SHIPROCK, NEW MEXICO,
June 24th, 1904.

The Honorable,
The Commissioner of Indian Affairs,
WASHINGTON, D. C.

Sir:

I would respectfully submit the following statements and recommendations in relation to the development of water for irrigation and stock purposes on the Navajo and Hopi Reservations in Arizona, Utah, and New Mexico.

FORT DEFIANCE DIVISION.

In your letter of instructions of April 20, 1903, in which you detailed me to the work on the Fort Defiance Division of the Reservation, you enclose for consideration the reports made by Engineer Robinson, transmitted with favorable recommendation by Superintendent Perry, for the reclamation, by repairs, at Red Lake of 1250 acres at an expense of $2,000: at Chin-lee, 3,000 acres at a cost for construction of $21,000; at Sa-ha-lee, 500 acres for $726.00; at Round Rock, 4,000 acres for $4,611.00; at Wheatfields, 800 or 900 acres for $4,572.86;- a total of 8,300 acres to be reclaimed by an expenditure of $30,910.00 (the Red Lake work is omitted as it is repairs).

You advised that $15,000 had been allotted to the Reservation for the fiscal year beginning July 1, 1905; and directed my especial attention to the proposition of Inspector Code to purchase and put in operation a first class well drilling rig; and, he states, $10,000 will be necessary to properly carry on such investigation.

By reason of the small amount of money set aside for this work during the year it was not possible to consider the well rig recommended by Chief Engineer Code, and which I consider an important factor in the water question here: and an examination of the estimates of Engineer Robinson for, and the ground of, the Red Lake and Wheatfield projects (determined to be constructed first for several reasons) indicated that the building of these, together with a few minor and unavoidable expenses, would exhaust the allotted sum:- the estimates being more than 50 per cent too small.

SAN JUAN DIVISION.

On September 4th last I received Office letter of August 26th, 1905, in which you refer to a letter of August 5, 1905, from Superintendent Wm. T. Shelton, in charge of the San Juan Division of the Reservation, reporting on some twenty five ditches demanding attention; on districts out near the mountains where storage reservoirs should be provided, and where existing springs should be improved; on the feasibility of sinking shallow and deep wells.

NAVAJO EXTENSION.

You cite the remarks and recommendations made by Supervisor Mead in his letter of July 28, 1905, concerning the Navajo Extension of 1901, in which he regards as vital the development of stock water on the range, and refers to a site for a large reservoir which he recommends to be exploited; and you refer to the letter of the Farmer in Charge, Mr. Maxwell, of April 20, 1905, which reports on this reservoir that, he says, will cost about $50,000, cover three or four square miles, store 20,000 acre feet, and reclaim some 7,000 acres.

You refer to the General Allotment Act as amended, which you say can be slightly modified; and say that before any survey is made for an irrigation system, or development of water, the location of the Indians and the land used and occupied by them should be ascertained.

WESTERN NAVAJO.

You refer me to the recommendations contained in Supervisor Mead's letter of June 26, 1905, for a permanent timber dam in the Moencopi Wash; for putting in fit condition for irrigating the lands of that wash; for the building of a reservoir at Tuba to store the combined flow of the local springs; for the building of a reservoir in Reservoir canon to store water for use on Hopi allotted lands, and forms lower down near Moencopi; to pipe water from reservoir canon to lands at Tuba; to build a reservoir at Moen Ava: all at a cost of $25,000.

HOPI.

In his letter of Aug. 1, 1905, (referred to me for investigation by Office letter of Aug. 30, 1905), Supervisor Mead states there are no running streams on the Hopi Reservation, that the present source is from a few springs and wells; advises the consideration of the possibilities of pumping subsurface water, and storing surface run-off.

You direct me to devote my attention to the study of the irrigation projects and the development of a water supply for the flocks and herds along general and formulated lines; giving careful consideration to the projects mentioned and the transmitted papers relative thereto: to adopt some definite plan or method in prosecuting the work,

to bring about maximum results; as you desire to have something permanent and substantial to show for the money about to be expended on repairs, improvements and new work.

Up to the time of the receipt of Office letter of August 26, 1905, I had two white employes, (the greatest number of whites hired this year), an assistant or foreman, and a teamster; and was doing some of the manual labor myself, not feeling warranted in securing other skilled and temporary white labor in view of the small sum allotted to the Fort Defiance Division of the reserve. In this letter you notified me that $10,000, and not $15,000, was the amount allotted; and that to the entire reservation. The six horses, and our one good wagon, were in daily use for construction; and on Sept. 30, 1905, I so stated and requested authority to buy four horses, dead axe wagon, buckboard, and two sets of harness, as necessary to transport a small party and light equipment for the investigations ordered. In Office letter of Oct. 27, 1905, you say that in view of the limited amount of funds, about $8,000, (I had had but $5,000) available for the work on the Navajo Reservation, the work planned in the letter of Aug. 26, and the fact that I had on hand 6 horses, it was the opinion of the Office that the purchase of the four additional horses should be dispensed with for the present. This reduced the Navajo apportionment from $15,000 to $8,000, and precluded securing the means of transportation or employment of assistants that was necessary to a compliance with instructions contained in letters of April 20, Aug. 26th, Aug. 30th, and one or two other details, until construction work closed for the winter. This amount of $8,000 was subsequently increased, but not to the original sum.

It was nearing the end of January before I got my accounts in shape, had the forage and equipments stored, made report on work near the agency, hired Mr. Damon for $20 per month to take care of horses not in use; and started west to visit the Hopi, Navajo Extension, and Western Navajo Reservations. Mr. Holbert was the only assistant I took on the trip.

HOPI.

At Keams Canon I met Mr. Lemmon, Superintendent in Charge of the Hopi Reservation; looked into a small reservoir and feed ditch proposition at Keams Canon above the school plant; prospected for a similar scheme between the school plant and the First Mesa; investigated a chance Superintendent Lemmon suggested of diverting water from the wash east of Oraibi to a small reservoir, and ran a series of levels to determine the possibilities of pumping stock and domestic water for the Oraibi settlement, also for the school there.

While there is no flowing water on the reservation there are undoubtedly many places on this 3800 square miles where springs and subsurface water can be developed, and natural basins improved for storing surface drainage. I have asked Superintendent Lemmon to note any possibilities that may come to his attention, that they may be looked into when a more thorough examination is made.

WESTERN NAVAJO.

On this portion of the reservation I found that, aside from the Hopi holdings which are served from the stream in Reservoir Canon, the Moencopi wash lands had not had water since their purchase from the Mormons; the orchards and alfalfa fields were suffering, and would in all probability burn out this year unless water was secured for them.

Survey was made to determine area of the lands, a dam site was determined on, a ditch located and staked; and report, estimates, and recommendations submitted March 1st, 1906; but you notified me the matter could not be considered this year by reason of shortage of funds.

A reservoir site has been staked out at Tuba, that covers about 6-acres, will hold 96-acre feet, or the present combined flow from the local springs for 160 days. To move the 22,000 yards of sand to form the basin will cost some $6,600; and I am now trying to determine some cheaper method of preventing excessive percolation through the sand sides and bottom of the basin other than by rock paving with grouted joints, the cost of which is almost prohibitive.

The Tuba springs yield daily about 142,000 gallons, and should be developed and made to yield considerably more water than they do now; and another and smaller supplemental reservoir may be required.

The stream, from springs, in Reservoir Canon flows double the amount of the Tuba springs, or about 291,000 gallons daily. Survey for a pipe line was made from the canon to Tuba, and if it should be deemed profitable to carry this water there after the local supply is developed, 17,000 feet of 10-inch wood stave pipe, at a cost of about $12,500 will be necessary. The abstracts and quotations you submitted for consideration in this connection are herewith returned; as they are for pipe of insufficient length, too small, and of a kind unsuited to the requirements.

A sandrock basin was noticed near Tuba just below the pipe line which seems to offer favorable conditions for storing water for the Hopi lands if a good dam site in Reservoir Canon is not discovered. The possibilities of reservoiring in the canon itself can only be determined by test borings, and these can best be made by bringing

over the light well rig which is at Keams Canon.

There is some good land at Moen Ava, a little of which is in orchard; and the springs there now flow about 216,000 gallons daily. This yeild can be materially increased, but the water will have to be stored if it is to be made to do anywhere near its full duty.

What is known as Lyond's springs is about 6-miles west of Tuba. These springs flow about 130,000 gallons daily; the flow can be increased, stored, and made to irrigate from 100 to 150 acres. The Government house is now in the occupation of a Missionary who has been there for 3-years and has made no improvements in, or use of the water, excepting to irrigate about 1-acre of grape vines and fruit trees and a half acre of garden.

Reservoirs for both of these places are being considered, and a plan for making them water-tight is being studied in connection with the one contamplated for Tuba.

NAVAJO EXTENSION.

The 625 square miles of the Navajo Extension is mostly a rolling prairie, broken by low ridges and hills. There are but two drainage channels of any moment; the Little Colorado, which flows from the southeast to the northwest corners of the reserve, dividing it into two nearly equal triangles; and the San Francisco wash in Canan Diablo, which comes in from the south and unites with the Little Colorado north-west from the center of the reserve. At times these streams are torrents, but when water is most needed they are but ribbons of dry, hot sand.

The Farmer in charge, Mr. Maxwell, knew of no springs on the

reservation, and I could hear of none. The underground waters near the surface are heavily impreganted with carbonates and sulphates, are of the class known as alkaline and salty waters: they may be developed for stock, but are not fitted for irrigation. I have made recommendation for a water system for the agency which will also be an experiment to determine if water better for stock and suitable for crops and domestic use can be had at greater depth.

While there may be chances in this territory to store flood water for agricultural and stock purposes, aside from the one reported by Mr. Maxwell, I do not know of them, and have not had facilities to make search.

I ran a line of fly levels over the proposition favorably reported by Mr. Maxwell for a reservoir, and found that a dam 40-feet high and 450-feet long would close the rock gorge through which the San Francisco wash passes to its confluence with the Little Colorado a half-mile below. To the west and south the reservoir is complete, but the rim of the confining bluffs to the east will have to be raised in places by a little diking; and there are two breaks in this rim that will have to be diked across.

The wash drains all of the south and considerable of the east slope of the San Francisco mountains; the water is of excellent quality, and the indications are that it carries considerable quantities of wood, but no sand or silt other than a little disintegrated lava. It is now thought that the run-off is sufficient to supply the basin which should hold enough to serve from 8,000 to 10,000 acres. A little of this land can be secured in two or three small tracts just below the reservoir and along the south bank of the Little Colorado; but the water should be

piped across this stream and carried to an unlimited amount of good land on the north side.

The Indians, numbering about 100 families, range their flocks and ponies where-ever feed can be had; they farm small patches of land along the banks of the Little Colorado securing a little of the intermittent flow in a haphazard way, and hoping that their crops will not be washed out.

There is no timber on the reserve for shelter or fuel excepting a little cottonwood along the Little Colorado and they catch drift that comes down the river fuel. This may account in part for the relatively few permanent locations there were seen on the trip across the reserve. There is no question but what all these people will abandon their present holdings, and as with as many others from the vicinity as can be accommodated, will gladly enter and farm all of the land water may be secured to.

While the system may cost in the neighborhood of $75,000, it appears practical and cheap, and should be examined into. It will take a party of about seven a month or six weeks to make surveys, sink test borings, and prepare maps, plans and estimates for the work.

As these withdrawn lands are unsurveyed it is not possible to locate the holdings of the Indians by legal subdivisions.

Another question which will have to be determined is what title the Santa Fe railroad may have to the odd sections within the 20-mile zone from their track, which embraces a goodly portion of this reservation.

SAN JUAN DIVISION.

There are numerous springs occuring from around the base of the mountains to well out into the valleys that can be developed.

and the water stored in small basins for stock purposes; and in some cases for watering small patches of garden and farm land. There are many small washes where surface wells can be sunk and water pumped by some simple method for the same purposes. There are indications promising a good chance for securing artesian wells, and at any rate deep ones, over a considerable area of the grazing land.

There are a number of little Indian ditches taken out of small streams in the hills which run a little water for short distances, that might be improved; and quite a few basins that can be turned into small reservoirs at slight cost. There may be some deep canons in which reservoirs can be made; but it is not often that suitable conditions exist in such places. I have seen one which may be good, but its capacity, dimensions and condition of its rock bed and walls at the dam site, and the size and physical condition of the catchment basin will have to be known before its practicability can be decided.

The Rio San Juan is the only stream of any moment on these reservations, and is the only project offering a possibility of putting in ditches of any size. Its channel has a fall of some ten or twelve feet to the mile in the northeastern part of the reserve, the bottom, banks, and adjacent lands are mostly of a light sandy soil with occasional gravelly streaks: and the stream flow varies from almost nothing in the last summer and winter to a torrent in spring and early summer. With the wide fluctuation of flow, and unstable channel owing to the nature of the banks, the placing of headworks to ditches and securing the river channel immediately above and below the headings will entail careful and somewhat costly work; but the tillable lands in the bottom and first bench are fertile, will be used, cannot be

overlooked when farming by irrigation is considered; and the good to accrue is comensurate with the cost of building of the possible ditches and repairing and extending many of the little ones now in use. The Tse-ke-yah-te-ga, or Ditch #4, has been built by Superintendent Shelton at a cost of $1578.00, is considered a good piece of work at a reasonable cost. It is about 2-1/2 miles long and covers some 550 acres school, agency and Indian land; but requires another and better headgate, sluice, and a little more brush work at the head, to make it complete.

The Costiano ditch is an old line, about three miles long and covering about 440 acres. The Superintendent has extended the intake about 1,000 feet up stream by blasting off the rock bluff for a heavy riprap in the river for that distance; this at a cost of $200 for powder and supplies and employment of white foreman to direct the labor of the Indians who did the work without pay. A little work to complete the riprap and earth channels, and the necessary headgate and other structures is needed to complete the system.

The Superintendent has expended $1590 on the Hoghack ditch in assisting the Indians interested to build a tunnel and approaches 250-feet long through solid rock for the heading, and some 3-3/4 miles of ditch to water some 770 acres. This is the best proposition on the river and one of the best in the country, and the work so far has been well done at a reasonable cost. By the enlargement, and extension of this ditch for 12 or 15 miles a secure ditch can be had to cover about 6,000 acres of excellent farming land, and will eliminate two or three smaller ditches. The work of a field and office party for a

month will be necessary to prepare estimates of cost which will approximate $35,000. The other ditches on which the Department has expended any amount of money are known as the Sandoval Ditch, or No. 2, and the Cudeia ditch, or No. 3. They both take out on the south bank of the San Juan, are about 4-1/2 miles long, and each covers about 800 acres. The reported cost is about $8,000 and $4,000 respectively.

The two flumes on Ditch No.2 were never properly constructed and will not carry water. On both ditches the headworks have washed out, possibly by reason of faulty design; the slopes of channels in thorough cutting are almost vertical and will not stand: and the first half or three quarters of a mile of both channels are either filled up or were never dug deep enough by from three to four feet. In their present condition neither can take water from the river except at its extreme high stage.

When I learned that Ditch No. 2 was not being used I thought it possible that the lands thereunder were being held by one Indian to the exclusion of the others. Investigation recently made assures me that water has never been served to the main body of the land and cannot be until the work is rebuilt: and an Indian cannot be induced to farm under a dry ditch. Both these ditches, Nos. 2 and 3, should be put in shape.

FORT DEFIANCE DIVISION.

Aside from what has been said of the Rio San Juan and its valley, remarks made concerning irrigation and stock water for the San Juan Division are equally applicable to, and true of, the Fort Defiance Division, and need not be repeated.

As a possible aid to a clearer understanding of the magnitude of the territory under consideration, its population and their needs, I would cite the following figures taken mostly from your annual report for the fiscal year 1905:

Division or Reservation.	Population Navajo	Population Hopi	Area Sq. Miles.
Fort Defiance Division,	12,000		4,180
San Juan Division,	8,000		4,810
Western Navajo Division,	6,000	500	5,265
Navajo Extension, 1901,	390		625
Hopi Reservation,	2,000	2,000	3,833
Total,.....	28,390	2,500	18,713

For to summarize, the reservations extend 200 miles east and west and 150 miles north and south, contain 18,713 square miles, or as much as the combined areas of the states of Rhode Island, Delaware, New Jersey, and Massachusetts; have a population of 30,890.

Relatively but little has been done in the way of irrigation or developing stock water; and we are concerned with a general scheme, almost from its inception, for the reclamation of the country.

It may be possible to colonize some under communal ditches along the San Juan and at a few other places where storage systems of some size may be secured; but the Navajo is forced to a more or less nomadic life in tending his flocks, one of the main factors in his existence. It is fortunate that this is so, for only be living in widely scattered settlements of a few families each can they manage to eke out an existence in a barren country where every drop of the meagre water supply should be developed and intelligently conserved and used.

If we consider a deep or shallow well for stock water for each hundred square miles, and twice that number could be profitably sunk, we have 187 that, with tanks or systems, pumps, etc., will cost not less than $50,000.

If there are 250 springs that it will pay to open up and supply with small reservoirs or watering troughs (and there are probably more than that number) there will be needed for this work not less than $12,000.

If 2-acres of irrigable land per capita is allowed, a 10-acre farm to the assumed average family of 5, there will be required more than 61,000 irrigated acres. At the minimum cost this calls for more than $610,000.

At first glance $750,000 or $1,000,000 may appear a large sum to contemplate for this work; but when the scarcity of water in this barren country is known, and when it is remembered that expensive development work will have to be resorted to in many instances, the amount will appear moderate for the number of people to be benefitted.

As has been said, there is a population of 30,890 to be considered; if 25 cents a month, $3,00 a year, be allowed to each person for 8-years the $24 per capita so expended to provide water for stock and to irrigate a little piece of land will amount to about $750,000 ; and this sum, if not inadequate, is the minimum for which the work can be done.

Under the present restricted conditions the following is about the items of expenditure for a year:

Pay of Superintendent,.....	$3095
Pay of Assistant,.....	1200
Pay of Interpreter,.....	600
Forage for 6-horses,.....	1235
	$6130

Leaving for Indian labor and purchase of supplies, $3870

Making the total allotted these five reservations for fiscal year 1906,..... .. $10,000

A small force and outfit to carry on repair and new work on the numerous little ditches should consist of a Foreman, Interpreter, Teamster, 6-mules, 2-wagons (a lead and trail), grading plow, and a few other tools. One such outfit is needed on the Fort Defiance Division; one can, for the present, meet the requirements on the Extension, Hopi, and Western Navajo; while two are required for the San Juan Division.

For the woodwork, such as headgates, flumes, etc., on these ditches, a carpenter, carpenter's helper (preferably a Navajo who can interpret), a 2-mule team and wagon, will be sufficient at the beginning; when the work is further advanced about two such outfits will be needed.

A pile driving outfit is needed on the San Juan river, as well as at other places on the reservations, and the driver should be secured and operated, for the present, by the second carpenter outfit mentioned above.

For the development of springs, a man should be outfitted with a team and wagon to transport himself, supplies, such as blasting powder, drills, small forge, crowbars, picks, hammers, troughs, etc., from place to place. Not less than three, and preferably four, such men should be put in the field to work systematically and continuously until this feature of the work is completed. It may be found more economical, and equally as good, to hire an Indian and his team to go with the man engaged in spring development; and I would so start the work.

A portable steam driller is advisable for sinking wells to develop an artesian flow, and for those wells more than 25 or 30 feet below the surface. Such a rig, with a capacity of 700-feet, weighs about 12,000 lbs; and costs, complete, at the factory, about $2,800 or $3,000; the freight will add about $300 or $400. A driller and assistant driller will be required to run the rig; and the necessary mules to move it from one well to another, as well as to haul the casing from the r .road points to the different wells, and the coal and water necessary to run the rig. No estimate can be made for the cost of casing as that can only be known as the work develops.

These, briefly, are the main requirements requisite to properly carry on the work you contemplate for the Navajos and Hopis. To investigate the territory, to make surveys, plans and estimates of the different possibilities, and to lay out those that are practical and superintend them during construction; to do the map and plan work in the office, and to attend to the cash and property accounts, correspondence, and other office details; I require a clerk and draftsman, an instrument man, two chainmen, and a teamster. There is needed a team and wagon to transport this engineering party and their instruments, bedding, subsistence; and I will have to have the means of getting around the country. Concerning the two teams now on construction work, one is of fairly good, medium weight horses; the other is too light and not built right. Of the team I am now driving one is still a good horse, although about 20-years old; the other is 25-years old, and though crippled and unserviceable is deserving to be pensioned for the work he has done for the Government during the past 14-years.

Both my assistant and Interpreter have been fully occupied in doing all kinds of work; and it has not been possible for us to touch the investigations, and make surveys of, and prepare estimates for, any of the numerous projects referred to in your several letters of instructions. For this reason it will be impossible to submit request for authorities other than by lump sums for certain works to be undertaken the first part of the coming year. It is a question of how much money can be secured to the reservations rather than how much is needed. When the amount available is known a systematic plan for its expenditure to the best advantage will be quickly formulated.

In your letter of Aug. 26th last you say, it is believed that the best results can be had in the construction of small ditches, such as the Indians will be able to keep in repair themselves, and that no extended plan or system should be made; that it appears to be almost an impossibility to build a reservoir, dam or ditch that will stand the force of the severe floods which come in this section of the country; and that since the work of irrigation was undertaken here some years ago, the records of the Office show that there have been submitted constantly, recommendations for repairs of constructed dams and ditches. You express a desire to have something substantial and permanent to show for the money now to be expended.

In a general report on the reservation, dated March 1900, I made recommendations for a ditch man, or overseer, to take charge of the work on what is now the Fort Defiance Division and direct its maintainance and use; to also help and direct the Indians in developing other small schemes. A Supervisor of Constructed Ditches was appointed, but he was sent to the San Juan District as the Agent's representative, and,

so far as I know or can learn, never performed any of the duties of the position I outlined.

No matter how substantial the work built for these people may be, it will not be permanent unless maintained; and it will not be profitable unless the water developed is intelligently, economically, and wisely directed to beneficial use. I can only reiterate the recommendation made in my report of 1900 that a competent white man be employed, under the agent, on each reservation, to superintend these ditches, wells and springs; to see that they are maintained by the labor of the Indians benefitted; to superintend repairs, extensions, and improvements; to see that the water is equitably distributed and profitably used to its full value. He should be provided with a good team, wagon, plow, and other small tools; and spend 12-months of the year out on the reservation. Unless this be done until the Indians have advanced far enough in intelligence and thrift to properly care for these schemes themselves, the history of the works to be built will be but a repetition of those of the past. There is no question but what these people can be induced to utilize the water facilities afforded them, and in such numbers under each system as to keep it up by their own labor, and eliminate the demands on the Office to rehabilitate a piece of work, and at a cost far greater than would have been necessary were the repairs made when the damage first occurred.

These Navajos are the best workers, the most deserving, the poorest, and the least aided of any Indians I have been among; and their reservation is the most barren. When the whole reservation was under one agency it was more than any one man could possibly attend to; but now that it is cut up into five divisions there are good prospects for the

material advancement of the Indians. It is my sincere wish to see these people aided in their efforts to become more prosperous, (they are and always have been independent and selfsupporting); and I would earnestly ask that as much of the irrigation funds as can possibly be secured be devoted to this work for the coming year: and, if the general yearly fund is insufficient, that a special appropriation for their re- lief be secured.

Very respectfully,

'GB(JvP)

Gen'l. Supt. Irrigation.