



ANNUAL REPORT
1917

H. F. ROBINSON
Superintendent of Irrigation

ALBUQUERQUE
N. M.
FRC 44800

48

GANADO PROJECT. NAVAJO RESERVATION.

This project has been the construction of a reservoir about three miles from Ganado, Arizona, in which the waters of the Rio Pueblo Colorado may be conserved together with the necessary diversion structures and canal and the distributing canal. On a flat north of the stream a small storm water lake has existed for many years and by the construction of a dyke about 3200 feet long, with a maximum height of 22 feet, a considerable quantity of water can be impounded and used for the irrigation of lands along the stream below.

Plans and estimates were made of this project and Congress appropriated \$60,100.00 for its construction. The plans prepared were for a diversion of the stream, the construction of the reservoir, the construction of the distributing ditch several miles long, the enlarging and rebuilding of a ditch formerly owned by J. L. Hubbell for several miles further and the extension of this ditch to cover lands below the Hubbell place. The ditch as planned was to cover something over 700 acres of land. After the preparation of the plans and before the construction commenced, the stream shifted its course from where it formerly ran on rock bed to a place in deep alluvial soil, and the channel was cut down some 15 feet below its former level. This made the diversion cost a great deal more

than was anticipated. By instruction from your office, the plans were also change providing for the construction of a concrete head work instead of wooden.

Heavy floods, both from the stream and cloudbursts enlarged both the main stream and side drainage so that a large flume was entirely washed out after being constructed. From a combination of these causes, the money appropriated was not sufficient to complete the project.

An estimate was made for completing the original project and for an extension to bring more land under ditch. The amount necessary was included in the Indian Appropriation Bill for 1916, which failed passage. The construction, therefore, was closed down during the fiscal year 1916. The only work done was that necessary for maintenance.

The Indian Appropriation Bill for 1917 contained an item of \$20,000.00 to complete the project and it was expected that this work would be done during the past fiscal year. In addition to the \$20,000.00 an item of \$3000.00 was appropriated for operation and maintenance.

Work was commenced in July with Engineer Ritter in charge temporarily. As the work had been closed down for a year there was considerable preparatory work necessary before real construction could be done.

Work was just under full swing when, "On the evening of July 30th, a flood came down the Rio Pueblo Colorado

that did considerable damage. The upstream wingwall at the headgate was carried away as was most of the spillway lip. The headgate structure and the bank of the ditch were overtopped by this flood. The upstream bank of the supply ditch was breached in two places and all the riprapping in the ditch adjacent to the headgate structure destroyed for all practical purposes.

The crest of the flood completely covered the headgate structure and deposited thereon a log about two feet in diameter and nearly thirty feet long. At times the water in the channel of the wash was slopping over the crib dam threatening its destruction. A considerable amount of water flowed around the east end of the crib dam.

The auxiliary crib immediately below the main crib was undermined and all the rock filling carried away. This was caused by the water pouring over the end of the concrete wing wall flanking the crib dam, and from the backwash from the main channel.

The flood after breaching the banks deposited from one to three feet of silt and debris in the supply ditch connecting the headworks and the reservoir. This ditch was bank full and running over, and in three hours, the duration of the flood, raised the reservoir level one foot. The camp building had from one to two feet of water in them and some of the cement stored in the shop was spoiled.

5-1

On the ditch line from the reservoir to the farms damage was confined to two places. At about Sta. 15, where the ditch closely followed the bank of the wash, the protective riprap was partially carried away and the bank of the wash eroded, part of the latter developing a slip or slide. The ditch itself was not breached but a protective cribbing and riprap are necessary here.

At flume No. 3 the flood lowered the channel of the wash about three feet. The protective crib around the piers supporting the lower or south end to the truss was carried away. It seems that the battering of the great number of logs and trees carried by the flood has shifted one of the piers very slightly. The footing of the piers should be carried down further and another protective crib built."

Temporary repairs were made immediately sufficient to allow water to run in the ditch, and work was resumed on the storage dam which was to be finished to the 19 foot elevation and the entire inner slope riprapped. Earth work was continued until the end of November when the ground froze too hard to do any further work, but a force was continued quarrying rock and placing the riprap. As soon as the weather conditions would permit work was resumed on the earth work of the storage dam which was completed and the riprap was also placed. Before the end of year 39,829 cu. yds. were put in the dam and 6,268 sq. yds. of riprap placed. In addition to this

the usual maintenance and operation were continued and such repairs as could be made with funds available was done.

It would seem some malign influence was working against this project, for in addition to the July flood, there was numerous heavy storms during the year doing considerable damage to the ditch each time. On February 23d, the weather moderated suddenly after heavy snows causing a heavy runoff and the arroyo just above Flume No. 4, cutting back took out part of the canal. Its further retrogression was stopped by putting in a wooden sluice and about 150 feet of the ditch was reconstructed around this. A heavy storm in July cut around the end of Flume No. 5 and as the ditch was carrying considerable head of water the lower end of the flume was partly wrecked and the water from the ditch escaped into the arroyo cutting a deep channel. Temporary repairs were made and the water was in the ditch again within a few days. Permanent repairs will be made as soon as possible.

During the night of February 27th the outlet tower and gate of the reservoir were wrecked by ice.

The damage was not done by broken ice but the entire ice sheet of the lake which was over twelve inches in thickness became detached from the shore line its entire circumference by melting, and during the night this entire mass was moved by a high wind against the

dam and the tower, entirely wrecking the latter. Great blocks of ice were crowded up the banks to a height of over 3 feet above the water elevation. The escaping water did some damage but nothing material.

Some movement of the ice around the tower was anticipated and to prevent any damage the ice was kept cut away from the vicinity of the tower for a number of feet, but after the ice mass became detached from the shore the tower was standing in open water.

No further money was appropriated for Ganado for 1918 excepting \$3,000.00 for operation and maintenance, but work will be continued on the construction of the extension of the canal with the unexpended balance still available for this purpose and the work will be extended as far as possible and it is hoped to have about 11,000 acres under ditch by the time this money is gone.

Very little land has been put under cultivation by the Indians as yet. All of the area under ditch has been subdivided into small tracts, but no movement has been made to allot any of this. While the Indians are desirous of cultivating the land, they are unwilling to go on to any tract and put in the work and money necessary to get it under cultivation, until they are sure that they will have a permanent right there.

I have directed the men in charge to furnish

water to any Indian applying for it, but to give no Indian any assurance that he will be allowed to remain on any tract of land selected for this is a matter that does not come within the jurisdiction of this office.

I believe that if any Indians desiring to cultivate a tract could be given positive assurance that he will be allotted the land selected, even though at some distant date, a great many would commence operation at once.

A large tract of the best land of this project, which aggregates some 270 acres has been withdrawn from any settlement by Indians for the purpose of using it for a school farm. This action also seems to be a preventative keeping the Indians from settling on land under the ditch.

UNDER GROUND WATER DEVELOPMENT.

The area covered by the Navajo and Hopi Res-
ervations, while not an absolute desert is an arid region,
most of the country having a very scanty rainfall, which
is very irregularly distributed throughout the year.

The greater part is of a character on which the
average white man would be unable to more than exist,
although the Indian population from generations of
living here, manages not only to make a precarious
living, but in many instances what would be considered
a competency by the white man.

While the rainfall is very scanty it is still
sufficient to bring to maturity grass and other vegeta-
tion in most parts of this country, forming good grazing
lands at certain times in the year.

Notwithstanding the fact that the feed conditions
are fair for grazing, the size of the flocks and herds
of the Indians have been limited heretofore from the
fact that the water supply has been insufficient and
there are great tracts of land where no surface water
exists, other than an occasional small spring or seep
or in temporary water holes following storms. In other
words the limit of the size of the flocks and herds is
set by the existance or non-existence of a water supply,
not by the feed.

It is because of this that the Indian Service

85

has been endeavoring for the past six or seven years to increase the water supply of these reservations. Water is desired in this country both for stock raising and irrigation though not much attention is given to developing underground water for the latter purpose.

The proper water supply for a grazing country involves not a few large supplies but many small ones; not an increase in quantity where water now exists, but a moderate supply at various points where at present it is not found, and the points where water is needed is where advantage may be taken of the grazing areas of the reservation.

In considering the development of water in new places it must be borne in mind that too great a quantity of water at any one place when there is a scarcity at others will have a tendency to cause that part of the range to be over stocked and as at no place is the grass and natural feed very luxurious more harm than good may be done, by the overgrazing and the stock trampling out the grass.

Stock raising, especially the raising of sheep, on these reservations has proved the salvation of the Indians. They are natural herdsmen and for a number of years their flocks have increased to about the maximum figure that the natural water would supply, although the limit of grazing has not nearly been reached. The natural increase of the flocks would

reach a maximum point, then there would be a season of drouth and the mortality would be very great reducing the flocks to that number that could exist on the water supply.

Under Ground Water Development in this District can best be considered by dividing it into five headings:

- (1.) Deep Well Drilling(Exploring for Artesian Water.)
- (2.) Shallow Well Drilling(to 300 ft.) Navajo.
- (3.) Well Maintenance.
- (4.) Spring Development.
- (5.) Shallow Wells, Pueblo.

The Office is familiar with the first efforts in developing artesian water where a well over 1300 feet was drilled at Keams Canyon, in order to determine whether it was possible to secure artesian water at any point south of the Black Mountain country. The trial resulted in failure and on the advice of the geologists the rig was transferred to the Choiska Valley; a well put down at the head of that valley some nine miles east of Tohatchi and about twenty-five miles north of Gallup. Artesian water was found at about 1000 feet and just below 1100 feet the flow was increased to 6500 gallons an hour. This proved conclusively that artesian water could be found in this valley, but the Indian Office decided that the cost of putting down such deep wells would not be justified by the results and I was directed not to go to such depth in the future; but to develop water at the shallower depths, securing

artesian water if possible but if flowing wells could not be made to follow the plan of putting in pumps and windmills as is done in other parts of the reservation.

The rig was moved north and east and good artesian flows have been developed at depths varying from 205 to about 500 feet. Other details will be given of these wells at another part of this report.

Two well rigs have been operated throughout the year putting in the shallow wells; one of them has been operating along the north and northeast side of the Black Mountains and in what is known as the Kayenta country; the other one, at the beginning of the year was working in the lower Chin Lee valley in the vicinity of Round Rock, but early in the year was moved to a point just within the border of the Hopi Reservation, but on land entirely occupied by the Navajo, lying south and southwest of the Black Mountains. It has been working west in the valleys coming down from this high ground during the year. An inspection of the map accompanying this will show the location of the various wells put down during the past year as well as those put down in former years.

The Indians are very anxious to have the well work extended as fast as possible, and in most sections they are cooperating with this service in every way

possible; are furnishing teams to help in moving the rig, hauling wood and water and doing other work of a like nature without charge as they feel that they will be benefited to such an extent that they are willing to donate time and labor in helping the work along.

Well maintenance is under the charge of Foreman Tomack and the actual work and inspection is done by men under him.

A camp is maintained at Chin Lee and from this all the wells in the Navajo country are visited at frequent intervals in order to oil these windmills and attend to all minor repairs, that may be necessary to windmills, pumps, troughs and tanks Polacca is the headquarters for the Hopi inspection and maintenance.

This maintenance work is absolutely necessary for any country and doubly so where the wind carries a great deal of sand and dust and the atmosphere is so extremely dry. Unless the windmills are regularly oiled the bearings soon cut out. Owing to this necessity for frequent oiling we have been installing a new type of mill, which is known as the auto oiled mill, in which all of the gearing and working parts of the mill are inclosed in one dust proof case, which contains a reservoir filled with oil and all of the working parts are automatically lubricated in a manner similar to the oil distribution in an automobile. It is only necessary

to fill this oil reservoir once or twice a year. While the cost of this mill is somewhat greater than that of the open type the difference in the cost will more than be offset in one year's operation and maintenance.

The oiling of the mills is only a small part of the care, however. With a well developed in the fine material encountered in this country the pump leather and valve last but a short time, in some wells only a few weeks. Then the pump rod must be pulled and a new leather inserted, at other times wells that are pumping considerable sand are frequently badly damaged during periods of calm when the windmills do not run and sand settles on top of the valve in sufficient quantities to weigh it down or even to fill the cylinder and when the windmill again begins to turn the valve is immovable resulting in the breaking of the pump rod or the wrecking of the cylinder connection. A report is sent in for each well visited with a memorandum of the work done, from which we keep track of the work and the costs.

In the well drilling we have had much trouble in developing a sufficient quantity of water at many points when it is found in sandstone owing to the fine nature of the sandstone and the slow movement of the water.

Experiments have been made during the past year in shooting the wells with very gratifying results. In drilling one of the wells with Rig No. 4 a fairly good

strata of water bearing sandstone was encountered but the water came in so slowly that with the sand bailer at work the entire amount of the flow would be bailed out by lowering the bucket twice. This well we shot with a small charge of ordinary 40 per cent dynamite and after cleaning it out the flow had increased to such an extent that it was impossible to pump it dry with a pump and it is proposed hereafter to shoot all the wells developed in sandstone, that are of this character.

The wells with the artesian flow are also developed in rather fine rock and we are going to try the experiment of shooting the last one put down, believing that the flow can be materially increased in that manner.

In the report of Foreman Womack for the month of June just received he makes some general statements which cover conditions very clearly and I will quote him to some extent that you may get the viewpoint of the man in the field.

"The work in the Moqui Reservation is confined to the development of water for domestic and stock use, by developing springs, making surface water reservoirs, drilling wells (50 to 300 feet deep) erecting windmills, tanks, troughs, etc.

Owing to the fact that we have increased the water supply the Moki Indians have increased the sheep and cattle to such an extent that we cannot keep pace with the demand for more watered range, notwithstanding they have three or four times as much range as they had five years ago. The Indians have become interested in the cattle and sheep business and are making use of all the water that has been developed. Many of them have in-

creased their herds three, and in some cases, four hundred per cent in the last five years. This progress may be expected to continue if water can be developed in more of the outlying country. In years past the Indian did not care to have many sheep as he was forced to lose them the first dry year as there were no wells or permanent water, and naturally the sheep would die off to a number that could live on the amount of water remaining. But now, with wells, we have developed water that is not affected by the drouth and they can see where it is possible to raise large numbers. Also we have confined the water in troughs where it can be clean and not so many die from drinking stale water. Many of the Moki Indians are abandoning the village and moving out to the windmills where there is an abundance of water, living there with their stock instead of driving them into the village at night.

We have drilled many wells in the part of the Moki Reservation inhabited by the Navajos and developed six good wells which has developed a large area of excellent grazing country. This will add to the available grazing about 30 per cent and will take care of thousands of sheep and cattle. The above country was almost without water. If we get a good flow of water in the Cedar Ridge Country, which is the next move with Well Rig No. 4, we will add a large country to the west side of the Moki Reservation and the east part of the Western Navajo Reservation.

Navajo Reservation.

We have kept in a repair all the wells on the Navajo Reservation and maintained a good supply of water. One string of wells on this reservation is 150 miles long and other strings leading off from this string make a distance to travel to take care of them about 350 miles and this is covered once a month for the reason that if one of the wells fails it is necessary to move all the stock to another well as the herds are in the most cases so large that they cannot find sufficient amount of water at the springs.

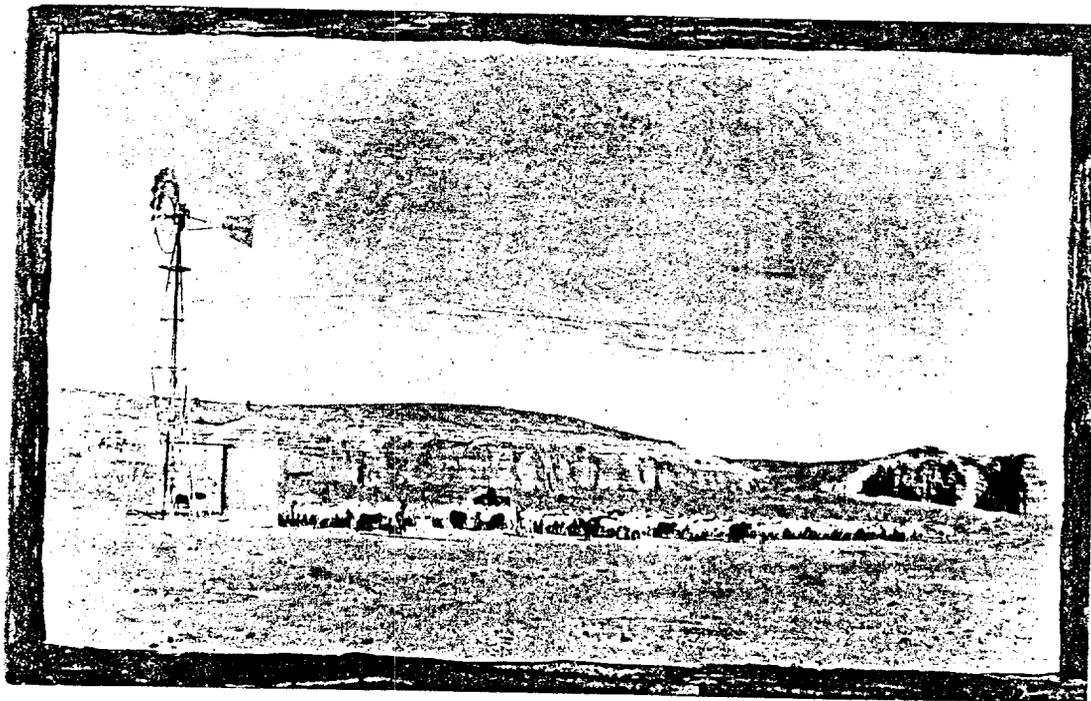
The Indians realize that they have a permanent supply of water and are giving their attention to the stock business and are increasing the number in great proportions and are willing to help in any way that they can to get more water.

Many of the Indians are building houses at or near the wells and establishing homes as they

can depend on the water supply and do not have to move the herds as they did in the past when they were compelled to go great distances to permanent water.

When you realize that one of the wells drilled by Rig No. 4 will flow twice as much water as the combined flow of all the springs in the Navajo and Moki Reservations you can appreciate what the wells have done to water the reservation and how little permanent water there was on the reservation."

* * * * *



An area of 40 square miles is often tributary to one of the wells dug in the Navajo land.

SPRING DEVELOPMENT.

During the year the work of developing springs on the Hopi reservation has continued, although not as rapidly as desired. The reason? Lack of money. We have been doing the spring development work on this reservation from the fund "Support of Indians in Arizona and New Mexico" and the amount available has been insufficient for the work we are doing. It has been divided between the well drilling for the Pueblos and the Hopi Spring Work. I cannot put the situation better than to quote from the April report from the foreman in charge. He says:

"The main drawback is the lack of money to carry on the work on a larger scale; for instance the country is so large that it is impossible for me to personally to supervise work in the remote sections as we do not have enough money to hire men to look after cementing up the springs and fitting in the pipe etc., it is a waste of material to go and lay out a plan of development of a spring and have to leave before it is completed as to leave much work as placing a filter, laying pipe, or cementing up the springs in the lands of the Indians, and for that reason the spring work does not go fast as it should. The Indians are increasing the herds so fast that we cannot keep up with them with the water development. What we should have, in my opinion, is a mason that can carry out a plan of development and have him help me do this kind of work that the Indians do not understand. I can get plenty of labor donated if I had time to go to those far away places and stay until a place was finished.

The Indians have seen the benefit of more water and are much encouraged and are making good use of the water, many of the progressive ones are willing to donate money or labor to help the work along. If we can keep up with the present increase of stock, with the water the Indians will make more progress in the stock business the next five years than they have done in the past fifty. As the stock in this country has always been limited to

the amount of permanent water, in the past when a drouth would come and the springs dry up the stock was forced to die off to the number that could live on that amount of water.

While the springs are becoming of less importance as compared with the wells, they will furnish a small permanent supply of water and do not require expensive labor. Also people looking at the map would get an idea that if the springs were developed that there would be all the water that the range required. This is in no way true, as many of the springs that are marked on the map are mere seeps and do not flow one gallon per hour, and there are others that if developed and conserved will water all the stock that will be able to travel to it.

Also many of the springs are in sandhills and as soon as they flow out of the close or impervious formation they are at once lost by seepage. In some cases the seepage is equal to the flow of the spring and a good spring will only be indicated by a moist place on the sand, and can be developed by excavating back to solid formation and all seepage cut off and piped to a concrete reservoir where there is only the evaporation and no seepage."

To further show the interest of the Indian in this work I will quote a letter from one of the Indians working for the Service on the Spring and Well Development. When it is remembered that when this work commenced several years ago the Indians as a whole opposed it, thought we would do something that would deprive them of the little water they had and were almost at the point of resisting by force any tampering with the spring, the change wrought by careful handling of them, ~~and~~ the situation is little short of marvelous, and the improvement in the condition of the Indian, the increased flocks, the moving down from the mesa of many is almost if not as great. The letter is as follows:

Polacca, Arizona, Feb. 22, 1917.

Mr. H. R. Robinson.

Dear Sir:

I am here dropping you these few lines to notify you of what the Indians think of the wells and the fixing of springs. I have talked with the Indians about it and they are all interested in it and have promised to help along with the work. The second mesa men have all got together and told me to write to your office people about it and they have select their men to look after the wells and spring work and are all willing to help what ever help we need and they all said that they all have organized a working party and will be willing to help and they have asked for these things to be furnished so that they can use them in building reservoirs and they said they are going to pull you people and have more wells dug south of Big Burrow spring as they said they needed wells down in that section of the country but as the well rig is slow coming through they said for you people to please send 6 plows 6 scrapers to be used in building their reservoirs, they are well pleased and willingly came over together to listen to what I had to say and I told them that we were suppose to help along with the work and to help ourselves for I told them every one has got some stock to look after and they said for you people please help them out, for they all claim that the reason the Indians do not all have stock and they just look up to the men who has got more cattle to think about the wells and springs but they said that they will all get together and work together and help you people and they themselves for they said they want the springs fixed and more wells dug. And they are going to all get together and work together so they said it will be easier for them to have more wells.

Well friends, I hope you will understand my writing and what I mean as though I am a very poor writer and has got a cripple hand and I am doing what I am asked to do by all the Indians. Well I will close my writing.

I remain your friend

Nelson Polacca.

P. S.

All the Indians are very much pleased and are thankful for the wells and all are well organized now every village has its own men selected to look after the work and they are going to help here at first mesa and other villages. There for they want help from you people and they do not ask for money but they are going to help along with the work and have more interest with the wells and springs.

Cencerly yours

N. Y. Polacca.

The progress in the spring work is best shown by the List of Springs, Hopi Resefvation, which is added to this report as a supplement. A list of all of the known springs on this reservation has been prepared, and a statement made concerning the development or such other information as may be needed. It has involved considerable labor and is the result of several years' work and observation.



Bridal veil Falls.
Havasas Canon Ariz.

Well Rig No. 5.

Because the conditions under which this rig has been working and the nature of the work done it has not been included in a comparative statement with the other three outfits.

At the beginning of the year the rig was directed to proceed to what is known as Canyoncito, a settlement of Navajos who live on the southeast slopes of Mount Taylor, far from their kindred, and under the jurisdiction of the Superintendent in charge of the Pueblo Indians, and classed with them in administration.

The section occupied by them is almost inaccessible and very dry. The first move was to build a road over which the rig could be moved. In this the Indians did much of the work without any compensation.

The first well put down, No. 543, was in a deep canon, with but a poor wind exposure, at an elevation of about 7000 feet, but with no water within seven miles and greatly needed, In fact in the whole settlement there was but one well and one spring which was in such condition that it gave but little water.

The conditions in here were very unfavorable for the development of any water. What was found was of very poor quality, most of it alkali, and the formation which held the water was without exception in a quick sand or soft muck very hard to control and difficult to develop the water in after it was found.

109

Four wells were put down and the one spring developed as follows:

Well 543. Depth 57½ feet, quality of water only fair. At 30 feet struck water bearing soft silt, from which it was difficult to separate the water. After pumping with the bailer well began to cave and it became necessary to fill hole with crushed rock as fast as it caved, to a depth of 53ft. After cave was filled the casing was driven through the rock. After screened casing was placed, water cleared after 4 hours pumping. Discharge 200 gals. per hour.

Well 544. Depth drilled 101 ft., afterwards cemented off at 60 feet as the water was unfit for use.

Quality of water:

"Good, soft water was encountered at 31 ft., but the quantity was insufficient to warrant the erection of a windmill; so a hand pump was installed, making the water at this level, available for immediate use, for domestic purposes; and the Indians of the settlement being so well pleased with the quality of this water, have selected this location for a future day school, and through their anxiety for its creation, on December 5th, 1916, Mr. Platero and his helpers began sinking an underground storage cistern, adjacent to Well No. 544, with hopes of increasing the volume in the drilled well, they sank through sand rock to 27 feet, from which level, myself and helpers sank the remainder to 34 feet, and tapping the drilled well, which is 3 feet distant from the underground storage cistern; this development has greatly increased the water volume, so that a windmill was erected on the drilled well, and the hand pump with a 1½" ball valve cylinder attached to a 2" Galv. pipe, standard iron pump head on a platform was installed on the dug well or cistern, and same having been covered by laying 4 iron cross joists over the opening at 4' below the surface on bed-rock covered same, with

sheet iron and flat rock grouted in cement an opening 18" x 30" walled with rock layed in cement to the surface to exclude rats and snakes which are very numerous in this section of the country. The dug well or cistern was lastly covered with 2" lumber on which the hand pump is set. The Indians of this settlement are now eagerly looking forward to a time, when the creation of a Day School will take place, same of which has been an urgent necessity for many years past."

Well 545. Depth drilled 85 feet, amount developed all that a 2½" cylinder can pump.

This well gave great trouble in its development and it would have been abandoned but for the fact that the location was a central one and it seemed almost absolutely imperative to make a well here if possible.

The formation where this well is located was evidently an old lake bed in the bed of a canon which has been filled with silt and drift sand to water level and which has been covered with adobe at a later date. To give an idea of the difficulty in developing a well here the following excerpt is made from the daily log of the driller:

3. Drove casing 3' and bailed sand.
4. Bailed sand. Succeeded in removing sand to 66' from surface. Sand raising as much as fifteen feet in casing. Sand coarser and water more abundant.
5. Succeeded in driving casing 2½' deeper which cuts off quicksand. Casing resting on heavy blue clay.
6. Mud rose in casing 9' during the night. After bailing same to bottom of casing at 72' or one foot below casing sand and mud again rose 15' in casing. Succeeded in bailing this out after which filled the casing with 2 feet of hard crushed rock. Drew casing back 6" and bailed balance of day. Water beginning to clear.
7. Found 35' of water standing in casing in the morning. After pumping with bailer two hours, sand again caved and cut off all water. This was drilled and bailed out to bottom of casing when water again came in. After

- 111
- bailing this water (4 gallons per minute), till nearly clear it again caved and shut off the water, and repeated this three times during the afternoon. Indications are quite discouraging.
8. Sunday.
 9. Found 34 feet of water in well in morning; sand had risen only 3 ft. Pumped out sand, mud and water for 2½ hrs. Well did not cave during day. Worked on perforated screen balance of day.
 10. Rain the entire day. Worked on screen etc.
 11. Rain all day. Between showers well again bailed. Find sand again rose in casing and shut off water. Placed screen in well which failed to hold sand back.
 12. Made fishing tool for drawing screen back but found quicksand held same so tight that it could not be withdrawn by engine. Drilled out bottom of screen and again started water, but less in quantity.
 13. Rain all day.
 14. Rain until noon. Found quicksand had risen 9' in casing. Drilled this out to 69' from surface, there being only a small amount of water.
 15. Sunday.
 16. Made general repairs to drilling rig and wagons.
 17. Drilled and bailed all day trying to clear casing and to start water which was cut off by sand cave.
 18. Succeeded in starting water and continued bailing sand. Prospects for clearing water promising.
 19. Bailed sand till 2 P. M. water nearly clear when well again caved shutting off all water. Drove casing 2' and again and again drilled and bailed out sand and mud.
 20. Added 21' of 6" standard pipe to casing which extended to surface to ground and when pumping was resumed found sand risen in casing 19'. Succeeded in cutting off sand at 5' from bottom at quitting time.
 21. Sand did not raise during night. Drove casing 3'--to 70' in clay. Encountered small amount of gravel which seemed to close off part of sand. Pumped and bailed balance of day. Water nearly clear. Promises to be O.K.
 22. Sunday.
 23. Pumped well with bailer, then filled in 2' of hard crushed rock. Resumed bailing after 5 P. M. and found water again shut off by a new cave.

(Work was transferred to the developemnt of a spring some distance from there, the development consisteng of blasting back into the rock and making a basin to hold the trickle of water).

28. Owing to the fact that I had no more 6" casing in camp and the sand and mud continued to come in I concluded to case with the 3½" casing inside of the 6". Six feet of the bottom of the 3½" has 60 - ½" perforations, covered with galvanized iron, slotted perforations 1" x ½". These perforations are held apart by winding a coil of galvanized wire over the casing and over this the galvanized sheet iron with nearly 1000 of the slots. I could not clear the sand to the bottom of the large casing so had to drive the small casing from 71 feet. Succeeded in getting down 81 feet where I found some sand rock. I hope to pump with bailer to clear water.
29. Sunday.
30. Found sand cut off and water rising to 36 feet from bottom of well. Pumped with bailer till noon. Water coming in nicely and entirely.

(Work resumed on spring to give well time to cave or otherwise misbehave before finishing.)

Well 548. Depth of well 110 feet. Good flow of water quality fair, from the standpoint of the Indian for stock purposes but not fit for domestic purposes. It is located in an open valley and much needed for stock.

Well No. 546 is the Platero Spring and was developed. This spring was but a trickle of water in the sandstone, and was developed by following it back into the rock until it was certain all of the water was found and then making a good cement lined reservoir into which the water was led and preserved. Driller Miller reports as follows:

"The completing and developing of Project No. 546 known as the Platero Spring, from a small seep in a sandstone crevice, to a modern, up-to-date cistern or well, whose capacity has been increased to deliver forth a stream of water, approximately one barrel per hour, of excellent, clear, pure, soft water, which is conveyed from the cistern or well through an 1½" pipe to a watering trough 30" wide, 12" deep and 16" in

113

length, whose ends and one side are of stone laid in concrete and whose wall and bottom are plastered with concrete also.

The developing of the spring, rendered it, as being one of the most valuable water properties now possessed by the Navajo Indians of this settlement. Heretofore, this spring was the only source of their water supply, through winter and early spring months, both for domestic and stock purposes, for several decades past. Occasionally, during the rainy periods (such periods at times being few and at long intervals) the surface water was utilized until it was exhausted by stock consumption and evaporation and also at certain periods, this section of the country has been a victim of "Drouths" which after times forced the inhabitants of the settlement to flee to the "Navajo Reservation" where food for themselves and pasture for their flocks and herds could be procured.

But now, since their water supply has been developed it stands to reason that they will be better equipped to combat with the elements of nature in whatever form they may make their future appearance.

Proud and thankful owners are they, to know and realize that the "Great White Father" at Washington, has at last come to their rescue, by sending men and machinery with which to develop their water resources."

The work for these Indians was completed in February and the driller was sent to inspect the wells put down heretofore for the Pueblos of Acoma and Lagunas, word having been received that they were in bad shape and many of them not working.

After they were put down they were turned over to the custody of the government farmers, but it would seem that they either failed to understand the necessity of frequent inspection and care or neglected it.

Well after well visited was found to be either entirely out of commission or in very bad condition, and many of them required new parts and several should have entire new pumping heads.

The drilling rig was sent on to Isleta and stored there, and such tools and equipment as was needed was taken with the crew to the Acoma and Laguna villages. About fifteen of the wells were over-hauled, some of them were not entirely finished owing to the delay in getting repair parts. Early in May it was seen that there would not be sufficient funds to carry on the work to the end of the year and a request was made for additional funds, but there was none available, so the rig was closed down and the men laid off until July 1st.

With the new year we will finish putting these wells in shape and following that will move on up the Rio Grande putting in wells for the various river pueblos for domestic water.

LEUPP, ARIZONA.

Authority was given to expend the sum of \$900 on building some dykes at this place to guard the Agency and School from flood waters which come in from the south, a portion being surface water from higher lands to the south and a portion being overflow water from the Little Colorado at extreme floods.

The work authorized was the building of two levees, one about 1000 feet long and 5.5 feet in height and the other about 3000 feet long with an average height of 2.4 feet.

Two other dykes needed to be repaired and strengthened, and the Agency forces combined with ours and this work was also under our supervision.

The work consisted of the moving of 3700 cu. yds. of earth at a total expenditure of \$877.22, and the agency should now be well protected against the floods by the work done. There is still danger of the river at some time changing its channel and doing further damage, but that cannot be counted upon nor guarded against with a reasonable amount of expenditure.

NEWS LETTER

Issued occasionally by the Superintendent of Irrigation,
U. S. Indian Service. District No. 3.

No. 2.

Albuquerque, N. M. January 1917.

TIPS

MISSDIRECTED ENERGY IS MENTAL
AND PHYSICAL FORCE SPENT
IN CHASING A GOOD
THING IN A DI-
RECTION IT
HASN'T
GONE

IF you had to do your work over again, the chances are that you would do it differently than you have done.

But how would you do it differently? I'll tell you one thing, and that is that you would make the same amount of effort for a bigger result.

You would not cultivate a lot of bad habits that you now have.

You would be more thorough. You would systematize your work. You would plan your work.

Why not apply this same plan to the future?

There would be a good basis to build the rest on. You would be prepared for the future!

Apply these present ideas both to the present and to the future.

© 1917

PROJECT THUMBNAIL SKETCHES.

GANADO, Arizona.

This project consists of a diversion from the Rio Pueblo Colorado, about 3 miles from Ganado, Arizona (60 miles from the railroad at Gallup, N.M.), a storage reservoir and distributing ditch.

The land to be irrigated lies in a long narrow strip; the area available is only limited by the storage capacity.

In 1903, Mr. J.L. Hubbell acquired water rights and built a ditch from this stream to divert the normal flow to his ranch.

Later Mr. Hubbell made a proposition to the Department to give up his water rights and constructed ditch in exchange for a reservoir right and carrying right in the ditch, and he agreed to guarantee the maintenance of the ditch so far as the annual cleaning was concerned indefinitely. His reservoir rights to be 400 acre feet per annum. This agreement was ratified by the Department on May 31, 1913.

The reservoir is being constructed by building an earthen dyke high enough to impound water 16' deep with an ample free-board. The dyke is 3200' long. At 16' the reservoir will contain 4438 acre feet.

The diversion consists of a rock filled crib dam, a concrete headgate with 4 openings, a diversion canal 16' on the bottom and a sand gate with a baffle wall across the canal.

The reservoir outlet is a concrete culvert 12" x 13" under the highest part of the dam, the steel gate being operated from a skeleton steel tower which is the bottom 30' of a 40' three-legged wind mill tower, which

NEWS LETTER

Issued occasionally by the Superintendent of Irrigation,
U. S. Indian Service. District No. 3.

No. 2. Albuquerque, N. M. January 1917.

TIPS

MISDIRECTED ENERGY IS MENTAL
AND PHYSICAL FORCE SPENT
IN CHASING A GOOD
THING IF A DI-
RECTION IT
HASN'T
GONE

IF you had to do your work over again, the chances are that you would do it differently than you have done.

But how would you do it differently? I'll tell you one thing, and that is that you would make the same amount of effort get a bigger result.

You would not cultivate a lot of bad habits that you now have. You would be more thorough. You would systematize your work. You would plan your work.

You may not apply this same plan in the future.

It would be a good basis to build the rest on. You won't be looking for the future.

The present makes both the future and the past.

W. H. HUBBELL

PROJECT THUMBNAIL SKETCHES.

GANADO, Arizona.

This project consists of a diversion from the Rio Pueblo Colorado, about 3 miles from Ganado Arizona (60 miles from the railroad at Gallup, N.M.), a storage reservoir and distributing ditch.

The land to be irrigated lies in a long narrow strip; the area available is only limited by the storage capacity.

In 1903, Mr. J.L. Hubbell acquired water rights and built a ditch from this stream to divert the normal flow to his ranch.

Later Mr. Hubbell made a proposition to the Department to give up his water rights and constructed ditch in exchange for a reservoir right and carrying right in the ditch, and he agreed to guarantee the maintenance of the ditch so far as the annual cleaning was concerned indefinitely. His reservoir rights to be 400 acre feet per annum. This agreement was ratified by the Department on May 31, 1913.

The reservoir is being constructed by building an earthen dyke high enough to impound water 16' deep with an ample freeboard. The dyke is 3200' long. At 16' the reservoir will contain 4438 acre feet.

The diversion consists of a rock filled crib dam, a concrete headgate with 4 openings, a diversion canal 16' on the bottom and a sand gate with a baffle wall across the canal.

The reservoir outlet is a concrete culvert 12" x 13" under the highest part of the dam, the steel gate being operated from a skeleton steel tower which is the bottom 30' of a 40' three-legged wind mill tower, which

will later be sheathed with concrete if it shows much corrosion. This construction was planned to save the large cost of a concrete outlet tower.

Five and a half miles of ditch have been constructed or rebuilt. There are six flumes on the line. The largest flume is in part a 72' steel truss resting on piers constructed by sinking two corrugated, pure iron culverts, 2' in diameter to the depth desired, using rods and angles as bracing between. The iron pipes were then filled with concrete and capped with a steel I beam upon which the truss rests.

Heavy rains and floods did considerable damage to the unfinished project this summer and considerable repair work was necessary. The work for the year will be to repair the damages done, to bring the reservoir dyke to a level surface three or four feet below the finished structure and to extend the main canal about three miles, with the placing of the structures.

The total expenditures on the project to date has been about \$70,000.00.

Pine River Valley Project.

The Ute Indians originally occupied a large portion of Colorado and their lands extended down into New Mexico. The first treaty made by the government was in 1850, by which they agreed to settle on lands in Colorado where they could make a living by agriculture and pastoral pursuits. Five or six subsequent treaties were made with them, each reducing their reservations until they finally had a strip in the southwest corner of the state bordering on New Mexico, 15 miles wide and about 140 miles long, including the lower valley of the San Juan, Piedra, Los Finos, Florida, La Plata, Las Animas, and Mancos rivers in Colorado. By two treaties, one in 1880 and the later in 1895, the majority of these Indians agreed to have their land allotted to them in severalty, and for those who did not so decide, a reservation was made of the west 40 miles of the old reservation. The Indian allotments that were made were along the valleys of the San Juan, Piedra, Los Finos, or Pine, Florida, Las Animas, and La Plata rivers, the bulk of the Indians being concentrated in the Pine River valley. A number of small ditches were taken out from the various streams in the early days which irrigated a small amount of land, but the bulk of the Indian lands were without water.

It is desired by the Indian Office that the good lands in the Pine River valley should be put under water and work was begun by surveys in the early winter of 1909. After the surveys were made it was decided to take out ditches on both sides of the river, forming two units. Each unit was designed to cover four or five thousand acres of land. Construction work on the project was actually begun in July 1910, and by the end of the fiscal year 1915, the main canals of the east side unit were practically completed with the exception

News Letter

Issued occasionally by the Superintendent of Irrigation, U. S.
Indian Service, District No. 3.

No. 3. Albuquerque N. M., March 1917.

T I P S .

The less you require looking after, the more able you are to stand alone and complete your tasks, the greater your reward. Then if you can not only do your work, but direct intelligently and effectively the efforts of others, your reward is in exact ratio, and the more people you direct, and the higher the intelligence you can rightly lead, the more valuable is your life.

-- Elbert Hubbard.

P R O J E C T T H E U N D E R G R O U N D S Y M P O S I U M .

UNDERGROUND WATER DEVELOPMENT.

We have been developing the underground water for the Navajo, Hopi and Pueblo in two ways -- by drilling them wells and by developing and improving the springs and conserving the water.

This is the most important work we are doing although it is not as spectacular as the building of large canals and the construction of big reservoirs for the impounding of water for irrigation.

The development of this water is for stock and domestic water, and if in so doing we can develop a little surplus water for the irrigation of a small patch of ground in addition, so much the better.

The entire Navajo and Hopi Reservations are arid -- almost absolutely desert in places. There is more or less feed for sheep and cattle but the watering places are so few and far apart that only a small portion of the grass area can be used, and much of that part which is used can only be ranged during the winter when there is snow or after the rains when there can be found some water holes which last for a short time only.

It is the policy at present to follow out the most likely places and put down wells at intervals of six to ten miles, that with the development of a small quantity of water an additional area of grazing land may be opened up.

Care must be taken in this water development that it is not overdone. That is, if we put down too many wells or develop too much water at close intervals the tendency of the Indian will be to overstock the range and quickly feed or trample it out. A small amount of water will care for a limited number of sheep and cattle which will be able to subsist on the grass of the region without destroying it is what should be striven for, and this will do the most good for the Indian.

The spring development has been particularly beneficial to the Hopi Indians.

Their range has been limited to the lands immediately adjacent to their villages, and the result has been that the range is practically worn out. They never took much care of the springs and the filth had accumulated in them until it is a surprise that the Indians could use the water and live. The springs used by them for the sheep only, were in such bad condition that often during the summer when the water was low and the sheep particularly thirsty from the hot weather that the first of the flock would get into the water, stir up the muddy filth, and the balance of the flock would come to the spring and be unable to drink, and often when driven frantic by thirst they would drink of the semi-liquid filth, and within a few minutes lie down and die.

Since the development of the spring water and the drilling of wells further from the villages the Indians have ranged the flocks further out, and because of the distance many of them have come down from the mesa tops and built themselves homes in the valley. The flocks having a plentiful supply of clean drinking water and better feed have increased many fold in the past few years and the prosperity of the tribe has greatly increased.

To show the interest they are now taking in the work, each of the villages have appointed a committee who are to cooperate with this service in the work and to do as much as they can to help themselves along the same line we have been working. This is one of the most important moves the Hopi Indians have taken for their own improvement in generations.

The water development is under the immediate supervision of Foreman A. H. Wemack who is located at Polacca, at the foot of the First Mesa. He looks after the spring development, the maintenance of all of the finished wells in the Navajo and Hopi Country, and has a general supervision of the well drillers in addition. Anything in the line of water development in either of the reservations is looked after by him.

The records of this office shows that there has been development work done at 28 springs in the Hopi country alone, and a large number of springs have been developed for the Navajo also.

WELL RIG No. 1 is the largest rig and is now working in the Chaiska Valley, north of Gallup and is working along the valley through which the Gallup-Shiprock road runs.

Artesian water has been found in this valley and it has been found at depths between 500 and 600 feet. The first well, near the head of the valley is a little over a thousand feet deep, and another well, with a small flow, is only a very little over 200 feet deep.

It is hoped that a line of artesian wells may be found clear through to the San Juan, and that later, after the country is explored with the drilling, to come back, and at favorable points to put down larger wells and develop sufficient water for irrigation. Oscar F. Olson is the driller in charge.

WELL RIG No. 3. This rig has been operating along the east and north sides of the Black Mountain, and at present is drilling at Kayenta, near the Indian school located there. Ben R. Senter is the driller.

WELL RIG No. 4. has been working down the Chin Lee Valley, and is now working along the south west side of the Black Mountain. Burt E. Cravath is driller.

Working in a desert country it is difficult to tell where a good well may be developed and many failures are the result. And even when a well is developed it often plays out from the fact that it was developed in a pocket in hard material and the water is soon pumped out, and at other places the failure is caused by the

material in which it is developed proving to be quicksand or fine mud which finally stops off the flow of water. Many of the wells have been redeveloped several times, and a number abandoned after furnishing water for a considerable period of time.

Out of 170 wells drilled in the Navajo and Hopi country only 57 are good wells and furnishing water now. Even at that, the value of the water in these wells is incalculable and the area of grazing land, otherwise unavailable, that has been opened up can scarcely be computed, but it is very large.

Constant care in the operation of all of these wells is necessary and two outfits are looking after them all of the time. The Navajo wells are visited several times a month by Noble Dunaway who makes Chin Lee his headquarters, and the Hopi wells are looked after personally by Foreman Wolack and his helper Nelson Polacca.

WELL RIG No. 5 has drilled wells in the Pueblos of Acqua, Laguna and the other villages of these people and for the Isletas. Lately it has been putting down wells for the Canyoncito Navajos who live at the foot of Mount Taylor. David L. Miller has charge of this rig.

NEWS AND NOTES.

Word comes from Washington that Chief Engineer Reed is in the field and promises to be in this District toward the last of April.

Mr. John R. T. Reeves, one of the attorneys of the Indian Office has been appointed Superintendent of Irrigation in charge of legal matters. He is with the Chief Engineer and will accompany him to this District.

Thirty thousand dollars has been authorized for protection work at Shiprock to prevent the high water flooding or washing out the school and agency plant. The work will be commenced at once, and is under charge of Mr. Gersbach, who also has the Forback project and the drainage work at Shiprock.

Last fall very heavy rains did considerable damage to the Zuni canal and plans for protective work in the way of additional drainage across the canal, both water bridges and culverts, has been planned. The plans were prepared by Mr. Ritter and the estimated costs about \$7,000. Approval has been given by the Chief Engineer, and an additional authority given for \$4,000, which with the balance on hand and available will probably do all the work necessary before the end of the fiscal year. Care taker Bruce Pilcher will have charge of the work.

The gate tower at Canada was wrecked the night of Feby. 27. Care had been taken all winter to keep the ice out around its base to prevent the ice action doing any damage. The last of February was warm and the ice along the shore had melted out for some distance, while the balance of the ice still remained in one sheet and over 12 inches thick.

It seems that the ice had drifted to the north side of the lake and in the night a north wind came up which hurled the entire mass to the south and against the dam, and the tower was caught in the movement and entirely wrecked. The gate was pulled out of its guides and a full head of water went down the ditch which did some damage. Temporary repairs were made and the water shut off by means of planks thrust down in front of the opening reinforced by sand bags, rock and brush.

NEWS LETTER

Issued occasionally by the Superintendent of Irrigation,
U. S. Indian Service, District No. 8.

No. 4. Albuquerque N. M., June 1 1917.

T I P S .

"The strength of the pack is the wolf, and the strength
of the wolf is the pack."

We can say: The strength of the Service is the in-
dividual employee, and the strength of the employee
is the Service.

If one man goes bad or fails to keep up with the pack,
the strength of the pack is lessened by much more than
the strength of that man.

* * * * *

DOING OUR "BIT".

The higher cost of material and possible increase of the price
of labor, due to the war and the demands for all material and the
shortage of labor will make all work we are doing cost more than it
has in the past.

The great need of the government for money to carry on the war
will of necessity curtail the amounts available for other purposes.

The costs of carrying on the operations of this service, for
a multitude of reasons have been high -- are high.

We all desire to carry our share of the war burden, and none
of us, perhaps, can give much from our private resources to assist
the government; cannot buy many Liberty Bonds. But we can do much
by practicing strict economy in the work we are doing. If by sav-
ing material and being economical in labor; if we can repair old e-
quipment instead of buying new; if we use short cuts in the way we
do our work; if we work with our heads as well as with our bodies,
that there may be no lost motions and if the labor employed is kept
busy at productive work by planning ahead; - if, I say, by these var-
ious methods we can save money for the government we will do as pat-
riotic a service as tho we bought more than our quota of Liberty
Bonds.

I am sure we can all think of mistakes that have cost a lot of
money; - my mistakes, your mistakes and those of the "other fellow".
Let's us try to avoid them in the future!

There are lots of little things, that in themselves do not mean
much, little leaks here and there, which, if we all make them time
and again, the aggregate will be large and well worth saving.

The amount of money appropriated for our work is going to be
less during and immediately after the war. This will mean less
work can be done and less men will be needed to do the work unless
we can do the work cheaper. We shall have to go on a war footing,

we shall have to save the government every ounce of energy, every dollar of money possible, because our country needs it -- and the jobs of many of you will depend upon it!

* * * * *

FOOD SHORTAGE AND UNIMPROVED INDIAN LANDS.

The great demand for foodstuffs over the entire world caused by the war and the lack of production where the battles have been waged will throw a great burden on the United States to raise the food we will need and the amount it will be necessary for us to send abroad to our allies to prevent their starving during the war period. We will need to cultivate every acre of land available in the entire country, and as in this service we are making available more land by irrigation, and already have large areas ready for water, it behooves us all to do what we can to see that the land is cropped. The area cultivated by any individual Indian may not be great, but every pound of food raised by him will mean that much less will have to be raised elsewhere to be used by him, and that amount, however small, will go to fill a hungry mouth "somewhere in Europe", yes, or "Somewhere in America."

On April 9th the Commissioner of Indian Affairs wired this office as follows:

"War situation and war shortage of food supplies demands every acre of farm land on Indian reservations be utilized for growing of cereals, potatoes, beans, and other food crops. Telegrams have been sent to all superintendents urging them to call meetings of farmers and Indians and urge aggressive cooperation. It will be your part to see to it that irrigable lands within your district are furnished with water wherever practicable. Confer with superintendents and cooperate closely."

Each man in charge of a project in this district was notified to follow the instructions closely.

There is in this district over 27,000 acres of land on Indian reservations under ditch, and I have estimated that there will be about 19,000 acres of this that will not be cultivated this year. Late figures from the field as to amount under cultivation have not been received, but the following table is thought to be practically correct.

PROJECTS.	Area under ditch	Area Cult. 1916.	Estimated area that will not be cultivated 1917
In New Mexico.			
Red Lake **	700	None	700
Jicarilla Apache	*430	?	300
Zuni	4500	3300	1200
Mescalero *			210
Hogback Project	4000	960	3040
In Arizona			
Cheatfields **	700	None	700
Canada	462	18	445

In Colorado.

Hancocks **	595	none	?
Pine River,	15971	3500	12471

- ** Need repairs. Work is being done on Hancocks now.
* Ditches not built, but labor and cost will be nominal.

Over 17,000 acres all under ditch and lateral and can be served with practically no cost so far as ditches and water are concerned.

To give an idea of any of this land in the production of food stuff, last year a company put in 30 acres of land at an elevation of between 7,500 and 8,000 feet, on the east slopes of the Zuni Mountains, without irrigation with the following results:

Planted 5,000 lbs of seed potatoes. Harvested 78,402 lbs.
Planted 4,000 lbs of seed oats. Cut 63,043 lbs oat hay.
Planted about 200 lbs barley. Harvested 1301 lbs grain.
Planted in miscellaneous vegetables, principally beans, peas, parsnips and turnips, with a number of other varieties in smaller quantities. Harvested 27,517 lbs.

All of the above were actual scale weights. The cost of putting this in was about \$400. The value of the produce was over \$2100., a net profit of over \$1600.

N O T E S .

Since the last NEWS LETTER several new appointments have been made to the permanent force.

Mr Ray C. Spitzer has been appointed Superintendent of Construction and assigned to the Ganado project. Mr. Spitzer comes here from Texas, but is a Colorado man, and has spent the last few years on irrigation work in Canada. He is married and has a wife with him on the project.

Mr. Herman C. Nuffer has been appointed Assistant Engineer and will look out for the miscellaneous projects for the time being. On his arrival he went to Santa Ana Pueblo Grant and did a little work there, and during June will be at Leupp, Ariz. building some protection dykes for the school and agency. Mr. Nuffer comes here from Idaho.

Mr. G. S. Willhoit of Gallup N. M. has been employed temporarily as Assistant Engineer and sent out to the Marsh Pass project to complete it. He will probably be there several months.

Mr. J. A. Winchester of Denver, has been employed as time-keeper and assigned to the San Juan (Shiprock) River protection work.

Owing to the exhaustion of the funds for well drilling on the Navajo Reservation, orders were sent out June 6 for the immediate shutting down of all well rigs and the stopping of all operations paid from this fund until July 1st.