Cochise	Coconino	Gila	Graham	Greenlee	Maricopa	Mohave	Navajo	Pima	Pinal	Santa Cruz	Yavapai	Yuma
Balance Forward January 1, 1919	$ 592,428.28	$ 1,600.00	$ 1,549.17	$ 30,875.58													3,530.47	$ 12,429.52	$114,658.42	$ 8.91*	$ 73,977.07	$ 13,893.70	$ 35,606.82	$ 68,318.49	$ 441.24	$ 4,871.59	$ 41,956.80	$ 5,235.20	$ 1,193.21	$160,730.97	$ 14,129.02
Tax Apportionment 1919-20	915,224.72															$ 60,000.00	211,596.18	5,467.96	159,196.65	15,667.31	121,719.88	10,674.83	32,353.90	75,488.09	17,402.78	6,858.56	48,402.37	51,802.89	8,486.35	100,562.83	14,916.40
Tax Apportionment 1920-21	948,443.18															60,000.00	221,119.78	7,037.55	132,029.91	17,126.57	116,332.56	10,432.11	31,475.39	100,684.91	17,519.65	9,265.65	47,773.13	55,331.16	9,586.06	97,533.32	17,502.90
State Engineer's Salary and Expense	11,000.00	6,000.00	5,000.00																											
Appropriations Sessions 1919	592,871.42				$ 27,871.42	$ 50,000.00	$ 65,000.00										200,000.00													
Emergency Appropriations	140,000.00							$ 65,000.00	$ 75,000.00																					
Motor Vehicle Fees	353,283.95									$ 30,000.00	$ 40,000.00	$ 50,000.00	$ 10,000.00	$ 10,000.00	$100,000.00		353,283.95													
Federal Aid	572,739.90																847,823.29													
Bonds	393,725.70				259.72			2,474.82								33,502.33	215,783.74		912.41	12,271.99	8,599.55		52.56	3,716.14	983.71	138.54	902.35	8,709.38	8,018.54	
Advances	93,459.72																22,469.73				15,000.00			20,000.00					40,000.00	
Total Revenue	4,816,260.88	7,600.00	6,549.17	30,875.58	28,131.14	50,000.00	65,000.00	67,474.82	75,000.00	30,000.00	40,000.00	50,000.00	10,000.00	10,000.00	100,000.00	153,502.33	1,883,356.17	25,935.03	378,716.40	45,054.37	226,429.00	34,391.64	100,095.21	259,635.95	39,347.38	22,134.34	138,941.74	123,578.74	19,265.92	406,997.86	46,547.32
Claims Paid	4,226,325.72	5,625.00	4,406.71	30,875.58	32,121.34	47,391.29	11,794.39	62,839.80	67,942.45						100,000.00	153,502.99	1,865,572.16	8,131.94	370,685.63	29,455.77	206,785.51	24,458.48	59,582.72*	265,796.45	35,576.89	20,357.66	121,953.34	122,551.73	12,240.13	404,859.96	46,148.14
Balance November 30th, 1920	589,934.16	1,975.00	2,142.46		25,000.00	2,699.71	53,205.61	4,635.02	7,057.55	30,000.00	40,000.00	50,000.00	10,000.00	10,000.00		1.34	17,783.99	17,803.11	31.57	5,003.10	20,234.49	9,933.16	40,511.49	14,039.06	770.49	1,776.68	16,988.39	27.01	6,025.79	47.88	94.18
																				*Overdrawn										

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