

Project Histories.
Arizona and New Mexico.
(NAVAJO RESERVATION)

ANETH.
BLACK FALLS.
BLUE CANYON.
CRYSTAL.
CHIN LEE.
FORT DEFIANCE.
GANADO.
HOGBACK CANAL.

by

H. F. Robinsen,
Superintendent of Irrigation.
Albuquerque, New Mexico.

1913.

Project Histories.

NAVAJO AND MOKI RESERVATIONS.

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1914.

P R E F A C E .

These project histories of the work done on the various Reservations in District No. 5, comprising Northern Arizona, New Mexico, Colorado and that part of Utah containing the Navajo Reservation, has been compiled from the records of this office, personal records and all available sources, and is supposed to give a concise history of all irrigation work planned, attempted and performed by the Indian Irrigation Service, as well as mention of that done by others, and the cost data is brought down to June 30, 1915.

Following the text will be found a tabulated statement of all money expended on that particular project in as far as the records of this office show, for with the exception of a few instances no records are available showing irrigation costs other than the expenditures of Superintendents of Irrigation J. B. Harper and H. F. Robinson.

The cost data has been prepared from the actual cash expenditures and include not only expenditures made direct on the work, but the salary, per diem and travelling expenses of the Superintendent of Irrigation have been charged, where possible, to the project visited or benefited by the work, and all other headquarter expenses have been prorated at the end of the quarter to all projects.

This is Volume 5 of the Histories, and covers all work on the Navajo and Moki Reservations.



Superintendent of Irrigation,
U. S. Indian Irrigation Service.

Albuquerque, N. M.,

May 25

1914.

Navajo and Moqui Indian Reservations.

The reservations of the Navajo and Moqui Indians, which are usually joined together when making appropriations for work, lie in a solid body in northeastern Arizona, northwestern New Mexico and southeastern Utah. Location. The eastern limit is the Range line between Ranges 13 and 14 west, of the New Mexico principal meridian. The western limit is the Colorado River, from the Utah line to the mouth of the Little Colorado, thence following the Little Colorado to the range line between Ranges 11 and 12 east, Gila and Salt River, base and meridian. The northern boundary is the San Juan River in Utah, and the boundary line between New Mexico and Colorado as far east as the Navajo meridian, thence the San Juan River again forms the northern boundary, north of Ranges 14, 15 and 16 west, of the New Mexico principal meridian.

There is also a considerable tract of land lying east of the Navajo Reservation, upon which are allotted various Indians under the jurisdiction of the Pueblo Bonito Superintendents, the limits of this area is somewhat indefinite.

Area. The report of the Commissioner of Indian Affairs for 1911, gives the area of the Navajo Reservation as 11,861,034 acres and of the Hopi Reservation, 2,472,320 acres.

Hopi
Reservation

The Hopi Reservation was set aside by executive

NAVAJO.



Navajo Summer Camp. Woman weaving blanket.

order Dec. 16, 1882, Act of March 1, 1907 (34 Stat.L. 1021) and the various treaties and executive orders setting aside the Navajo Reservation and modifying its boundaries are as follows:

Treaties.

Treaty of June 1, 1868, Vol. 15, p.667, and executive orders, Oct.29, 1878, June 6, 1880, two of May 17, 1884, April 24, 1886, Nov. 19, 1892.

1,679,600 acres in Arizona and 967,680 acres in Utah, were added to this reservation by executive order of May 17, 1884, and 64,080 acres in New Mexico restored to public domain but again reserved in executive orders, April 24, 1880, Jan.8, 1900 and Nov.14, 1901. Executive orders of Mar.10 and May 15, 1905, 61,523 acres were added to the reservation, and by executive order of Nov. 9, 1907, as amended by executive order of Jan.28, 1908, 2,972,160 acres were added. 2,064 Indians have been allotted 328,963 acres under the Act of Feb.8, 1887, (24 Stat.388) as amended. By executive order of Dec.31, 1908, and Jan.16, 1911, the surplus lands, approximating 1,641,180 acres in that part of New Mexico were restored to the public domain, (See 35 Stat.L.457 and 787) (See 1277-9) Act of May 27, 1902 (32 Stat.264) See also Executive Order Feb.19, 1912.

Elevation.

The elevation of this reservation runs from 4,000 feet to 9,000 feet on some of the mountain tops. There

is not sufficient data to give much information regarding the rainfall but from such records as are at hand, the following is taken:

Rainfall..

"Being far removed from the normal storm tracts; the character of the precipitation in the district under consideration is vastly more local than general, resulting mainly from the cold of elevation. Therefore at the higher levels, the process of condensation occurs more rapidly, giving out generous supplies of moisture, while in the lower valleys conditions of drouth prevail". "The average annual precipitation . . . in the Little Colorado valley . . . is about 12 inches . . . while on the mountains between the Colorado and the Little Colorado valleys the annual precipitation ranges from 18 to 27 inches, and is much greater at the higher elevations." "Fully 60% of the yearly precipitation is recorded during July, August and the first decade of September". "Evaporation over the region in question proceeds rapidly under the influence of cloudless skies, low relative humidity, gentle to moderate winds and varying atmospheric pressure." "Evaporation measurements made at Holbrook, Navajo County Arizona show: "For the Year 1906, 51.83 inches; 1907, 42.06; 1908, 49.70, annual average 47.86." (From Summary of the Climatological Data for the United States, by Sections. Sect.4).

The following rainfall data is from the same publication.

In Arizona	Elevation	Mean annual rainfall
Flagstaff, Coconino Co.	6,907 ft.	23.87 inches
Holbrook, Navajo Co.	5,069 "	8.99
Keams Canon, " "	3,326 "	12.37
Tuba, Coconino Co.	4,500 "	6.33
Winslow, Navajo Co.	4,853 "	7.04
St. Michaels, Apache Co.	6,950 "	13.60
In New Mexico.		
Fort Wingate, McKinley Co.	6,997 "	14.53
Fruitland, San Juan Co.	4,800 "	5.16
Manulita, McKinley Co.	6,252 "	14.86

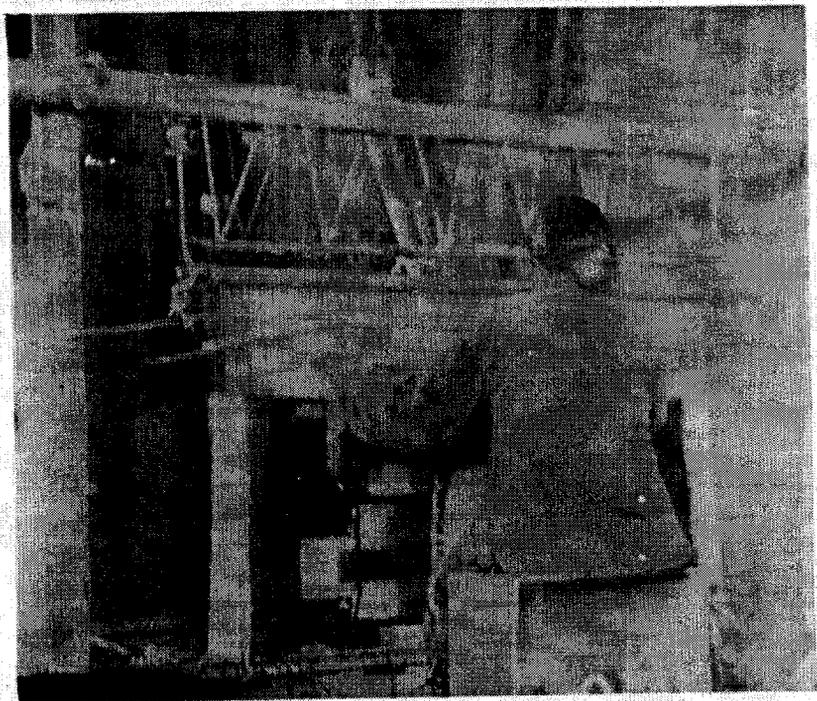
Temperature.

The temperature ranges are probably from -20 to +115. The large area of this reservation makes it rather difficult to state in a paragraph, the data

NAVAJO.



Typical Navajo
Woman.



Navajo Woman Weaving.

naturally expected concerning the rainfall and temperature.

Streams. On this entire reservation, the only permanent running streams of water are the San Juan River in the north (1), the Little Colorado River (2), on the southern boundary, which is dry several months in the year and the Moencopi Wash, which, at Tuba, has a normal flow of a few second feet, with tremendous flood discharges from time to time, and a few small streams flowing out of the various mountain ranges, upon which no data is at hand.

More complete data regarding these streams will be found under the various projects reported upon later in this report.

(1) For data relative to the San Juan River, see

Water Supply papers as follows:

1905	W. S. Paper No. 175, page	131.
1906	211	99
1907-8	249	152
1909	269	185
1910	289	170

(2) For data relative to the Little Colorado River,

see Water Supply Papers as follows:

1905	W. S. Paper No. 175, page	145
1906	211	104
1907-8	249	163
1909	269	200

Irrigable
lands.

Of irrigable lands on this reservation, there are very large areas but as there is no running water, and we have no knowledge of underground flow in sufficient amounts to warrant pumping plants, very little of it can be irrigated or cultivated.

For administrative purposes in handling the Indians, these reservations are divided into several parts under the Superintendents of the Moqui School at Keams Canon, Arizona; the Leupp School, Leupp, Arizona; the Navajo School at Ft. Defiance, Arizona; the Western Navajo School at Tuba, Arizona; the San Juan School at Shiprock, New Mexico and the Pueblo Bonito School at Crown Point, New Mexico.

In the following pages will be found a condensed history of all of the projects that have been undertaken on these reservations, or which may have been investigated with the idea of doing work, whether the project was found feasible or not.

Aneth and the Lower San Juan.

Some investigations have been made on the lower San Juan River, that is, the portion of the river lying below the Shiprock Agency and School.

The San Juan River carries sufficient water for the irrigation of a considerable area of land, but it flows for the most part between bluffs or hills, and unless a project running into millions of dollars is contemplated, the area of irrigable land is limited to a number of small flats along the river bottom, varying in size from a few acres in extent to several hundred, and the physical difficulties in getting water from the river to these small tracts would be great, owing to the flat grade of the river and long stretches of steep banks and bluffs along which a ditch would have to be constructed.

Investigations and surveys were made during the summer of 1911, near Aneth, Utah. It was reported that there was a considerable area of land near Aneth that could be covered at a moderate expense by a ditch and the water would be utilized by the Indians. A preliminary examination, early in 1911, seemed to confirm this. There is, at the present time, a small ditch here that was constructed by the Indians but it is almost impossible to get any water into it.

Upon the surveys being made, it was found that heavy floods in the San Juan and from McElmo Canon had destroyed about 200 acres of the best land and this, in connection with the fact that the value of the land was so much less than anticipated, it was decided that the ditch was impracticable.

On the south side of the river, about 6 miles above Aneth and about 50 miles below the Hogback Project, an old ditch was found that had been built by the Indians years ago but which had fallen into disuse and it had been destroyed in a number of places by the encroachment of the river during flood periods. A survey was made to rebuild the ditch to cover this land and it was found that it would be necessary to construct between 5 and 6 miles of ditch. The estimated cost was \$6,360 and there is under the proposed ditch, 530 acres of first class land, of which about 75 acres is covered with a cottonwood grove. Including the area covered by the grove as part of the irrigable land, the cost of the project would be about \$12. per acre.

No work has been done on this project but it is one of the future pieces of work to be taken up on this reservation.

There was expended on these various surveys and investigations \$647.70.

I would refer particularly to reports, dated January 30 and September 7, 1911, Monthly Reports for July and August 1911, and Annual Report for 1911.

Showing expenditures of H. P. Robinson, Superintendent of Irrigation, from 1908 to 1913 inclusive.

Compiled from his cash reports.

Project

ANNON

Fiscal yr. Year	White	Indian	Material	Equipment	Supplies	Travel exp. & misc.	Total	Headq's ppo rata	Total
1911 3rd.						10.07	10.07	.54	10.61
1912 1st.	424.50	71.88				141.25	637.63	30.53	668.16
Total	424.50	71.88				151.32	647.70	31.07	678.77

Black Falls.

In 1909, a proposition was brought before the Indian Office by Mrs. P. G. Gates, then residing at Tolchaco, to construct an irrigation system at Black Falls, 24 miles below Tolchaco and 33 miles from Leupp, on the Little Colorado River.

Location.

Mrs. Gates' plan was to irrigate certain lands from this stream, the land to be used for colonizing returned Indian students, and as an object lesson to them in right farming and civilized living, each alternate tract was to be settled by a family of white people.

Detailed surveys were made during the early summer of 1910. The land under the proposed ditch could be classed as fair, but it lies in a long, narrow strip on the north side of the river. The good land is broken up by large beds of lava, making the amount available for irrigation to less than 1,000 acres. This land also lay in the old Atlantic and Pacific Land Grant and each alternate section belonged to the railroad.

The quantity of water available is very limited during the summer months as the river is entirely dry from six weeks as a minimum to three months of each year.

Cost.

The cost for the ditch system would run about \$35. per acre and in order to make the proposition a success, a pumping plant would of necessity have to be

installed to draw from the underflow, by pumping during the dry season. This would bring the original cost to over \$60 per acre.

As the plan did not look feasible, nothing further was done on the matter. A full report, including maps and photographs, showing the quality of land, etc. was made under date of August 9, 1910. Reference is also made to Monthly reports for January and July, 1910; and Annual Report for 1909.

The cost of the surveys and investigations amounted to \$491.40.

Showing expenditures of N. F. Robinson, Superintendent of Irrigation, from 1908 to 1913 inclusive.

Fiscal Year	Qr.	Project						Compiled from his cash reports		
		White	Indian	Material	Equipment	Supplies	Travel exp. & misc.	Total	Headq's ProRata	Total
1910	4th.	112.	60.				26.90	198.90	13.47	212.37
1911	1st.	210.	82.50					292.50	16.68	309.18
		322.	142.50				26.90	491.40	30.15	521.55

Blue Canon Reservoir.

About 3 miles from Ft. Defiance is a small canon known as Blue Canon, in which a small stream flows a portion of the year, and at times, there is a large flood discharged.

It was hoped that a reservoir could be constructed in this canon to augment the supply for the Agency and school farm at Ft. Defiance.

Location.

A dam site was found where the distance between the walls of the canon were 65 feet and where a dam 32 feet high could be constructed. This would give a reservoir capacity of but 144 acre feet. The estimated costs would bring the cost per acre feet stored at \$41., and assuming the duty of water at $2\frac{1}{2}$ acre feet, about 58 acres could be served.

No knowledge of the flow was obtainable, but it would probably be possible to fill the reservoir twice a year. A large quantity of silt is carried down Bonito Canon, of which this Blue Canon is a branch, and I have been informed that the amount carried in this branch is fully as great as that in the main canon. Measurement by the writer in 1904, showed over 13% of solids carried in this water. On this basis, 8 or 9 fillings of the reservoir would fill it with silt, therefore no construction work was attempted.

The cost of the surveys was \$296.75.

Reference is made to monthly reports for November and December, 1910.

Showing expenditures of H. F. Robinson, Superintendent of Irrigation, from 1908 to 1913 inclusive

Compiled from his own reports.

Fiscal Year	Project						Total	Heady'rs. Pre rata	Total
	White	Indian	Material	Equipment	Supplies	Travel exp. & Misc.			
1911	210.	21.25				65.50	296.75	14.91	311.66

CRYSTAL.

Near the postoffice known as Crystal, some 10 or 15 miles north of Red Lake and 25 miles from Ft. Defiance, a small ditch has been used by the Indians for a great many years taking water from the wash that carries water after rains and a small flow at some other seasons of the year.

In 1909, the ditch was badly damaged by flood waters and repairs were made at a cost of \$85.76, which put the ditch in shape for the use of these Indians.

No data is at hand showing the area under cultivation nor any other details regarding this small ditch of the Indians.

Had diversion dam built with ditch

Showing expenditures of H. P. Robinson, Superintendent of Irrigation, from 1908 to 1913, inclusive.

Pro feet

Fiscal Year	Qr.	White	Indian	Compiled from his cash reports.				Total	
				Material	Equipment	Supplies	Travel exp. & Misc.		Headq's pro arts
1909	1st	18.33	60.66				78.99	6.77	85.76

CHIN LEE.

In 1904, surveys were made at Chin Lee, located at the mouth of Canon de Chelly, about 55 miles by wagon road from Pt. Defiance, and 85 miles from Gallup, New Mexico. Canon de Chelly is a typical canon of this region with vertical walls of red sandstone from one to nine hundred feet in height and is noted for the large number of cliff dwellings on its walls and on those of its tributaries.

Canon de Chelly.

The water of this canon has its source in the mountains to the east and has a drainage area of about 440 square miles.

No gaugings have ever been made on this stream but it has been roughly estimated ^{from} ~~that~~ the mean annual rainfall ^{the runoff} would be approximately 60,000 acre feet.

During the winter time, there is no flow, the precipitation being in the form of snow and the springs being frozen. In the spring, the snow and ice gradually melting usually produces a constant flow of water of considerable magnitude, generally lasting into June.

During the balance of the season, the flow depends entirely upon the rainfall.

Reservoir.

To make use of this water coming as it does largely in the shape of freshets or floods, it will be necessary to store it. A small reservoir site is found which could be made available by the construction of an earthen dam or dyke with a maximum of 22 feet and about 1600 feet of high bank and 900 feet of a low dyke. It would have a capacity of 1047 acre feet.

To fill this reservoir, it would be necessary to build some kind of a very low diversion dam at the mouth of the canon and about a half a mile of ditch.

Below this reservoir site is a large amount of good land which could be reached by this reservoir.

In a report made at the time of the surveys in 1904, it was estimated that one irrigation from the reservoir would be sufficient to mature crops as the land would be thoroughly soaked up during the early spring floods and such rainfall as is had in that vicinity usually comes at the best time of year for the crops.

Estimate. It was estimated that there was sufficient water in the reservoir to allow 25% for losses and still irrigate 3,000 acres of land once with $\frac{1}{2}$ acre foot. The estimated cost of the project as outlined was \$20,593.

Reference is made to my report of June 1904, for further information.

Ft. Defiance.

A report was made in August 1904, relative to the development of water for the irrigation of the school farm at the Navajo Training School at Ft. Defiance.

The source of the water was in Bonito Canon and three different plans were mentioned by which the water could be diverted to the land. Since this report was made, the school force has completed the diversion of this water and there is no data at hand by which a description can be given or its cost.

Reference is made to my report of August 8, 1904, showing the conditions obtaining at that time. (See in connection the report on Red Lake).

Showing expenditures of H. P. Robbins as Superintendent of Irrigation, from 1903 to 1913 inclusive.

Project BLACK CREEK (Ft. Defiance) Compiled from his cash reports.

Fiscal Year	Project		Material	Equipment	Supplies	Travel exp. & Misc.	Total	Headq'rs. Pro Rate	Total
	White	Indian							
1913	189.	15.				81.34	223.34	16.47	239.81

1913

The Ganado Storage and Irrigation Project.

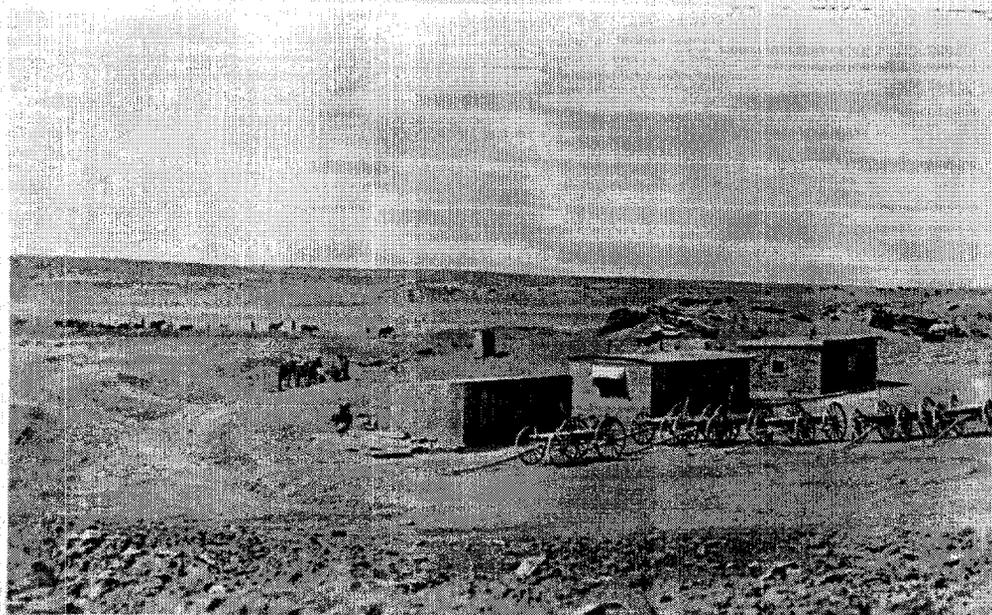
This project is to construct a reservoir about three miles from Ganado, Arizona, by impounding the waters of the Rio Pueblo Colorado in a reservoir in the flat on the north side of the stream where a small lake now exists and to irrigate land lying along the stream below, from it.

Location. Ganado lies in fractional T.27 N., R.26 E., Salt River Base and Meridian.

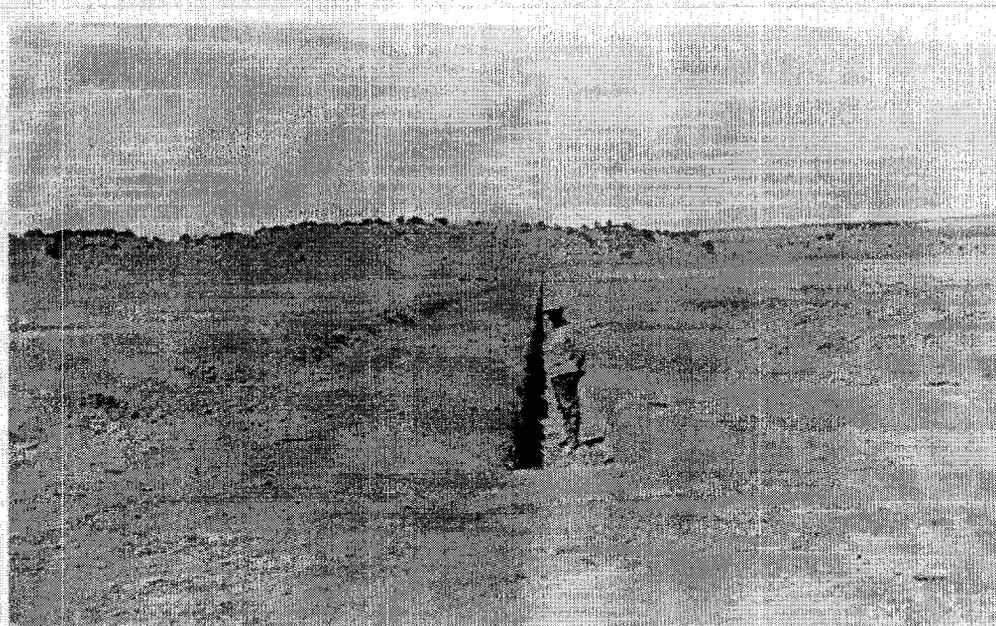
Elevation. The elevation is about 6100 feet and the rainfall is estimated at somewhere between 12 and 13 inches. The nearest railroad point is Gallup, 60 miles distant.

Runoff. The stream has a drainage area of about 205 square miles. No positive statement can be made of the amount of water available but investigations would indicate that it is ample to fill the proposed reservoir many times during the season.

The land to be irrigated lies in a long, narrow



The Camp.



Puddle trench for reservoir dam.

valley and the area available is almost unlimited and far exceeds any possible storage.

Mr. J. L. Hubbell in 1903, constructed a canal from this stream to divert the normal and flood flow to his land, which consists of 160 acres.

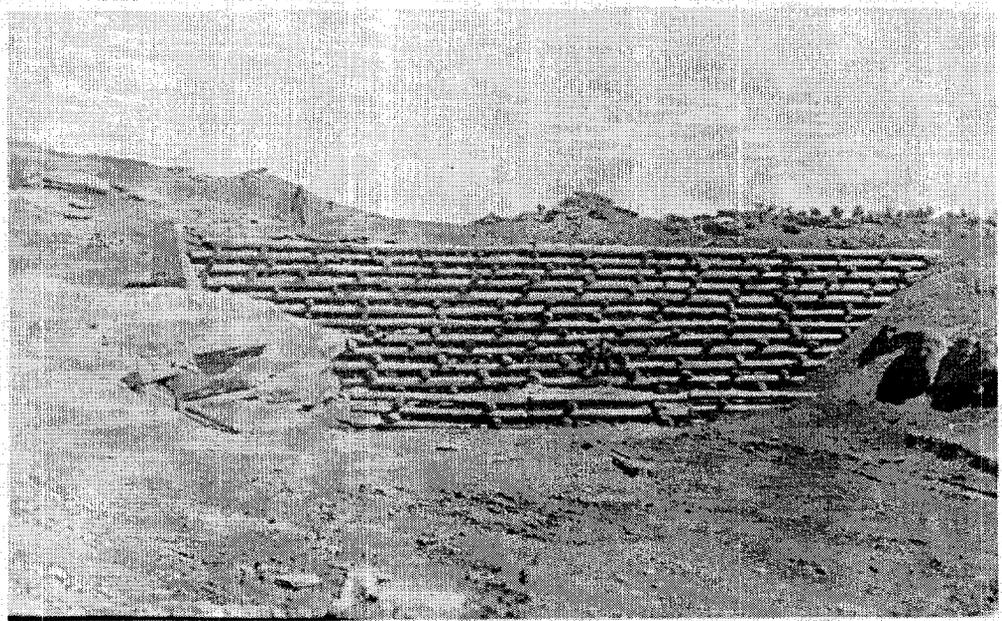
Hubbell proposition.

Mr. Hubbell made a proposition to the Government to give up his water rights and his constructed ditch in exchange for a reservoir right in the proposed reservoir and the right to convey the water to his land through the Government ditch, and he further agreed to guarantee the maintenance of the ditch indefinitely. This agreement has been ratified by the Department on May 31, 1913.

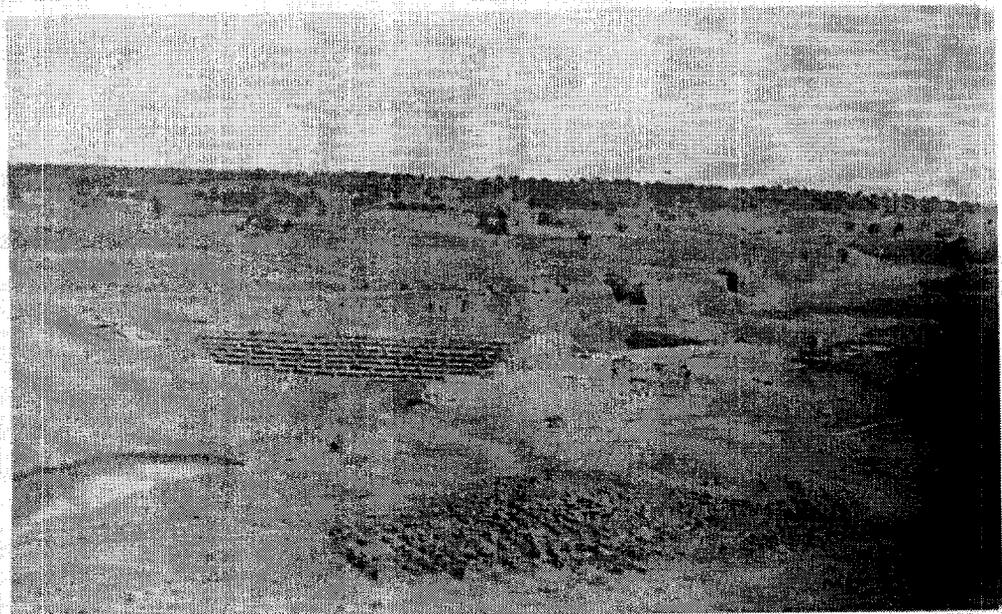
Reservoir.

The reservoir will be constructed by building an earthen dyke, high enough to impound water 16 feet deep with ample freeboard. This reservoir will contain 4438 acre feet of water and will be filled from the stream by means of a diversion weir and short canal which will be 16 feet wide on the bottom.

The plans submitted and upon which Congress made specific appropriation for the construction of the project, includes the storage works and $5\frac{1}{2}$ miles of ditch, which will cover 707 acres of good land, and, with a short lateral extension, an additional 75 or 80 acres. The further extensions would be a ditch on the north side of the river for about 4 miles, which will cover about 800 acres. Further extensions can be made as



Two views of Diversion dam
during construction.



found advantageous, to the limit of the water supply.

Diversion.

The diversion dam in the stream will be partly a rock filled crib dam which will divert the water to a solid rock bottom and a low diversion lip of concrete will divert it into the canal through concrete headgates. The outlet to the storage reservoir will be through concrete culvert 18" x 24", controlled by steel headgates from a steel tower. Although no water is supposed to enter the reservoir excepting through the canal, a spillway is provided which will be ample to care for any possible local drainage from the hillsides.

Estimated
cost.

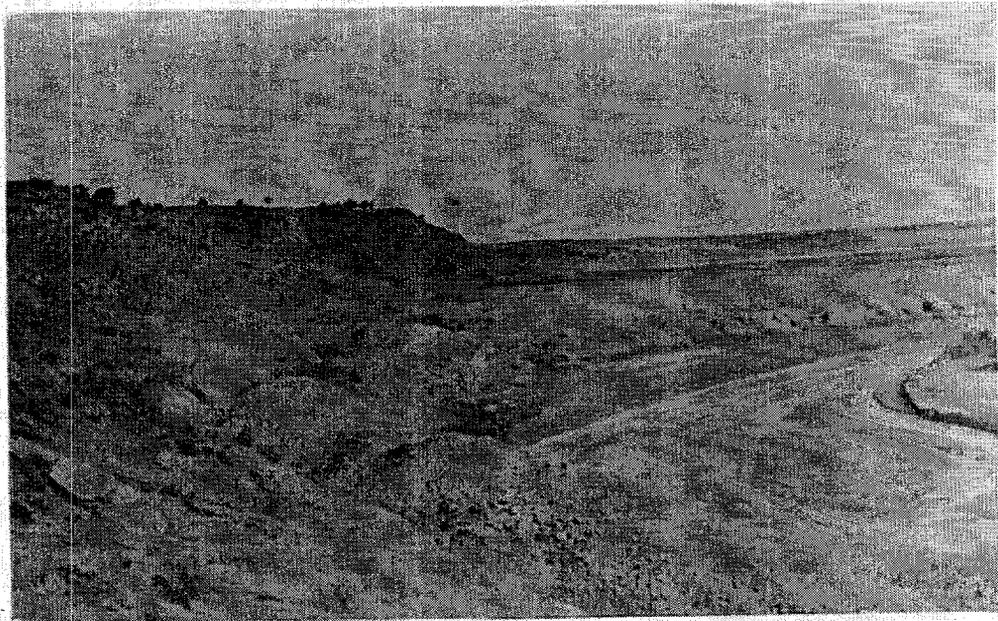
The estimated cost was a little over \$60,000 and the construction has been provided for by special act of Congress.

Construction work was begun in the spring of 1913 and will be pushed to a rapid completion.

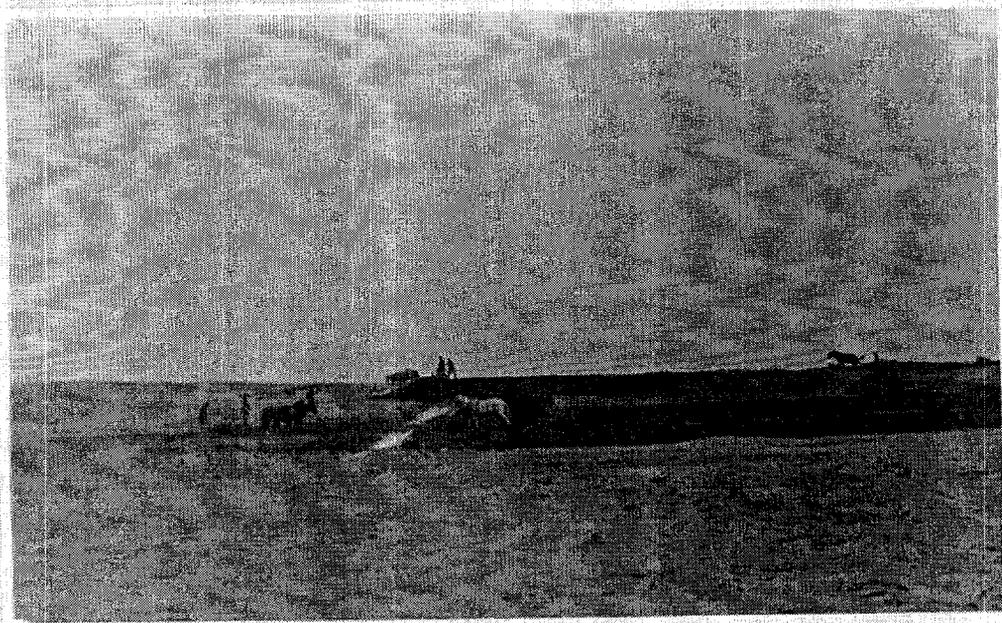
For further details of this project, reference is made to reports dated Feb., July, Aug., Sept., Oct. 1910; Feb. 14, 1912, and November 8, 1912, and monthly reports commencing with December, 1912. Also report of Dec. 27, 1913. Annual reports, 1910, 1911 and 1912.

The preliminary surveys and examinations cost \$1,489.71 and construction costs to the end of 1913 amounted to \$12,258.04 as shown in detail by the cost data sheet.

NAVAJO
Canado Project.



Distributing system.
Side hill cut on canal.



Making the fill on Reservoir dyke.

Showing expenditures of H. F. Robinson, Superintendent of Irrigation, from 1908 to 1913 inclusive

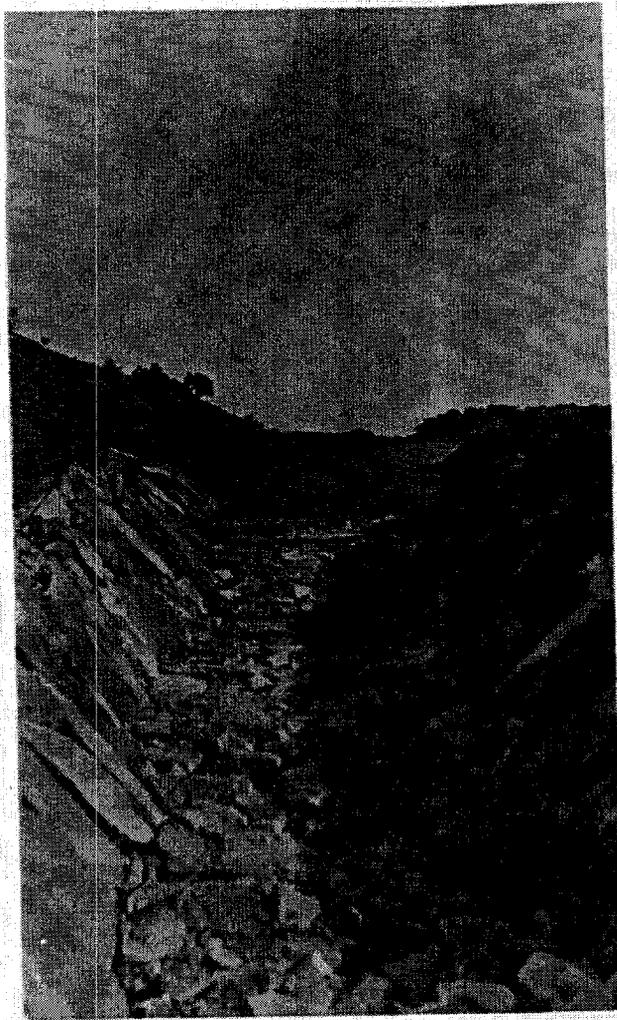
Project

CANADA

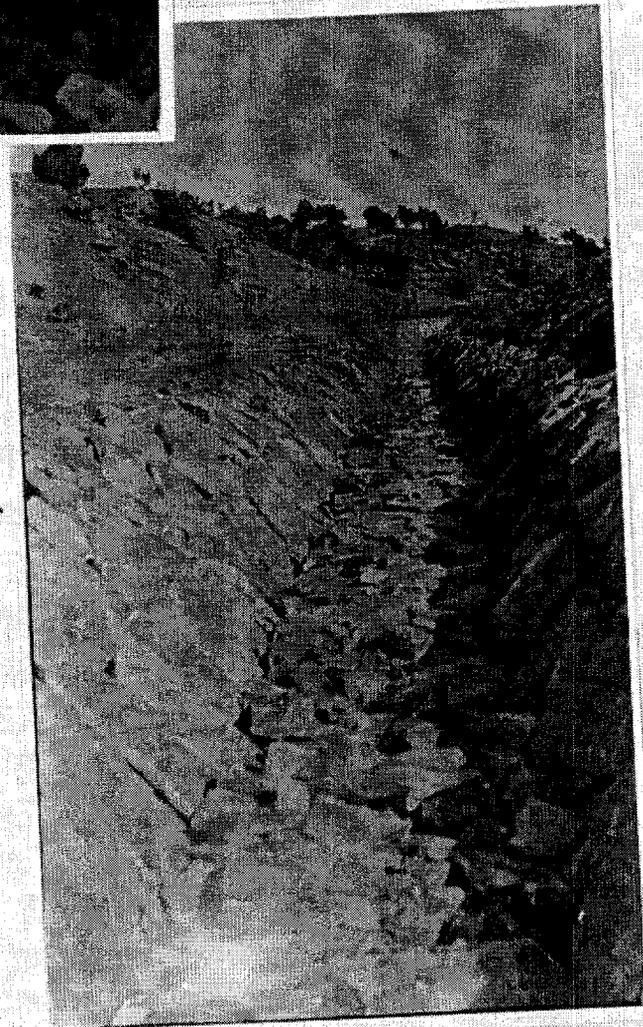
Compiled from his cash reports.

Fiscal Year	White	Indian	Material	Equipment	Supplies	Travel exp. & Misc.	Total	Headq'rs pro rata	Total
1911	662.	59.75				150.95	872.70	46.77	919.47
	492.	23.				59.38	574.38	30.79	605.17
						42.63	42.63	2.28	44.91
							1,489.71	79.84	1,569.55
1913	183.50	418.50	412.60			24.25	207.75	15.31	223.06
	1,084.	6,511.42	997.07	581.55	35.50	6.25	2,538.20	187.11	2,725.31
	1,875.75			52.63	26.47	48.75	9,512.09	701.09	10,213.32
							12,258.04	903.65	13,161.69
Total	4,297.25	7,012.67	1,409.67	634.18	61.77	332.21	13,747.75	983.49	14,731.24

NAVAJO
Canado Project.



Two views of
paved drop
yet to be
grouted.



Prints of Ganado.

Headworks, Location Diagram.

Headworks, Gate and Wall.

Layout of Diversion Works.

Diversion Dam.

Isometric sketch Diversion Works.

Plans Ganado Project.

Reservoir Outlet.

Reservoir Outlet structures.

Flume Standard Plan.

Isometric Projection Stilling Box.

HOGBACK CANAL.

Inception and early surveys. In 1903 or 1904, a small ditch was built to take water from the San Juan River, about nine miles above the Agency at Shiprock. The heading was in solid rock, and consisted of about 75 feet of tunnel (approximately 5'x 5'), with a headgate at the mouth. This tunnel and headgate was built by the Indian Office and the ditch, which was about four miles long, was built by the Indians at their own expense. The cost to the Government was some \$350 for the headworks.

Surveys for present ditch. In 1907, surveys were made by Blair Burwell, acting under Superintendent of Irrigation J. B. Harper, under instructions from the Indian Office, and in the fall of 1908 and the spring of 1909, final location surveys were made by Asst. Engineer Rollin Ritter, and general plans were made.

In March 1909, the proposition was gone over by Consulting Engineer J. H. Quinton and reported upon favorably.

Description of project. The Hogback Canal heads on the east edge of the Navajo Reservation on the San Juan River, from which it secures its water, the head being constructed on a rock point, and runs in a generally westerly direction a distance of 12½ miles, covering a narrow strip along the river for some seven miles, then swinging to the west

Location.

Source of water.

NAVAJO.
Hogback Canal.
San Juan Project.



Navajo woman
and children.
One tree of
an apple or-
chard set out
by her.



Navajo Corn field on this project.

across a flat mesa where there is a considerable body of fine land.

The land covered is parts of Tps.12 and 13 N., Range 1-2 W., Navajo Meridian.

Water Supply.

The San Juan River, rising in the high mountains of Southern Colorado, has a drainage area of some 12,500 square miles, and an estimated annual runoff of 1,900,000 acre feet. The Geological Survey gives the runoff as follows:

Drainage Area.

Runoff.

	Drainage Area.	Annual Mean Runoff.
San Juan at Farmington	6,920	2,500,000 ac.ft.
" " " Shipreck	13,100	2,800,000 " "

See Water Supply Paper No. 269, p.185, for description of the San Juan River Basin.

Soil.

Most of the land is a sandy loam, and will be very productive.

Av.elevation of land.

The average elevation of the land under the canal is 4950 feet above sea level.

Temperature.

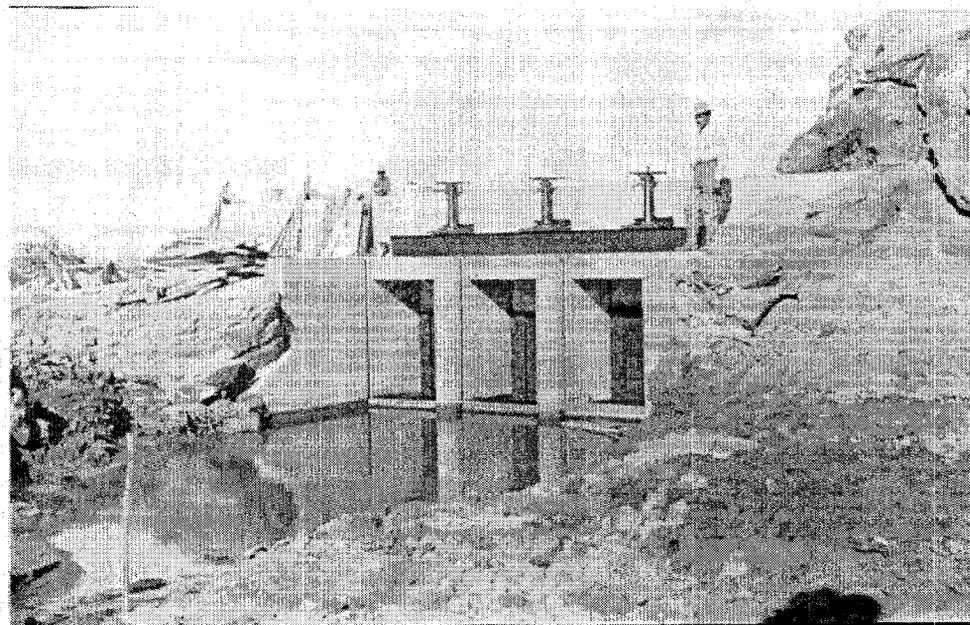
The temperature ranges from +115° to -15°

Rainfall.

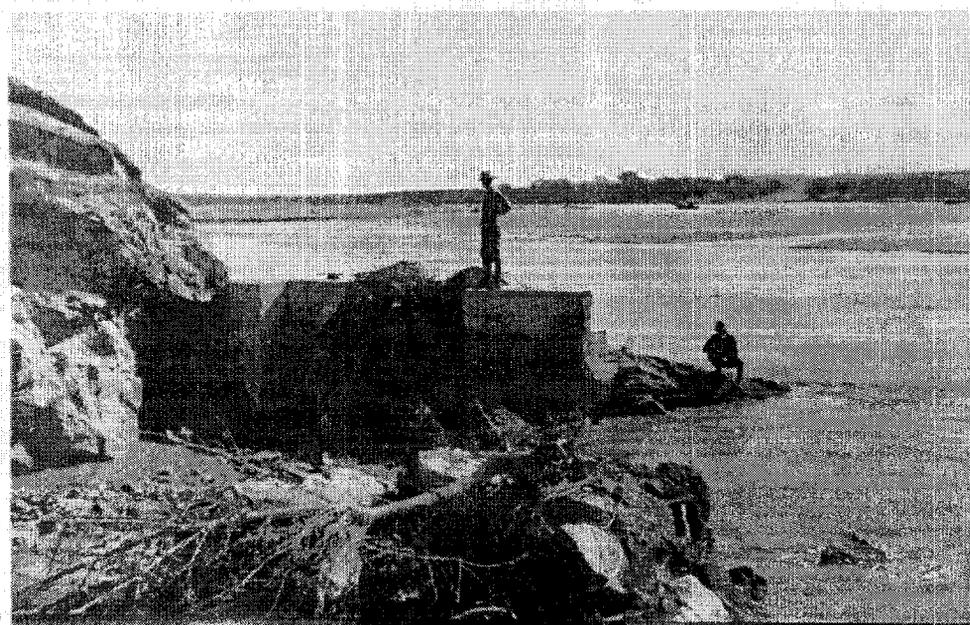
The average rainfall on the project is unknown, there being no records kept within a reasonable distance where the conditions are the same, but it is probably 8 inches or less per annum.

Land covered.

The canal will cover 3900 acres of land, of which at the date of this report, 423.9 acres are under cultivation.



Headgate before the Flood.



Headgate after the flood.

Capacity
of canal.

The capacity of the canal is 100 second feet at the head and the quantity of water needed to be carried in any section of the canal was determined by assuming that one second foot was required by each eighty acres of land and that the losses by seepage and evaporation in the canal would amount to 5% per mile.

Markets.

The Canal is 25 to 35 miles from the nearest railroad, the D. & R. G. Ry., and Farmington is the nearest town on the road. Other markets would be the local traders.

Plans.

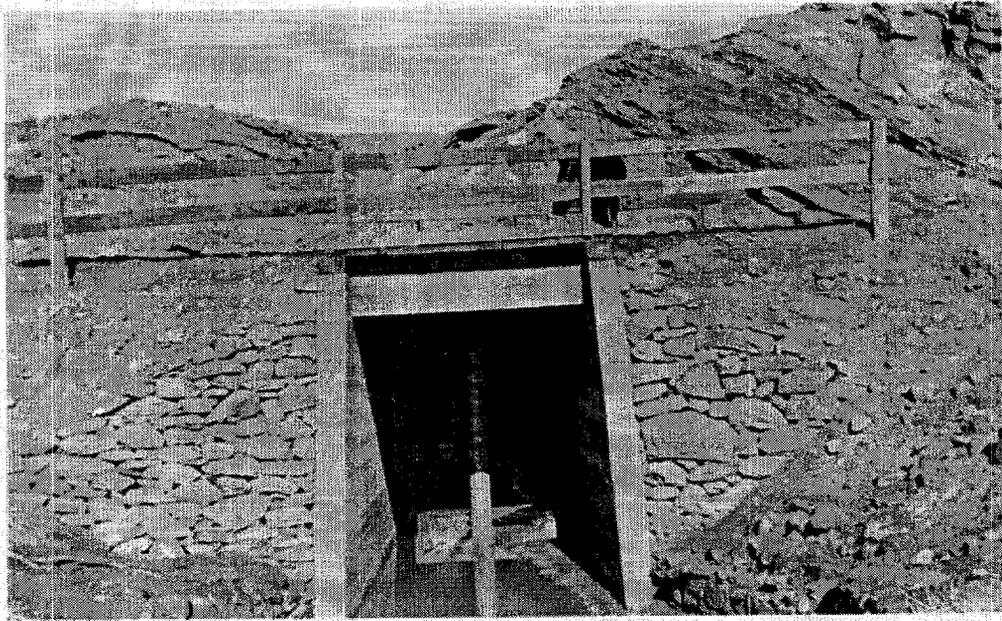
The plans adopted and the construction done so far, are for permanent structures; the headgates, the wasteway as well as the lateral turnouts being of concrete, the flumes being metal with wood substructures excepting Flume No. 1 will be rebuilt with steel substructure. The substructures rest on concrete foundations. The Highway bridges are of timber.

Construction.

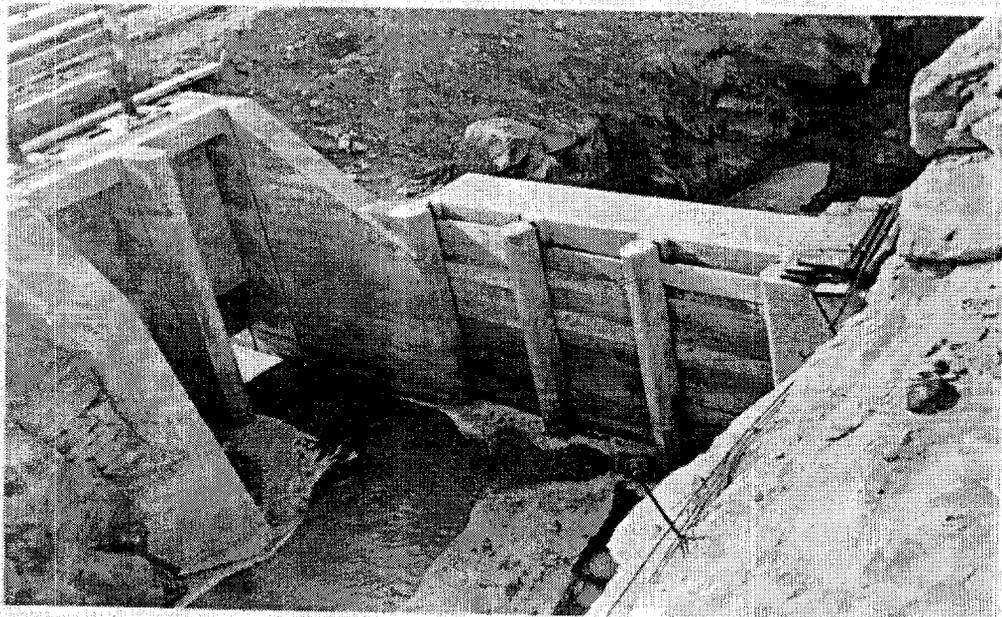
On April 17, 1909, the Chief Engineer directed that construction work be commenced, and plans for the head section were prepared in his office and were approved by the Consulting Engineer.

Actual work was commenced in May 1909, by Mr. R. G. Bush, Asst. Engineer, who established camp and commenced cross sectioning and the hauling of material purchased to the work. Mr. Bush resigned May 30, 1910.

San Juan Project.
Hogback Canal.



Two Views of the Wastegates.



Fiscal Year
1910.

During the Fiscal Year 1910, work was continued and the section from Station 30 to Station 231 was completed, and water was furnished to 370 acres of Indian land which had been under the old ditch heretofore mentioned, and which was destroyed by the building of the new ditch, and which was actually cultivated during the year.

Various matters conspired to cause the work during this year to be not as favorable as would have been desired.

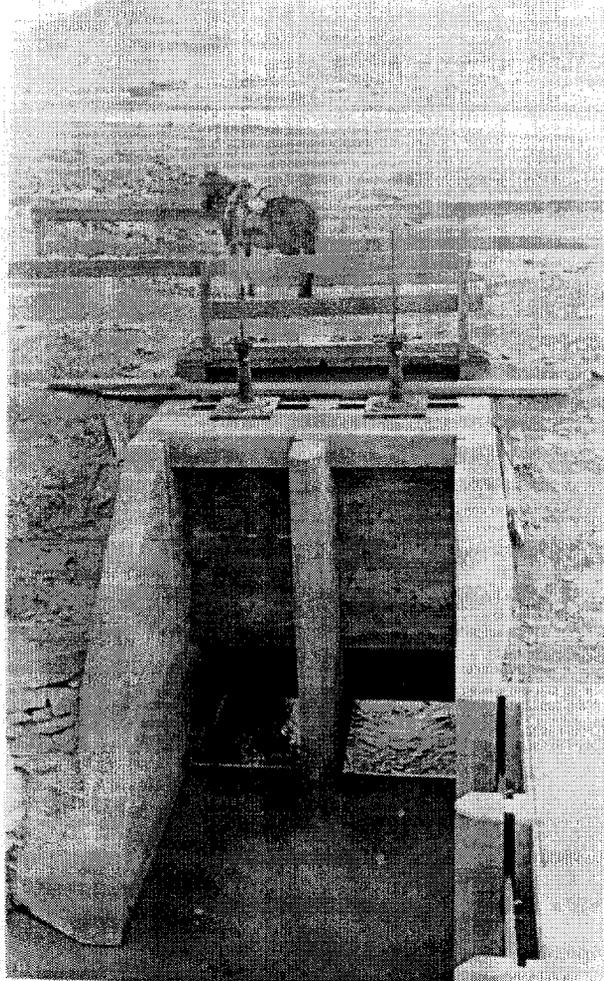
A number of changes in the force was made. Mr. P. M. Churchill was appointed to take the position vacated by Mr. Bush and reported in August, but he was relieved from duty on December 6.

There being no engineer available, Mr. S.S. Carroll was placed in charge as Superintendent of Construction, but he resigned early the following April. Between the times when the above mentioned men were in charge and during the balance of the year, the work was in charge of the foreman, Mr. S. F. Burnham.

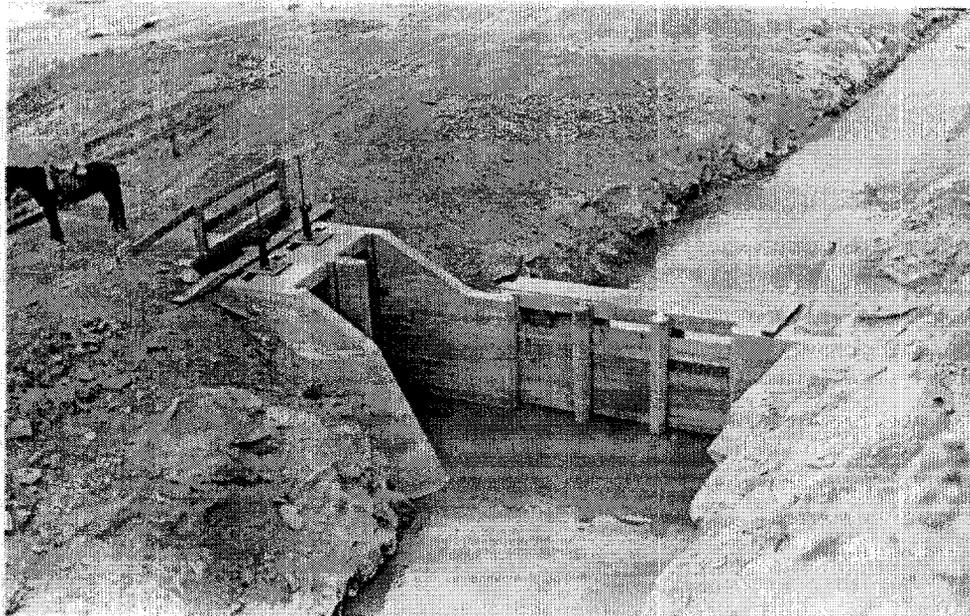
Fiscal Year
1911.

During the Fiscal Year 1911, the heavy work on the head section, which was largely in rock and entirely side hill work, was continued until this section was nearly to grade. Below Station 231, which was finished last year, work was continued to Station 410, one half of which was about 85% completed and the balance about

San Juan Project.
Hogback Canal.



Two views of wasteway gates and step structure.



50%. All of the flumes on this section were completed including Flume No. 4, about one-half a mile in length, excepting a few bents of the latter.

Mr. E. C. Gersbach was put in charge as Superintendent of Construction, July 6, 1911.

Fiscal Year
1912.

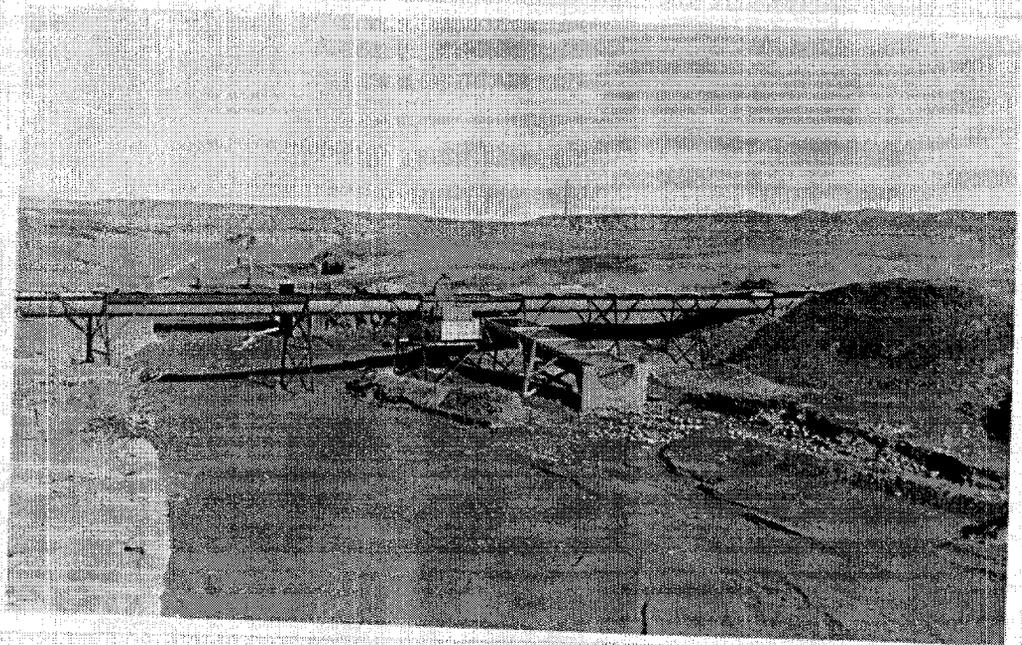
During the Fiscal Year 1912, practically no new work was opened on this project.

Floods.

In July, occurred the heaviest flood known from the time of the settlement of the whites, in the San Juan River. In September, a local storm washed out a highway bridge across the arroyo which came down and struck Flume No. 1, tearing it out and it was carried down the river. The water did much damage to the canal. Another local flood in September did much damage to the canal, and in the first week in October, general rains over the entire drainage basin caused a larger flood than that in July, the water reaching a point about five feet higher, setting a maximum high water mark. Water went over the entire head section and extended 1000 feet above the line of the canal between Stations 30 and 75, and between these points 600 feet of the canal was entirely destroyed by the river changing its course. (See Water Supply Paper 269, p. 187).

This flood made it necessary to change the entire plan of the headworks, all of them having to be carried

San Juan Project.
Hoback Canal.



Two views of Flume No. 1, as completed with
spillway.



much higher than anticipated and planned for, and the banks of the head section, some 2900 feet long, had to be raised about six feet higher than the plans called for. A new section of the canal had to be built above the high water mark to take the place of the section washed out.

Inspector W. B. Hill visited the work after the floods and the changes made were by his advice and instructions.

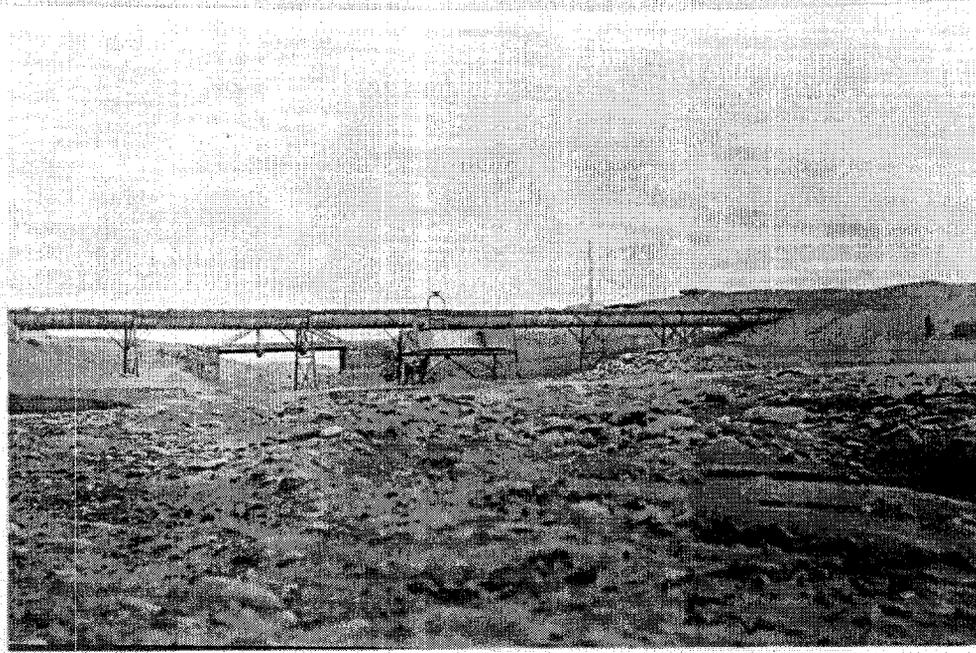
**Additional
work.**

The additional work caused by the floods includes 21,000 cu. yds. of borrow used in raising the banks of the head section; 34,200 cu. yds. for the new cut-off section of canal built between Stations 30 and 80; 5,000 cu. yds. in addition to estimate for change of location near Station 235; a number of channel changes of arroyos to control flood water from local storms; numerous repairs to canal banks caused by the floods and local storms, and the cleaning and general maintenance of the canal for two seasons for the section in operation; enlarging and rebuilding the headgates, badly damaged by the flood passing over it; the redesigning and enlarging of the waste gate structure and the rebuilding of Flume No. 1.

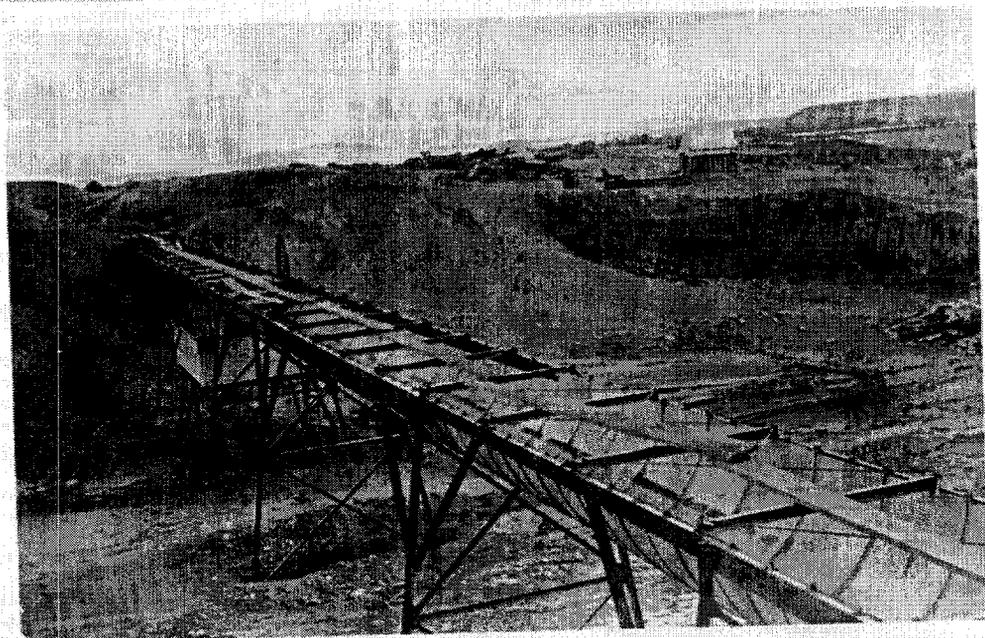
**River
protection
work.**

A considerable amount of river protective work has been necessary to protect the canal and prevent the

San Juan Project.
Hogback Canal.



Two views of Plume No. 1. all steel
structure with concrete foundations
and end walls.



river from cutting into it. This did not show until the late floods demonstrated its necessity. It is difficult to estimate the cost thus added to the project as while a portion of it was done where the material had to be carried some distance, and was specifically charged to the protective work, much of it was built of rock wasted from excavation. Separate accounting shows an expenditure of \$8,280.10, and an amount should be added for the additional haul and labor of placing material in the jetties, probably \$800. to \$1,000.

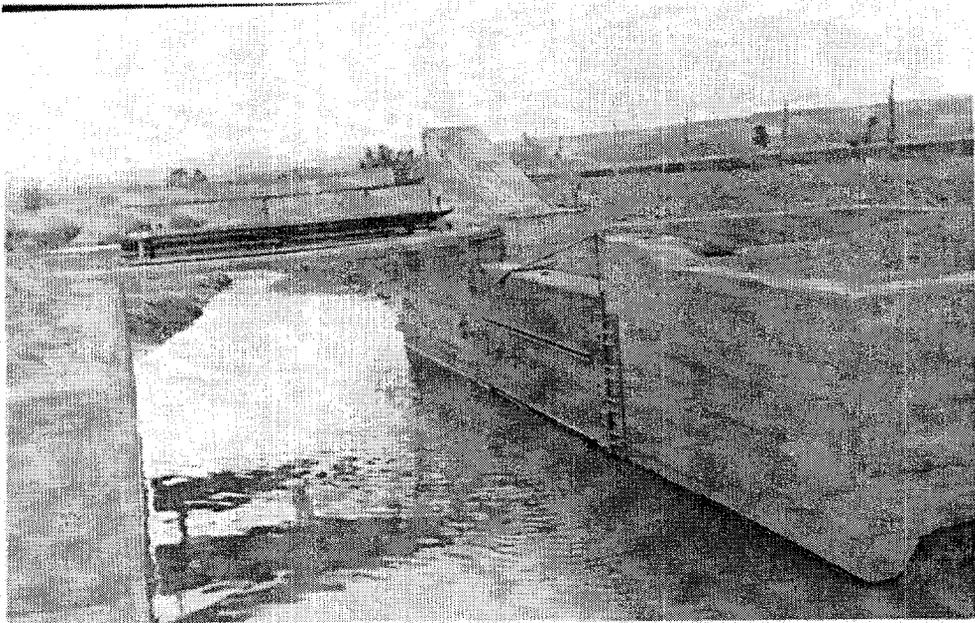
The expenditures for the Fiscal Year 1912 should practically all be charged to the repair and additional work occasioned by the floods.

A plane table survey, covering the entire project, was made during the year by another party. The expenditures on this were as follows:

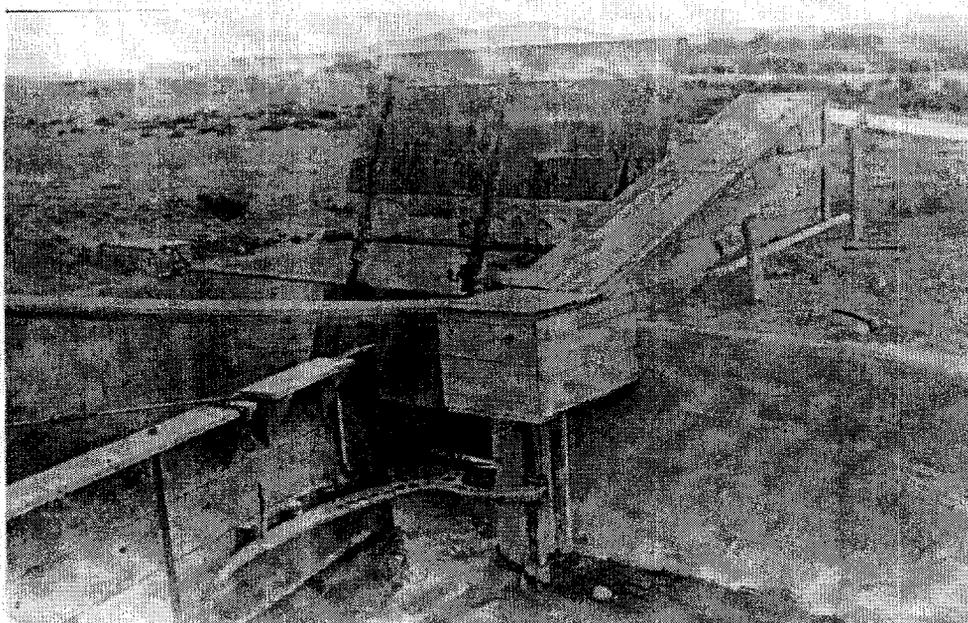
White labor,	\$449.00
Miscellaneous,	<u>90.50</u>
Total	\$539.50

Fiscal Year
1913.

During the first half of the present Fiscal Year 1913 (from July 1, 1912 to December 31, 1912), the work was much hindered by the delay in the passage of the Indian appropriation bill, but when the work was under way it was mainly a continuation of the work of the previous year, the new work on the canal not being opened until November. The heavy work between Stations 410



Automatic spillway. Gate closed
showing clear waterway in canal.



Automatic spillway beginning to open.
Note fan in water, the current operating
the mechanism.

and 430 is now being done as the cold weather has made it almost impossible to work elsewhere on account of the frost in the ground. This section is in gravel which is dry.

Total cost of project to date. The total cost of the project to the end of the Fiscal Year 1913 is shown in detail on the accompanying cost data sheet.

Filings. Filing on 110 second feet of water was made with the State Engineer March 13, 1913, which was approved August 11, 1913.

Reference to reports. For details of the work and other information, reference is made to the following reports:

From J. H. Quinton, Consulting Engineer to Chief Engineer
March 31, 1909.

From Rollin Ritter, Asst. Engineer to H. P. Robinson,
April 9, 1909.

From H. P. Robinson, Monthly reports:
Oct., Nov. and Dec. 1908.
Jan. to May incl., Aug., Sept.,
Oct., Nov. 1909.
All of 1910 except March.
All of 1911.
All of 1912.

From H. P. Robinson, Annual Reports:
1908, 1909, 1910, 1911, 1912.

Showing expenditures of H. P. Robinson, Superintendent of Irrigation, from 1908 to 1915 inclusive.

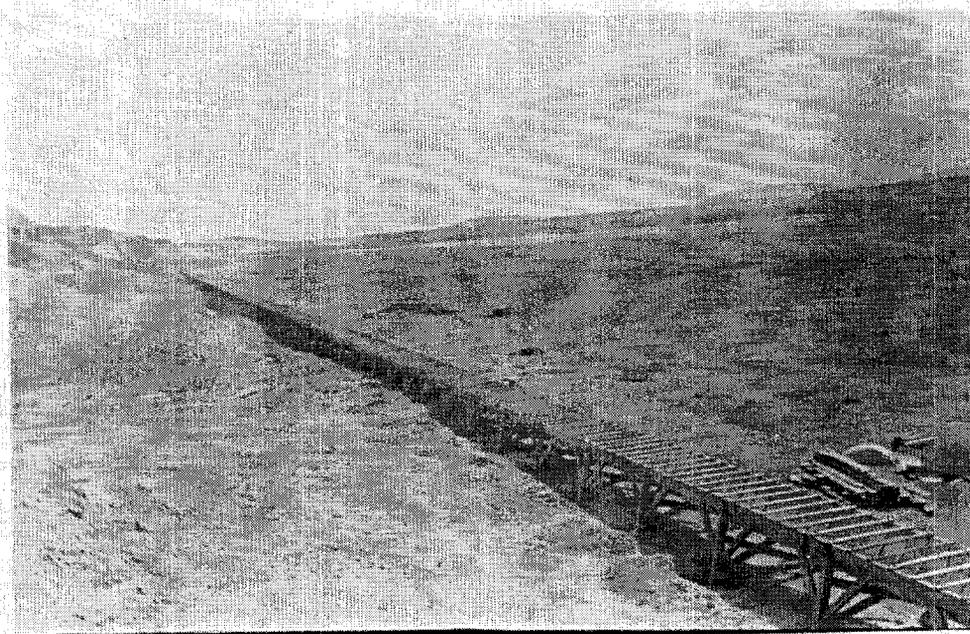
Project

Compiled from his cash reports.

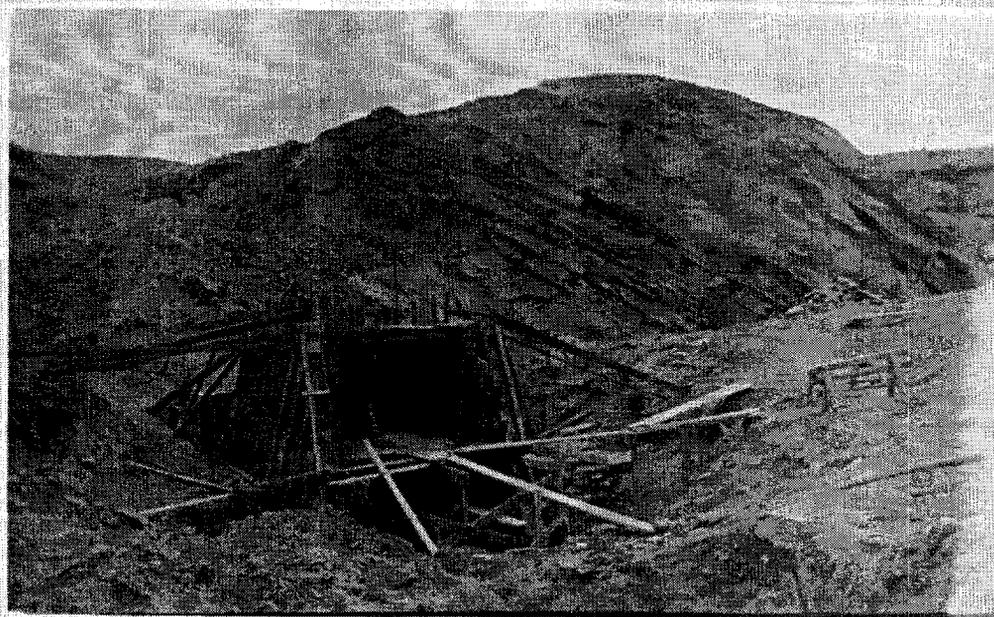
Fiscal Year	Or.	White	Indian	Material	HOODACK			Supplies	Travel exp. & Hhso.	Total	Headq's pro rata	Total
					Equipment							
1909	2nd.	270.	551.30	29.65		15.	23.50	32.90	912.35	70.25	990.56	
	3rd.	1,476.09	143.63			173.04	15.32	157.48	1,802.20	154.56	1,956.76	
	4th.	2,587.30	844.16	10,132.45				405.32	14,157.59	1,213.88	15,371.47	
										16,872.12	1,446.67	18,318.79
1910	1st.	1,465.25	1,054.05	54.93	142.70	37.40	27.07	3,281.40	222.31	3,503.71		
	2nd.	2,397.75	4,054.48	168.15	181.56	6.55	18.60	6,827.09	462.51	7,289.60		
	3rd.	1,798	3,123.23	63.30	24.20	77.10	82.85	5,173.68	300.50	5,524.18		
	4th.	1,656.33	2,500.13	320.30	345.86	322.97	44.50	5,190.09	351.61	5,541.70		
1911	1st.	1,126.50	1,798.43	521.91	513.79	72.45	99.40	3,096.78	165.97	3,262.75		
	2nd.	5,026.17	15,085.25	1,092.93	80.	535.20	50.13	21,732.55	1,164.66	22,897.21		
	3rd.	5,093.39	12,812.22	318.19	178.25	50.38	54.87	19,133.41	1,023.37	20,158.78		
	4th.	2,911.68	3,699.63				23.20	7,181.34	304.86	7,566.20		
1912	1st.	1,859.50	1,111.38	834.99	4.75	99.50	29.20	3,939.32	182.63	4,127.95		
	2nd.	2,352.65	4,523.28	260.64	2.70	54.56	41.10	6,919.71	351.33	7,271.05		
	3rd.	4,036.63	12,040.58	317.21			35.85	16,429.25	786.66	17,215.92		
	4th.	3,247.76	5,974.78				61.95	9,601.70	459.70	10,061.46		
1913	1st.	1,922.75	595.52				7.50	2,525.77	186.20	2,711.97		
	2nd.	2,245.50	3,395.08	412.50		50.41	34.48	5,725.47	422.82	6,148.29		
	3rd.	4,596.	17,325.17	2,775.76	541.98	9.12	12.40	15,959.75	1,029.12	17,018.87		
	4th.	4,513.33	6,594.16					44,947.58	3,313.55	48,261.13		
Total		50,582.57	97,226.46	17,807.89	2,027.25	1,359.56	1,322.30	170,326.03	10,654.41	180,980.44		

Showing expenditures of H. P. Robinson, Superintendent of Irrigation, from 1908 to 1913 inclusive.

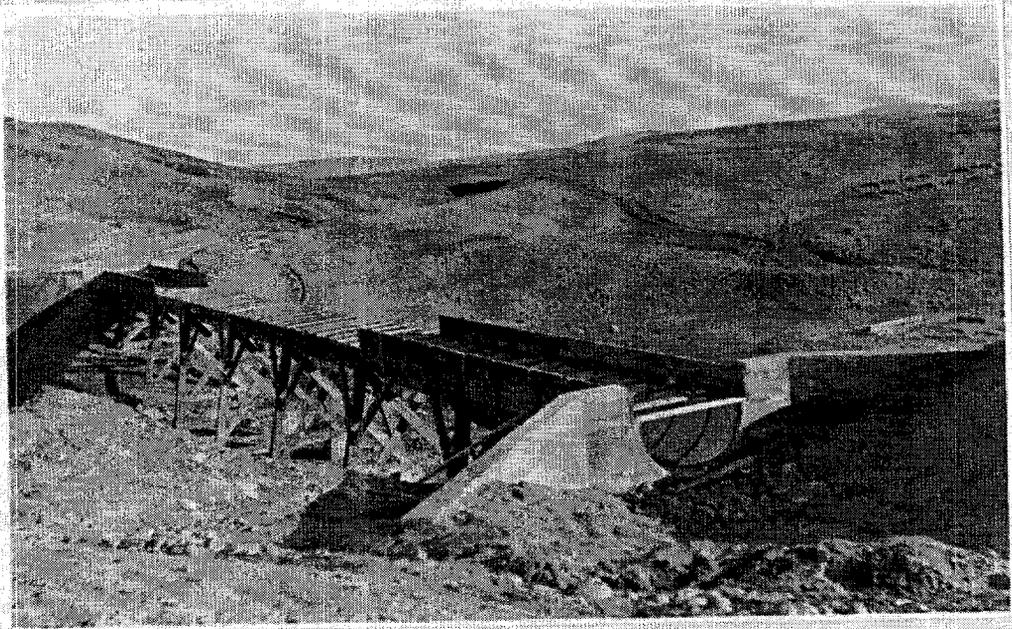
Fiscal Or. Year	Project					Compiled from his cash reports.			
	White	Indian	Material	Equipment	Supplies	Travel exp. 48 miss.	Total	Headq'rs. Pro Rata	Total
1912 3rd.	499.					90.50	538.50	25.83	565.33



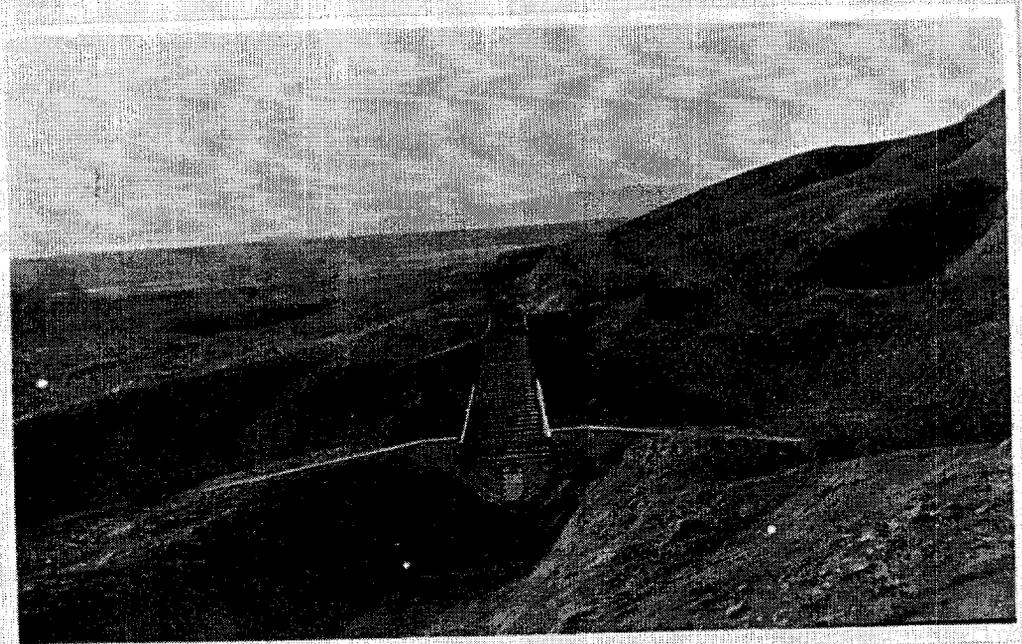
Flume No. 4.



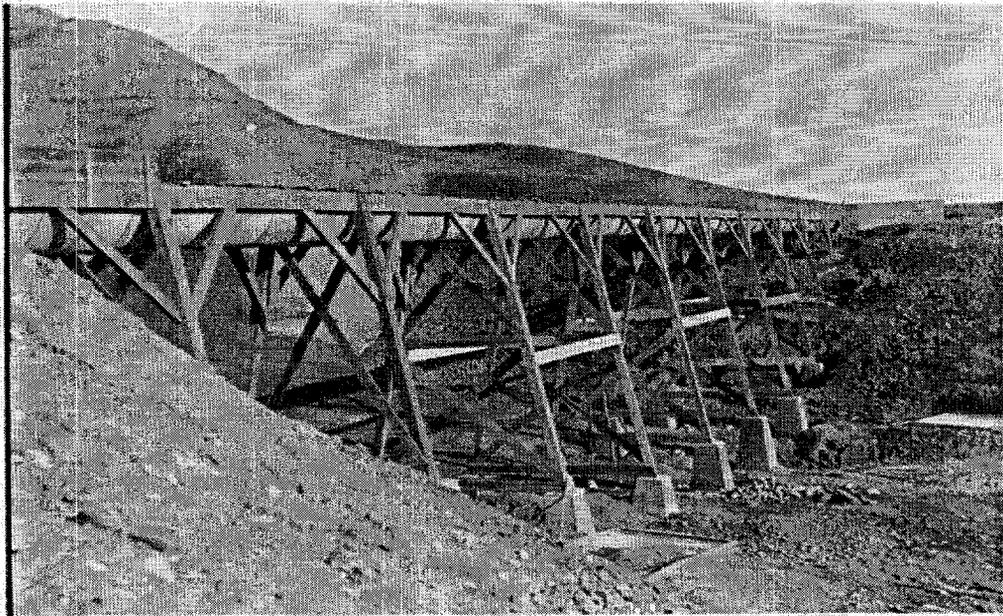
Forms for wasteway. concrete partly
deposited.



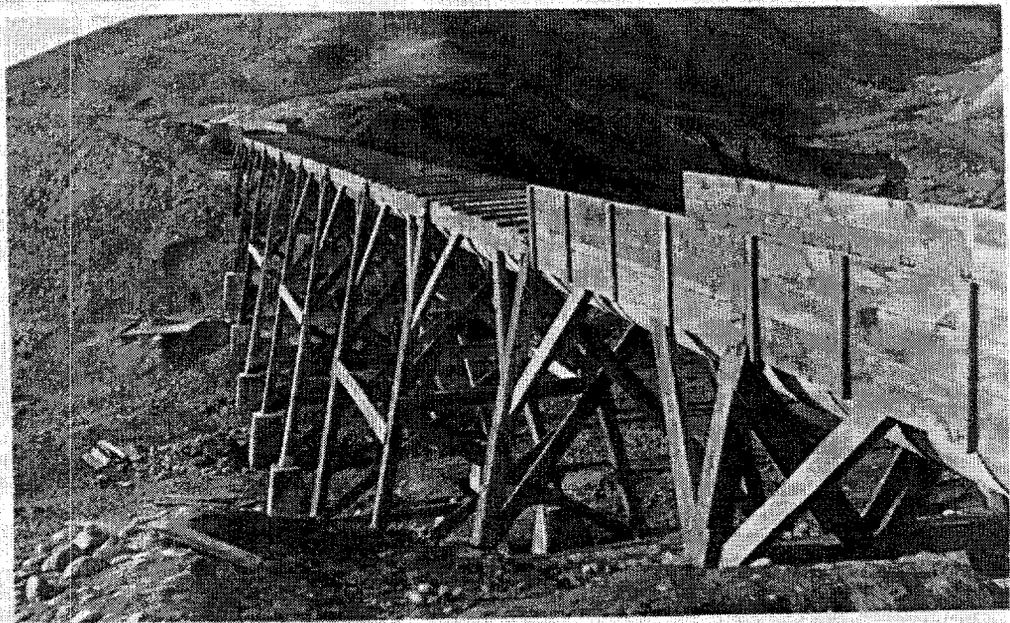
Two views of Flume No. 5.

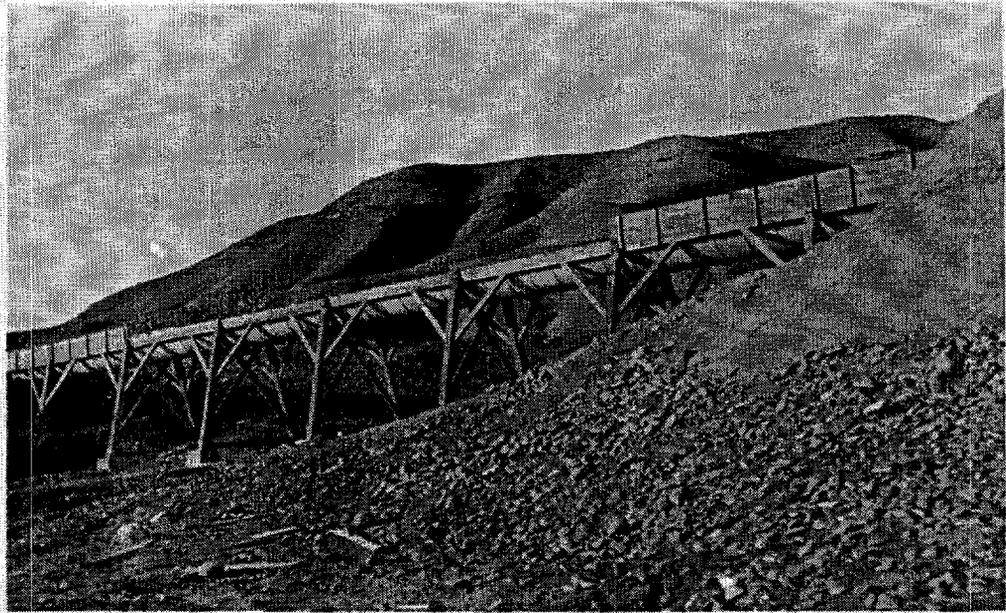


San Juan Project.
Hogback Canal.

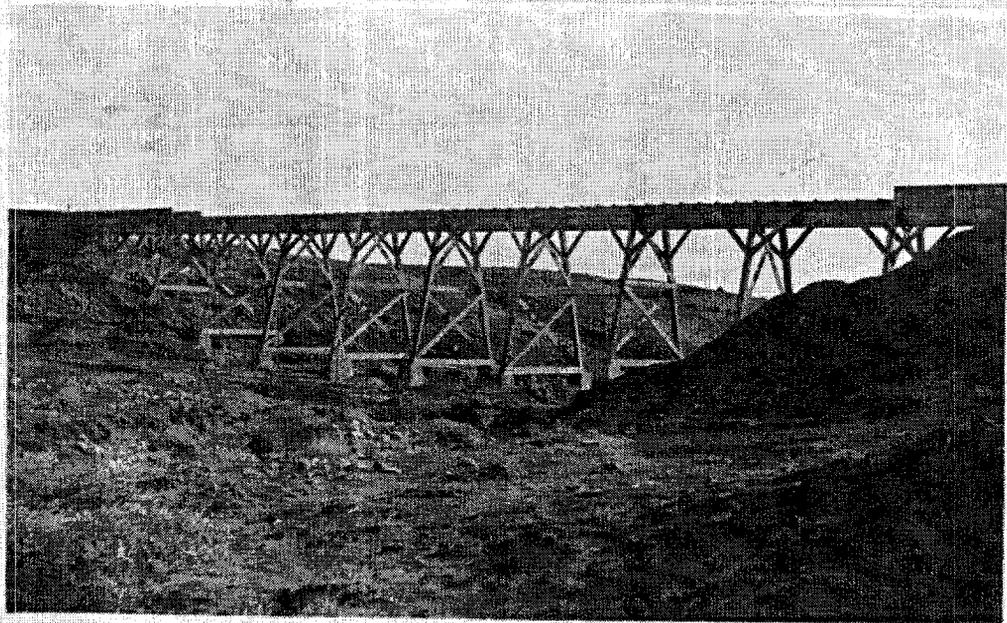


Two Views of Flume No. 6.



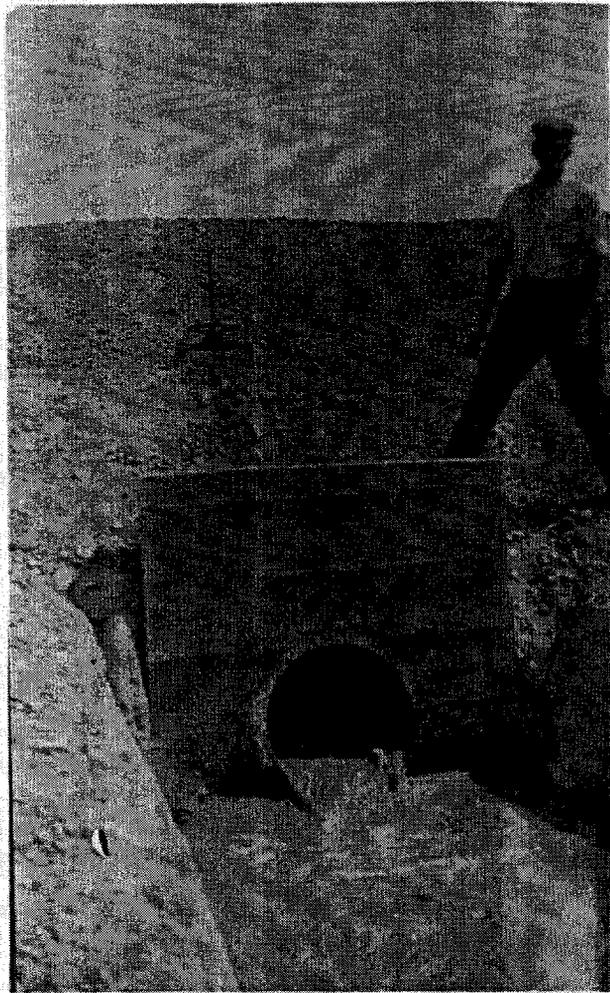


Flume No. 5.

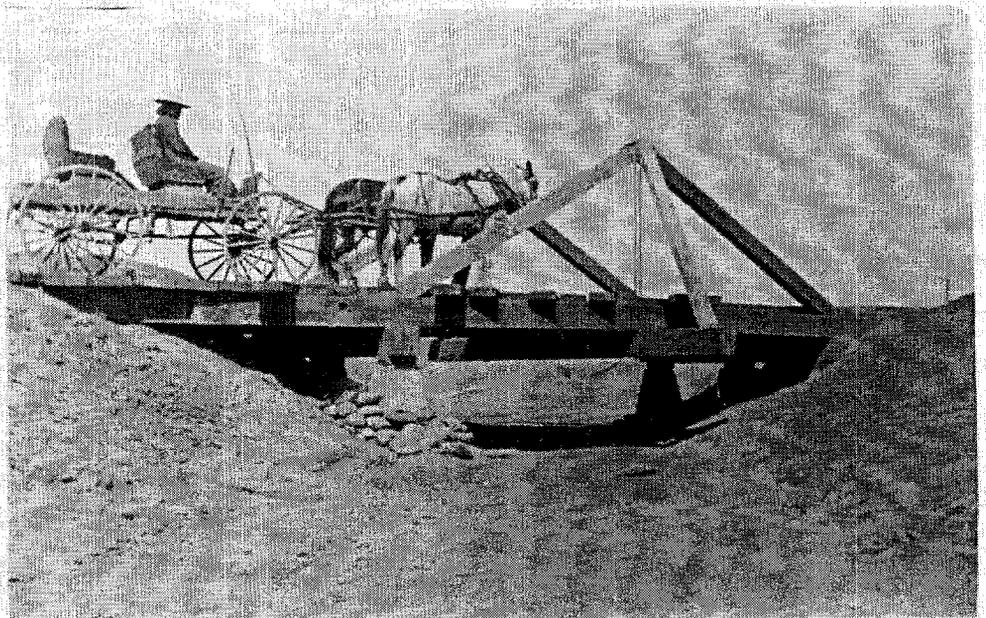


Flume No. 6.

San Juan Project.
Hogback Canal.



Standard lateral outlet with concrete pipe, concrete head walls and steel gate with screw lift.



Highway bridge. Crossing is on a skew.

List of Structures on Hogback Canal.

September 1913.

Station.	Kind of Structure.	Material.	Size.	Remarks.
2+20	Headgate	Concrete	3 openings 4'x4'	Gate raises only 41". Fitted with gate hoists gates of wood. Grooves for flash boards in front of gates. Stone abutments. Built by Supt. Shelton.
3+00	Bridge	Wooden structure		
26+40	Wastegate and stop structure.	Concrete. Rein-3	Openings 4' in stop. 2 in waste gate 4'	
38	<i>Bridge</i>	<i>wood</i>		
70+48	New line equals			Bridge over waste gate, concrete stringers, wooden floor. Waste gate opens 41" <i>Built by Mr. Shelton.</i>
80+44	old line.			
81	Lateral turnout	concrete	12" concrete pipe	
95+50	Culvert	Concrete	24" concrete pipe	All turnouts standard with concrete pipe, concrete abutments, steel gates with screw lift. All culverts standard. Concrete pipe and concrete abutments and collars. Standard. No. 2.
114	Lateral turnout	concrete	24"	
149	Automatic Spillway.	Concrete	10'	Automatic Spillway. Opens full width of canal, or 10'. Is operated by trip and the current.
168+50	Bridge	wooden		On main Shiprock - Farmington road. At Camp.
175	Lateral Turnout	Concrete	24"	Standard No. 3.
187+50	Lateral Turnout	Concrete	24"	Standard No. 4.
227+75	Bridge	Wooden		A truss.
232+40	Steel Flume	Steel sub-structure.	192 feet long.	Has 8 bents 20' long and one 32'. Has sand box, automatic overflow, spillway, 16'. On each side of flume, sandbox outlet 32 feet long. All foundations of concrete, carried 11 feet below bed of arroya. Main abutments 28 feet high. Lennen Flume Flume No. 2. Standard plan. Maginnis flume.
262+70	Steel Flume	Wood sub-structure	80 feet long	

Structures Hogback Canal. Page 2.

Station.	Kind of Structure.	Material	Size	Remarks.
263	Drop	Wooden		In arroya below Flume No. 2 to prevent retrogression of arroya grade.
272	Bridge			
309+46 to 310+10	Steel flume	Wood sub-structure	No 108. 64 ft long	Standard. Concrete foundations carried 13' below bottom of arroya. Total height abutments 20' wings 16' long.
334+45 to 335+75	Flume	Maginnis wood sub. Maginnis wood sub.	80 ft long 2176 ft long	Piers 4 to 7 ft below bottom of wash.
349+02 to 370+78	Flume	Concrete	24"	Along a shale bluff. Concrete piers carried from 4 to 7 ft below ground. Steel waterway Standard framing of wooden bent. No. 4.
379	Culvert	Concrete	24"	Standard.
385+50	Culvert	Concrete	24"	Standard.
398+25	Culvert	Concrete	24"	Standard.
424+50	Culvert	Concrete	24"	Standard.
482	Flume	Steel	80ft long	Maginnis. No. 5. Not yet erected.
521+86	Flume	Wood sub.	128 ft long	Maginnis Size 96. No. 6. Not yet erected.
521+86	Flume	Steel	192 ft long	Ditto No. 7. Not yet erected.
529	Flume	Wood sub. Ditto		

The above is the list to the end of September 1916