Anonymous - LAND MANAGEMENT UNIT NO. 6, LAND PLANNING REPORT - Aug. 15, 1937

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RECORDS AND STATISTICS

LAND MANAGEMENT UNIT NO. 6

LAND PLANNING REPORT

August 15, 1937

STUDY GROUP "C"

Chief of Party

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PART ONE - BASIC DATA

I. LAND MANAGEMENT UNIT NO.6

A. INTRODUCTION:

The Land Planning Survey field work on Land Management Unit No. was started April 7, 1937, and completed July 16, 1937.

The following men made the field survey:

Forestry - - - - - -	David W. Dresbach - - - - -	Jr. Forester
Agronomy - - - - - -	Ernest A. Nicholson - - -	Jr. Agronomist
Biology - - - - - -	Gale Monson - - - - - - - -	Jr. Biologist
Engineering - - - -	Allen A. Stamm - - - - - -	Engineering Aide
Human Surveys - - -	Gordon B. Page - - - - - -	Under Agricultural Aide
	Hasko Haswood - - - - - -	" "
	Otto Lomavitu - - - - - -	" "
Soils and Erosion -	Howard F. Johnson - - - -	Jr. Soil Surveyor
	Lucien A. Hill - - - - - -	Jr. Soil Technologist
Indian Irrigation -	W. W. Perkinson - - - - -	Indian Irrigation Service
Range Management -	Walter R. McKinney - - - -	Jr. Range Examiner (Chief of Party)
	Odis Holly - - - - - - - -	Jr. Soil Conservationist
	Johnny Russell - - - - - -	Under Agricultural Aide

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The various branch reports were written by the following men:

Forestry	David W. Dresbach
Agronomy	E. A. Nicholson
Biology and Planting	Gale Monson
Engineering	Allen A. Stamm
Human Surveys	J. H. Provinse
Soils	Howard F. Johnson
Range Management	Walter R. McKinney

B. GEOGRAPHICAL FEATURES:

1. Description:

a. Location and Political History:

Land Management Unit No. 6, known as "The Hopi Unit", is located in the west central part of the Navajo Reservation. There are 443,649 acres in Navajo County and 55,599 acres in Coconino County, Arizona. The whole of this area was included in the land which was established as an Indian reservation by an Executive Order on December 16, 1882.

A land survey of the whole area has been made, and it is marked with iron stakes.

b. Area and Boundaries:

The area of Unit No. 6 is 499,248 acres. The boundaries are rather well defined and easy to follow in the field since

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they follow along prominent topographical features, such as mesa escarpments, washes, ridges, etc. This Unit is bounded on the north by Unit No. 4, on the east by Unit No. 7, on the south by Unit No. 5, and on the west by Unit No. 8. (See Map No. 1).

Five boundary changes were made affecting Unit No. 6 when Units No. 4 and No. 5 were studied. These changes were made in order to separate Navajo and Hopi land use in so far as possible at the present time. The following table (Table I) shows the acreage and carrying capacity of each change:

Table I BOUNDARY CHANGES

Change Number	Subtractions (Acres)	C. C. S. Y. L.	Additions (Acres)	C. C. S. Y. L.
*4-2			7,140	142
4-3	5,946	122		
4-4	27,652	925		
4-5	1,078	27		
Tovar Mesa 5-1	16,110	418		
Shonto Springs 5-2			9,210	314
Totals	48,786	1,499	16,350	455
Difference	32,436	1,044		

*The first number in the "Change Number" indicates which Unit was being worked when the change was proposed.

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The changes resulted in a total deduction of 22,436 acres with a yearlong carrying capacity of 1,044 sheep units.

2. Physiography:

a. Elevation and Topography:

The elevation varies from about 6,400 feet to 5,400 feet: At Keams Canyon 6,184 feet, at Polacca 5,800 feet, at Oraibi 5,700 feet, at Hotevilla 6,365 feet, and at the point where the Dinnebito Wash leaves the Unit approximately 5,400 feet.

The topography of the northern portion of this Unit is characterized by high, elongated mesas, which are fingerlike extensions of Black Mesa on the north. Deep, alluvial valleys form the breaks between the mesas. The southern portion is less broken than the northern portion, exhibiting a rolling topography. Three large drainages enter from the north and leave the Unit along its southern boundary. They are; The Polacca, with its large tributary, the Wepo; the Oraibi; and the Dinnebito. These drainages have cut deep channels through the alluvial valleys, have numerous lateral tributaries and flow in a southwesterly direction.

b. Geology:

A summary of the geology of this Unit has been written by Mr. Tom Meeks and is quoted below (See Map No. 2).

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"Physiography and General Geology

"Since the beginning of the Tertiary period, continental conditions have prevailed in the Navajo Country, and the regional uplift which removed the Cretaceous sea was accompanied by anticlinal, monoclinal and synclinal folding. Unit No. 6 lies wholly within one of these flexures - the Tusayan downwarp. This structure includes the whole of Black Mesa and has its southern border near the Little Colorado River.

"The geology of the region is represented by the Mesa Verde, Mancos and Dakota formations of the Cretaceous age and the Morrison formation of Jurassic age. Strata classed as basal Morrison, in this report, closely resemble the Entrada and Carmel but according to Baker, Dane and Reeside* these formations do not extend this far south.

" The Mesa Verde is the most outstanding formation of the Unit and forms the resistant cap rock of the mesas on which the Hopi villages are situated. One long finger of this formation extends as far south as Blue Point, forming the cap rock of this landmark. This outlyer to the south is due to a north-south anticlinal flexure which elevates the mancos to a horizontal level which is equal to the basal Mesa Verde of the Hopi mesas.

" The Morrison is probably the most wide-spread formation in the Unit and is exposed over the entire central and southern portion. Its main importance lies in its dependability as an aquifer.

*U.S.G.S. Prof.Paper 183

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Stratigraphy

Jurassic Formations

The Jurassic in the Unit may be represented by the Carmel, Entrada and Morrison formations, but the existence of the Carmel and Entrada is not a certainty so the entire Jurassic of this district will be included in the Morrison.

Morrison Formation

The Morrison formation in the Unit is taken to include all beds between the Navajo-Wingate and the Dakota. It has a thickness of 600 to 700 feet over most of the area with a thinning to the south.

The Morrison is made up principally of a fine grained, white, greenish, and light brown sandstone with a few thin layers of red and green shales. The cementing material is mainly lime and green ferrous iron. In places, the Morrison contains thin beds of resistant lime and banded chert. Zones of small, rounded concretions are common in the sandstones.

In the southern portion of the area the Morrison is made up of dark red, cross bedded sandstone which grades downward into red shale and siltstones. Greenish gray deoxidized spots and streaks are common.

Cretaceous Formations

The Cretaceous formations, as previously stated, include the Mesa Verde, Mancos, and Dakota formations. The Mesa Verde

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is the most wide-spread and important of the three. The Mancos forms the long slopes at the foot of the mesas but its lateral extent is not great. The Dakota is very thin in this Unit and only occasional outcrops of it may be found.

Dakota Sandstone

"The Dakota is a massive coarse to medium grained buff sandstone about ten to fifteen feet thick and underlain by equally thick beds of gray clay and coal. The base is commonly marked by a conglomerate. The formation is everywhere lenticular with lenses of sandstone, shale, conglomerate and coal overlapping in a very irregular manner. The contact with the underlying Morrison formation is marked by an erosional unconformity. Although the Dakota is usually coal bearing, the beds in this Unit are thin and of short lateral extent, making mining unpractical.

Mancos Shale

"The Mancos includes all the beds between the Dakota sandstone and the Mesa Verde formation. It consists of drab, sandy clay shale with thin, platy sandstone members. The beds are gypsiferous and in some places are quite fossiliferous. The Mancos shale is conformable with the beds above and below but in its entirety is lithologically unlike them. The contact with the Dakota can be established with a fair degree of approximation but the upper contact with the Mesa Verde must be arbi-

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trarily drawn within 100 to 200 feet because the Mancos passes into the Mesa Verde by a series of transition beds of shale and sandstone possessing features of both formations. The Mancos is a marine formation and, although coal has been reported in it, the writer has been unable to substantiate these reports at any place observed on the Reservation.

Mesa Verde Formation

"The Mesa Verde in the vicinity from Gallup northward is divided into three divisions: The Point Lookout sandstone, the Menefee sandstone and shale, and the Upper Cliff House member. Although the distinction has never been made in this locality, the sandstones and shales in Unit No. 6 are comparable to the lower Point Lookout member.

"The Mesa Verde in the northern part of the Unit is from 280 to 300 feet thick with a rapid thickening to the north. It is composed of a massive, coarse grained sandstone alternating with beds of gray to brown shales and coal. Stringers of gravel are also common. Gypsum is abundant in the shales and rounded sandstone concretions are common throughout. Small, well-rounded and boitroyoidal ferruginous concretions and slabs of coarse sandstone cemented with hematite are also common.

Pleistocene Deposits

"During the course of this investigation a hitherto unreported deposit of Pleistocene gravels was discovered in the

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vicinity of Burro Springs. These deposits are composed of sand and gravel with a few interbedded clays in places. Well cemented gravels occur in some places and occurrences of lime are common in patches and as a matrix for the gravels.

"The gravels vary from a coarse sand upward to boulders a foot or more in diameter. The sandstone boulders are characteristic of the Cretaceous formations to the north, and although some are well rounded, others are angular and platy. Concretions of sandstone and of hematite are common.

"These deposits are believed to have been made near the close of the Pleistocene, after the valleys had been cut and the later process of deposition had set in.

Landslides

"The topography of the northern part of this Unit appears to favor landslides. The cliffs are steep and high, erosion is active in the valleys, and the heavy sandstones are underlain by clay and shales. The landslides in this Unit are a peculiar type called 'Toreva Blocking'* from the type locality at Toreva. They are a result of a favorable combination of surface water, ground water and rock structure.

"Landslides occur at the site of all of the Hopi villages and near the mouth of Keams Canyon. Springs and seeps at the base of the sandstones wet the shale to produce a sliding plane which allows the blocks to slide on this zone of lubrication.

*P. Psiche. Unpublished paper.

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In this district the base of the sandstone blocks has rotated outward from the parent formation causing the block to dip inward toward the mesas. In recent years landslides have occurred when unusual amounts of precipitation have fallen.

HISTORICAL

"Since time did not permit a detailed study of the region it is impossible to do more than generalize on the history of the region.

"As stated previously in this paper the regional uplift which drove the Cretaceous sea from the region was accompanied by anticlinal and synclinal folding during which the Tusayan downwarp was formed.

"The Tertiary was largely a time of erosion during which the Mesozoic sediments were beveled off in the territory south of the present Hopi villages. During Pliocene time the Hopi Buttes volcanoes came into existence and the present Tertiary deposits south and east of Unit No. 6 are a product of the Hopi Lake which was formed by a dam built by the ash and lava from the volcanoes.

"At the close of the Pliocene the volcanoes ceased to be active and erosion again set in. It was during this time and the early Pleistocene that the present valleys were cut. The infilling of these valleys to 100 feet or more probably took place toward the close of the Pleistocene and at present these alluvial valleys are being dissected by deep gullies.

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MINERAL DEPOSITS

Coal

"Commercial coal deposits in this Unit are confined entirely to the Mesa Verde formation in the northern part of the Unit. The coal occurs in lenses interbedded with shale and is usually thin, 36 inches being the thickest bed measured. The coal seam at the Keams Canyon mine is about eight feet thick, but it is made up of alternating thin beds of coal and shales. Another mine inoperation at Oraibi was not visited but four to five feet of coal is reported. Coal was observed from Keams Canyon west and in all the mesas in this Unit. The limited time available for this report prohibits making an estimate of the available coal or recommendations for future development.

GROUND WATER

"Ground water in the Unit may be divided into two classes, alluvial and formational. The main valleys of the district, the Oraibi and the Polacca, have been filled with alluvium to a depth of 100 feet and more and the sands and gravels in them offer a convenient source of water at relatively shallow depths. Minor valleys also offer available water in shallow wells.

"The two formational aquifers of the region are the Mesa Verde and Morrison formations. The Dakota is a possible aquifer in the extreme northern portion of the area but it cannot be depended on for sufficient water to justify drilling to the limited depth of about 900 to 1000 feet.

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"The Morrison formation will produce water at almost any locality in the Unit with depths varying from 200 feet in the southern portion to 1200 feet in the northern part of the Unit. Care would have to be exercised in making well locations in order to provide a sufficient intake area. Abundant water in the Morrison is usually assured at proper locations. It is universally salty, but in most places is suitable for stock and even human consumption.

"The Mesa Verde forms a source for most of the springs in the Unit, but is not suitable for deep wells. The springs are forced out of the base of the sandstones by the underlying impervious shales, and the water from them is practically always good. Blow sand in the Unit also forms a source for many of the springs where it rests on a fairly impervious formation.

ENGINEERING

"The sandstone of the Mesa Verde is one of the most suitable building stones on the Reservation and is also suitable for a base in reservoirs but jointing must be carefully studied if an impervious foundation is to be obtained.

"The Mancos is also suitable for a base for reservoirs if proper precautions are taken. It is second to none in imperviousness on the Reservation, but the soils derived from it are heavy and 'piping' is characteristic and must be guarded against.

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"A few suitable building stones may be found in the Morrison but these should be carefully selected since they usually are weakly cemented and have a tendency to melt when becoming wet. For this reason, care should be exercised in using the Morrison as a base for reservoirs, although the silt carried by the streams in this district would quickly seal the leaks."

c. Soils and Erosion:

The following information is taken from the "Soils and Erosion Report" by F. F. Johnson:

According to their ability to produce native vegetation under normal climatic conditions, the range soils of Unit No. 6 have been grouped into five classes. Class "A" is rated as a excellent and is found in the northern portion of Sub-unit No. 1 and in the southern and eastern portions of Sub-unit No. 2. These soils are deep and permeable, have a high water-holding capacity and are, at present, little affected by erosion.

Class "B" is rated as good and is similar to Class "A". These soils are either less permeable, moderately eroded, have a moderate water-holding capacity, or possess all three characteristics. The largest areas of Class "B" land are in the southern portions of Sub-unit No. 2; smaller areas are scattered over Sub-unit No. 2 with still smaller areas in Sub-unit No. 3. The soils in both of the above classes should respond readily to a land management program.

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Class "C" soils have a fair or relatively low productive capacity. This may be the result of natural or induced causes, such as low water-holding capacity, high alkali content, shallow soil cover, or accelerated erosion caused by overgrazing and farming. The largest areas of Class "C" soils are found in Sub-unit No. 2, and the least in Sub-unit No. 1. They are generally located along valley bottoms and on mesa tops, usually representing the critical erosion areas. This class of soil will be slow to respond to a range improvement program.

Class "D" generally consists of rough broken and stony lands having an intermittent soil cover. Usually little improvement is possible. However, these soils represent an important part of the watershed and their present vegetative cover should be protected as much as possible.

Class "E" soils represent steep, inaccessible, rough stony and broken escarpments. Essentially no improvement can be expected on these soils. The following table (Table II) shows the acreage of each class of range soil by Sub-units:

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Table II RANGE SOIL CLASSIFICATION (Acres)

Class	Sub-unit No.1	Sub-unit No.2	Sub-unit No.3	Total
"A"	29,548	23,326	4,130	57,004
"B"	30,212	64,890	14,229	109,331
"C"	29,613	74,054	82,247	185,914
"D"	11,768	12,032	42,368	66,168
"E"	23,071	43,405	9,831	76,307
Cult.	1,069	1,006	2,449	4,524
Total	125,281	218,713	155,254	499,248

Erosion on this Unit is varied in kind and severity. Primary erosion factors are the strong southwesterly winds, torrential seasonal rains, overgrazing, farming practices and, around the villages, human activity and trampling.

Wind erosion is universally active in farming areas. The practice of farming an area for a few years and abandoning it when the light surface soil has blown away has greatly increased the wind erosion problem. Grazing close to farming areas has aided in increasing wind erosion on grazing land, areas of severe erosion correspond very closely to areas which have been heavily overgrazed, such as: Near the villages, along all the main valleys, and near old developed water supplies. On those areas which are farther from permanent water supplies, erosion is slight.

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Gully erosion was not active along the secondary drainages until the torrential storm of 1923, which cut many gullies. Since then most of these gullies have continued to cut, vegetation stabilizing only a few.

Sheet erosion is usually found only adjacent to gullies on the lighter textured soils.

The kind, extent and degree of erosion are shown on Map No. 8.

d. Precipitation, Temperature and Growing Season:

The average annual precipitation is probably about eleven inches, the average annual temperature 55° F, the average maximum temperature 98° F, the average minimum temperature -15°, and the growing season approximately 155 days. Climatological data for this Unit were taken from records for Keams Canyon and Jeddito, supplemented with estimates and information from other parts of the Unit. The following table (Table III) is a summary of the climatological data for this Unit:

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TABLE III

CLIMATOLOGICAL DATA

Area or Station	Elevation (Feet)	Avg. An. Precipt'n	Avg. An. Temp.	Max. Temp.	Min. Temp.	Avg. Dt. 1st Klg. Frost	Avg. Dt. Last Klg. Frost	Avg. Length Growing Season
Keams Canyon	6,184	12.43"	50°F	96°F	-12°F	10-12	5-27	135 Days
Jeddito	6,150	12.50"	50°F	96°F	-12°F	10-12	5-27	135 "
*First Mesa	5800-6400	11"-13"	51°-49°F	96°F	-12°F	10-12	5-27	135 "
*Second Mesa	5600-6300	11"-12½"	52°-49°F	96°F	-12°F	10-12	5-27	135 "
*Third Mesa	5700-6400	10½-13"	52°-49°F	96°F	-12°F	10-12	5-27	135 "
Southern Half of Unit	5400-5700	9½"-10½"	52°-55°F	98°F	-10°F	10-15	5-25	140 "

*All figures except elevations are estimates based upon elevation, vegetation, and the records from Keams Canyon, Jeddito and Land Management Unit #5.

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TABLE III CLIMATOLOGICAL DATA

...ea or ...ation	Elevation (Feet)	Avg. An. Precip'n	Avg. An. Temp.	Max. Temp.	Min. Temp.	Avg. Dt. 1st Klg. Frost	Avg. Dt. Lst. Klg. Frost	Avg. Length Growing Season
...Canyon	6,184	12.43"	50°F	96°F	-12°F	10-12	5-27	135 Days
...se	6,150	12.50"	50°F	96°F	-12°F	10-12	5-27	135 "
...s Mesa	5800-6400	11"-13"	51°-49°F	96°F	-12°F	10-12	5-27	135 "
...d Mesa	5400-6300	10"-12½"	52°-49°F	96°F	-12°F	10-12	5-27	135 "
... Mesa	5700-6400	10½-13"	52°-4...°F	96°F	-12°F	10-12	5-27	135 "
...re Half Unit	5400-5700	9½"-10½"	53°-55°F	98°F	-10°F	10-15	5-25	140 "

...gures except elevations are estimates based upon elevation, vegetation, and the records from Keams ...yon, Jeddito and Land Management Unit #5.

NN006011

e. Relative Humidity, Evaporation and Wind Movement:

There are no records on the relative humidity, evaporation, or wind movement for this area. The relative humidity is low, probably ranging from 40 to 60 per cent. Evaporation from soils and reservoirs is high. The highest evaporation occurs during the driest and hottest months, or May and June. The evaporation of water from tanks is estimated at 65 to 70 inches per year. The prevailing winds are from the southwest with the highest velocities occurring during March and April. At times these winds carry a great amount of dust and sand, which results in some damage to vegetation and structures. Probably wind velocities of fifty miles per hour are rare.

3. Ecological Zonation:

a. Vegetative Zones and Types:

Vegetation on Unit No. 6 falls in the Upper Sonoran zone and, for all general purposes, can be grouped into three major types; namely, Grassland, Browse, and Woodland. (See Map No.5). All lands typed as inaccessible, barren, and barren with weeds have been termed waste.

Table IV shows the Surface Acres, Per cent of Area, Forage Acres, and Per cent of Carrying Capacity for each major vegetative type.

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Table IV VEGETATIVE TYPES

Forage Types	Surface Acres	Percent Area	Forage Acres	Percent of C.C.
Grassland	169,634	33.98	20,113	45.63
Sagebrush	3,527	.71	835	.87
Browse	257,862	51.66	21,098	47.87
Pinon and Juniper	38,465	7.70	2,482	5.63
Waste	19,356	3.87	0	0
Cultivated	10,404*	2.08	0	0
Total -	499,248	100.00	44,[illegible]	100.00

*This figure does not agree with the acreage obtained by Agronomy, because new fields have been added and some old fields abandoned since the completion of the Range Survey in August, 1935, and the Agronomy figures give only the actual acreage farmed, and not the acreage inside the fence.

The following is a list of the most common vegetative species:

Grasses

Blue grama - - - - - - Bouteloua gracilis

Galleta - - - - - - - - Hilaria jamesii

Alkali sacaton - - - Sporobolus airoides

Sand dropseed - - - - Sporobolus cryptandrus

Three awn - - - - - - Aristida spp.

Spiny muhley - - - - Muhlenbergia pungens

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Shrubs

Bush mint - - - - - - *Poliomintha incana*

Chamise - - - - - - - *Atriplex canescens*

Greasewood - - - - *Sarcobatus vermiculatus*

Mormon tea - - - - *Ephedra spp.*

Shadscale - - - - - - *Atriplex confertifolia*

Yellow bush - - - *Chrysothamnus greenii*

Snake weed - - - - *Gutierrezia spp.*

Rabbit brush - - - *Chrysothamnus biglovii*

Salt bush - - - - - - *Atriplex cuneata*

Parryella - - - - - - *Parryella filifolia*

Trees

One-seeded juniper - *Juniperus monosperma*

Pinon - - - - - - - - *Pinus edulis*

Weeds

Russian thistle - - *Salsola pestifer*

Croton - - - - - - - *Croton texensis*

Colorado beeweed - *Cleome serrulata*

Lambs quarter - - - *Chenopodium spp.*

Along the main valleys, adjacent to many of the permanent water supplies, and around the villages, the vegetation is less abundant, palatable and vigorous than it is on the mesas in the northern portion or on the rolling country to the south. Such indicators of over-grazing as Snake weed, Yellow bush,

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Rabbit brush and annual weeds are present on all parts of the Unit but are the most abundant vegetative species near the villages. These indicator plants are undoubtedly the result of prolonged over-grazing, human trampling, and the present agricultural practices. The most vigorous vegetation is found at these points where the present utilization is the least; that is, farthest from permanent water supplies.

b. Poisonous Plants:

Several traces of poisonous plants were found on the Unit but none of them are in sufficient abundance to be classed as serious. Loco, Astragalus spp., is the most abundant. The heaviest concentrations are on top of the mesas to the north of the Villages. Annual lupine, Lupinus spp., is found in scattering stands over the entire southern portion of the Unit. Death camas, Zygadenus spp., is very scattered and causes few if any losses. Whorled milkweed, Asclepias galioides, is very limited, the only infested area found is on Second Mesa, an area of one acre in extent. Rayless goldenrod, Haplopappus heterophyllus, cocklebur, Xanthium commune, and broadleaf milkweed, Asclepias speciosa, are present but are of no importance. Precaution must be taken to prevent the influx of whorled milkweed into cultivated fields or hay meadows.

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4. Developmental Improvements:

a. Population and Population Centers: (See Map No. 4)

There . . approximately 3,090 people or about 540 consumption groups. The people are concentrated at the villages on the three mesas, with a smaller concentration at Talahogan Canyon. The largest concentrations are at First and Third Mesas. During the summer, stock owners usually move out from the villages to farm and to graze their livestock. During the winter they move back to the villages in order to send their children to school, to be closer to food supplies, and to carry on their numerous ceremonies. Some, however, live at their ranches the year around.

There are twenty Navajo families or consumption groups living inside this Unit. Five of these groups are at Talahogan but, according to all information obtained, they are considered to be squatters and not permanent residents. In the vicinity of Shonto and Burro Springs there are two groups that are permanent residents. North of Sand Springs there are six groups who reported they have lived in this vicinity and have considered this as their home and range for many years. In the northeastern portion of this Unit there is one Navajo family which is employed by a Hopi as a sheep herder and cannot be considered as having rights in Unit No. 6. There is one group east of Tovar Mesa and four along the north boundary who live inside the Unit part of the time. One group lives in Keams Canyon as permanent residents.

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b. Roads and Telephones: (See Map No. 8)

Highways, roads and car trails serve all parts of this Unit. One primary road enters the Unit from the south at Shoute Springs, goes north to Oraibi, from Oraibi via Second and First Mesas to Keams Canyon, then southeast to Holbrook. There are four secondary roads taking off from this primary road as follows: (1) from Oraibi via Hotevilla to Tuba City; (2) from Second Mesa to Pinon; (3) from Polacca via Teestoh to Winslow; and (4) from Polacca via Wepo Dipping Vat to Pinon.

All the schools are connected by telephone. The Halderman, Pavatea, and Hubbell trading posts have phones. There is a switch board at Keams Canyon that is connected to Holbrook through the switchboard at Indian Wells.

c. Trading Posts, Schools, Hospitals and Missions: (See Map No. 9)

There are four trading posts on the Unit: H. F. Halderman at Keams Canyon, Tom Pavatea at Polacca, Lorenzo Hubbell and the James Brothers at Oraibi. In addition there are seven stores in the various towns, which are often nothing more than habitation shops.

There is a boarding school and a public school at Keams Canyon, and day schools at Polacca, Tereva, Chimopovi, Oraibi, and Hotevilla respectively, and a high school at Oraibi, or a total of one boarding school, one public school, five day schools, and one high school. All of these schools are main-

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tained for Hopi children except the boarding school and public school at Keams Canyon. The boarding school has all Navajo pupils and the public school white and Hopi children.

The hospital is maintained at Keams Canyon with a resident doctor and dispensary at Oraibi; small dispensaries are located at each of the day schools so that medical assistance is in easy reach of the people at all times.

There are two missions at Keams Canyon, one at Toreva, one at New Oraibi, and one at Bacavi.

C. EFFECT OF ENVIRONMENT ON HUMAN ACTIVITIES:

The Hopi Indians have lived in their present villages for many years. Oraibi is probably the oldest continuously inhabited village in the United States, the first recordings being made about 1580. The actual age is not known, but it is probably more than five hundred years old. The villages were built on the tops of high, precipitous mesas for protection from other Indian tribes; only in the past few years have they begun to build villages at the foot of the mesas. Many years ago there were villages on the flats and on other outlying mesas as is evidenced by the Awatobi Ruins and the large ruins on the flat south of Walpi. The depredations of the Ute, Piute and Navajo probably was the principal reason for the abandonment of these outlying villages.

The first domestic livestock came shortly after the Span-

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iards in the early 17th century. Prior to that time deer, Antelope, and domestic dogs were used as food. By 1904, according to the Indian Service census, the domestic livestock had increased to 56,000 sheep, 15,000 goats, 1500 cattle, and 4550 horses, or a total of 98,750 sheep units of livestock. On the basis of the present estimated maximum yearlong carrying capacity, the total areas of Units 4, 5, 6 and 10 would be required to graze this number of livestock. In the early days, for protection, the livestock were grazed close to the villages and usually corraled at night. As a result, the range near the villages has been subjected to prolonged, heavy overgrazing which has induced serious wind, gully and sheet erosion. This accelerated erosion has caused the destruction of much valuable farm land, such as the holdings of the Snake Clan along the Wepo Wash west of First Mesa, and has rendered extensive areas of range land worthless. Deep arroyos have cut through the alluvial valleys because of the lack of vegetation on the valley floors and watersheds. Undoubtedly the ground water level has been lowered.

Ancient customs and beliefs are probably the major reasons why these people have not progressed more rapidly than they have. During the winter, the Hopi confines himself to his village and spends most of his time carrying on traditional ceremonies. The houses are usually made of stone, are built by the

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women, and considered to be the property of the women of the family. The household and contents are inherited from mother to daughter, and so on. Many of these houses have been occupied by the same family for several generations, and are a sort of sacred possession.

Agriculture is probably the most important single item in Hopi life. Almost every consumption group has some land which they farm. The agricultural lands on First and Second Mesas are clan owned; at Oraibi they are usually individually owned. The trees in the peach orchards are individually owned, although the land is clan owned. Many of the outlying farms are owned by individuals who, oftentimes, are the larger stock owners. In contemplating improvement on agricultural lands or potential agricultural lands, clan ownership and village segregation must be given consideration.

Schools were first established in the Hopi country in the early 1890's. The consequent compulsory education has resulted in a large number of people being educated. On the whole, the Hopi seems to be more intelligent than the average Navajo. This seemingly higher intelligence is probably the result of his education and of his life as a village person. The influence of the white man can be seen in the Hopi's houses, livestock, and, to a very limited extent, in his farming, in his manner, and in his standard of living. At the present time

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most houses are equipped with beds, stoves, chairs, etc. Many of the Hopis own cars and pickups. Those individuals who work for the Government usually drive back and forth from the villages to the place of work in their cars and pickups. The Hopi is industrious and takes fairly good care of what he owns.

The larger part of the trade of the Hopi is carried on at the trading posts and habitation shops in the villages where they live. They are not inclined to stay away from home very long at a time. They do, however, in many cases, make numerous trips to the railroad towns, such as Holbrook and Winslow. Up until the last few years practically all their supplies were purchased at home.

Hubbell's Trading Post at Oraibi was established about 1880 and for many years was the only trading post in reach of the Hopi. Some trade and barter are carried on with the Navajo, the Hopi trading livestock and corn for wood, and corn for livestock. Once in awhile a Hopi will load his wagon or car with groceries and peddle among the Navajos, exchanging his wares for meat, wood, etc.

Before the white man came, the Hopi traded with the Pueblos and other Indians, many times exchanging his products for wares which came from great distances such as Mexico and California.

The droughty area in which he has lived and depredations of other Indian Tribes, etc., have tended to make the Hopi a thrifty, self-sufficient people.

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D. HUMAN ACTIVITIES:

1. Livestock and Range:

a. Present Resources:

(1) Area and Carrying Capacity:

As stated above, the area of the Unit is 449,248 acres. The estimated maximum carrying capacity is 17,651 sheep units yearlong, or 211,574 sheep months.*

Table V AREA AND CARRYING CAPACITY

Sub-unit	Acres	% of Area	C. C. S. Y. L.	% of C.C.	Surface Acres per S.Y.L.
First Mesa	125,281	25%	4,505	26%	28
Second Mesa	218,715	44%	8,628	49%	25
Third Mesa	155,254	31%	4,498	25%	35
Total - -	499,248	100%	17,651*	100%	Av. 28

*Based on the forage acre requirements of 2.5 forage acres per sheep unit yearlong, from the grazing survey completed in August, 1935.

Table No. V shows that more surface acres per sheep unit are required on Third Mesa Sub-unit than are required on First Mesa and Second Mesa Sub-units. This substantiates observations made in the field that this sub-unit is more severely overgrazed and the productive ability of the soil is less than in the other two sub-units. (See Map No. 3).

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(2) Seasonal Use and Class of Stock:

Unit No. 6 is considered yearlong range. There is no reason, at the present time, why this range cannot be used yearlong, but in the future, if seasonal use would be desirable, any part of the range may be used at any season of the year desired. Browse is moderately abundant on all parts of the Unit, but there is little protection from winter storms in the southern two-thirds. However, the winter seasons are usually mild enough so that few losses occur. The winter of 1936-37 was rather severe and numerous losses resulted. The major cause for these losses was the poor condition of the livestock in the beginning of the winter as a result of over-stocking rather than the inclement weather. Therefore, the proper adjustment of livestock numbers and the proper animal husbandry practices would undoubtedly materially reduce such losses. All of the Unit is adapted to the grazing of either cattle or sheep.

(3) Water Development:

Livestock water is rather abundant. Maintenance work and a few new developments of existing water supplies should result in a sufficient amount of water to insure satisfactory livestock distribution over the range. At the present time there is an average of one permanent water supply for every 6,241 surface acres. Including the temporary water supplies there is an average of one water for every 4,710 surface acres.

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(See Map 8). In practically every case the range adjacent to temporary water supplies will have to be used while water is available. During the late spring and early summer permanent water must be depended upon entirely. Therefore, forage adjacent to permanent supplies will have to be conserved for use in the spring and early summer.

(4) Wildlife:

(a) Big Game:

The population concentration renders this Unit unadaptable to big game mammals.

(b) Migratory Waterfowl:

Very few migratory waterfowl are found on this Unit. The few that are found are confined to temporary surface tanks which are used as resting places during migration. These resting places can be improved by protecting the watersheds and, in some cases, by planting shrubs and grasses in the desilting plots. Migratory waterfowl will probably never be of importance as a source of food.

(c) Upland Game Birds:

Very few upland game birds are found at the present time. Doves are most abundant and widely scattered. Quail are very scarce, but the chamise and greasewood flats are potentially good habitats. The proper grazing practices would result in an increased food supply for quail.

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(d) Furbearers:

Coyotes have a very limited value, at the present time, as furbearers and probably they will be of but little importance in the future. Rabbits are used by Indians as food but, due to their small numbers, are of little importance. Their numbers will probably not increase.

(e) Rodents:

Rodents have very little or no value, at the present time, as furbearers or as a source of food. The prairie dog is eaten to a limited extent.

(5) Value of the Land:

The chief value of the land in Unit No. 6 is for watershed and grazing. The watershed value is not so great as it is on other units, as, for example, Unit No. 4, which is at the top of a watershed area. The present cultivated area is approximately 1% of the total. Probably the maximum that agricultural land could be increased would be 1/2 of 1%, or a total of 1.5%. The value of agricultural land, however, is very high in comparison to the range land because of the large number of people who derive their livelihood from the comparatively small acreage. The topography of the area and the lack of water storing or diverting possibilities limit the extent of agricultural land. The present acreage of woodland coupled with the limited possibilities of increasing this acreage results in the production of woodland products being

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of minor importance. This does not mean, however, that the production of the present woodland cannot be greatly increased nor that the acreage of woodland cannot be expanded. All of the major drainages seem to offer possibilities of being planted with trees for the purpose of erosion control, stream bed protection, and woodland products supply.

No minerals were found on the Unit. There is a quantity of coal at all of the mesas which, if developed, would greatly relieve the present demand for woodland products. The development of these coal deposits may also be of limited commercial importance. A deposit of Pleistocene gravel was located near Burro Springs.

b. Utilization of Range Resources:

(1) Present Stocking:

The dipping records for Unit No. 6 show 17,006 grown sheep, 1,100 grown goats, 168 grown cattle, or 672 sheep units of cattle, and 218 grown horses or 1,090 sheep units of horses - a total of 19,868 sheep units of livestock. The present estimated maximum carrying capacity is 17,631 sheep units yearlong. Therefore, the Unit is 11.26% overstocked at the present time.

The number of livestock as taken from the Human Surveys records are shown in Table VI, page 33.

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Table VI — PRESENT STOCKING (From Human Survey Schedules)

Sub-unit	Sheep	Goats	Cattle	Mules Burros Horses	Sheep Units	C.C. S.Y.L.	% of Stocking
First Mesa	7,531	188	(1764)* 7,056	(587)* 2,935	17,710	6,505	
Second "	2,894	83	(168) 504	(302) 1,520	4,991	8,628	
Third "	777	46	(45) 135	(128) 640	1,593	4,498	
Total	11,202	317	7,695	5,085	24,299	17,631	

*Numbers in parenthesis are head of livestock.

There are 121 consumption groups on First Mesa, one of which was not complete for the stock counts.

There were nine schedules incomplete of the 93 taken on Second Mesa. Of the 299 schedules at Third Mesa, only 44 were completed for stock counts.

From all indications, the number of livestock obtained by the Human Surveys Branch would be more correct than the dipping records if a complete coverage could have been made. Until a more accurate record of livestock numbers is obtained, the establishment of a maximum livestock limit or base preference number will be impossible. The branch of Range Management estimates that there are 2500 cattle, 1500 horses on the Unit. The estimated over-stocking is 35 to 40%. Some adjacent range in Unit No. 7 is used by Hopi cattle and horses, but only a few of the sheep graze on lands other than that in Unit No. 6.

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The twenty Navajo consumption groups living in Unit No. 6 own 789 sheep, 75 goats, 45 cattle and 115 horses, or a total of 1679 sheep units of livestock.

(2) Distribution and Livestock Movements:

Movements of livestock were secured for all of the Navajo and a few of the Hopi livestockmen and are shown on Map No. 5. An idea of the livestock concentrations can be secured from the range utilization shown on Map No. 5. The majority of the sheep and cattle are grazed on the rolling country south of the mesas. The next heaviest concentrations are in the valleys to the north of the villages. Heavy concentrations also occur near the villages, but these are mostly of horses which are used by the village people.

(3) Seasonal Use:

This Unit can be grazed at any season of the year which is proved to be most satisfactory in a land management program.

(4) Animal Husbandry Practices:

(a) Selection:

The livestock on Unit No. 6 are of medium type and quality. They are probably better than the average for the Navajo Reservation, but there is still much room for improvement in the selection of breeding stock. Numerous instances of unprogressive selection are evident. The following practices should result in a more progressive selection:

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(1) Control of the breeding season.

(2) The culling of inferior and old breeding stock.

(3) More rigorous selection of sires.

(4) Proper stocking of the range and proper grazing and handling methods so as to insure maximum fleshing condition of the animals intended for sale.

(b) Bucks and Bulls:

A large percentage of the bucks and bulls on this Unit are of improved type and quality. Usually the unimproved or inferior sires are found in the smaller flocks and herds. Quite often, imported, improved sires die. This is a result of lack of range forage and care. Imported livestock, especially yearling animals, must be given care until they become acclimated and learn the range. At the present time, many of the sires are too old to be of but little service. Bulls over eight and bucks over six years old should be replaced with young sires. All sires should be given special care to insure a larger crop of increase.

(c) Breeding and Lambing:

Almost invariably parturition dates are too early. As a result many lambs and calves freeze, many are stunted, some mothers die, and the crop increase is not uniform. Prior to April 10 there is very little green feed for the mother stock to eat and on the average, parturition dates should be

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after this date. Many ewes and ewes lamb and calve too young, resulting in a stunted ewe or cow lacking in hardiness, and a stunted or inferior lamb or calf that is difficult to sell and inferior to retain in the breeding flock or herd. The "slipping" of wool is not caused from shedding, as is generally supposed, but because of too early lambing, lack of water, driving too far or too fast, etc. Therefore, controlled breeding is necessary.

(d) Docking and Castrating:

Wether lambs are often undocked and ewe lambs docked too long. When docked too long or undocked, lambs have a shaggy appearance and are usually harder to sell. In the case of ewes, docking too long may result in a decreased lamb crop. Increased prices, increased number of sales, increased lamb crop, and increased value of wool and pelts should result from the proper docking of lambs.

Wethers and steers are often not castrated young enough, resulting in staggy animals which are harder to sell and bring a lower price per pound. One reason for this practice is to attempt to increase the size and weight of the animals at selling time. Usually these practices result in the opposite end, or at least a decrease in value per pound.

(e) Shearing:

All shearing is done by hand. There is a possibility that all of these people, especially the larger owners, would adopt machine shearers if they were made available. Shearing is usually too early, resulting in some death losses,

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lighter fleeces, higher foreign material content of wool, and a handicap to bucks at breeding time. The last week in May and the first week in June would probably be a more desirable shearing period. The tieing and sorting of wool would undoubtedly increase the income from this product.

(f) Herding:

The herding practices of the Hopi may be said to be superior to those of the Navajo in one respect - they allow their sheep to scatter and graze more slowly. The practice of corraling for long periods of time at the same place coupled with trailing over the same ground day after day, results in serious damage to the range as well as a loss of flesh-ing and decreased wool production. Wet ewes, dry ewes, lambing ewes, and wethers are very seldom separated, probably resulting in a few death losses, especially at lambing time, a loss of flesh-ing in the lambs and some "slipping" of wool.

(g) Salting:

Traders' records show a total of 1,865 pounds of salt being purchased in 1936 by the Hopi. The salt content of the stock water and the abundance of salt-containing plants would tend to lower the salt requirement of the livestock on this Unit. However, the average yearly consumption of salt by livestock on southwestern ranges approximates seven pounds for sheep and twenty pounds for cattle and horses. On the basis of our livestock dipping records, approximately 65 tons of salt

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would be required under average conditions. If we compare the 65 tons that may be required to the one ton that was purchased, we are led to believe that the livestock on this Unit are in need of salt. This is especially true on the areas south of the mesas where salt-containing shrubs are not so abundant.

(h) Supplemental Feeding:

A survey of the traders' records show that 117,247 pounds of hay, 14,820 pounds of oats were purchased in 1936.* How much of this feed was fed to range livestock is not known. Probably the most of it was fed to saddle horses, burros, and teams but, last winter being severe, some feed may have been fed to cattle and sheep. It is believed that the development of native hay meadows would be of great value to range livestock if these areas can be developed at not too great a cost. One of the greatest benefits of the native hay meadows would be for the purpose of feeding the horses and burros which are now concentrated at the various villages. The production of enough feed to fatten livestock is doubtful because of the limited supply of suitable land and the availability of water.

(5) Livestock Pests and Diseases:

Probably the most serious livestock pest is lice. Some lice are found on sheep, but the most damage is to cattle. Horn flies and heel flies are of little consequence. Ear ticks cause some damage to all classes of livestock. Grub-in-the-head

*Land Management Unit No. 6, Human Surveys Branch Report, July, 1937.

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and screw worms are seldom found. Infectious diseases are practically unknown at the present time, but dourine in horses and scab in sheep formerly caused serious losses.

(6) Range Rodents:

Rodents on Unit No. 6 are not nearly as serious in the case of range land as they are in agricultural land. Prairie dogs are damaging range land in certain areas, the most important of which are: Southwest of Wind Terrace Butte, along the Polacca Wash near the northeast boundary, and along the north boundary near the Oraibi Wash in types Nos. G-11, G-4, M-10, G-9 (See map No. 6). Prairie dog control has been carried on in various places, but these areas have become reinfested to the extent that they are damaging range vegetation. (See Map No. 7). Kangaroo rats are not causing excessive damage to range vegetation at the present time. Ground squirrels, mice, rock squirrels, chipmunks, wood rats, pocket gophers, jackrabbits and cottontails are present on the range but they are doing little damage.

(7) Predatory Animals:

Coyotes are the most abundant predator but they are responsible for very few losses. Bobcats are rather numerous along mesa escarpments, probably causing a few losses, although none were reported. Domestic dogs are known to cause some losses. Two Hopis at Toeva lost 22 and 56 sheep respectively

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as the result of the depredations of a single dog one night last winter. This is probably more damage than inflicted by coyotes in several years. The last bear reported on the Unit was twelve years ago, 1925, and no lions have been seen for several years. The Indians will probably keep the influx of predators at a minimum.

(8) Poisonous Plants:

Poisonous plants cause very few losses of livestock but the infestations of hay fields must be guarded against.

c. Marketing:

(1) Home Consumption:

It is estimated that the value of livestock products consumed at home is $11,250.00. (See Table XII, Page 61)

(2) Sale, Trade and Barter:

A survey of the traders' records indicates that the major part of the commercial livestock income is from the sale of livestock products. The income from live animals was $7,107.28 and from livestock products $33,168.50, with wool representing $24,787.00. (See Table XIII, page 63.) Most of the meat was sold to the schools and to Tom Povatea at Polacca. Tom Povatea sold most of the meat which he purchased to the schools. Some meat is probably sold in Holbrook and Winslow but there are no figures to show the amount.

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2. Farming:

a. Present Resources:

(1) Present Farmlands:

(a) Acreage and Type:

There are 6,084 acres of farmland in this Unit at the present time. Of this, 4,460 acres are flood irrigated, 1,613 acres are rainfall and 11 acres are irrigated. Table VIII shows the classification of agricultural land by sub-units. The 11 acres of irrigated land are gardens which are irrigated from springs.

Table VIII Classification of Agricultural Land

Sub-unit	Present Class	Farmland A	B	C	Total	Expansion A	B	Total
1	Rainfall	1	23	2	26			
	Flood	1,152	218	16	1,386	124	50	174
	Total	1,153	241	18	1,412	124	50	174
2	Rainfall	209	220		429			
	Flood	795	129	13	937	637	13	650
	Total	1,004	349	13	1,366	637	13	650
3	Rainfall	243	912	3	1,158			
	Flood	1,807	341	0	2,148	124		124
	Total	2,050	1,253	3	3,306	124		124
GRAND TOTAL		4,207	1,843	34	6,084	885	63	948

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(b) Location and Distribution:

Farmland is concentrated near the three mesas and in Talahogan Canyon, but there are many scattered farms, some of which are quite large and are farmed by a large number of owners. (See Map No. 10).

(c) Agricultural Soils:

Table IX shows the classification of agricultural soils by soil types:

Table IX Agricultural Soil Groups by Sub-units (Acres)

Soil Type	A	B	C	D	Totals
		SUB-UNIT NO. I			
Oraibi sandy loam	1,069				1,069
Crown loamy sand		6,983	7,075	477	14,535
Crown sandy loam		3,864	1,554	2,031	7,449
Crown clay loam	1	1,492	838		2,330
Dinnehbito sandy loam	181				181
Dinnehbito clay loam	1,530				1,530
Concho sandy loam			4,411	242	4,653
Concho clay loam		1,983		2,111	4,094
Concho clay				6,622	6,622
Wepo sandy loam		1,175			1,175
Wepo clay loam		8,538			8,538
Totals	2,780	24,033	13,878	11,483	52,174

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Table IX (Continued)

Soil Type	A	B	C	D	Totals
		SUB-UNIT NO. II			
Oraibi loamy sand		2,187	161		2,348
Oraibi sandy loam	236	373	203		872
Crown loamy sand		4,774	1,756		6,530
Crown sandy loam	9,342	5,668	2,033		17,041
Crown clay loam		3,729	10,169		13,898
Dinnehbito sandy loam	2,505	2,152			4,657
Dinnehbito clay loam	3,769		668		4,437
Ives sandy loam		415			415
Ives clay loam			3,613		3,613
Ives clay			2,967	6,813	9,780
Concho clay			4,266	6,429	10,695
Totals	15,912	19,316	25,836	13,242	74,306

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Table IX (Concluded)

Soil Type	A	B	C	D	Totals
		SUB-UNIT NO. III			
Oraibi loamy sand		2,380	1,400		3,780
Oraibi sandy loam	402	936			1,338
Crown loamy sand		19,615	6,978		26,593
Crown sandy loam		2,650			2,650
Krown clay loam	3,080	2,020	1,460		6,560
Tolani sandy loam		416			416
Ives clay loam			218		218
Ives clay			2,622	6,360	8,982
Concho clay loam			4,774		4,774
Concho clay			1,610	8,720	10,330
Totals	3,482	28,067	18,062	15,080	65,691
UNIT TOTALS	22,174	71,416	58,776	39,805	192,171*

*The amount of potential farmland that can be developed is limited because of the supply of water. Therefore, this figure does not agree with the acreage of potential farmland on this Unit.

Group "A" soils have the following limitations:

Slope - 5% or less

Erosion - Slight or moderate water erosion, few gullies, not susceptible to excessive wind erosion.

Alkali - Less than .2% white and no black alkali.

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Drainage - Good.

Soil - Readily permeable, high fertility, and high water-holding capacity. Friable and easily worked.

The rate of moisture penetration is rapid enough that run-off occurs only during maximum storms. Irrigation water will penetrate readily. The water-holding capacity is medium to high, so that they will make maximum use of water in the production of cultivated crops. The water requirement should be the lowest on Group "A" soils. Any crops adapted to this area should grow well, namely, corn, beans, sorghums, melons, squash, pumpkins, potatoes, and sweet clover. Erosion is generally not serious. However, cultivated areas of Graibi sandy loam are susceptible to wind erosion and gully heads are occasional.

Group "B" soils have the following limitations:

Slope - Less than 5%.

Erosion - Severe sheet and deep gullies infrequent.

Alkali - .5% white and slight black. (Essentially none of either.)

Drainage - Water table below 6 feet.

Soil - Moderate fertility and permeability.

The penetration of water varies from good on the loamy sand to moderate on the Gensho clay loam. The water-holding capacity on the sandy loam and clay loam types is high but the loamy sand type is droughty. This group is adapted to irrigation but more water is required than on Group "A" soils. These soils are

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usually located in the valley bottoms and are traversed by deep gullies. Wind erosion is often advanced but is not so serious because of the friable light clay loam sub-soil. Sheet erosion is very slight. The coarse-textured soils are very susceptible to wind erosion and precautions will have to be taken when the native vegetative cover is broken.

Group "C" soils have the following limitations:

Slope - 5% or less.

Erosion - Moderate to severe water erosion with occasional deep gullies and numerous shallow gullies.

Alkali - .4% white and .1% black.

Drainage - Water table between 4 and 6 feet.

Soil - Fair fertility, permeability and water-holding capacity.

Water penetration slow on clays and moderate to rapid on all other types. Water-holding capacity about the same as Group "B" except it is higher on the clay types. Group "C" soils are limited in their value for irrigation. About the same crops can be grown as on Group "B" but yields will be lower. These soils are very susceptible to wind erosion and extreme precautions must be taken.

Group "D" soils have the following limitations:

Slope - Greater than 5%.

Erosion - Severe water and gully.

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Alkali - Greater than .4% white and .1% black.

Soil - Low fertility, permeability, and water-holding capacity. These soils are non-irrigable and are not recommended for Agricultural purposes.

(d) Yields:

Table X shows the present and expected average yields per acre of cultivated land.

Table X CROP YIELDS

Crop	Present Average Production	Expected Average Production
Corn	15 bu.	25 bu.
Peaches	*25 bu. (1937)	60 bu.
Beans	103 bu.	250 lbs.
Apples	44 bu.	80 bu.
Melons, squash and pumpkins	1,500 lbs.	2,000 lbs.
Apricots	40 bu.	80 bu.
Garden		

*Late frosts killed most of the peaches.

Corn is the principal crop grown, representing 72.6% of the cultivated area, and orchards represent 13.2%. (See Table XI, Page No. 48).

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Table XI PRESENT CROPS

Sub-unit	Corn	Beans	Melons	Peaches	Agri-cots	Apples	Gar-den	Idle	Total
1	1,217	6	63	56		9	5	77	1,412
2	996	96	75	150	28	6	5	42	1,366
3	2,204	427	42	352	64	157	1	19	3,306
Total	4,417	529	158	557	92	172	11	138	6,084
%	72.6	8.7	2.6	8.9	2.8	1.5	.1	2.8	100.0

(2) Potential Farmland:

(a) Acreage, Type and Location:

There is a possibility of developing an additional 948 acres of farmland on this Unit. (See Table VIII, Page 41). In addition there is the possibility of developing 100 acres of hay land at the proposed Polacca Diversion Project. Of the 948 acres of potential land, 100 acres of "A" land are at the proposed diversion on the Wepo Wash in Sub-unit No. 1 and 600 acres of "A" land at the Polacca Diversion Project in Sub-unit No. 2. The remaining acreage is scattered over the Unit as follows: Sub-unit No. 1 - 74 acres of "B" land; Sub-unit No. 2 - 50 acres (37 acres of "A" and 13 acres of "B" land); and Sub-unit No. 3 - 124 acres of "A" land.

(b) Expected Yields:

The expected yields on the potential land are given in Table X. In addition to the expected yields given in Table X we may expect three tons of alfalfa, three tons of

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potatoes, and 20 to 25 bushels of wheat per acre.

(8) Wildlife on Agricultural Land:

(a) Rodents:

Kangaroo rats are probably the most damaging rodent on agricultural areas. This is especially true in Type G-2. (See Map No. 6).

Ground squirrels and chipmunks may be damaging on some agricultural land, but not seriously.

Miscellaneous mice are found in all parts of the Unit and, at times, their damage to agricultural crops may be quite serious. Prairie dogs are serious in localized spots.

b. Present Utilization of Farm Resources:

(1) Crops:

Corn is the most important crop grown. (See Table XI, page 48). Some corn is probably fed to livestock but the most of it is used for human consumption. It is harvested and stored in grain houses and oftentimes, shelled after it has become thoroughly dry. Apparently, little corn was sold. (See Table XIII, page 63.) Squash are often cut into strips and dried for use in the winter. Melons are stored, but most of them are eaten when ripe. Peaches and apricots are dried and stored - a few are canned - for winter use.

The following practices would tend to increase the yields on agricultural land: Proper subjugation of present farmland,

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strip cropping in wind eroding areas, correct use of simple farm machinery, field selection of seed, introduction of new crops - especially soil binders - crop rotation, fall plowing, improved seed bed preparation, timely cultivation, and abandonment of severely eroded farms.

(2) Present Farming Methods:

(a) Type of Farming:

There has been very little change in the farming practices of the Hopi since the white man first found him. These people have become specialists in the production of corn, beans, peaches, and melons under semi-arid conditions. The crops grown by the Hopi are not soil binders and wind erosion has become so serious that a change must be made in the type of farming. By a change in the type of farming, we mean a change from the present type of crops to crops which are soil binders. Such a change should by no means be complete, but only on those areas which we may call "key" erosion areas or critical from the standpoint of wind erosion.

At the present time, much effort is spent in building windbreaks to protect the young plants from wind and sand. After the crops are harvested there is nothing left on the soil and much of the topsoil is removed by wind. The temporary windbreaks of rock, snakeweed, etc. are not effective except for a short time.

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(b) Location of Farms:

Usually, farms are located on the lighter textured soils at the mouths of washes or at any place where water concentrates. Many times, the edges of sand dunes seem to be preferred as cultivation sites, probably because of moisture. Some farms are located at places which are critical wind-blown areas. These fields do not produce efficiently. The orchards are located on the sandy toe slopes of the mesas. Probably, there is some lateral water seepage under these sands which is a major factor in the productivity and life of these trees.

At one time the valleys were the main sources of farmland but erosion has rendered them worthless, so that now, the best farmland is on the slopes of the mesas instead.

(c) Planting and Cultivating:

The farms are planted by hand with the planting stick or hoe. The planting season is set by the chiefs and is stretched over as long a period as possible in order to increase the chances of a crop. During planting seasons, planting parties are organized and as many as twenty-five people can be seen planting one field. Hills of corn, or beans or squash, etc., are planted four to five steps apart.

The plow is little used in the Hopi country. Some of the smaller fields are hoed, the entire top soil being moved, while other fields are run over with a cultivator in preparation for planting. In other words, the seed bed is usually poorly

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prepared.

Cultivating is usually done with the hoe but the horse-drawn blade is sometimes used prior to planting to kill the weeds.

(d) Pests and Present Methods of Control.

Cutworms are the most serious insect enemy to cultivated crops and cause considerable damage each year. They are especially damaging to melons and squash. Grasshoppers usually are not serious. Army worms, potato beetle, wire-worms, borers, etc., are present and in combination cause a limited amount of damage.

Hopi fruit trees are free from insects, probably due to their isolation. Extreme precaution must be taken to prevent the introduction of some pest which may totally destroy all of these orchards.

The only insect control now practiced is on the cutworm. Fruit cans are often put around the young plants to keep the worm away from the plant until it is large enough to survive. Also, Hopi farmers are constantly digging around the roots of the plants in search of this pest.

(e) Use of Water:

Generally speaking, very poor use is made of the water. However, some of the people build dykes, spreaders, etc., but the majority of the fields are located where the water naturally collects. Although the Hopi probably makes better use

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of water than the Navajo, there is still much to be accomplished.

(f) Harvesting and Storing:

All crops are harvested by hand, hauled to the village on burros, in wagons, or in pickups and stored. Corn is usually stored in sandstone houses; peaches, apricots, apples, and squash are usually dried.

(3) Marketing:

(a) Home Consumption:

The value of agricultural products grown and consumed at home amounted to $267,177.69. (See Table XII, page 61). A survey of the traders' records shows that very small amounts of melons, squash, beans, peaches, apples and vegetables are sold, so we assume that practically all of these are consumed. In 1936, $5,247.38 worth of corn was sold. (See Table XIII, page 65). On the basis of the estimated yields there should have been about 927 tons of corn produced last year. Estimating that corn sold for an average price of $2.40 per hundredweight, there were about 106 tons sold, leaving approximately 820 tons to be consumed.

(b) Sale and Trade:

Corn sales amounted to $5,247.38 last year and all other crops $122.40. (See Table XIII, page 65). Corn that is sold or used is three years old because of the ancient custom of storing the corn for three years to insure them against famine in time of drought.

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A great deal of trade goes on between the Hopi and Navajo, but the extent is not known. Exchange for wood, livestock or meat is quite common. Also, trade within the Hopi tribe is prevalent.

3. Woodland:

a. Present Resources:

(1) Acreage and Location:

There are 49,100 acres of land in Unit No. 6 which are classed as woodland or 9.8% of the total area of the Unit. This woodland is distributed in the Sub-units as follows: Sub-unit No. 1 - 24,000 acres or 19.1% of the area of the sub-unit; Sub-unit No. 2 - 11,540 acres or 5.2%; and Sub-unit No. 3 - 13,760 acres or 8.9%. (See Map No. 11).

All of the woodland is pinon and juniper, the average crown cover is 10% and the average composition is juniper 80% and pinon 20%.

(2) Condition:

All of the woodland falls in "condition (c)", which is poor. There is not sufficient reproduction, the trees are old, mortality is high, and the density is low. The poor condition is the result of: Excessive past cutting, small size of trees, low vigor and quality of the stands, inadequate reproduction, and disease (mistletoe). Most of the trees are of such inferior quality that they cannot be expected to furnish anything but fuel, either now or in the future. However, the better trees

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may have been cut and the poorer ones left.

Most of the woodland areas contain a majority of mature and over-mature trees. There are, however, a few stands in which the trees are predominantly medium aged and where a moderate percentage of young growth is found. There are four age classes represented on this Unit, namely: Reproduction, young (up to 80 years); medium (200 years or over); and over-mature (of indefinite old age). Where the younger trees predominate, the stands are practically pure juniper and seem to be on grassland that has been depleted by over-grazing. This is very noticeable on Second Mesa in types B-3 and A-3. (See Map No. 11). On the ridge south of Bluebird Springs (Types C-3 and D-3) and near the south end of Third Mesa, south of Hotevilla (Type B-1), all of the principal age classes are represented in more or less even distribution.

(5) Available Products:

None of the live material should be cut. There is very little dead material available because it is removed for fuel as fast as it dies. The following is a rough estimate of the dead material obtainable from areas where a noticeable supply was seen: (See Map 11).

Sub-unit No. 1, Area B-1		20	cords
" A-1 and B-1		240	"
	Total	260	"
Sub-unit No. 2, Area B-1		120	"
" A-1		70	"
	Total	190	"

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Sub-unit No.3, Area B-2 260 cords

Total for the Unit 710 "

The pinon-nut crop is very small on this Unit because of the poor size and vigor of the trees and the predominance of juniper in the composition of the stands.

The future yearly supply of dead material may be comparable to the above figures because of the high mortaility in many of the stands. Under a program of protection for ten or fifteen years, some areas may add enough new growth to provide some products of poor to fair quality without over-cutting the stands. These areas are as follows:

Sub-unit No. 1 (See Map No. 11)

Area	C-2	1,340	acres	- Juniper posts					
"	C-3	850	"	Juniper posts & pinon mine props					
"	A-1	3,020	"	"	"	"	"	"	"
"	B-1	2,840	"	"	"	"	"	"	"
"	D-2	2,580	"	"	"	"	"	"	"
"	D-3	400							

Total - 10,650 " with an average of one post or prop per acre, or 10,650 posts and props.

Sub-unit No. 2:

Area	B-1	3,600	acres	- Juniper posts and pinon props				
"	B-3	470	"	"	"	"	"	"
"	A-1	2,110	"	"	"	"	"	"
"	A-3	4,780	"	"	"	"	"	"

Total -10,960 acres or an average of 10,960 posts and props.

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Sub-unit No. 3:

Area	A-4	3,270	acres -	Juniper	posts	&	pinon	props
"	A-5	4,640	"	"	"	"	"	"
"	B-1	1,000	"	"	"	"	"	"
"	B-2	2,820	"	"	"	"	"	"

Total - - 11,730 acres or 11,730 posts and props.

It is estimated that after ten or fifteen years there should be at least 33,820 posts and props available, or about 26,000 juniper posts and 7,000 pinon mine props.

(4) Grazing Value:

Generally speaking, the grazing value of the woodland areas is only fair. Many times the woodland areas are barren and have no value for grazing. This is especially true along mesa escarpments and on Padilla Mesa.

(5) Watershed Value:

The watershed value of the woodland is of importance, but only in so far as the acreage covered. The understory of grass has a much greater effect upon the control of erosion than the present scattering stands of trees. Increased density of the stands would enhance the watershed value.

(6) Wildlife:

Mice, white-tailed ground squirrels, chipmunks, and rock squirrels are the most abundant rodents in the woodland areas. Porcupines are causing serious damage in the outlying pinon woodlands where they are damaging about 5% of the trees.

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The woodland stands - at the present time nor in the future - are not particularly desirable as a wildlife habitat. However, if they are protected, cottontail rabbits, quail, and insectivorous birds will increase in numbers but no more so than if grassland areas are protected.

b. Utilization of Woodland Products:

(1) Cutting Practices:

The heavy concentration of population, coupled with the sparse, slow-growing woodland has resulted in and is still resulting in use which is greater than the ability of these stands to produce fuel, posts, and mine props. There is a shortage of dead material for fuel and a scarcity of trees suitable for fence posts and mine props.

(2) Pests and Diseases:

Porcupines are causing great damage, especially in Type B-2a, Quad. '10'15' x 36°00'. All age classes of pinon trees are damaged. (See Map 11).

Ips are found in pinon trees, but infestations are not of epidemic proportions. Flat-headed borers appear to have entered the pinon trees following the Ips beetles and are often found in dead or dying junipers. Mistletoe and blight (probably a leaf-killing fungus) are damaging many trees - both juniper and pinon.

(3) Fire Damage:

Fire damage is very slight at the present time

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but may be increased by eliminating over-grazing.

(4) Grazing Damage:

There appears to be some damage to the woodland from grazing. Most of the damage is to reproduction. If not killed, the form is impaired and growth is slower. Although livestock graze on the more mature trees, little damage is thought to result.

e. Marketing:

(1) Home Consumption, Sale and Trade:

There are twenty Navajo consumption groups or 160 Navajo people who are residents of Unit No. 6. Seven of these are in Sub-unit No. 1, using an average of six cords per group per year, or 42 cords; five in Sub-unit No. 2, using a total of 28 cords; and eight in Sub-unit No. 3, using a total of 40 cords; or a total of 110 cords of wood used by Navajos living in this Unit. Some browse is used. The forty cords used by the Navajos in Sub-unit No. 3 are practically all taken from Padilla Mesa. The remaining seventy cords come mainly from Units 4 and 7.

Information on the amount of fuel wood, posts and poles used by the Hopis is not sufficiently complete to analyze the consumption for the Unit. However, an attempt to obtain this information will be made in the near future.

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The income from the sale of woodland products amounted to $7,041.15 or $2.88 per capita. Of this amount, $5,227.84 came from the sale of pinons, a very small part of which were produced on Unit No. 6. (See Table XIII, page 85). Also, the wood posts, poles and mine props sold came mostly from Units 4 and 7, so that the income from woodland products produced in Unit No. 6 is very small.

Some livestock, livestock products, and agricultural products are traded to Navajos in Units No. 4 and No. 7 for wood. How much of this form of barter is carried on is not known at the present time.

4. Income:

Table XII is a brief analysis of the commercial and non-commercial income for Unit No. 6. The commercial income was taken from a survey of the traders' records, payrolls at Keams Canyon and Central Agency, etc. The non-commercial income was taken from the individual census schedules which were taken in the field.

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Table XII

INCOME

Item	Commercial Amount	Commercial Percent	Commercial Per Capita Com. Income	Non-commercial Amount	Total Income	% of Total Income	Total Per Capita Income
Wages	$164,301.84	72.18	$53.10	$	$164,301.84	32.47	$53.10
Livestock	40,275.78	17.69	13.02	11,250.00*	51,525.78	10.18	16.65
Agriculture	5,369.78	2.36	1.74	267,177.69	272,547.47	53.86	88.09
Woodland Products	7,361.19	3.23	2.38		7,361.19	1.45	2.38
Rugs and Blankets	6,056.05	2.66	1.96		6,056.05	1.20	1.96
Miscellaneous	4,279.66	1.88	1.38		4,279.66	.85	1.38
Total - -	$227,644.30	100.00	$73.58	$278,427.69	$506,071.99	100.00	$163.56

*The non-commercial income from livestock is a round figure estimate, which will probably be changed slightly when the final figures are completed.

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In the case of wages, probably not nearly all of the amount shown in Table XII was spent on Unit No. 6, although that amount may have been disbursed through the Keams Canyon Agency. Keams Canyon is the headquarters for Roads, Irrigation, and BCW but: much more area is serviced from here than is actually in Unit No. 6. Furthermore, these wages cannot be broken down, at the present time, so that we can get an indication as to the actual amount spent on Unit No. 6.

Very few of the woodland products came from Unit No. 6, but the money from them went to residents of this Unit. Probably all of the pinon nuts (See Table XIII) came from off the Unit, principally in Units Nos. 4 and 7, as well as the wood that was sold.

The following table (Table XIII) is an analysis of the commercial income as taken from Agency Records, traders' records and other sources:

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Table XIII COMMERCIAL INCOME

*Wages:

Keams Canyon Mine	$ 4,634.50	
Oraibi Mine	1,122.90	
Hopi Boarding School	18,877.43	
Polacca Day School	507.00	
Toreva Day School	489.75	
Chimopovi Day School	396.50	
Oraibi Day School	900.00	
Hotevilla Day School	825.00	
**Moenkopi Day School	1,125.50	
Indian E.C.W.	43,756.25	
Hopi Agency	5,122.51	
Hopi Hospital	4,615.21	
Medical - Field	975.50	
Dipping Vats	81.50	
Freighters' payroll	1,043.67	
Roads	39,784.65	
Irrigation	4,613.88	
S. C. C.	2,185.56	
***Other Miscellaneous	678.13	
Total Government Wage Work - -		$160,609.84
Traders Wage Work - - - - - - -		3,692.00
Total of all Wage Work		$164,301.84

*Wages paid to Indians only.
** Not included in total because it is not in Unit #6.
*** Includes per diem,etc. paid by Navajo Agency to Indians in Unit 6.

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Table XIII (Continued)

Livestock:		
Sheep, goats and lambs	$ 4,321.56	
Cattle	2,785.72	
Income from Sale of Live Animals - - - -		$7,107.28
Wool	$24,787.00	
Mohair	90.65	
Pelts and Hides	828.98	
Meat	7,461.89	
Income from sale of Livestock Products -		$33,168.50
Total Income from Livestock - - - -		$40,275.78
Agriculture:		
Corn	$ 5,247.38	
Melons and squash	28.50	
Beans	32.80	
Peaches	18.00	
Apples	10.50	
Vegetables	32.80	
Total Income from Agriculture - - - - -		$ 5,369.78

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Table XIII (Continued)

Woodland Products:		
Wood to Navajo Agency	$ 531.00	
Wood to Hopi Agency	925.00	
Wood to Traders	330.85	
Mine props, ties, and posts	546.50	
Pinons	5,227.84	
Total Income from Woodland Products - -		$ 7,561.19
Rugs and Blankets:		
Blankets to Traders	$ 6,038.05	
Rugs to Hopi Agency	18.00	
Total Income from Rugs - - - - - - - - -		$ 6,056.05
Miscellaneous:		
Plaques, jewelry and baskets	$ 1,901.41	
Pottery	1,786.00	
Slops	37.50	
Eggs	248.75	
Gravel	6.00	
Rental space	300.00	
Total - - - - - - - - - - - - - - - - - - -		$ 4,279.66
GRAND TOTAL OF ALL COMMERCIAL INCOME -		$227,644.50

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5. Expenditures:

The following Table (No. XIV) is a summary of the expenditures taken from a survey of traders' records:

Table XIV INDIAN PURCHASES FROM TRADERS

Gross Purchases:

	Amount
Food	$ 73,899.61
Clothing	26,442.67
Household equipment	8,443.22
*Production equipment	4,464.07
Gas and Oil	1,305.00
Total Gross Purchases - - -	$113,249.57

*Production equipment includes such items as wagons, harness, saddles, plows, shovels, etc.

Goods Purchased by Indians from Traders (Basic Commodities)	Quantity	Amount
Flour	318,960 lbs.	$15,031.60
Corn	415 "	12.07
Oats	14,820 "	282.32
Hay	171,247 "	2,462.82
Beans	1,445 "	128.25
Potatoes	72,555 "	3,075.00
Melons	29,939 "	935.59
Onions	12,680 "	802.81
Peaches	945 "	86.70
Apples	13,116 "	860.18
Stock salt	1,863 "	27.94*
Total - - - -		$23,705.28

*Estimated price at $30.00 per ton or $0.015 per pound.

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TABLE XIV Continued)

Goods Purchased from Indians and Resold to them by the Traders:	Amount	
Food:		
Corn	$ 1,279.92	
Beans	17.60	
Peaches	26.75	
Meat	4,388.44	
Pinons	552.50	
Melons	28.00	
Total Food Resold - - - -	$ 6,293.21	
Other Goods:		
Wool	$ 43.97	
Blankets	27.32	
Jewelry	21.18	
Total Other Goods - - -	$ 92.47	
Total Goods Resold - - - - - - - - - -		$6,385.68

The difference between the total commercial income and the gross purchases is $114,384.73, or $56.97 per capita. Undoubtedly this difference is not retained by the Indians as savings; however, most Hopis have some cash reserves. Probably the most of this cash balance is spent in the form of cash for automobiles, clothes, food, etc., in Holbrook, Winslow and Flagstaff. To check on the amounts and classes of these cash purchases would

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be very difficult to secure but not impossible. In other words, the figures on gross purchases are probably more than is shown on Table XIV.

XI. SUB-UNITS

Unit No. 6 has been divided into three sub-units, the numbers of which correspond to the names of the Mesas; that is, First, Second and Third Mesa. (See Map No. 4). The boundaries are the same as those recognized by the Hopis for the past century or longer.

The boundary between sub-units Nos. 1 and 2 is very hard to follow in the field since there are very few topographical features to follow, but the division between Sub-units Nos. 2 and 3 is easily distinguished since it follows the center of the Oraibi Wash. In farming operations, these boundary lines are strictly observed by the people, especially the division between First and Second Mesas, but between Second and Third Mesas there is some over-lapping of farm ownership.

The Sub-units were established because they are definite, separate parts of the whole Unit and if any work is done, these lines will probably have to be recognized. Most of the basic data for Unit No. 6 has been worked up on the basis of these sub-divisions. Table XV, page 59, is a summary of the basic data by sub-units in so far as it was possible to secure.

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Table XV — SUB-UNITS — (SUMMARY)

Item	Sub-unit No.1	Sub-unit No.2	Sub-unit No.3	Total
Number of Consumption Groups	131	101	307	539
Number of People	733	856	1,885	3,004
Surface Acres	125,281	218,713	155,254	499,248
Carrying Capacity	4,506	8,438	4,498	17,631
Surface Acres per sheep Yl.	28	25	35	Avg. 28
Range Soils:				
Acreage of A	29,548	23,326	4,130	57,004
" " B	30,212	64,890	14,229	109,331
" " C	29,613	74,054	82,247	185,914
" " D	11,768	12,032	42,368	66,168
" " E	23,01[illegible]	43,406	9,831	76,307
Cultivated	1,069	1,006	2,449	4,524
Total - -	125,281	218,713	155,254	499,248
*Present Stocking: (In sheep units)				
Sheep	7,531	2,294	777	11,202
Goats	188	83	46	317
Cattle	7,056	504	135	7,695
Horses, mules & burros	2,935	1,510	640	5,085
Total sheep units	17,710	4,991	1,598	24,299
Farm Land:				
Present Farm Land:				
Acreage of A	1,153	1,004	2,050	4,207
" " B	241	249	1,253	1,743
" " C	18	13	5	36
Total - - -	1,412	1,266	3,308	6,084
Potential Farm Land:				
Acreage of A (100 A. at Wepo)	124	(600 at Polacca) 637	(Scattered) 124	885
" " B (Scattered)	50	(Scat.) 13	0	63
" " C	0	0	0	0
Total - - - -	174	650	124	948

** Income: All commercial and non-commercial income in Tables XII and XIII.

** Consumption:
Home produced and consumed } See Tables XII and XIV
Purchases from traders }

Woodland Products:	First Mesa	Second Mesa	Third Mesa & Padilla Mesa	
Source:				
Acreage	24,000	11,340	13,760	49,100
Per cent Acreage	19.1	5.2	8.9	9.8
Condition:	"C" (Poor)	"C" (Poor)	"C" (Poor)	
Amount:				
Fuel (cords) dead wood only	260	190	260	710
*** Posts, poles & mine props	10,630	10,960	11,730	33,320
Planting Possibilities:				
Windbreak	22	712	48	782
Erosion Control	64	223	36	323
Woodlot	160	300	190	650
Range	4	0	40	44
Biology (In desilting plots only)	0	200	40	240
Total - - - -	250	1,435	1,375	3,060

Rodent Damage: (Not compiled by sub-units)

Range:	
Acreage needing new treatment -	42,200
Acreage needing re-treatment -	41,400
Total acreage - - - - - - - -	83,600
Farm Land: (Mostly kangaroo rats) -	2,500

* From Human Survey Schedules. Second and Third Mesas not complete. (See page 33

** Could not be broken down by Sub-units.

*** This amount should be available after ten to fifteen years protection from cutting and grazing.

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III. THE EFFECT OF HUMAN ACTIVITIES on the NATURAL RESOURCES

A. DESTRUCTION OF VEGETATION AND SOIL AND WATER LOSS:

1. Improper Range Management:

Continued over-use of the range for a long period of time has resulted in a severe over-grazed condition of the vegetation near the villages, along the main valleys and adjacent to old developed water supplies. Domestic livestock came into the "Hopi Country" shortly after the first visit of the Spaniards. These flocks and herds increased very rapidly, so that within a relatively short time, the range was over-burdened. The Hopi people were forced to graze their livestock close to the villages so they could protect them from the depredations of neighboring Indian tribes. Permanent water was available at the villages and a few places along the main drainages, further necessitating the concentration of livestock.

In later years, although the depredations of other Indian tribes were largely eliminated, water was still not well distributed. At the present time, most of the permanent water is still to be found along the bottoms of the main valleys and there is only one dipping vat serving the "Hopi Country". The continued concentrations and trailing of livestock has resulted in the depletion of range forage on rather extensive areas. The valleys are cut by deep washes and wind erosion is removing, and has

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removed, a large part of the top soil on many areas. (See Map No. 8). The destruction of the natural vegetation through over-grazing has increased the rate and amount of run-off and decreased the amount of water penetration until great soil and water losses are occurring.

2. Improper Woodland Management:

The most important woodland areas are on the mesas north of the villages and on Padilla Mesa. (See Map No. 11). All of these woodland stands have been subject to severe mis-use through cutting and over-grazing which has resulted in trees which are of little value at the present time. The areas now covered by these scattering woodlands are probably little or no smaller than they were before the severe mis-use began, but there were probably more trees, which resulted in more protection to the soil. Therefore, woodland mis-use has resulted in a loss of top soil and water from rather extensive areas covered by the scattered woodland as well as a marked decrease in the amount of available products.

B. CHANGE OF VEGETATION:

1. Indicators of Over-grazing:

Indicators of over-grazing are found on all parts of this Unit. Yellow brush and Snakeweed are widely scattered and are often times the principal vegetative species adjacent to old developed water supplies and old corral locations. Russian

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thistle and other annual weeds are the most abundant plants in parts of the main valleys. Spiny muhley, Parryella, and Rabbit bush are the principal vegetative species on much of the areas adjacent to the Hopi villages. At one time, the principal vegetative species were probably Galleta, Blue grass, Sand drop seed, Alkali sacaton, Chamiso, Greasewood and Mormon tea, but these have been killed out to such an extent that less palatable species have been given a foothold and allowed to take their places. Shrubs such as Yellow brush, Rabbit bush and Snakeweed are much less adapted to the retention of soil and water, and annual weeds are effective only during the growing season. Therefore, the changes in vegetation as a result of the mis-use of the range has aided materially in the loss of soil and water. How much of the vegetational change is due to natural ecological changes is not known, but certainly a large part of it is due to improper grazing use.

2. Available Forage:

The actual density of the ground cover, in many cases, probably has not been reduced below what it was before the introduction of domestic livestock but the available forage has decreased because the original species have been largely replaced by less palatable and less nutritious species. Volume growth of a forage species is a vital factor in determining the amount of available forage. Almost all of the palatable species appear to be low in vitality. They are very slow to respond to favorable moisture

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and temperature conditions so that a small amount of volume growth is obtained during a growing season. Probably the most important cause of low volume growth is over-grazing. Low vitality of the plant may result in high mortality of the plants during growing seasons which have a low amount of precipitation. Several years may be required for the vegetation to recover from the damage occurring during one season of low rainfall. Climatological records show that there is a rather wide variation from year to year in the moisture which falls during the growing season. Therefore, extreme care must be exercised not to overgraze any part of the range on the Unit if we are to decrease the amount of soil and water losses now occurring or likely to occur in the future.

C. DESTRUCTION OF FARMLAND AND SOIL AND WATER LOSS:

1. Improper Subjugation and Use of Water:

The Hopi seems to make better use of his land and water than does the Navajo. However, little work is done to divert more water onto their farms or to properly conserve the water that actually falls on the farmed area. Most of the farms are located in places where water naturally collects. Numerous errors are made in the farming practices, such as: Improper preparation of the seed bed, the location of farms on badly wind-blown areas, farms are not leveled, bordering is not practiced, contour listing and furrowing is not practiced, the

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available water may be too much or too little, diversion ditches are usually on too steep a grade, surplus water is seldom properly taken care of and no control of wind erosion is practiced after the crop is removed.

2. Improper Cultural Methods:

Some of the most common cultural errors are: None of the crops are soil binders, fall plowing is not practiced, fall and winter cover crops are not planted, crop rotation is not practiced, fields are usually left bare during winter and spring and strip cropping, contour listing or furrowing is not practiced.

D. DESTRUCTION OF WILDLIFE AND WILDLIFE HABITATS:

The antelope in this area have been killed out by hunting and forced out through competition for feed with domestic livestock. The rabbit population is held at a minimum by the use made of them for food. Quail are very scattered, probably because of the destruction of their habitat by domestic livestock and because of their use as food. The habitat for waterfowl is very poor, since the surface tanks have a value as a resting place during migrations only. The control of grazing and the proper distribution of livestock would greatly improve the scaled quail habitat.

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PART TWO. ESTABLISHMENT OF PROPER LAND USE.

I. RECOMMENDED ADJUSTMENTS - (Work Plan)

A. PROPER RANGE CONTROL

1. Grazing Dates:

The range in Unit No. 6 shall be grazed yearlong. In the future, if seasonal use would be desirable, any part of the range may be used at any season of the year desired.

2. Proper Class and Number of Livestock:

Two horses per consumption group, or 1,078 horses, 1,500 cattle, and 7,051 sheep will be the maximum number of livestock allowed. There is a possibility of reducing the cattle to 1,000 head, thereby increasing the number of sheep to 8,241. These livestock shall be distributed roughly as follows:

Table XVI FUTURE DISTRIBUTION OF LIVESTOCK

Sub-unit	C. C.	Horses	Cattle	Sheep	Total
No. 1	131	262	200	2,405	4,505
No. 2	101	202	1,000	4,418	8,628
No. 3	307	614	300	228	4,498
Total	539	1,078	1,500	7,051	17,631

3. Sires and Their Care:

Approximately 300 bucks, 60 bulls, and 8 stallions should

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be allowed. The bucks and bulls should be cared for in a pasture and the stallions should be owned and controlled by the government. A pasture location has been made which will care for 525 bucks and 60 bulls. It is recommended that the bucks and bulls be cared for in the same pasture or, if desired, a division fence may be put in to separate the bucks from the bulls. Rodent control is recommended on this pasture as soon as it is built.

4. Breeding and Lambing:

The breeding season of sheep shall be from December 1 to January 10, and from July 20 to November 20 for cattle. This will make the lambing dates from April 1 to May 10 and the calving dates from April 20 to August 20.

5. Shearing:

The shearing dates shall be from June 20 to July 1. Two shearing plants should be constructed - one at Wapo Dipping Vat and one at Well No. 6-M-35. (See Map No. 3 and construction program, Page 116.)

6. Range Water Developments:

The maintenance work and the new developments as recommended on Pages 109 to 115 inclusive, shall be carried out in priority as listed. Additional improvements and maintenance work will be necessary from time to time, and the observations of the Unit Manager, Range Riders and Stockmen shall determine, to a large

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extent, the class, location, and need for these developments. A water maintenance crew should be established on the Unit to see that all range improvements are taken care of and kept functioning.

7. Livestock Movements and Distribution:

Only those livestock movements necessary to effect the proper distribution and improvement of the range shall be made. All excessive concentrations adjacent to permanent water supplies and farming areas shall be eliminated. All range surrounding temporary water supplies shall be grazed when water is available and the forage in reach of the permanent water supplies conserved for periods when temporary water is not available. One range rider is needed and should be stationed at the proposed dipping vat at Well No. 6-M-55.

8. Reduction of Injurious Range Rodents:

Range rodent control is needed in various parts of the Unit and shall be carried out according to the following recommendations: (Priority as listed)

a. Prairie Dog Control: (See Map No. 7)

(1) New Treatment:

(a)	Treatment of proposed buck pasture -	15,000 A.
(b)	" " Type G-4 - - - - - - - -	6,700 A.
(c)	" " Type G-9 - - - - - - - -	2,800 A.
(d)	" " Type G-5 - - - - - - - -	17,700 A.
	Total - - -	42,200 A.

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42,200 acres @ 10¢ per acre - $4,220.00

Treatment of prairie dog colonies in Types G-2, G-6 and G-8
Estimated 2500 acres @ 20¢ - - 500.00

(See Map No. 7) Total - - - - - $4,720.00

(2) Re-treatment:

(a) Re-treatment of Type M-10 - 8,600 A.
(b) " " " G-11 - 32,800 A.

Total - 41,400 A

41,400 acres @ 8¢ per acre - - - - - $3,312.00

Total Cost - - $8,032.00

9. Control of Predatory Animals:

At the present time, there is no control needed and the people will probably keep predators in check to the extent that none will be needed.

10. Wildlife Development:

It is recommended that 25 Gambel Quail be introduced into Keams Canyon. Three existing and two proposed desilting plots have been recommended for planting, according to Diagram L-468 on page 136 of this report. Locations and numbers of these projects are listed on Page 108, Table No. 17-D, Map No. 12.

11. Range Waterspreading and Erosion Control:

In Part Two, "Construction Program", page 127, the recommended erosion control and waterspreading projects on Unit No. 6 are shown. (See Map No. 13.) There are approximately 122,264

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acres which are in danger of being destroyed by erosion unless mechanical aid is given. These areas which are "critical" are in need of immediate treatment. There is a possibility that the "secondary" areas can be controlled by regulating the grazing use. In addition, there are 2,125 acres of range land on which "Special Erosion Control Projects" are needed for the protection of head-cuttings or rapidly cutting gullies. (Page No. 130, Map No. 15).

12. Range Planting Possibilities:

Most areas seriously needing revegetation, from the range standpoint, are excessively grazed and trampled tracts where most of the vegetative cover has been removed and severe wind erosion is taking place. The planting on these areas will consist only of trees and shrubs for the purpose of breaking the wind and allowing native vegetation to come in under protection. Only two areas have been recommended for range control planting. (See Table No. 17-C, Page No. 107.)

In addition, there are 323 acres that seem to offer a possibility of being planted for the purpose of controlling gully erosion. These possibilities are shown in Table No. 17-A, page 104 and on Map No. 12. The desilting plots recommended for planting as shown on Page 108 will have great value in the retention of silt above the reservoirs. All planting must be preceded by rodent control.

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15. Education and Demonstration:

Education and demonstration in the proper range management and animal husbandry practices should be carried on at all times. Constant individual and group advice and assistance should be given, especially at dipping, shearing and selling times. The demonstration of the proper range management practices should be carried on in the proposed buck pasture.

B. FARM IMPROVEMENT:

1. Present Farm land:

a. Subjugation and Flood Irrigation:

Farm number, acreage, present crops, suggested crops, present yield, expected average yields, class of farm land and costs of recommended work on the present farm land are shown on page 119. The farms on which no work has been recommended are not shown. A great deal of work has been recommended on individual farms which can be done by the Indians themselves with supervision of the District Manager or an agronomist. These agreas are usually very small and the work needed would entail only a small amount of labor. For that reason, costs have not been figured on much of the work that has been recommended. A list of the farms to be abandoned is as follows:

Sub-unit No. 1:

Quad No.	Farm No.	Acres	Remarks
14	12	12	
14	78	1	Severe wind erosion
14	182	4	" " "

Total - - 17 Acres

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Sub-unit No. 2:

Quad No.	Farm No.	Acres	Remarks
7	332	2	All top soil removed

Total - - 2 Acres

Sub-unit No. 3:

7	219	1	Severe wind erosion
7	267	1	" " "
16	10	8	" " "

Total - 10 Acres

GRAND TOTAL - - 29 Acres

There are a number of farms which, at the present time, are being severely eroded by wind and it is probable that some of these will not last many more years. Also, these areas are wind erosion hazard areas and should be abandoned. Specific recommendations have not as yet been made on these areas and more study is needed to determine which these areas are.

b. Recommended Cultural Practices:

Numerous recommendations as to improved cultural practices have been made on this Unit. Usually, these practices can be carried on by the Indians with supervision of an agronomist or the District Manager. For the most part, these recommended cultural practices consist of contour listing, contour bordering, terracing, strip cropping, pruning, and the planting of small wind breaks. The following is a list of the farms upon which such cultural practices have been recommended.

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Quad. No.	Farm No.	Acreage	Recommendations
			SUB-UNIT NO. X
13	9	5	Small contour borders every ten feet
13	53	8	Check gully and contour list.
13	54	4	Small borders, check gully
13	72	3	Check gully
14	1	5	Contour lister plant
14	2	31	" " "
14	3	6	" " "
14	4	1	" " "
14	5	70	" " "
14	6	8	" " "
14	7	15	" " "
14	11	3	" " "
14	8,9,10	115	Lister plant
14	19	2	Lister plant, plant windbreaks.
14	23	4	Contour border with alternate openings.
14	27	5	Brush windbreaks.
14	28	4	Strip crop.
14	36	2	Lister plant.
14	35	2	" "
14	38	11	Strip crop. Small spreader.

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Quad. No.	Farm No.	Acreage	Recommendations
14	40	5	Strip crop, windbreaks.
14	39	3	Prune trees
14	41	2	" "
14	43	40	Strip crop. Lister plant
14	179	4	Strip crop.
14	183	5	Contour borders
14	46	2	Strip crop. Spread gully.
14	61	20	Contour list.
14	162	3	Spread gully and lister plant.
14	62	6	Lister plant
14	60	5	Spread water.
14	59	2	Contour list.
14	63	5	Strip crop.
14	68	4	Strip crop. Plant windbreaks.
14	65	2	Prune trees. Throw brush in gullies
14	76	5	Border with alternate openings
14	79	4	Level and border
14	80	2	Spread water.
14	83	9	Strip crop. Lister plant.
14	84 & 85A	3	Prune trees.
14	85	1	Lister plant.
14	86	1	Contour border.

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Quad No.	Farm No.	Acreage	Recommendations
14	87	1	Border.
14	88	1	Spreader.
14	92	1	Contour border.
14	94	4	Strip crop. Spread water.
14	95	20	Lister plant.
14	98	1	Brush spreader
14	154	20	Spread gully. Contour list.
14	155	6	Contour list.
14	164	5	Contour dykes
14	171	4	Prune trees, put brush in gullies.
14	172	4	" " " " " "
14	173	2	" " " " " "
14	185	3	Contour borders.
14	187	1	Small borders.
14	193	2	Spread water.
14	194	1	Prune trees.
14	195	2	Small borders.
	TOTAL for Sub-Unit No. 1	517	

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Quad No.	Farm No.	Acreage	Recommendations
			SUB-UNIT NO. II
7	280	2	Divert water.
7	285	10	Strip crop. Lister plant.
7	293	10	Plug gullies. Lister plant.
7	296	2	Prune trees.
7	298	3	" "
7	300	4	" "
7	306	3	" "
7	307	8	" "
7	308	1	Prune trees, cultivate
7	309	1	" " "
7	323	1	Prune trees
7	324	1	" "
7	325	1	" "
7	328	2	" "
7	340	1	Spread gully
7	341	6	Spread gully, contour list.
7	342	6	Strip crop and spread gullies
7	343	10	Fall plowing. Strip crop.
7	345	6	Strip crop. Fall plowing.
7	351	9	Lister plant.
7	355	7	Prune trees.

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Quad No.	Farm No.	Acreage	Recommendations
7	350	9	Lister plant.
7	363	4	" "
7	367	3	Strip crop & lister plant.
7	384	3	" " " "
7	406	25	" " " "
7	410	5	Prune trees.
7	411	2	" "
7	420	5	" "
7	421	5	" "
7	416	1	" "
7	417	1	" "
7	418	1	" "
7	423	8	" "
7	424	3	" "
7	425	5	" "
7	426	1	" "
7	427	1	" "
7	429	2	" "
7	430	3	" "
14	56	3	List between spreaders.
14	102	6	Spread small gullies.
14	116	4	Spread gully.

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Quad No.	Farm No.	Acreage	Recommendations
14	126	4	Strip crop.
14	127	2	" "
14	128	18	Lister plant. Strip crop.
14	130	9	Lister plant. Strip crop.
14	135	85	Strip crop. Lister plant.
14	136	5	Strip crop.
14	137	8	Lister plant. Strip crop.
14	139	18	Strip crop.
14	143	6	Plant windbreaks
14	144	6	" "
14	145	10	" "
14	147	6	Plant windbreaks. Strip crop.
14	152	20	Prune trees.
14	213	11	" "
14	217	6	" "
14	218	2	Check gully.
14	219	10	Prune trees.
14	220	5	" "
14	221	5	" "
14	222	2	" "
15	42A	6	Strip crop.

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Quad No.	Farm No.	Acreage	Recommendations
15	44	27	Strip crop and lister plant.
15	45	10	" " " " "
15	10	4	Lister plant.
15	11	3	2 spreaders, strip crop, lister plant
15	12	5	Lister plant.
15	14,15,16	80	Lister plant and strip crop.
15	19	2	Contour.
15	20	6	Contour borders.
15	32	8	Strip crop. Lister plant between borders.
15	35	4	Lister plant.
15	36	1	Contour list
15	37	5	Build spreaders.
15	39	3	Strip crop. Lister plant.
16	18	12	Lister plant.
16	19	3	" "
16	20	12	Contour list. Strip crop.
16	21	10	Contour lister plant.
16	22	15	Spread gully and strip crop.
16	23	7	" " " " "
16	24	17	" " " " "
16	28	50	Strip crop and lister plant.

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Quad No.	Farm No.	Acreage	Recommendations
16	39	16	Strip crop and lister plant.
16	40	8	Strip crop.
16	42	4	" "
16	44	3	" "
	Total for Sub-unit No.2	721	

SUB-UNIT NO. III

7	1	12	Prune trees & strip crop.
7	3	53	Prune trees.
7	4	12	Strip crop.
7	5	70	Prune trees and strip crop.
7	10	6	Strip crop
7	15	3	" "
7	16	3	" "
7	17	2	Strip crop and spread gully.
7	18	3	" " " " "
7	24	125	Plant strips of sorghum between rows of trees.
7	29	4	Prune trees
7	30	4	" "
7	32	12	Strip crop.

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Quad No.	Farm No.	Acreage	Recommendations
7	33	18	Strip crop.
7	38	50	Strip crop and spread gullies.
7	49	3	Strip crop.
7	51	10	Spread gullies.
7	59,62,63	4	Strip crop.
7	76,80,81	6	" "
7	82	12	" "
7	83	6	" "
7	84	24	Strip crop and spread gullies.
7	85	20	Strip crop and lister plant.
7	86	6	Strip crop.
7	88	20	Strip crop and spread gullies.
7	89	[illegible]	" " " " "
7	90,98	21	" " " " "
7	91,92	51	Strip crop & contour list
7	93	5	Spreaders
7	94	55	Strip crop and contour list.
7	95	3	Spread gullies
7	96	5	Abandon farm on south side of road. Strip crop.
7	100	2	Strip crop.
7	102	1	" "

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Quad No.	Farm No.	Acreage	Recommendations
7	104	5	Spread gully
7	107,108,109	78	Spread gullies, lister plant, strip crop.
7	110	70	Strip crop and lister plant.
7	112,113	5	Strip crop.
7	116,117	7	" "
7	119	2	" "
7	121	4	" "
7	123	15	Contour list and strip crop.
7	124	3	Strip crop.
7	125	1	Dyke lower edge of farm.
7	126	3	Build spreaders.
7	138,139	120	Contour list, strip crop, spread gullies.
7	142	25	Strip crop.
7	144 to 147 Inc.	24	Strip crop and lister plant.
7	151	22	Strip crop and contour list.
7	153	20	Strip crop.
7	155	6	Contour list
7	157	9	Lister plant and strip crop.
7	158	2	Contour spreaders
7	159	90	Spread water and strip crop.

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Quad No.	Farm No.	Acreage	Recommendations
7	160,161	80	Spread water and strip crop.
7	163	3	Strip crop and lister plant.
7	170	3	Lister plant and strip crop.
7	171	4	" " " " "
7	172	4	Lister plant and spread water.
7	173	3	Contour list
7	174	4	Strip crop.
7	175	6	Prune trees and strip with Sudan
7	177	6	Strip crop.
7	178	11	Prune trees.
7	179	85	Prune trees and plant Sudan strips between the rows.
7	181	35	Prune trees.
7	185,186,187	3	" "
7	188	20	Strip crop.
7	189	44	Strip crop and lister plant.
7	190	20	Prune trees, spread gullies.
7	191,192	3	Prune trees.
7	195	3	" "
7	196,197,198	5	" "
7	199	5	Spread gully.

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Quad No.	Farm No.	Acreage	Recommendations
7	200	1	Prune trees.
7	204	8	Spread gully
7	205	2	Prune trees.
7	206	3	" "
7	210	4	" "
7	212	1	" "
7	214,215	6	" "
7	216	3	" "
7	217	1	Spread gullies.
7	218	2	Prune trees.
7	221	2	" "
7	222	2	Plug gullies. Plant new trees.
7	235	5	Prune trees.
7	238	3	" "
7	247	4	" "
7	246	3	Contour list
7	251	1	Prune trees.
7	252,253	8	" "
7	255	½ 7	" "
7	263	2	Contour list and strip crop.
7	265	3	" " " " "
7	268	4	" " " " "

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Quad No.	Farm No.	Acreage	Recommendations
7	266,267	45	Contour list and strip crop.
7	268	4	" " " " "
7	270	4	" " " " "
7	361	1	Spread gully, contour border.
7	372	12	Strip crop.
7	375	3	Spread gullies.
7	376	5	Lister plant.
7	381,382	27	Contour list - spreaders.
7	384	6	Contour list.
7	385	12	" "
7	386,387	9	Strip crop.
7	390,391	8	" "
7	392,393	12	Lister plant and strip crop.
7	394	2	Contour terrace
7	395	4	6 spreaders 40' long
7	397	4	Spread water and dyke lower end.
7	399	20	Spread water and build spreaders.
7	400	2	2 spreaders 50' long by 2.5'
7	431	4	Divert and spread water.
7	437	3	Spread gullies.
7	438	1	Three 40' spreaders.

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Quad No.	Farm No.	Acreage	Recommendations
16	7,8	28	Strip crop.
96	11	185	" "
96	15	4	Contour list.
96	19	5	Contour list and strip crop.
96	24,25,26	4	Strip crop.
96	42	4	" "
96	43	1	Contour list
96	44	4	" "
	Total of Sub-unit No. 3	2,690	
GRAND TOTAL -		3,219	

Y

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e. Erosion Protection:

(1) Planting:

Planting for erosion protection on agricultural land consists principally of windbreak planting. Strip cropping has been considered as a cultural practice. Table XVIII, page 102, shows by sub-units the farm number, acreage and suggested species to be planted in the recommended windbreaks. Almost every farm in this Unit is threatened by wind erosion which is removing valuable top soil in some instances and covering cultivated crops in others. This type of erosion is especially serious where farms are contiguous, as in areas along the Hopo and Oraibi Washes.

The principal method used by the Hopi for controlling wind erosion is the construction of brush and rock windbreaks. Such structures are short-lived. During the winter and spring, when the wind velocity is highest, the cultivated lands are barren. On small areas one row of windbreak planting will probably suffice, but on larger areas rows four to five hundred feet apart are needed. The prevailing winds are from the southwest and the lines of windbreaks should be planted perpendicularly to the prevailing wind direction.

In instances where only a few trees or shrubs are needed to protect an isolated farm, it is thought that the Indian could do the planting and we have made no cost estimates. A list of these can be found in the farms enumerated on page 82.

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(2) Engineering Structures:

The cost of engineering structures provided for the protection of erosion on the present farm land is included in the cost estimates of the "Special Erosion Control Projects" page 150. Here also, it is thought that the Indian can accomplish a great amount of the work that has been recommended on individual farms, since these structures are usually small and consist of small spreaders, dykes, terraces, borders, diversions or gully plugs. (See list on page 82).

d. Protection from Pests and Rodents:

Fall plowing is recommended to help control insect pests such as cut worms, grasshoppers and army worms. The poisoning of insects on farm land will probably not be necessary except in certain years when they may become so numerous as to be termed epidemics. Rodent control, however, is constantly needed and must be carried on year after year. Kangaroo rats are the most abundant. Recommended annual kangaroo rat control on 2500 acres at 20¢ per acre, total cost $500.00. (See Map No. 7 and page No. 135.)

e. Harvesting and Storing:

Crops are usually harvested by hand, which is satisfactory at the present time. However, the subjugation of new land and the pursuance of proper cultural practices will necess-

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sitate the introduction of farm machinery. This is especially true of hay lands and on areas where contour listing and contour furrowing are needed. Such machinery as machine mowers, rakes, hay wagons, hay balers, lister planters and furrowers will be needed. Store houses must be made rodent proof and probably some rodent control will be needed around store houses and grain bins.

f. Marketing:

There is a possibility that, with the development of new land as recommended in this report, there will be a surplus of agricultural products such as corn, beans, melons, peaches. Cooperative agricultural produce organizations may be of advantage in marketing these products commercially. Probably all the hay that is produced can and should be fed to livestock on the Unit, especially horses. Barter between the Hopis and Navajos should not be encouraged.

2. Potential Farmland:

By diversion and the economical use of flood water, approximately 955 acres of new agricultural land may be put under cultivation in this Unit. On page No. 125 are shown the acreage, location, suggested crops, expected average yield, class of land, soils classification, cost per acre and the total cost of subjugating potential farm land. In the proposed Polacca Diversion Project there are 600 acres of "A" class agricultural land

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and 500 acres of hay land, which could be developed. In addition, there are approximately 1,290 acres of Class "A" and Class "B" land which may be developed for either agricultural purposes or as hay land, or left in range land and desilting area, whichever need is greatest in the future.

At the proposed diversion in the Wepo Wash there are 100 acres of "A" class agricultural land which could be put under cultivation. The remaining 255 acres are scattered over the Unit in tracts varying in size from one to fifty acres. Total cost for the subjugation of potential farmland is $11,640.00, varying from $5 to $20 per acre, depending upon the topography of the land.

C. WOODLAND MANAGEMENT:

1. Cutting and Marking:

There shall be no cutting of healthy, live trees on this Unit until satisfactory reproduction and young tree growth are established. After this condition is attained, all trees intended for cutting shall be properly marked. Diseased trees and trees which are expected to live for only a short time should be marked for cutting by authorized persons.

The removal of dead material in accordance with the estimate previously stated - on page 55 - can be made.

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NN006093

2. Protection:

a. Fire:

No measures needed at present.

b. Rodents:

The treatment of the pinon stands in the northern part of the Unit for porcupines. Estimated cost - $500.00. (See page No. 155).

c. Disease:

Damage serious but control measures not justified because of the low value of the stands. Additional investigations needed.

d. Insects:

Endemic. Control not feasible. Additional investigations needed.

3. Reforestation and Afforestation:

Obtain livestock adjustment and distribution to insure reproduction in the present woodland stands.

More detailed surveys are needed on the woodlot planting areas shown on Map No. 12 and Page No. 106 to determine the feasibility of planting trees for the production of wood products. Rodent control preceding plantings is needed.

4. Other Recommendations:

Secure the needed wood from Units Nos. 4 and 7.

Develop the coal deposits on the Unit.

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D. ADDITIONAL STUDIES NEEDED:

1. A study of the Hopi boundary to properly and fairly divide the lands between the Hopi and Navajo Tribes.

2. Detailed surveys on the Wepo Project.

3. Detailed surveys on the Pelasca Project.

4. Detailed surveys on the Taylor Springs Project.

5. Detailed plans on all proposed planting sites.

6. Additional studies as to the feasibility of developing the coal deposits.

7. Accurate determination of the present numbers and classes of livestock.

8. Number of horses needed by each consumption group.

9. More detailed studies to determine those "key" erosion fields which should be abandoned.

10. Studies on the diseases and insects of the woodland stands and the most feasible and economical methods for control.

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TABLE XVII WINDBREAK PLANTING POSSIBILITIES

Number	Farm Number	Quad Number	Farm Acreage	Sug. Ac'g to be Planted	Suggested Species
		SUB-UNIT NO. I			
6-F-9		110°15' x 36°00'		8	Chamise, tamarisk, osage orange, Chinese elm, honey locust.
6-F-10	At Five Houses			7	Chamise, tamarisk, osage orange, Chinese elm and cottonwood.
6-F-13	51	110°00' x 36°00'	60	7	Chamise, osage orange, honey locust, Russian olive, Chinese elm, and tamarisk.
			Total - -	22	
		SUB-UNIT NO. II			
6-F-3	141	110°30' x 36°00'	150	3	Two to three rows of windbreaks of osage orange, plum, honey locust, poplar, Chinese elm and sand cherry.
6-F-6	Potential Water spreading area.		50	2	To be planted only if this land is developed.
6-F-7	22	110°30' x 35°45'		1	Chamise, greasewood, honey locust and Chinese elm.
6-F-8	24	110°30' x 35°45'		1	Chamise, greasewood, honey locust and Chinese elm.

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Table XVII (Continued)

Number	Farm Number	Quad Number	Farm Acreage	Sug.No'g to be Planted	Suggested Species
		SUB-UNIT NO. II (Cont'd)			
6-F-11	Polacca Diversion	110°15' x 36°00'	2,800	685	Chinese elm, mulberry Russian olive, osage orange, cottonwood, honey locust, willows
6-F-12	14,15, 16	110°15' x 35°45'	80	4	Chamise, osage orange and tamarisk.
6-F-4				16	Same as recommended on 6-F-4 below.
			Total -	712	
		SUB-UNIT NO. III			
6-F-1	22	110°45' x 36°00'	140	16	Plum, osage orange, honey locust, poplar, Chinese elm, sand cherry.
6-F-2	11	110°45' x 36°00'	185	17	Same as above.
6-F-4	138,142, 148,150,151	110°50' x 36°00'	572	10	Same as above.
6-F-5	159	110°50' x 36°00'	90	5	Same as above.
			Total - -	48	
				&	
	Total Windbreak Plantings - - -			782	

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Table XVII-A EROSION CONTROL PLANTING POSSIBILITIES

Number	Quad Number	Sug.No'g to be Planted	Suggested Species
		SUB-UNIT NO. I	
6-E-9	110°15' x 36°00'	12	Chinese elm, black locust, Russian olive, honey locust, black walnut, mulberry, cottonwood, hackberry, osage orange, plum, ash and catalpa.
6-E-10	" "	9	Same as 6-E-9.
6-E-11	" "	9	" " "
6-E-12	" "	9	" " "
6-E-13	Taylor Springs 110°15' x 36°00'	1	Sweet Clover and Bermuda Grass. Raspberry, Rhus, plum, mulberry, etc.
6-E-14	110°15' x 36°00'	*50	Already planted. Observe success.
6-E-15	" "	12	Sweet clover, grass and trees.
6-E-16	110°00' x 36°00'	12	
		Total - 64	
		SUB-UNIT NO. II	
6-E-2	110°45' x 36°00'	40	Cottonwood, poplars, mulberry, plums, black locust, Chinese elm,
6-E-4	110°30' x 36°00'	*21	Already planted. Observe success.
6-E-5	110°30' x 36°00'	24	Blackberry, mulberry, plum, poplar, Chinese elm, Russian olive.
6-E-6	110°30' x 35°45'	9	Sweet clover and western wheat grass.

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TABLE XVII-A (Continued)

Number	Quad Number	Sug.As'g to be Planted	Suggested Species
		SUB-UNIT NO. II (Cont'd)	
6-E-7	110°30' x 35°45' Little Burro Spgs.	100	Probably saccaton and shamise.
6-E-8	110°30' x 35°45' Polacca Wash.	50	Sweet clover and western wheat grass.
	Total -	225	
		SUB-UNIT NO. III	
6-E-1	110°45' x 36°00' Dinnehbito Wash	12	Lombardy poplar, plum, Russian olive, Chinese elm, tamarisk, Forestoria, etc.
6-E-2	110°45' x 36°00'	12	Cottonwood, poplars, mulberry, plum, black locust, Chinese Elm.
6-E-3	110°30' x 36°00' Oraibi Wash	5	Clover and western wheat grass.
6-E-4	110°30' x 36°00' Oraibi Wash	*21	Already planted. Observe success.
6-E-6	110°30' x 35°45'	9	Same as #6-E-3
	Total -	36	
	Total Erosion Control Plantings -	325	

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TABLE XVII-B WOODLOT PLANTING POSSIBILITIES

Number	Quad Number	No. Ac'g to be Planted	Suggested Species
		SUB-UNIT NO. I	
6-W-5	110°15' x 36°00' Nepo Diversion	120	Chinese elm and black locust.
6-W-6	110°15' x 36°00'	40	" " " " "
	Total -	160	
		SUB-UNIT NO. II	
6-W-2	110°30' x 36°00' Oraibi Wash	300	Cottonwood, Chinese elm, black locust.
	Total -	300	
		SUB-UNIT NO. III	
6-W-1	110°30' x 36°00'	120	Chinese elm and black locust.
6-W-3	110°30' x 36°00'	30	" " " " "
6-W-4	110°30' x 35°45'	40	" " " " "
	Total -	190	
	Total Woodlot Plantings - -	650	

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TABLE XVII-C RANGE PLANTING POSSIBILITIES

Number	Quad Number	Sug. Ac'g to be Planted	Suggested Species
		SUB-UNIT NO. I	
6-D-2	110°15' x 36°00'	4	Chinese elm, black locust, cottonwood as windbreak for sand dune.
	Total - -	4	
		SUB-UNIT NO. II	
		None	
		SUB-UNIT NO. III	
6-E-1	110°30' x 36°00'	40	Windbreaks for sand dune.
	Total -	40	
	Total Range Plantings	44	

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TABLE XVII-D BIOLOGY PLANTING POSSIBILITIES

Number	Quad & Location	Tank No.	Acres	Planting	
	SUB-UNIT NO. I				
	None				
	SUB-UNIT NO. II				
6-B-1	110°15' x 36°00' 6-1/2"W x 16-7/8"S	6-M-20	40	Diagram L-468	
6-B-2	110°30' x 35°45'	6-M-27	40	"	"
6-B-4	5-1/8"W x 8-7/8"S	6-M-23	60	"	"
6-B-5	110°15' x 35°45' 7-3/8"W x 7-1/2"S	6-M-28	60	"	"
		Total - -	200		
	SUB-UNIT NO. III				
6-B-3	110°45' x 35°45' 1/8" W x 3" S	6-M-35	40		
		Total - -	40		

Total Biology Planting Possibilities - 240

Grand Total Acreage of Planting Possibilities suggested on L. M. U. No. 6:

Sub-unit No. 1	250	Acres
" " " 2	1,435	"
" " " 3	1,375	"
Total - -	3,060	Acres

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II. CONSTRUCTION PROGRAM
A. RANGE MANAGEMENT DEVELOPMENTS
1. Range Waters

a. Maintenance Work
(In Order of Priority)

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.U. Y.L.	Est. Value to Stock	Est. Val. Erosion Control	Estimated Cost
6-M-1	Permanent Shallow Drilled Well. Build a dike above trough to keep flood water and sand out. Clean out trough.	110°00' x 36°00' 11-1/2W x 12-S/4S	955		Yearlong	54	$135	$255	$ 40.00
6-M-8	Temporary ECW Surface Tank #85B. Tank is washed out. Replace.	110°15' x 36°00' 4 W x 15-1/4 S	5,880			259	$647		$ 770.00
6-M-9	Permanent ECW Dug Well #130. Repair hand pump.	110°15' x 36°00' 6-1/4 W x 13-1/4S	700			28	$ 70		$ 5.00
6-M-32	Permanent ECW Developed Spring. Pipe is stopped up, should be repaired.	110°30' x 35°45' 11 W x 4 S	5,181			194	$485		$ 10.00
6-M-42	Permanent ECW Developed Spring #27. Develop more water if possible.	110°15' x 36°00' 13-7/8W x 1.0" S	4,500			216	$540		$ 150.00

NN006103

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.U. Y.L.	Est. Value to Stock	Est.Val. Erosion Control	Est. Cost
6-M-46	Permanent ECW Dug Well #137. Releather hand pump.	110°45' x 36°00' 4-5/8 W x 13-3/4W	7,737			52	$154		$ 10
6-M-68	Permanent ECW Spring #43. Replace top of cistern to keep sand out.	110°15' x 36°00' 6-7/8 W x 9-7/8S	2,000			40	$100		$ 5
6-M-174	Permanent drilled well. Repair valve.	110°45' x 36°00' 4-3/8 W x 10-5/8W	8,056			257	$644		$ 15
6-H-2	Permanent EC W Developed Spring. Needs rock and cement replaced around south end of trough.	110°15' x 36°00' 6-5/8W x 7-4/8S	4,483			126	$314		$ 15
6-H-8	Permanent Shallow Drilled Well. Releather cylinder.	110°15' x 36°00' 4-6/8 W x 2-3/8S	8,315			299	$748		$ 10
6-H-13	Permanent ECW Developed Spring. Change pipe directly into trough, 3' of 1/2" pipe. New top for cistern.	110°15' x 36°00' 4-7/8 W x 4-3/8S	3,160			190	$474		$ 10

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NN006104

Project Number	Description and Recommendations	Location	Area Serviced (Acres	Miles of Fence	Length of Service Period	C.C. S.U. A.L.	Est. Value to Stock	Est. Val. Erosion Control	Est. Cost
6-H-15	Permanent ECW Shallow Drilled Well. Mill needs cut-off.	110°15' x 36°00' 10-6/8W x 13-5/8S	5,120			99	$248		$ 5
6-H-16	Permanent ECW Shallow Drilled Well. Storage tank has 9 holes and leaks badly.	110°15' x 36°00' 9-6/8W x 11-4/8S	8,500			204	$510		$ 10
6-H-24	Permanent ECW Developed Spring. Cement and rock have given way. Repair.	110°30' x 36°00' 3/8 W x 11-4/8W	500			8	$ 20		$ 10
6-M-20	Temporary ECW Surface Tank. Remove fence from upper side of dam.	110°15' x 36°00' 6-1/2W x 16-7/8S	2,030			89	$223		$ 5
6-M-60	Permanent Shallow Dr. Well. Clean out trough.	110°30' x 36°00' 4-3/4W x 6-3/8S	10,978		Yearlong	88	$220		$ 5
6-M-62	Permanent ECW Developed Spring #28. Further development by excavation.	110°30' x 36°00' 13-3/8W x 1/8 S	3,939		Yearlong	126	$315		$15150

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NN006105

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.U. Y.L.	Est. Value to Stock	Est. Val. Erosion Control	Est. Cost
6-H-11	Permanent ECW Dug Well. Clean out trough.	110°15' x 38°00' 4/8 W x 1-1/8 S	4,584		Yearlong	165	$412		$ 5
6-H-14	Permanent ECW Drilled Well. Repair holes in storage reservoir.	110°15' x 38°00' 8-4/8 W x 13-2/8S	3,157		Yearlong	50	$125		$ 5
				Total cost of Maintenance - - - - - -					$1,275

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NN006106

b. New Development

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.U. Y.L.	Est. Value to Stock	Est. Val. Erosion Control	Est. Cost
6-M-3	Permanent Shallow Drilled Well. Put dikes above trough as flood protection, and build small charco.	110°15' x 36°00' 5/8 W x 11-3/8S	3,892		Yearlong	171	$428		$ 225
6-M-7	Permanent Shallow Drilled Well. Change Overflow to opposite side of tank and build a small charco to catch overflow.	110°15' x 36°00' 6-3/4W x 12-1/4S	2,476		Yearlong	79	$198		$235
6-M-12	Permanent ECW Developed Spring. Build masonry wall to keep sand out of trough.	110°15' x 36°00' 1-3/4 W x 15 S	4,855		Yearlong	252	$631		$ 210
6-K-29	Permanent Shallow Drilled Well. Put an overflow pipe in trough to carry water away so trough won't fill so full.	110°30' x 35°45' 1-1/4W x 1-3/4 S	12,031		Yearlong	529	$1,323		$ 17
6-H-31	Permanent ECW Developed Spring. Build new concrete trough 20' long.	110°30' x 36°00(1-7/8 W x 13-3/8S	6,148		Yearlong	123	$307		$ 300

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NN00610

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.J. Y.L.	Est. Value to Stock	Est. Val. Erosion Control	Est. Cost
6-M-19	Permanent Shallow Drilled Well. Put overflow pipe in trough.	110°15' x 36°00' 11 W x 16-7/8 S	5,748			92	$230		$ 20
6-M-23	Temporary ECW Surface Tank #99. Fence a 60 acre desilting plot.	110°30' x 35°45' 3-1/8 W x 8-7/8S	6,839	1-1/4		328	$821		$ 440
6-M-28	Temporary ECW Surface Tank #0-73. Fence a 60-acre desilting plot.	110°15' x 35°45' 7-3/8W x 7-1/2S	6,582	1-1/4		290	$724		$ 440
6-M-35	Permanent Shallow Drilled well. Replace iron tank with 15,000 gallon steel reservoir, and build float box with float.	110°30' x 36°00' 8-3/4W x 15-1/4 S	10,771			259	$648		$ 485
6-M-45	Permanent ECW Dug Well #107. Install hand pump.	110°45' x 36°00' 3/4 W x 16-3/8S	6,376			306	$765		$ 35
6-M-61	Permanent Shallow Drilled Well. Replace tank with 15,000 gal. storage and build charco.	110°30' x 36°00' 3 W x 3-3/4 S	7,048			168	$422		$ 675

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NN006108

Project Number	Description and Recommendations	Location	Area Serviced (Acres)	Miles of Fence	Length of Service Period	C.C. S.U. Y.L.	Est. Value to Stock	Est. Val. Erosion Control	Est. Cost
6-M-69	Permanent ECW Developed Spring #22B. Attempt to increase flow, if that is possible, build trail to trough.	110°30' x 36°00' 3-1/2 W x 10-1/4S	9,544			230	$577		$ 500
7-M-21	Temporary ECW Charco #85 B. Fence 80-acre desilting plot.	110°30' x 35°45' 1/2 W x 12-3/4 S	8,034			176	$440		$ 525
6-M-38	ECW Deep Well #4. Test depth of water and if warranted install windmill 14', 15,000 gal. tank and troughs with float.	110°15' x 35°45' 11-1/2W x 7-7/8 S	16,614			998	$2,492		$ 950
6-M-~~40~~ 70	Permanent Indian Dug Well. Deepen north wall, crib with rock. Install hand pump and 20' trough.	110°30' x 36° 12 W x 5 S	8,240			198	$494		$ 260

Total cost of New Developments - - - $5,312

Total cost of Water Developments and Maintenance - - - $6,587

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NN006109

2. Dipping Vats:

a. New Developments:

110°30' x 36°00' - 8-3/4" W x 15-1/4" S
At Well No. 6-H-35

Build a 60' concrete dipping vat, drain pens and corrals. This development justified because there would then be a dipping vat nearer the center of the livestock concentrations and greatly reduce trampling and trailing enroute to the present Wepo Vat.

Estimated cost - $1,500

3. Shearing Plants:

Construction of two 5-man shearing plants:

One plant at Wepo Vat - - - - - - - $1,500

One plant at Well No. 6-H-35 - - 1,500

Total - - - - - - - - - - - $3,000

4. Fencing:

a. For Erosion Control:

110°15' x 36°00' - 5" W x 8" S

Construction of four miles of fence to exclude livestock from 2000 acres of moving sand dunes which are endangering additional, valuable farmland.

4 miles of fence @ $250 - - - - - - - - - - - - - - - - $1,000

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110°15' x 36°00' - At Five Houses.

Construction of four miles of fence to exclude livestock from 600 acres of sand dunes which are endangering valuable range and agricultural land.

4 miles fence @ $250 - - - - - - - - - - - - - - - - $1,000

Total - - - $2,000

b. Buck Pasture:

110°15' x 35°45' - 8-1/2" W x 5" S

For the regulation of breeding and the improvement of the livestock. Both bucks and bulls to be pastured in the same enclosure. 325 bucks for 10-1/2 months and 60 bulls for 8 months.

16 miles of fence $250 - - - - - - - - - - - - - - - $4,000

c. Hay Meadows:

At Proposed Polacca Diversion Project.

The fencing of 500 acres of native hay land for the production of hay for horses so as to relieve the pressure of the severely depleted range adjacent to First and Second Mesas.

3 miles fence @ $250 - - - - - - - - - - - - - - - - $ 750

d. Boundary Fence:

Fencing of the entire boundary of Unit No. 6 for the protection and control of the range.

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No estimate can be made on the amount of fence required until the location of the boundary is definitely established.

Total cost of fencing $6,750

GRAND TOTAL COST OF ALL RANGE MANAGEMENT PROJECTS - - - - - - - $17,857.

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B. FARMLAND DEVELOPMENTS
1. Subjugation of Present Farmland

Quad No.	Farm No.	Acreage	Present Crops	Suggested Crops	Present Yield	Expected Average Yield	Class Farm-land	Cost per Acre	Total Cost	Remarks
				SUB-UNIT NO. I						
14	48,54	165	50 Idle 115 Corn	Sorghum, corn, beans, melons.	Corn, 12 bu.	Corn, 25 bu. Beans, 250#	A	$15	$ 2,475	Spread gully and contour spreaders on farm. Strip crop.
14	50	40	40 Corn	Melons, corn, beans.	Corn, 10 bu.	Corn, 25 bu. Beans, 250#	A	$ 5	$ 200	List between spreaders.
14	67	40	40 Corn	Sorghum, corn, beans.	Corn, 10 bu.	Corn, 25 bu. Beans, 250#	A	$15	$ 600	(Strip crop. Contour border.
14	84,47	200	200 Corn	Corn, sorghum.	Corn, 10 bu.	Corn, 25 bu.	A-160 B-40	$18	$ 3,600	(List between borders.
14	99	30	30 Corn	Corn, beans, sorghum.	Corn, 12 bu.	Corn, 25 bu. Beans, 250#	A-20 B-10	$18	$ 540	Contour spreader. List between borders.
14	100	10	10 corn	Corn, beans, sorghum.	Corn, 15 bu.	Corn, 25 bu. Beans, 250#	A	$20	$ 200	Divert gully. Bordering & leveling.
14	153	155	5 Melons 150 Corn	Melons, sorghum/corn, beans.	Corn, 18 bu.	Corn, 25 bu. Beans, 250#	A	$15	$ 2,325	Contour spreaders. Diversion dykes.
Totals - -		640							$ 9,940	

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Quad No.	Farm No.	Acreage	Present Crops	Suggested Crops	Present Yield	Expected Average Yield	Class Farmland	Cost per Acre	Total Cost	Remarks
					SUB-UNIT NO. II					
7	274	14	14 Corn	Melons, corn, sorghum.	Corn, 8 bu.	Corn, 25 bu.	A	$15	$ 210	Contour border.
7	275, 276	8	8 Corn	Melons, corn, sorghum.	Corn, 8 bu.	Corn, 25 bu.	A	$12	$ 96	Contour border.
7	281	15	15 Corn	Sorghum, corn, melons.	Corn, 8 bu.	Corn, 25 bu.	A	$15	$ 225	Bordering.
7	282-A	38	38 Corn	Melons, corn, beans, sorghum.	Corn, 12 bu.	Corn, 25 bu. Beans, 250#	A	$10	$ 380	Strip crop. Contour list between terraces.
14	149	9	2 Melons 7 Corn	Corn, melons.	Corn, 15 bu.	Corn, 25 bu.	A	$ 8	$ 72	Spread water and contour list.
14	150	15	15 Corn	Corn	Corn, 12 bu.	Corn, 25 bu.	A	$10	$ 150	Check gully head.
15	38	8	8 Corn	Corn, beans, sorghum.	Corn, 8 bu.	Corn, 26 bu. Beans, 250#	B	$20	$ 160	Contour dykes. list between borders.
15	13, 18	16	12 corn 3 melons	Beans, melons.	Corn, 12 bu.	Beans, 250#	A	$10	$ 160	Spread gully. lister plant.

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NN006114

Quad. No.	Farm No.	Acres	[illegible]	[illegible]	Present Yields	Expected Average Yields	Class Farm Land	Cost Per Acre	Total Cost	Remarks
				BULLETIN NO. [illegible]						
7	264	5	[illegible]	[illegible]	[illegible]	Corn [illegible]	[illegible]	$10	782	Spread water.
7	260	20	[illegible]	[illegible] sorghum	[illegible] 10	Corn 25 bu. Beans 250	[illegible]	$16	100	Spread water, strip crop, contour list.
7	265	[illegible]	[illegible]	[illegible] sorghum	[illegible] 10	Corn 25 bu.	[illegible]	$16	120	Contour list, strip crop.
7	266	50	[illegible]	[illegible] clean	[illegible]	Corn 25 bu.	[illegible]	$10	500	Spread water.
7	272	20	[illegible]	[illegible]	[illegible]	Corn 25 bu.	[illegible]	$12	120	Border.
7	274	[illegible]	[illegible]	[illegible] sorghum	[illegible]	Corn 25 bu.	[illegible]	$16	56	100' contour dykes.
7	277, 279	20	[illegible]	Corn, sorghum	[illegible] 10	Corn 25 bu.	[illegible]	$6	80	4 contour dykes.
7	285	28	[illegible]	[illegible] sorghum, beans	[illegible]	Corn 25 bu.	[illegible]	$5	80	[illegible] dykes. Rough spreader
7	285	2	[illegible]	[illegible]	[illegible]	Corn 25 bu.	[illegible]	$15	30	Divert gully. Contour list & border.
[illegible]	27	166	[illegible]	[illegible], beans, [illegible]	[illegible]	Corn 25 bu. Beans 250	[illegible]	$5	700	Spread water.
Totals		277							$4,084	
GRAND TOTAL		[illegible]							$15,827	

2. Subjugation of Potential Farmlands.

Quad No.	Farm No.	Acreage	Suggested Crops	Expected Average Yields	Class Land	Soils	Costs per Acre	Total Cost	Remarks
				SUB-UNIT NO. I					
14	100	15	Corn, beans, sorghum.	Corn, 25 bu. Beans, 250#	A	Loop sandy loam	$49	$ 300	Divert gully, border and level.
14	59	5	Corn	Corn, 25 bu.	A	SL CL			Contour list.
14	153	58	Sorghum, Corn, melons, beans.	Corn, 25 bu. Beans, 250#	A	SL to sand	$15	$ 870	Contour spreaders and diversion dykes.
14	155	6	Grapes, sorghum, corn, beans.	Corn, 25 bu. Beans, 250#	A	SL			Contour lister plant.
14	Repo Project Total - 182	100	Corn, beans, melons, sorghum.		A-50 A B-50 A	SL	$20	$2,000	Subjugation of new land.
								$3,970	

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NN006116

Quad No.	Farm No.	Acre-age	Suggested Crops	Expected Average Yields	Class Land	Soils	Cost per Acre	Total Cost	Remarks
				SUB-UNIT NO. II					
7	275,276	55	Melons, corn, sorghum.	Corn, 25 bu.	A	SL	$12	$ 420	Contour bordering.
7	340	1	Corn, beans.		A	Sand			Spread small gully
7	342	5	Corn, sorghum.	Corn, 25 bu.	A	Sand & SL			Spread gullies
14,15, 16	Pelaces Project	600	Corn, sorghum, Beans, melons.	Corn, 25 bu. Beans, 250#	A	SL CL	$12	$7,200	Subjugation of new land.
15	41	1	Corn, beans, melons.	Same	A	SL			Contour list
16	27	3	Beans, corn.	Same	B	SL Clay			
	Total	645						$7,620	
				SUB-UNIT NO. III					
7	93	5	Beans, Corn, sorghum	Same	A	LS			
7	128	3	Corn, sorghum	Corn, 25 bu.	A	LS			Put in spreaders.
7	140	10	Melons, corn sorghum.	Corn, 25 bu.	A	SL			Contour list and spread gully.

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NN006117

Quad No.	Farm No.	Acreage	Suggested Crops	Expected Average Yields	Class Land	Soils	Cost per Acre	Total Cost	Remarks
				SUB-UNIT NO. III (Cont'd)					
7	141	30	Corn, sorghum.	Corn, 25 bu.	A	SL	$ 5	$ 150	Spread water, contour list.
7	156	5	Melons, corn, sorghum.	Corn, 25 bu.	A	SL & LS	$15	$ 75	Spread water.
7	259	50	Corn, sorghum.	Corn, 25 bu.	A	LS & SL Clay	$15	$ 750	Contour lister plant and strip crop.
7	361	5	Beans, melons	Corn, 25 bu.	A	Sand & SL			Spread gully & contour border with weeps.
7	394	3	Corn, beans	Corn, 25 bu. Beans, 250#	A	SL Clay			Contour terracing.
7	431	4	Beans, corn.	Same	A	Sand & SL			Divert water onto land.
7	435	5	Corn, melons.	Corn, 25 bu.	A	SL	$15	$ 75	Divert gully, contour and border.
7	458	1	Corn, beans.	Corn, 25 bu. Beans, 250#	A	SL			Spread water.
96	14	1	Beans, corn	Same	A	SL-Clay			

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NN006118

Quad No.	Farm No.	Acreage	Suggested Crops	Expected Average Yields	Class Land	Soils	Cost per Acre	Total Cost	Remarks
				SUB-UNIT NO. III (Cont'd)					
96	28	2	Corn	Corn, 25 bu.	A	LS-Clay		$	
	Total	124						$ 1,050	
GRAND TOTALS - 955								$11,640	

TOTAL COST OF SUBJUGATION ON BOTH PRESENT AND POTENTIAL FARMLAND - - - - $27,567.00

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NN006119

G. ENGINEERING STRUCTURES

1. Erosion Control and Water Spreading (By Sub-units)

Card No.	Comd No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Priority	Description
					SUB-UNIT NO. I			
4	14	E. C. #1	14 F 1,350 R	$15.00 0.40	$ 210 270	$ 270	Semi-critical	The control of two 5' heads and gullies and the protection of Farms #31, #32, #33.
5	14	E. C. #2	4,700 R	$ 0.30	$ 705	$ 705	Semi-critical	Scattered treatment with small dykes, checks and spreaders.
13	14	E. C. #5	7,350 R	$ 0.30	$1,100	$1,100	Semi-critical	Intensive treatment with horseshoe dykes, spreaders, gully plugs, etc.
14	14	E. C. #6	3,200 R 300 G	$ 0.20 1.50	$ 545	$ 545	Semi-critical	Intensive treatment on grassland near tank No. 6-3-45 and scattered treatment on balance.
15	14	E. C. #7	13,500 R	$ 0.15	$1,015	$1,010	Semi-critical	1-1/2 to 3' heads over most of this area. Treat with rock and brush checks and small earth dykes.
3	13	E. C. #1	7,400 R	$ 0.15	$ 550	$ 550	Secondary	Fifteen 300' spreaders and 2000 yds. earth work. Has been turned in as part of E. C. #1 in Unit No. 4.

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NN0006120

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Priority	Description
					SUB-UNIT NO. I (Cont'd)			
8	14	E. C. #3	4,250 R	$ 0.10	$ 215	$ 210	Secondary	Scattered treatment along northwest side of Polacca Wash.
11	14	E. C. #4	14,000 R	$ 0.10	$ 700	$ 700	Secondary	Small scattered structures near mesa top. Rock checks and drops and earth horseshoe dykes.
			14 F					
			300 G					
		Totals - -	55,750 R		$5,310	$5,090	Total cost - - -	$10,400
					SUB-UNIT NO. II			
5A	15	E. C. #1	3,400 R	$ 0.60	$1,020	$1,020	Critical	Approximately one-half of cost for earth dykes and diversions. Balance is for checks & drops at headcutting
29	7	E. C. #5	9,000 R	$ 0.49½	$2,225	$2,225	Critical	Intensive treatment over entire area with spreader fences and diversion dykes.
28	7	E. C. #2	1,000 R	$ 0.35	$ 175	$ 175	Semi-critical	Three diversion dykes and four spreader fences on small gully.
		Totals - -	13,400 R		$3,420	$3,420	Total cost - - -	$6,840

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NN006121

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Priority	Description
					SUB-UNIT NO. III			
35	96,17	E. C. #1	21,500	$ 0.21	$2,250	$2,250	Critical	Scattered treatment over entire area with horseshoe dykes and spreaders.
36	96	E. C. #2	13,100	$ 0.22½	$2,475	$1,475	Critical	Work concentrated along western valleys - long spreaders and horse-shoe dykes.
37	17-96 16	E. C. #1	11,200	$ 0.25	$1,400	$1,400	Critical	Intensive treatment with dykes and checks.
38	16	E. C. #1	4,700	$ 0.20	$ 470	$ 470	Critical	Horseshoe dykes and water conser-vation dams.
18	97	E. C. #1	2,300	$ 0.40	$ 460	$ 460	Semi-critical	Dyke around 5' head and general spreaders along valley floor.
		Totals - - -	52,800		$3,055	$6,055	Total cost - - -	$12,110
GRAND TOTALS			14 Farmland 300 Grassland 121,930 Rangeland 122,284 Acres		$14,785	$14,565	Total cost - - -	$29,350

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NN006122

2. Special Erosion Control Projects

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Cost of Subjugation	Priority	Description
					SUB-UNIT NO. I				
2	13	SP.E.C.#1	60-Farm	$ 8.00	$ 480	$	$	Critical	Head protection of Farm #61. Has been turned in as Card #70 for Unit No. 4.
10	14	SP.E.C.#3	30-Farm	$26.00	$ 120	$ 120	$ 540	Semi-critical	Development of Farm #99 and dykes for head protection below.
1	13	SP.E.C.#1	4-Orchard	$22.50	$ 90			Secondary	Jetty to protect school orchard at Keams Canyon Agency
7	14	SP.E.C.#1	25-Range	$12.00	$ 150	$ 150		Secondary	1000' dyke around headcutting to protect 25 acres of grassland.
9	14	SP.E.C.#2	6-Expansion 6-Farm	38.90	$ 235	$ 235		Secondary	Not needed if subjugation of Farm No. 155 will handle water.
			Totals - - - -		$1,075	$ 505	$ 540	Total cost - - - $2,120	

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NN0061231

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Cost of Subjugation	Priority	Description
					SUB-UNIT NO. II				
17A	14	SP.E.C.#4	24-Farm	$21.70	$200	$100	$ 222	Semi-critical	Development of and diversions to Farms #150 and #149.
28	7	SP.E.C.#6	175-Farm	$ 5.00			$ 875	Semi-critical	Development of Farm #148.
27	7	SP.E.C.#7	130-Farm 30-Expansion	$ 6.40	$150	$ 70	$ 800	Semi-critical	Development of Farm #141 and #3 and dykes to stop headcutting.
24	7	SP.E.C.#4	850-Range	$ 0.30	$125	$150		Secondary	Three spreader fences above heads on east side of Oraibi.
25	7	SP.E.C.#5	3-Farm	$33.33	$100			Secondary	Two spreaders to divert water onto Farm #173.
30	7	SP.E.C.#8	250-Range	$ 0.30	$ 75			Secondary	Special road protection. Head cutting threatening 250 acres of range.
			Totals - - - -		$655	$295	$1,897	Total cost - - -	$2,847

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NN006124

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Cost of Subjugation	Priority	Description
					SUB-UNIT NO. III				
22	7	SP.E.C.#3	New School at Oraibi.		$150			Critical	900' of windbreak.
19	7	SP.E.C.#1	30-Farm	$21.00	$100	$ 80	$ 450	Semi-critical	Development of Farm #151.
31	7	SP.E.C.#9	16-Farm	$11.50	$105		$ 80	Semi-critical	Development of Farm #298 and dykes to protect headcutting.
33	7	SP.E.C.#11	18-Farm	$14.70	$175		$ 90	Semi-critical	Development of Farm #377 & #378. Dykes to control head-cutting.
20	7	SP.E.C.#2	34-Farm	$12.60	$110	$110	$ 210	Secondary	Development of Farms #153 & [illegible] and dykes to control headcutting.
32	7	SP.E.C.#10	350-Range	$ 0.40	$100	$ 40		Secondary	Spreader fences above head-cutting.
34	7	SP.E.C.#12	600-Range	$ 0.35	$105	$105		Secondary	Dykes and spreaders to divert water onto spreading area.
39	16	SP.E.C.#1	80-Farm	$ 5.00			$ 400	Secondary	Development of Farm #1 by the construction of six 100' spreaders.

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NN0006125

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water S'r'd'g	Cost of Subjugation	Priority	Description
					SUB-UNIT NO. III (Cont'd)				
40	16	SP.E.C.#2	1-Farm 50-Range	$20.00 2.00	$ 60	$ 60		Secondary	Two dykes to divert water from east side of Palacca to the south.
			Totals - - -		$905	$595	$1,250	Total cost - - -	$2,550
GRAND TOTALS			611 Farmland 2,125 Rangeland 36 Farmland Expansion		$2,635	$1,155	$3,667	Total Cost - - -	$7,457

2,772 Acres of land for Special Erosion Control Treatment

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NN006126

3. Agricultural Diversions and Developments

(In Order of Priority) (Does not include subjugation needs)

Card No.	Quad No.	Project Number	Acres	Cost per Acre	Cost of Erosion Control	Cost of Water Spr'd'g	Total Cost	Priority	Recommendations
12	14	Agri.Dev. #2	155-Farm 50-Exp.	$10.73	$1,900	$ 300	$ 2,200	A	Development and erosion control on Farm #155. Drop structure in head cutting.
17	14	Agri.Dev. #3. Wepo Proj.	205-Farm 100-Exp.	$21.38	$1,300	$5,020	$6,520	A	Masonry partial diversion, sausage stabilizers and dykes.
41	15,14, 16	Agri.Dev. Polacca Proj.	600-Exp. 500-Hay 1290-Other		$1,410 (8,550)	11,900	13,310 (21,860)	A	Complete diversion, dykes and spreaders. $8,550 for drop structure and dykes at lower end of spreading area which may be deferred until later date. The immediate cost would be $13,310 and if drop is needed the cost will be $21,860.
42	14	Agri.Dev. Taylor Sprs.	10	$15.00			$1,500	A	Cost is for pipeline and reservoir. An irrigation project.
6	14	Agri.Dev. #1	165-Farm 65-Exp.	$8.77	$2,020		$2,020	B	Cost only for erosion control. Diversion included in Subjugation costs on page No.
23	7	Agri.Dev. #1	50-Exp.	$36.00	$ 750	$1,050	$1,800	B	Diversions and dykes. To be developed at a later date.
						Totals - -	$27,350 (35,900)		

GRAND TOTAL COST OF ALL ENGINEERING STRUCTURES - - - $72,747

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NN0006127

The total cost of all suggested construction and maintenance projects - $118,151

Range Rodent Control - - - - - -	$8,052	
Rodent & Insect Control on Farms - - - - - - - - - - -	500	
Woodland Rodent Control - - - - -	500	
Total Rodent Control - - -		9,052
GRAND TOTAL OF ALL WORK - - - - -		$127,183

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