N A V A J O S E R V I C E

LAND MANAGEMENT

INTEGRATED REPORT OF THE STUDY GROUP 'C'
for
PUEBLO UNIT 17

September, 1936.

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Gallup, New Mexico
December 28, 1936.

W. G. McGinnies,
District Manager,
Soil Conservation Service,
Navajo Project,
Gallup, New Mexico

Dear Sir:

An integrated report on Land Management Unit No. 17 (Pueblo Unit) is hereby being submitted by the Study Group 'C'.

Very truly yours,

John P. Bewley
Associate Soil Scientist
in charge of Party.

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The improved roads are: St. Michaels-Keams Canyon, Chambers-Chin Lee, Cornfields-Ganado, and the Salina roads. One truck trail extends from Ganado to the Fluted Rock, the Summit, Klagetoh and Greasewood. Another extends from the above mentioned trail at a point about 10 miles above Pine Springs, and passes thru Pine Springs to the U.S. Highway 66. The numerous Indian trails cross and re-cross these roads and trails and form an intricate network of byways to all parts of the area, making it accessible to all types of transportation and livestock.

Agriculture

The areas of agricultural concentration are located along the main washes. About 340 acres are irrigated and farmed in the vicinity of Ganado. This is the only irrigated land in the District. Other areas of concentration are located around Klagetoh, Wide Ruins, west of Pine Springs, Cornfields, Greasewood Springs, and the Steamboat wash. There are, however, many scattered farms over the entire district. Corn, alfalfa, and oats are the principal crops. There are approximately 5,956 acres farmed and 1,750 acres of potential land.

Demonstration Areas

The Steamboat, Canada, and Klagetoh Demonstration areas are in this Unit. They represent 86,178 acres.

The total area of the unit is 1,144,122 acres.

SOCIOLOGICAL SURVEY

Population

Land Management Unit 17 has a total Navajo population of 3,587, grouped in 512 consumption units.[1] The inhabitants gain their livelihood from the raising of livestock, farming, and in recent years, wage work. The eleven trading posts located within Unit 17 provide the people with goods which they do not produce and serve as collecting and distributing centers for the livestock and other products which are marketed.

There are several general areas of population concentration which are located in the vicinity of agricultural lands. These may be divided into an eastern section including Klagetàh, Wide Ruins, and Pine Springs; a western section composed of Steamboat; and a large central concentration extending from Kin Li Chee and Cross Canyon in the north-east corner of the Unit through Ganado and Cornfields in the center to Sunrise and Greasewood in the south central portion.

(1) The consumption groups range in size from 1 to 25 with the average number 7. Over half (55%) of these groups, including nearly half of the total population, vary between 4 and 8 persons per group.

Table I

Population by Farming Areas

	Number of People	Number of Con. Groups
Klagetoh, Wide Ruins, Pine Springs	1131	132
Steamboat	478	68
Kin Li Chee, Cross Canyon Mountains	939	134
Ganado, Cornfields	619	88
Greasewood, Sunrise, Mesa	420	60
TOTAL	3587	512

Income

The people of Unit 17 depend almost completely upon the income derived from wage work, livestock, and agriculture for their livelihood. The total income in 1935 exceeded half a million dollars ($525,900.00), of which two-thirds ($353,400.00) represented a commercial or cash income. The other one-third ($172,500.00) included the purchase value of livestock and agricultural products produced and consumed by the inhabitants. The division of the total income into its five principal categories indicated that wage work and livestock each contributed one-third respectively, of the total amount.

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Another one-fourth (24%) was derived from agriculture. The income from the sale of rugs was the fourth most important source of revenue.

Table II

Total Income - 1935

	Comm.	Non-Comm.	Total	%
Wages	$175,600.		$175,600.	33
Livestock	119,300.	$ 53,700.	173,000.	33
Agriculture	6,700.	118,800.	125,500.	24
Rugs	48,600.		48,600.	9
Miscellaneous	3,200.		3,200.	1
TOTAL	$353,400.	$172,500.	$525,900.	100

The analysis of non-commercial income demonstrates that agriculture was considerably more important than livestock. Nearly 70% ($118,800.00) of the non-commercial income was represented by agricultural crops produced and consumed. A considerable but unestimated portion was consumed by livestock, principally horses. The commercial income from agricultural products was negligible, and is of even less significance when it is realized that practically all of such products sold to the trader were later repurchased by the Navajos.

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Other than wage work, livestock was the most important source of commercial income and also represented a considerable portion (50%) of the total non-commercial income.

The break-down of commercial income into separate items emphasizes the importance of wage work as a source of revenue which includes half of the total amount. The income from livestock accounts for another one-third and is particularly important in its relation to the negligible income derived from agriculture, (2%). It becomes evident that the production of livestock products is on a semi-commercial basis, while farming activity is definitely non-commercial. The figures from Tsailee and Monument Valley are corroborative.

A particularly significant source of income in terms of Navajo culture, is that derived from rugs. Although it represents only one-eighth of the total, if we deduct wage work it amounts to one-fourth.

Gross non-commercial income represents the quantity and value of food products produced and consumed by the people of this district. Agricultural products account for two-thirds of the total, the balance arising from the consumption of sheep and goats.

The agricultural income was derived from approximately 3800 acres in cultivation in 1935. This represented an average per acre income of $33.00, and represents the value expressed in money terms of the products which the Indians consumed.

The value per acre of any one crop varies with the yield and selling price. The calculation of the value per acre of the various agricultural crops shows wide variation. According to available figures potatoes proved to be the most, and beans the least valuable in 1935.

Table III

Relative Value of Crops Per Acre

Potatoes	$200.00
Melons	150.00
Alfalfa	50.00
Corn	27.00
Oats	23.00
Beans	8.00

The total livestock grazed in the Unit, exclusive of horses, totaled 56,777 sheep units. The total income from livestock was $173,000.00, or approximately $3.00 per sheep unit. This figure is probably high, inasmuch

as it is estimated that the stocking of the range is 20% higher than the stock dipping records indicate. This would reduce the per sheep income to $2.40 per unit.

The total livestock income does not include the value of the wool used in rugs. It is estimated that 48,000 lbs. of wool were so used, and if purchased from the trader at 25¢ a pound would add an additional $12,000.00 to the total. Since this amount is included in the value of rug sales, to include it here would be a duplication.

There are approximately 1000 head of cattle owned and grazed in the Unit. Since no trader reported buying cattle, it is impossible to gauge the income from this class of stock.

One acre of agricultural land in the district during 1935 produced income equivalent to that produced by 13 sheep units, figuring $2.40 as income from one sheep unit, and $33.00 as representing income per composite acre.

Consumption

The total value of goods consumed in Land Management Unit 17 during 1935, exclusive of products such as fuel, which were collected, was $443,000.00.

Approximately 40%, ($172,000.00), represented non-commercial consumption of agricultural and livestock products produced and consumed by the Navajos and not distributed through the trader.

Table IV

Total Consumption

Commercial	$271,000.00	60%
Non-Commercial	172,000.00(1)	40%
TOTAL	$443,000.00	100%

Sixty per cent, ($271,000.00), of the consumption in the Unit was represented by products purchased through the trader. The total commercial income,($528,000.00), was some $82,000.00 greater than their money outlay. This discrepancy between income and consumption was also observed in Monument Valley and, as there, may be accounted for through the large wage income ($175,000.00).

(1) Goods valued at cost to the Navajos if purchased at trading posts.

Table V

Gross Commercial Consumption - 1935

Food	$153,474.00	58%
Clothing	78,916.00	29
Household Equipment	9,892.00	4
Productive Equipment	25,549.00	9
TOTAL	$270,831.00	100%

By adding the $172,000.00 of products which were home produced and consumed we reach a total of $323,000.00, or 74%, (75% in Monument Valley) of the total consumption going for food. It is estimated that slightly over half of this amount represents food fed to livestock.

By dividing the food imports into those which are producible and those not producible, the former amounts to $69,000.00, or 46% of the total. Hay, corn, potatoes, melons, and oats are agricultural products which are immediately producible if additional arable land were made available. Flour, which represents the largest single item of food imports, could be produced from wheat if methods of processing were developed.

On the basis of present consumption of imported food commodities, their yield per acre, there has been calculated the acreage needed to produce a food supply to displace that which is now imported.(1) An additional 584 acres would be required for the raw agricultural products and some 1333 for sufficient wheat to supply an equal amount of flour now consumed. There would thus be required an additional 1917 acres of agricultural land.

Table VI

Acreage Required for Production of Producible Imports Now Purchased

	Pounds	Dollars	Yield (Pounds)	Acres
Potatoes	145,259	$ 7,451.	4000	36
Melons	57,612	2,179.	4000	14
Onions	17,365	941.	3000	6
Corn	161,500	4,921.	780	207
Oats	59,900	1,926.	720	83
Hay	873,920	10,952.	4000	218
Beans	2,500	116.	150	17
Peaches	2,775	161.	12000	3
Total (Raw Agric. Products)		28,507.		584
Wheat	966,000	40,026.		1333
TOTAL		68,533.		1917

(1) The estimates of yield per acre have been furnished by the agronomist and are conservative, but do not take into account the additional cost to the Navajos to till such additional agricultural land.

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If this amount of land were developed and planted to the specific crops indicated, it would eliminate the need for some $68,500.00 of income which now leaves the district. This is equal to 57% of the commercial income from livestock, or 58% of that derived from wage work.

The distribution of livestock ownership is available for the people living in the Steamboat area, which includes 13% of the total population of the Unit.

Table VII

Distribution of Livestock Ownership(1)

Band Size	People	Total Owned Sheep Units Excluding Horses	Per Cap. Owner
0	6	0	0
1 to 50	138	745	5
51 to 100	108	1565	14
101 to 200	142	3458	24
201 to 300	31	1262	41
301 to 400	25	1074	43
401 to 500	22	910	42
501 to 600	7	562	80
601 to 700	0	0	0
701 to 800	0	0	0
801 to 900	0	0	0
901 to 1000	0	0	0
1000 /	11	1090	100
TOTAL	489	10,666	

(1) 13.5% sample taken in Steamboat Canyon.

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Some 50% of the people in the ownership class 0 to 100 own 22% of the livestock. In the ownership class 0 to 300 there are 87% of the people owning 66% of the livestock while some 13% of the inhabitants owning 300 or more sheep possess 34% of the total.

If this proportion is applied to the total stocking of the Unit there would be a total of 80,000 sheep units exclusive of horses. Horses would add another 15,000 sheep units, bringing the total to 95,000, which is the estimate of the total stocking of this Unit.

Agricultural Soils

The area of agricultural land in Unit 17 is very small compared to the total. The present land, farmed and potential, amounts to approximately 5,400 acres, or about .4 of 1% of the total area.

The soils that will produce crops under the present conditions are those deep soils located in the higher altitudes where dry farming is practiced to a limited extent, those located along the washes which receive an occasional flooding from the overflow of the streams, and soils that are irrigated from the impounded flood waters.

The best agricultural soil in the unit is the deep fine sandy loam with a moderately heavy subsoil. This type of soil has an open and friable surface which permits rapid penetration of rain and flood waters and a heavier subsoil which holds the accumulated water for plant use. These soils are well drained and free from alkali.

The principal areas of this type of soil occur in the vicinity of Klagetoh, west of Pine Springs, the lower end of the Ganado irrigation project, and the area below the present Ganado irrigation project where potential land has been mapped.

In the vicinity of Cornfields, Greasewood Springs, the lower end of the Steamboat Wash, and below Wide Ruins, there are extensive areas of fine sandy loam which have a heavy clay subsoil, at a depth ranging from 6" to 30" below the surface. This type of soil is well suited for agriculture, but care must be exercised in subjugation to prevent water-logging through excessive applications of water.

In the Sage House Wash, southwest of Fluted Rock, there is an alluvial clay loam soil developed from shale and disintegrated sandstone. The soil is primarily a clay loam, but the inclusion of small sandstone fragments, which are continually disintegrating, give the soil an open and friable structure, making it suited for crop production. The rate of water penetration is slow but the water holding capacity is high. The surface drainage of this soil is good, but the subsoil drainage is poor, due to an impervious layer of clay which varies from 8 to 20 inches below the surface.

Some clay soils which are now being formed in the north end of the Ganado irrigation project and in the vicinity of Kin Li Chee are not recommended for further agricultural development.

The soil profile is composed of heavy clay derived from the Chin Lee formation. Low water penetration and the possibility of alkali concentrations are sufficient to condemn this type of soil for agricultural development.

AGRONOMY

The agricultural land in Land Management Unit No. 17 is scattered over about two-thirds of the total area. There is no farming in the southwest corner, where the Unit extends down into the Painted Desert country. At the present time there are 3,956 acres being farmed in this Unit and, by the diversion of flood water and the proper utilization of irrigation water, this acreage can be increased to 5,706 acres. There are 341 acres being farmed in the Ganado Irrigation Project this year, and this can be increased to 841 acres, or until the supply of water in the Ganado Lake is being used to capacity. The other areas of agricultural concentrations are dependent upon water from intermittent streams, with the exception of part of the Klagetoh area, which may be irrigated next year (1937).

The total agricultural land, both present and potential, was divided into three classes.

(1) Irrigated land, that land which has permanent water available, 841 acres.

(2) Flood irrigated land, or the land being irrigated from intermittent streams, 4,270 acres.

(3) Dry farm land, or that which depends upon direct rainfall, 595 acres.

Alfalfa is the principal crop grown in the Ganado Irrigation Project, but 77% of the total farmed land in the Unit is devoted to the production of corn.

The total farmed land is divided between six principal crops.

	Acres	Percent
Corn	3,066	77%
Alfalfa	269	7
Oats	956	6
Melons	146	3
Beans	65	2
Potatoes	24	1
Idle	161	4
Total	3,956	100%

Four percent of the total land that has been farmed within the last few years was idle this summer.

Present yields can be increased by the improvement in farming practices and by the subjugation of the land.

The following table shows the average estimated yields and the expected average crop production resulting from a land improvement program.

	Present Average Production	Expected Average Production
Corn	15 bu.	20 bu.
Alfalfa	4000 lbs.	6000 lbs.
Oats	12 bu.	20 bu.
Beans	150 lbs.	300 lbs.
Potatoes	4000 lbs.	7000 lbs.

The cultural practices range from primitive to modern. No seed bed preparation is made in some places, while at Ganado, for instance, modern farming methods are practiced with good results.

Small grains and vegetables can be grown to a good advantage on the Defiance Plateau, and at Ganado, while on the western half of the Unit corn, beans and melons are the principal crops grown.

Of the concentrated areas the Ganado Irrigation Project is the largest. More of the land could be devoted to growing of vegetables and alfalfa. Erosion of the land is a serious problem and it will not be checked until the irrigation system is improved. The ditches are too small and in many places on too much grade. Gates were not located at convenient places. The runoff from the bad lands on both sides must be checked. There are 500 acres of potential land below the present farmed land, which must have erosion protection now, so it will be rendered more easily subjugated as the necessity and possibility of more irrigated land has been proven. Since the increase in the available water for irrigation by the building of a diversion dam and an equalizing reservoir above the Ganado Lake, it is quite certain there will be water available for the 500 acres of potential land.

The concentrated areas at Cornfields, Greasewood and Satan Butte are very much alike. Corn is the main crop grown. A partial diversion from the main drainage will be necessary in order to irrigate the land. Wind erosion is a problem.

The Klagetoh area is the most productive of the flood irrigated areas. The soil is friable and well adapted to agriculture. Part of this area will be irrigated next year. Proper subjugation of the land should be carried out before the water is turned in the ditches.

There is considerable land at Wide Ruins that can be farmed, but definite recommendations cannot be made until further studies have been completed. These studies will include available water, storage capacity, costs, and available agricultural land.

The lowest crop yields were found at Kin Li Chee, where the soil is heavy and high in Alkali. Only a small portion of this area was recommended for subjugation.

There are small concentrations found on the Defiance Plateaus, but these farms will in most cases be subjugated as individual farms and not as one big unit.

The cost of agricultural development, involving leveling, bordering and terracing,as the case may be, on the farm land is 78,938. Contour listing was recommended wherever possible. There was no cost figured for listing, as it is a farming operation and not classed a form of subjugation.

The estimations of yields and costs of subjugation are only an ocular estimate, and should be used only as indications and not as definite material.

RE-VEGETATION

This Unit as a whole is covered with some form of vegetation and wholesale re-seeding of barren country is no problem. However, planting of windbreaks where wind erosion is serious, the planting of badly eroded areas after erosion control structures have been built, bank protection plantings where there is valuable land adjacent to the wash, and the planting of fenced inclosures in some form of vegetation which will offer protection for wild life, has been planned.

Windbreak plantings are to be at Cornfields, Greasewood, Wide Ruins and Satan Butte. The exact location cannot be made until definite plans for subjugation have been completed.

Bank protection of the Canado Wash along the proposed and present farm land has been suggested.

Plans have been proposed to fence the moving dunes at Greasewood. Planting on the windward side will probably hasten stabilization of the dunes.

Some planting should help stabilize the soil in the Canado Irrigation Project, after erosion control structures have been built.

The planting of fenced inclosures in some kind of vegetation that will grow in this Unit, and offer protection and food for wild life has been planned.

(See Biology Report, Page 26 - 34, Diagram L-350.)

RANGE MANAGEMENT

General

1. Vegetative Types

The vegetation on Unit No. 17 can be grouped into five general types, namely: Ponderosa pine, Pinon and Juniper woodland, grassland, big sage, and browse. Table No. 1 shows the acreage, percent of total acreage, carrying capacity, and percent of carrying capacity, and percent of carrying capacity of each major vegetative type on the Unit.

Table No.I — Vegetative Types — F. A. R. 2.5

Type	Surface Acres	Percent of Area	Forage Acres	C.C. S.Y.L	Percent of C.C.
Grassland	388,558	35.20	74,113	29,645	40.55
Big Sage	107,631	9.75	27,266	10,906	14.92
Browse	50,518	4.58	10,241	4,096	5.60
Ponderosa Pine	109,637	9.93	18,137	7,255	9.92
Inaccessible	6,006	.54	0	0	0
Barren	50,791	4.60	0	0	0
Woodland	379,872	34.42	53,034	21,214	29.01
Cult.	10,858	.98	0	0	0
Total	1,103,872	100.00	182,791	73,116	100.00

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The principal vegetative species on this Unit are as follows:

Grasses

Bluegrama	(Boutelcua gracilis)
Galleta	(Hilaria jamesii)
Alkali sacaton	(Sporobolus airoides)
Sand dropseed	(Sporobolus cryptandrus)
Three awn	(Aristida spp.)
Mountain muhly	(Muhlenbergia montana)

Shrubs

Big Sage	(Artemisia tridentata)
Chamise	(Atriplex canescens)
Snake weed	(Gutierrezia spp.)
Yellow brush	(Crysothamnus greenii)
Deciduous oak	(Quercus spp.)
Mormon tea	(Ephedra spp.)
Cliff rose	(Cowania stansburiana)
Mt. Mahogany	(Cercocarpus spp.)
Service berry	(Amalanchier spp.)
Winter fat	(Eurotia lanata)

Weeds

Russian thistle	(Salsola pestifer)
Croton	(Croton texensis)
Pingue	(Actinea floribunda)
Sunflower	(Helianthus spp.)
Lambs quarter	(Chenopodium spp.)

Table No. II shows the distribution of vegetative types by sub-units.

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TABLE NO. II

VEGETATIVE TYPES BY SUB-UNITS

Sub-Unit	I		4		5		6		7	8	9		Cult	Total	
	SA	FA	SA	FA	SA	FA	SA	FA	SA	SA	SA	FA	SA	SA	FA
I	5140	981	9196	2757	5499	959	74370	9558	344	115	37415	6190	2356	134456	20145
II	37630	10485	37069	11006	15230	2183	29915	7128	1102	2034	97149	16946	3209	223338	47743
III	49110	12189	11634	2588	8645	766			223	689	51546	6467	957	122804	22010
IV	115828	23231	21915	6063	15343	5907			1284	4188	45627	6529	2400	206585	41739
V	156837	21750	4450	958	5801	426			3053	43712	80169	8568	1228	295251	31702
VI	24013	5477	23367	3894			5352	1451		23	67966	8334	708	121129	19156
TOTAL	388558	74113	107631	27266	50518	10241	109637	18137	6006	50791	379872	53034	10858	1103872	182791

3. Water Development

Livestock water is rather abundant and widely scattered over the entire Unit. (See Map No. 3) With the development of a few more waters and maintenance work on a number of already developed water supplies - as indicated on Map No. 3 and the range improvement survey report - Unit No. 17 should have a sufficient livestock water supply to secure proper distribution and proper seasonal use of livestock. The observation of the Unit Manager and his Assistants will be necessary at all times in order to determine whether or not more water is needed. These observations should also determine whether the developments be wells, surface tanks, springs, etc.

There are, at present, three semi-permanent Indian surface tanks, two semi-permanent government-developed surface tanks, fifty-five temporary Indian surface tanks, thirty-three permanent Indian dug shallow wells, twenty-four permanent government dug shallow wells, eighteen permanent undeveloped springs, ten permanent government developed springs, two semi-permanent undeveloped springs, one temporary undeveloped spring, twenty-six permanent drilled wells, nine intermittent natural lakes, one permanent artificial lake and three permanent streams (all in Kin Li Chee wash), or a total of two hundred and thirty-one livestock waters on the Unit. Excluding the Demonstration Areas there would be an average of one livestock water for every 4,798 surface acres, or one permanent water for every 9,634 surface acres.

LAND USE

1. Chief Value of the Land

The chief value of the land in Unit 17 is for watershed and grazing. The low rainfall, the slope, and the lack of possibilities for water storing and water spreading make all but a very small percentage of this Unit unadaptable to farming. Farming can be practiced only along the main drainages, to a limited extent on the Defiance Plateau, and at such other places where water spreading or natural flood irrigation can be practiced. In the vicinity of Fluted Rock there is approximately 100,000 acres that have a value for lumbering.

2. Past and Present Use

In general, the land in Unit No. 17 has, since the introduction of domestic livestock, been used for grazing. To a lesser extent the woodland areas have long been a source of fuel and building material for the Indian and a source of fuel and posts for the white man. The Ponderosa pine country, especially in the neighborhood of Fluted Rock, has been used in the past for limited lumbering operations.

The following are the present chief uses made of this land in order of their probable importance: grazing, fuel, poles and posts, farming, and lumbering. This usage is very similar to that practiced in the past.

TABLE NO. III

LIVESTOCK NUMBERS ON UNIT NO. 17

Cattle and Horses Given in Sheep Units. Taken from 1935 Dipp ng Records.

Classes of Stock	Garado	Greasewood	Klagetch	Kin-Li-Chee	Steam-boat	Sunrise	Pine Springs	Corn-fields	Wide Ruins	Oak * Springs	TOTAL
No. of Bands	59	59	13	69	37		1	18	60	17	333
Sheep	6169	12757	1661	4831	5025		162	2136	13372	2044	48155
Goats	734	903	361	1274	847		19	254	972	430	5794
Cattle	(29) 116		(376) 1504	(94) 376	(256) 1024	(58) 232				(94) 376	3628
Horses	(45) 225		(976) 4880	(452) 2260	(574) 2870	(644) 3220				(411) 2055	15510
Total Grown Sheep Units	7244	13360	8406	8741	9764	3452	181	2390	14344	4905	73087
Lambs	3477	7291	950	2374	2764		84	1129	5223	1080	24372
Kids	414	365	236	763	389		15	112	556	263	3143
Calves	8		272	23		29				37	369
Colts	5		166	37		64				49	321

PERCENTAGE INCREASE
Lambs 51%
Kids 54%

Calves 41%
Colts 10%

Note: Numbers in parenthesis are the actual numbers of cattle and horses.

* Oak Springs is t in Unit #17 but some sheep from this Unit dip here.

3. Carrying Capacity

The estimated maximum yearlong carrying capacity of Unit 17 is 73,116 sheep units.(1)

All of Unit No. 17 may be classed as winter of yearlong range except the Defiance Plateau, which is strictly summer range. The estimated maximum yearlong carrying capacity of the Defiance Plateau summer range is 9,754 sheep units or 32,965 head from July 15 to November 1.(2) The maximum estimated carrying capacity of the remainder of the Unit is 63,362 sheep units yearlong.

4. Numbers and Classes of Livestock

According to the 1935 dipping records there are 73,087 grown sheep units of livestock grazing on Unit No. 17; 15,510 sheep units of which are grown horses and 3,628 sheep units are grown cattle. The 1935 dipping records were used because the 1936 records are not complete. The Steamboat vat has not yet come in to be tabulated and compiled. Table No. III shows the number, class, and distribution of livestock by chapters.

(1) The maximum carrying capacity is determined by using a forage acre requirement of 2½ forage acres per sheep per year.

(2) The period from July 15 to November 1 is not the date covering the present use of the Yellow Pine country. July 15 was selected as the probable average date of range readiness and November 1 was selected as the probable average date that livestock would have to move off. Range readiness is the date at which approximately 20% of the seed stalks have appeared.

The dipping records of Unit No. 17 are inadequate as a livestock count. Three bands of sheep were seen on the unit that were not dipped. From a reliable source came the following information; "The sheep are not coming in to be dipped. They did not come in last year but they came in better last year than they are coming in this year."

There are no records available for one dipping vat located in the extreme south end of the Unit and which belongs to Willis Lynch. There is also a large band of sheep which comes from the Crystal and Tsaille region into the southwest portion of the Unit in the winter and are not included in the dipping records for Unit No. 17. There are about 3,000 sheep which come into the Unit from allotments to the south and which are not counted in this Unit.

There are more cattle and horses on the Unit than is shown by the dipping records.

5. Utilization

The heaviest utilization on the Unit is adjacent to the concentrated areas of farming and population. (See Map No. 5)

The area along the Ganado or Pueblo Colorado Wash from the Ganado Demonstration area to the junction of the Pueblo Colorado and the Steamboat Washes exhibits the most severe utilization; second, the woodland area in the Kin Li Chee drainage from the Ganado Demonstration area to the Ponderosa Pine;

third, the Wide Ruins and Leroux drainages from about two miles east of the Wide Ruins Trading post to about two miles west of Tanner Springs; fourth, the Steamboat Wash from the Steamboat Demonstration area south for approximately ten miles; and fifth, from the junction of the Steamboat Pueblo Colorado Washes north along the Steamboat Wash for approximately five miles.

6. Distribution and Seasonal Movements of Livestock

Distribution of livestock on this area depends upon several factors. These factors include such items as: the concentration of population and farming land; the location of livestock water; the fuel, wood and hogan pole supply; and the location of Day Schools and Trading Posts.

The same factors which affect distribution also affect seasonal movements.

In the winter the livestock are distributed throughout the woodland areas, with the heaviest concentration being nearer the Trading Posts, Day Schools, and permanent water supplies. In general the treeless areas are not used to a great extent as winter range because of the lack of fuel wood and hogan material, the lack of permanent water supplies and the lack of protection from winter winds and storms. The treeless areas along the Pueblo-Colorado and Steamboat Washes are, however, used quite extensively as winter range because of the permanent nature of the population in these areas, the nearness to fuel wood, the presence of Day Schools and

Trading Posts and the abundance of water. In the Spring and early summer the concentration of livestock increases near the concentrated farming areas for several reasons, the most important of which are: (1) the temporary water on the winter ranges begins to dry up and the livestock must move closer to the permanent supplies; (2) the people move nearer to the agricultural areas for the purpose of working their fields. The treeless ranges, such as the upper Chinle Valley, the valleys west and southwest of Greasewood and the open area in the southwest corner of the Unit are used as soon as summer rains start and the temporary surface tanks catch water. Water determines the date of entrance into these regions.

The Ponderosa pine country or the Defiance Plateau is strictly summer range. The snow often gets too deep and the temperature too low to permit grazing in this region in the winter. As soon as the snow leaves and the temperatures moderate the sheep are driven onto the Plateau. Losses of lambs and oftentimes older sheep occur as the result of moving to this area too early in the spring. Some die from freezing, some from poison plants and some from a lack of nutritious feed. Severe damage to Ponderosa pine reproduction is caused by too early grazing and by the wrong class of livestock. Cattle can utilize the coarse Mountain Muhly grass more efficiently than sheep. Sheep are

doing untold damage to Ponderosa pine reproduction in spite of the abundance of coarse grasses. The average date of entrance into this area probably should not be before July 15th for either class of livestock. This year the range was not ready to be grazed until after August 10th.

The open grasslands in the southwest portion of the Unit are used as winter range for sheep and as yearlong range for cattle. The factors affecting seasonal use and distribution, as mentioned above, do not apply to this part of the Unit because it is controlled by two large owners. This area is very sparsely populated and from all reports of Indians and others it is probable that few, if any, people will move into this area as long as it is controlled by the large owners now living there. Several water developments have been made by these large owners. One well was drilled about ten miles west of Klagetoh by CCC and a 50,000 gallon steel storage tank and concrete troughs installed, but use rights are reserved by an individual because he erected and owns the windmill that pumps the water.

The heaviest concentrations of livestock in the southwest part of the Unit are near the permanent waters, most of which are controlled by large owners. This area is now used as a winter sheep range. Large bands of sheep and a limited number of cattle are brought into the Unit from the north in the fall and moved out again in the spring.

The vegetation in the southwest portion can probably be more efficiently utilized by cattle than by sheep. The principal vegetative species are Saccaton, Galleta, Snake weed, Chamise and Blue grama. There are also small areas of grassland surrounded or almost surrounded by barren or rough land into which a couple or three cows could go. If a band of sheep were to be herded in such areas there would not be enough forage for them and trampling would be excessive. This area has long been considered by the white man as an excellent winter range for cattle.

ANIMAL HUSBANDRY PRACTICES

1. Selection

Some progressive selection is practiced by the livestock breeders of this Unit. This is especially true of the large owners. For the most part, however, unprogressive selection is the prevailing practice. The owners sell only the best lambs or the best ewes. There is no sale for the inferior animals, consequently they are being retained as the foundation for the breeding flocks. In this way the Indians of this Unit are breeding an increasingly inferior type of livestock. Such a practice, if continued, will result in inferior livestock no matter how good the herds or flocks were to start with, how closely breeding dates are observed, how good the sires are, or how abundant the feed.

ENGINEERING

General Discussion

Throughout the entire study of this Unit much credit is due members of the various other divisions in the selection of the several works projects. All farm studies were made by the Agronomy, Soils and Engineering divisions, while water spreading and gully control projects were primarily discussed by the Soils, Range Management and Engineering personnel. The divisions of Sociology, Forestry and Biology contributed very pertinent information.

The Agronomy and Engineering divisions jointly prepared the map accompanying this report. All discussion in this report is based on findings during the study period of this Unit and is referenced on the enclosed map.

Drainage

Drainage of the entire Unit is in a general southwesterly direction with the exception of a small area in the northwest portion which drains north into Chin Lee Valley.

Each individual drainage system was numbered, using the conventional decimal system. The two major drainages, the Pueblo-Colorado and the Leroux Washes, have been given numbers 1.0 and 2.0 respectively. There are three minor drainages. Two, located on Padre Mesa, have been numbered 3.0 and 4.0, while the area

draining into Chin Lee Valley has been numbered 5.0. Proceeding upstream from the Unit boundary, all tributaries were assigned the Unit number of the main drainage followed by a decimal system which gives odd numbers to those entering from the left and even to those entering from the right. For example, the Steamboat Wash, which is the first branch entering the Pueblo Colorado from the left, was numbered 1.1. (See Enclosed map for complete numbering system.)

Runoff

A system of runoff factors was worked out using the data from Mexican Springs in conjunction with factors worked out from field investigations. The field investigations consisted first of runoff calculation of various washes. The amount of runoff was figured from measurements of various sections along the drainages, using debris lines and the word of residents as to the size of floods and the number expected each year. From this data and the drainage area, annual expectancy and maximum expectancy factors were computed. Note was made on each drainage of the main soil and vegetative types on the watershed. The factors were then applied to drainages of like types.

Water Supply.

The amount of water expected at all important points has been calculated. (See following table.)

COMPARISON OF WATER SUPPLY WITH AVAILABLE FARM LAND

LOCATION	WATER SUPPLY			FARM LAND			
	Annual Expectancy A/Ft.	Maximum Expectancy Sec/Ft.	Maximum Expectancy A/Ft.	Cultivated	Potential	Excess Water A/Ft.	Excess Land A.
Irrigated Land Ganado	2300		4400	341	500	400	
Quad #53 Farm #53 #54 & #55	300	5000	1250	62	120		32
Greasewood	175	1870	470	325	70		308
Quad #53 Farm #17	900	9500	2375	97	100	450	
Proposed Project at Wide Ruins	870	14550	3640	41	200	145	
Klagetoh Lake	940	11280	2820	279		100	
Kin-Li-Chee	Water supply exceeds available farm land. So evident no computation was made.			70			
Satan Butte Farms	530	6300	1600	147	44	100	

NOTE: The excess of 400 A. Ft. of water at Ganado will be needed for privately-owned land and should not be considered in the development of additional land.

The above table includes the concentrated farm Units within the area which take irrigation water from a single source. The other concentrations have more than one source of water supply and the annual expectancy is calculated for each individual tract. This table includes approximately 42 percent of the entire farm land, present and potential, in Unit 17 and should be used as a guide in the development of the indicated farm projects. The subjugation of the farming areas should cover a period of five to ten years, depending upon the needs of the people and further observation of the water supply.

The annual expectancy for the irrigation project at Ganado has been based on the records of the water impounded at the Ganado Reservoir during the past twenty-six years plus the additional amount which can be expected due to the U.S.I.I.S. secondary reservoir built in the spring of 1936. Since these measurements were taken at the reservoir, no evaporation or seepage loss was figured. The only loss considered was a 10% loss per mile of ditch.

The following records, covering a period of twenty-six years, furnished by the U.S.I.I.S., show the average amount of water impounded at the Ganado Reservoir due to the diversion on the Pueblo Colorado Wash:

In the months of December, January and May the runoff and evaporation are equal in normal years.

In November there is an average runoff of from forty to fifty acre feet.

In February, March and April the average runoff from melting snows is from 1200 to 1400 acre feet.

In June, July and August the average runoff from summer rains is from 400 to 750 acre feet.

In September and October the average runoff is from twenty to fifty acre feet.

The column headed "Excess Water" indicates that there is more water available than can be used on the land, while the column headed "Excess Land" indicates the acreage available for farming in excess of that which will be expected to receive two acre feet per year. The 308 acres of Excess Land at Greasewood does not mean that this should be removed from cultivation. However, it does show that this land will be practically dry farm, except in years of more than average rainfall.

In the smaller farming sections throughout the Unit, there is a large excess of available farm land in comparison to the annual expected water supply. Generally, the proposed expansion on flood irrigated lands was limited by the available amount of water.

Erosion

Head erosion is a serious problem at various points throughout the Unit as will be noted by erosion control projects outlined on the accompanying map. Gully heads are progressing through the potential farm land at Ganado, making it necessary to institute an erosion control project at this point prior to any subjugation.

Minor gullying has started on the farm land at Canado and Klagetoh which will present a problem in the future unless immediate control measures are taken. (See 1936 Agronomy Report on Unit No. 17) Many of the erosion control projects within the Unit have been instituted to stop gully heads which are destroying much of the grazing land of the valleys.

Sheet erosion is also serious on the farm land of the Unit. This will be checked by subjugation and by controlling the amount of flood water allowed to reach the farm. The same procedure will stop much of the silting of flood irrigated farms. In places, recent silt deposits were a foot or more in depth. (See Erosion Map for location of sheet erosion areas).

Wind erosion is common throughout the entire Unit but the largest single affected area is along the Pueblo Colorado Wash from Canado to approximately three miles below Greasewood. In this area two wind erosion projects have been suggested in addition to planting plans. The above projects are located on the Engineering-Agronomy Map, one at Greasewood and the other approximately three miles west of Canado.

All roads and trails within Unit No. 17 present a serious erosion problem. This includes both old roads which are beyond the usable stage and the new roads which are potential sites for active gullying. It is estimated that there are 1,656 miles of such roads and trails within the Unit boundary.

Water Spreading

Water spreading possibilities are of two types. Projects located on the lower portion of main drainages requiring large structures to divert the water onto sizable areas of range land, meadow or agricultural land. This type of project is located at the lower end of the Pueblo Colorado and Leroux drainages. The second type of water spreading projects are located in the upper portion of individual drainages. The diversion structure for this type consists of a relatively small dam or dike and spreader fences to control discharge over a small spreading area.

In presenting this type of water spreading an entire area requiring this treatment has been combined into one project and outlined on the Engineering-Agronomy map as a general erosion control area treated on water spreading basis.

Summary

Plans for water spreading and gully control projects were made with the idea in mind of using the water on agricultural land where at all possible. The basis of working plans on all farm development is to provide a diversion and ditch system which will best suit the subjugation plans of the Agronomy division. Such projects include total diversion, partial diversion, irrigation ditches, equalizing reservoirs, drops, checks, and dikes for erosion control.

Suggested work projects, including their location, type of treatment, and estimates will be found in the 1936 Engineering report of Unit No. 17.

MINIMUM REQUIREMENTS

In any program of land use adjustment we must consider first the needs of the land and second the needs of the people living on that land. We can state the present conditions of the land and we can specify a plan of procedure which will result in maintaining or increasing its productivity. Such a program should consider the people and make necessary provisions to maintain their present level of livelihood.

To maintain or increase the vegetative cover is the primary minimum requirement of the land in Unit No. 17. The fulfillment of this requirement has a dual purpose. First, from the standpoint of productivity of the land and its economic bearing upon the local people and upon the nation as a whole, and second from the standpoint of watershed protection and its effect upon the local people, the state and the nation.

The most desirable method of maintaining or increasing the vegetative cover is by natural means or proper range and forest management in all its phases.

Adjustment of livestock to the carrying capacity of the range is of primary importance on this Unit. The range forage is being depleted, an estimated 20%, erosion is accelerated, woodland reproduction and production is being reduced below the point at which the supply can equal the demand, forest reproduction is being damaged beyond the point of sustained timber yields, and

the value of agricultural land is being decreased by over-grazing. Changes in the seasonal use of the range are necessary to insure the proper reproduction of timber and woodland and to secure the use of those range forest plants which can be utilized more efficiently at one period of the year than at another. The class of livestock grazing the Unit must be able to utilize the forage with the least possible damage to forage plants and tree seedlings. In certain cases the wrong class of livestock is resulting in the under utilization of some species at the expense of others. This is especially true of Ponderosa Pine seedlings which are being severely damaged. Excessive rodent numbers , which result in serious damage to forage, woodland, timber and agricultural crops require artificial control measures. Insects and disease outbreaks of epidemic proportions, as well as fire suppression, require that adequate provisions be made for treatment as needed.

Control of erosion by artificial means is next in line of importance in maintaining or increasing the vegetative cover. Artificial means are supplementary to natural means and are important in speeding up the natural processes of erosion control. Engineering structures in the form of gully plugs, diversion dikes, thank-u-mams, road drains and drops are of utmost importance.

Erosion control planting in gullies, along certain drainages and on windblown areas are necessary to insure water and soil conservation. Water spreading structures and range planting are vital in revegetating barren areas and in maintaining the top soil and existing vegetation on some areas. Additional livestock reductions and livestock exclusions on certain areas are fundamental in stabilizing the vegetation and soil.

(For location of the above structures refer to the Engineering and Agronomy Map.)

The initiation of any program of land use adjustment must of necessity produce certain effects on the livelihood of the people if that program restricts the present uncontrolled utilization of natural resources. These effects will be most noticeable in those products upon which the Navajo places chief dependence for the continuation of life. The Indians' dependence upon sheep as a source of commercial income and as a readily available supply of food may be adversely affected. Thus it becomes apparent that any change in land use must also involve an adjustment in the resources placed at the Navajos command from which he wrests his living. This assumption is predicted on the basis that it is desirable to preserve, insofar as possible, the present level of livelihood. This being true, the restriction of any one source of income makes necessary the substitution of other resources from which an additional income can be derived.

According to estimates based on the range survey, a reduction of 10,000 sheep units in sheep and goats is necessary. In addition to the recommended changes in other classes of livestock this adjustment would result in a reduced income (figured on the basis of $2.40 per sheep unit) of $24,000. The actual loss in income arising from the necessary sheep adjustment would probably be less than $24,000.00, since the initial adjustment involves the elimination of the least productive portion of the flock. Nevertheless, it appears desirable to insure an adequate supplementary income to offset such decreases as may occur.

The analysis of the income and expenditures for 1935 shows an annual expenditure of $28,500.00 for raw agricultural products which are imported into the district and sold to the Indians through the traders. These commodities, which include corn, oats, hay, potatoes, etc., are producible in the district if sufficient agricultural land were made available. On the basis of estimates furnished by the Agronomist, an additional 584 acres would be necessary to produce these specific crops to the amount desired. The development of this additional agricultural land will equalize the loss of income from sheep, incurred through reduction, and enable the natives to maintain their present standard of living.

IMMEDIATE WORK

The findings of the study group show that there are certain plans of work jobs which should be carried out at once, and others that should be carried out in a long-time plan. Work areas in which we can do the greatest good with the least expenditure of time and money are recommended for immediate work. The first job is to adjust the number of livestock to the carrying capacity of the range. This is the natural way of establishing a vegetative cover, the best means of erosion control. Artificial erosion control or work projects are of immediate importance in order to assist natural erosion control.

Livestock adjustments should occur inthe following order:

1. Horses. Remove the least serviceable first.
2. Goats.
3. Sheep. Remove the least productive first.
4. Cattle. Remove the least productive first.

The following are classed as immediate work projects of primary importance:

1. Farm Development

Ganado Irrigation System. (Present farmed.)
Erosion control to protect above system.
Re-vamping of the system.
Maintenance and enlargement of ditch system.
Enlargement of ditches depends upon amount of land to be subjugated below.

Klagetoh Area.

Completion of ditch system and complete subjugation of the land before irrigation water is used. Due to the danger of erosion no water should be used on the land before subjugation.

2. Water Development

M-198: -- Temporary E.C.W. Surface Tank.
109° 30' x 35° 45' -- 11 1/5" W x 1½" S.
Bad headcutting above this tank. Put in drop to stop headcutting.

M-156: -- Permanent E.C.W. Dug Well
109° 15' x 35° 30' -- 10 3/4" W x 6 3/10" S.
Well 15 feet deep - cribbed with rock and concrete. Concrete top - 2 foot concrete trough. Caving in around top. Dig 10 feet deeper. Fill in around top so that water won't stand around well. Put in hand pump.

M-18: -- Permanent E.C.W. Spring
109° 15' x 35° 45' -- 11 1/2" W x 10" S.
Rock cribbed spring 30 feet x 20 feet x 6 feet deep. Open top. 150 feet of 1 1/4" Galv. pipe and forty feet of concrete trough. Pipe is stopped up. Clear out pipe and fit it so that it won't get trash in it.

3. Erosion Control

Erosion control on Proposed Expansion of Canado.
Irrigation System.
Purpose to control active gully cutting on the land with the idea of future subjugation.
Erosion control on an estimated 1650 miles of old and new roads within the Unit.
Such work will consist of Thank-u-mams and wire-rock sausages at the more important gully crossings.

Quad #53 E. C. #1
This is an area of actively eroding gully heads.
Project combines gully control and water spreading.
Area affected - 5700 acres.

Quad #54 E.C. #1
Erosion control project to prevent head cutting in a large flat valley.
Requires a large dike to turn water over natural sandstone spillway.
Area affected - 2000 acres.

4. Special Jobs

Quad #54 S #2.
Main structure consists of an equalizing reservoir.
Estimated 60-70 acres ft. capacity.
Will control active head cutting up the main valley.
Twenty acres of potential farm land directly below reservoir.

IMMEDIATE WORK

The following projects are classed as immediate work of secondary importance.

1. Erosion Control

Quad #54 E.C.#2
Erosion control project to protect roadway and a small area of range land.
Requires two drops and a small dike.
Area affected - 100 acres.

Quad #54 E.C.#3
Drop structure to stop active head cutting in large valley.
Area affected - 200 to 400 acres.

Quad #54 E.C.#4.
Drop structure to check head cutting in valley.
Area affected - 1000 acres

Quad #56 - Farm #29
Erosion control to stop a large actively cutting gully.
Includes a drop structure with small deflection dikes.
No subjugation is required on the farm.

Quad #57 E.C.#1
Five large gully heads actively cutting back from Steamboat Wash.
Dikes to be placed around the heads to spread the water on range land.
Area affected - 400 acres.

2. Water Spreading

Quad #58 - #24 and #25.
Water can be spread over approximately 1900 acres of range land.
Will also reduce the amount of head cutting along the Pueblo Colorado Wash.

3. Timber Development

A timber survey to determine opportunities for commercial development of Ponderosa pine stands.

4. Water Development

M-2: -- Permanent Indian Dug Well
109° 15' x 35° 45' - 5 7/8" S x 1 3/8" W.
Well 6 feet deep, cribbed with rock.
10 foot long trough.
Dig well three or four feet deeper - crib with rock and concrete - concrete top.
Put in hand pump - 20 foot concrete trough.

M-11A:--Permanent Indian Dug Well.
109° 15' x 35° 45' - 5 3/4" S x 9 1/8"W
Well 15 feet deep - 10 feet of water
cribbed with rock - 15 foot log trough.
Concrete the top. Put in 20 feet concrete trough and hand pump.

M-22: --Permanent E.C.W. Dug Well
109° 30' x 35° 45' - 10 1/4" S x 2 3/4"W
Rock cribbed well 25 feet deep, concreted top,
25 foot concrete trough.
Put in: 15,000 gallon storage tank.
10 foot windmill.
20 feet more concrete trough.
Float box and float .
Dig well 10 feet deeper.

M-23: --Temporary E.C.W. Surface Tank
109° 30' x 35° 45' -- 3/4" W x 10 1/4"S
Widen spillway.
Turn other drainage into dam instead of around it.

M-29: --Permanent Indian Dug Well.
109° 15' x 35° 45' -- 3 3/8" W x 8" S.
Well 6 feet deep. 3 1/2 feet water.
Dig 5 feet deeper.
Crib with rock and concrete - put in 20 foot concrete trough - put in hand pump.

M-31: --Permanent Indian Dug Well.
109° x 15' x 35° 45' -- 9 1/2"S x 1/4"W
Well 5 foot deep. Cribbed with Juniper logs.
20 foot log trough.
Dig well three to five foot deeper.
Crib with rock and concrete top.
Put in 20 feet concrete trough.
Put in hand pump.

M-32: -- Permanent Indian Dug Well
109° 15' x 35° 45' --6½" W. x 4 1/4"S
Well 15 feet deep and cribbed with rock.
Concrete top
Deepen if necessary
Put in 20 foot concrete trough
Put in hand pump

M-60: -- Permanent Indian Dug Well and Semi-Permanent Undeveloped Spring
109° 15' x 36° 00' -- 14 3/4" S x 6" W.
Well four feet deep and cribbed with rock.
Dig five or six feet deeper
Cribb with rock and concrete the top
Put in 20 foot concrete trough - put in hand pump.

M-63: -- Permanent Undeveloped Spring
1109° 15' x 36° 00' -- 11 1/4"W x 11 7/8"S.
Dig out and prepare to collect the water.
Put in 20 foot concrete trough.
Fix the whole thing so that floods won't wash it out or fill it up.

M-64: -- Permanent E.C.W. Spring
109° 30' x 36° 00' -- 6"W x 16"S
Investigate and see if there is enough water here to be of any value for livestock water. If there is, then clean out the pipe so the water will run into the trough.

M-65: -- Permanent E.C.W. Dug Well.
109° 30' x 36° 00' -- 6"W x 15 7/8"S.
Snake Springs. (Lizzard Springs)
Repair the hand pump.
Water gets low here in late spring.
Deepen the well if necessary.

M-72: -- Permanent Indian Dug Well.
109° 30' x 36° 00' -- 1/7/8"W x 8"S.
Well on east side of M-71-12 feet deep and cribbed with Juniper logs. Two log troughs ten feet long.
Cribb with rock - concrete top.
Put in hand pump - put in 20 foot concrete trough.

M-74: — Permanent Indian Dug Well.
109° 30' x 36° 00' — 3 3/8"W x 15 5/8"S.
Well 10 feet deep, cribbed with Juniper logs.
Two feet of water now.
Dig five feet deeper.
Cribb with rock and concrete top.
Put in 20 feet concrete trough.
Put in hand pump.

M-79 — Permanent Indian Dug Wells.
109° 45' x 36°00' — 1"W x 15 1/2"S.
Two wells here - both practically dry.
Cribbed with Juniper logs - about ten feet deep.
Deepen one of these wells and if can get more water then crib with rock, concrete top. Put in hand pump and 20 feet of concrete trough.

M-87: — Permanent E.C.W. Dug Well.
109° 30' x 35° 45' — 16 5/8" S x 1 3/4"W at Klagetoh.
Well 12 feet deep - four feet water
Cribbed with rock and concrete top. 20 feet concrete trough.
Put in hand pump.

M-105 — Temporary E.C.W. Surface Tank.
109° 30' x 35° 45' — 14 3/4" S x 12"W.
Put three rock sausages in spillway - 50 feet apart.

M-107 — Temporary Indian Surface Tank.
109° 30' x 35° 45' — 7 3/9" W x 16"S.
Large Indian dam. A wall of Juniper logs on each face.
Capacity 3 a. feet - no spillway.
Build a spillway on north side and put a diversion dike around headcutting on south side. This isn't especially needed for livestock water, but the structure should be saved.

M-108 -- Temporary Indian Surface Tank.
109° 30' x 35° 45' -- 6 1/2"W x 15"S
Large Indian dam.
Wall of Juniper logs on each face - small spillway.
Build a spillway.

M-168 -- Permanent E.C.W. Dug Well.
109° 45' x 35° 45' - 6 3/10"W x 15 4/5"S
At Greasewood dipping vat.
Repair hand pump.

M-170 -- Permanent E.C.W. Spring
109° 45' x 35° 45' - 6 1/2" W x 16"S
On hill above dipping vat.
Clean out trough.

M-190 -- Permanent E.C.W. Dug Well
109°45' x 35°45' -- 4"W x 13 1/5"S.
Repair hand pump.

M-205 -- Permanent E.C.W. Dug Well.
109°34' x 35°45' -- 8"W x 7 5/8"S.
Well 15 feet deep, cribbed with rock and concrete - concrete top and 20 feet concrete trough - 400 sheep watering here now.
Put in hand pump.

M-206 -- Permanent E.C.W. Dug Well.
109°45' x 35°45' -- 8"W x 6 7/8"S.
Well 15 feet deep - four feet water cribbed with rock and concrete top.
20 feet concrete trough and double action hand pump.
Clean out trough and build a dike above trough to keep out water and sand.

M-210 -- Temporary E.C.W. Surface Tank
109°45' x 35°45' -- 12 7/8" W x 4 3/4"S.
Dam 300 feet long - water in it now.
Capacity about 12 acre feet.
Cut spillway 20 feet wider and put in three or four rock sausages so that it won't wash.
Put 800 yards on top of dam so as to

make the crown wider - make upstream face a three to one slope.
Take dirt from bar pit.

M-215 -- Temporary Indian Surface Tank and Natural Lake.
109°30' x 35°45' -- 11 1/8"W x 1 1/2"S.
Dam 80 feet long and three feet high.
No spillway - old natural lake covering about 15 acres.
Capacity now about 20 a. ft.
Full now and has run over.
Build dike five feet higher and make spillway. Allow three feet free board. Will then hold approximately 45 acre ft. of water.

LONG TIME WORK PLAN

An executed long-time work plan will carry out the minimum requirements as stated in the preceding paragraphs and further develop the land resources to meet the needs of the land and the people. By doing this, the people will automatically adjust themselves to their incomes and we will have a self-supporting people.

The following long-time work plan should, if properly executed, take care of the rising needs of the people and stop a large amount of the accelerated erosion which is at present destroying the resources of the Navajo people.

Range Management

1. Proper stocking of the range as to class and carrying capacity.
2. Development of livestock water as recommended in the water survey report. (See Map #)
3. Improved distribution of livestock.
4. Improved seasonal use of the range. (See Map #)
5. Improved animal husbandry practices.

Forestry

1. Protection.
2. Silvicultural work.
3. Commercial development.
4. Community forest activities.
5. Tree planting.

Agronomy

1. Subjugation of present farmed land.
2. Subjugation of new lands as the need arises.
3. Introduction of plants to furnish food for the people and livestock.
4. Introduction of simple farm machinery.
5. Erosion control planting as needed.

Biology

1. Control of rodents and predators.
2. Control of insects, parasites, pests and diseases.
3. The establishment of game and water fowel refuges as the possibilities permit.

Sociological Surveys

Make organic studies of significant aspects of Navajo livelihood for the purpose of more efficiently developing the land resources.

Education and Demonstration

Education and demonstration of all phases leading to the maintenance and development of the resources.

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Refer to the individual branch reports for detailed plans of procedure for the execution of the long-time program.

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