WORK REPORT

RECONNAISSANCE SOIL CONSERVATION SURVEY

LAND MANAGEMENT UNIT NO. 2

NAVAJO DISTRICT

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1937

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SOUTHWEST REGION

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NOTE

ALL SOIL SERIES NAMES USED IN THIS REPORT ARE TENTATIVE, PENDING CORRELATION BY THE INTER-BUREAU CORRELATION COMMITTEE.

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FOREWORD

The purpose of this investigation of Land Management Unit No. 2 was primarily to classify the soil types, land use, erosion and slopes on a reconnaissance basis and to evaluate, from these data and others, all areas on the basis of their adaptability to soil and water conservation measures and to various phases of agriculture - grazing, dry farming or irrigation.

Navajo Mountain, the area north and west of the mountain, and Navajo and Piute Canyons are virtually unsurveyed, due to their inaccessibility. Parts of these areas were penetrated on foot and with pack and saddle animals from a succession of short camps, but, due to the pressure of time, the relative impassability of the country and the low value of native resources, it was neither practical nor desirable to map these areas in detail. Small remnants of various soil types may be found in this region, but they were mapped merely as inclusions in a region consisting principally of sandstone formations. Details visible on aerial mosaics and those seen on short trips were relied upon to furnish the information required to compile the maps.

Note: Detailed surveys of Navajo Canyon and of Piute Canyon have been made. Reports may be obtained from the Section of Conservation Surveys.

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INTRODUCTION

Land Management Unit No. 2 is located in the northwest portion of the Navajo Reservation. The north portion of the Unit lies in San Juan County, Utah, and the remainder is equally divided between Navajo and Coconino counties, Arizona. The Unit is approximately 60 miles long and varies from 5 to 55 miles in width. It is bounded by such natural physiographic features as the Colorado and San Juan Rivers, the eastern edge of No Man's Mesa, the western rim of Segi Canyon, the Moencopi Wash, the eastern slopes of White Mesa and the south rim of Navajo Canyon. It embraces an area of 1,094,976 acres.

The survey was begun August 24, 1937 and completed October 6, 1937.

Accessibility of the Area

The Tuba City-Kayenta primary road traverses the southern portion of the Unit. This road is inadequately maintained and often impassable after a heavy storm. Secondary roads extend from Red Lake to Inscription House and from Cow Springs to Shonto. The south half of the Unit, with the exception of portions of Black Mesa, is readily accessible by automobile. Saddle and pack-horses must be relied upon for transportation in the greater part of the northern sections.

Schools and Hospitals

Two day schools are located within the Unit, one at Shonto and one at Navajo Mountain. The nearest hospitals are at Kayenta and Tuba City, both approximately 25 miles outside the Unit.

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Telephones

Telephones at Shonto, Inscription House and Navajo Mountain are connected with the Tuba City exchange.

Trading Posts

The 3 trading posts within the Unit are located at Inscription House, Shonto and Navajo Mountain, all of which can provide accommodations for guests. Accommodations, guides and equipment for pack trips to Rainbow Bridge and other points are available at Rainbow Lodge.

Population

Living within the Unit, and dependent upon its productivity, are some 915 Indians, comprising 116 consumption groups. Several white families live at the trading posts and at Rainbow Lodge.

National Monument

Inscription House National Monument is located within the Unit. A National Park Service ranger supervises the ruins, which are accessible by automobile and pack animal.

Mineral Resources

"Placer gold in small amounts has been found in the gravel bars and terraces along the San Juan River. At Zahn Camp, 7 miles below the mouth of Nakai Canyon, a plant for washing gravel was installed. A small amount of gold was taken but the camp was abandoned in 1909. A second camp was installed 6 miles below Zahn Camp but this was also abandoned in 1909. Several other attempts were made along the San Juan but all work was stopped by 1912.

"The gold along the San Juan is extremely fine and is known as

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flour gold. It occurs throughout the gravels but due to the inaccessibility of the region, mining is unprofitable. Small quantities of gold - twenty to forty cents a ton - are also said to occur disseminated in the Wingate and Navajo sandstones.

"Copper in the form of malachite, azurite and chrysacolla has been reported at a few places impregnating the Shinarump conglomerate and sandstones in the Chinle formation and Piute canyons. No deposits of commercial value have been discovered." *

Numerous outcrops of low-grade coal occur in the Mesaverde formation on Black Mesa.

Topography

Land Management Unit No. 2, with its deep canyons, high cliffs and endless variety of fantastically eroded rock forms, has unusual scenic beauty. The topography of the northern portion of the Unit consists of numerous deep, narrow canyons surmounted by high, rounded domes and lofty mesas, the walls of which reveal rock exposures continuous for miles. In the extreme northwest, hidden by a maze of sandstone knobs and domes separated by deep clefts, are Rainbow, Owl and Hawkeye natural bridges. The solitary peak of the Navajo Mountain in the north central portion of the area rises thousands of feet above the surrounding country. The upland surface in the south is less spectacular and is characterized by exposures of sandstone domes and low mesas. Rough, rugged Black Mesa bounds the Unit on the south.

*Geology Report LMU #2

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The main physiographic features of the Unit are Navajo Mountain, Rainbow Bridge, Owl Bridge, Hawkeye Bridge, Colorado River, Cummings Mesa and numerous canyons in the northwest; Piute Canyon, Piute Mesa, No Man's Mesa and Nakai Canyon in the northeast; Navajo Canyon to the west; Klethla Valley and Black Mesa in the south and east.

Drainage

Land Management Unit No. 2 is well to excessively drained. The greater portion of the Unit drains northward into the Colorado and San Juan Rivers. The abundance of bare rock surface, with the consequent rapid run-off, produces large-volume floods in this region. Light sandy soils in the central portion of the Unit readily absorb moisture, consequently run-off is fairly low in this area. The steep, rocky slopes of Black Mesa are conducive to a high degree of run-off and silt production, and accelerated erosion of the more easily eroded soils of Klethla Valley. A high percentage of the soils of this Unit absorb water rapidly, but the torrential character of the rainfall often causes excessive run-off. Nearly all the drainages are intermittent except in short stretches fed by springs. All have large drainage basins and are periodically subject to heavy floods.

Climate

Climatic records were available from stations at Kayenta, Tuba City and Lee's Ferry, all outside the Unit. Records taken from the Kayenta station are probably the most generally applicable. Records from the Grand Canyon station are presented for comparison.

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The climate of the Unit is arid. Temperature records show a variation in mean annual temperature of 52.2 to 61.5 degrees. The average annual range in temperature at Kayenta is between 2°and 100°F.

Table I. TEMPERATURE RANGE

Year	Station	Temperature Range Maximum	Minimum	Average
1935	Tuba City	104°	+3°	55.9°
1935	Lee's Ferry	109°	+13°	61.5°
1935	Kayenta	100°	+2°	52.2°
1935	Grand Canyon	91°	-6°	49.0°

Prevailing winds in the area are from the southwest. A wind station at Lee's Ferry, immediately outside of the Unit boundary, recorded an average annual wind movement of 2.11 miles per hour. At the same station, the average annual rate of evaporation was 88.95 inches during the years 1921 and 1922.

Table II is the precipitation record observed at Tuba City over a 29-year period.

TABLE II

Month	Precipitation - Inches Minimum 1924	Maximum 1906	Average
December	.82	2.32	.58
January	.16	.53	.55
February	.00	.34	.54
March	.12	1.59	.54
April	.09	.19	.43
May	.02	.34	.53
June	.00	.00	.19
July	.00	1.73	.34
August	.10	1.26	.93
September	.14	1.37	.84
October	.13	.27	.68
November	.00	2.92	.78
TOTALS	1.58	12.57	6.92

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TABLE III.

EVAPORATION AND WIND MOVEMENT
Lee's Ferry, Arizona
Oct. 1921 to Dec. 1928

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann. Evap.	Average hourly wind movement
*Evaporation	1.69	3.11	5.70	7.93	11.86	13.64	13.78	11.27	8.97	6.15	2.94	1.91	88.95	
**Wind movement	1.36	1.80	2.76	2.70	2.72	2.49	2.18	1.95	1.83	1.73	1.47	2.29		2.11

*Evaporation expressed in inches.
**Wind Movement expressed in miles per hour.

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The average length of the growing season in the Unit has not been recorded, but records at the Kayenta, Lee's Ferry and Tuba City stations vary from 169 to 237 days.

Vegetation on Navajo Mountain indicates that the climate is more humid there than elsewhere in the Unit; however, no climatic records are available.

TABLE IV — Dates of Killing Frost in Spring and Autumn and Length of Growing Season

	Length of Record (Years)	Av. Date Last Killing Frost in Spring	Av. Date First Killing Frost in Autumn	Latest Date Killing Frost in Spring	Earliest Date Killing Frost in Autumn	Average Length Growing Season
Kayenta	12	Apr 27	Oct. 13	May 23	Sept. 21	169
Lee's Ferry	5	Mar. 21	Nov. 7	Apr. 9	Oct. 26	231
Tuba City	24	Apr. 23	Oct. 19	May 9	Sept. 19	179

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Table V is the precipitation record at the three stations over a 33-year period.

Table V — Average Annual Precipitation and other Data

Station	Period of Records	J	F	M	A	M	J	J	A	S	O	N	D	Ave. Ann. Precipitation	Ave. Length Growing Season	Date, Last Killing Frost	First Killing Frost
Kayenta	1915-1930	.63	.43	.64	.42	.36	.38	1.45	1.58	.75	.91	.64	.61	8.80	163	6/1	9/21
Tuba City	1897-1930	.55	.54	.54	.43	.53	.19	.34	.93	.84	.68	.78	.58	6.92	179	5/19	9/19
Lee's Ferry	1916-1930	.34	.60	.44	.59	.26	.16	.76	.96	.59	.64	.42	.44	6.20	229	4/18	10/18

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Agriculture

Range soils are of primary importance in Land Management Unit No. 2. Of the total surface area of the Unit, approximately two-thirds might be classed as barren land, a practically inaccessible maze of sandstone knobs and deep canyons. Because of the low annual precipitation and high rate of evaporation, farming is restricted to flood-irrigated alluvial fans or other small irrigation projects.

Agriculture is at present concentrated in Navajo and Piute Canyons, Shonto Wash and Klethla Valley. Farming methods are today little changed from those of past generations. Most crops are planted, tilled and harvested by hand, and little effort is made to maintain and protect the agricultural soil, consequently the farm plots are frequently abandoned.

Cultural Practices*

"The farming methods of the people within the Unit are mostly old-fashioned. No large-scale farming is found and the hand methods of producing crops are used. In most cases the agricultural crops are just a side issue and no real interest is taken in the crop production. In a few instances an effort is being made to maintain the farm land and protect it for future production, but most farms are used just the way nature has provided them.

"If a gully head cuts back through the farm and destroys it, the owner will move to a new location rather than try to maintain the old farm. This practice is probably more noticeable on this Unit where

*Agronomy Branch Report, L. M. U. No. 2.

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the farms were smaller and a small three or four acre farm would not mean much to a family when they could move to another place for growing their crops. It is true, however, that where irrigation water is supplied or where larger flood irrigated farms are located an effort is made to conserve the land.

"The crops are produced almost entirely by hand. Sometimes the land is plowed but more often it is not. Planting is done entirely by hand. On the larger fields the horse-drawn blade is used for cultivating and weeding, but the smaller fields are cultivated with the hoe. In the fall the crop is harvested by hand and what is not consumed is stored for winter. After the crop is harvested, livestock are allowed to run in the field and no work is done until the next spring, when planting time arrives.

TABLE VI ACREAGE BY CROPS

Crop	Acres	Percent of Total
Corn	693	63.17
Squash & Melons	71	6.47
Idle	243	22.15
Peaches	21	1.92
Beans	4	.36
Alfalfa	14	1.28
Vegetables	2	.18
Oats	1	.09
Pasture	48	4.38
TOTALS	1,097	100.00

Yields

"No actual yield measurements were made on this Unit; therefore, the yields to be listed on ocular estimates and comparisons with other

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yields. For this reason, these figures should by no means be taken as definite material.

TABLE VII CROP YIELDS

Crops	Present Average Production	Expected Average Production
Corn	11 bu.	18 bu.
Squash	1,000 lbs.	3,000 lbs.
Peaches	75 bu.	250 bu.
Beans	150 lbs.	250-300 lbs.
Alfalfa	1.5 tons	2 tons
Oats (for hay)	1 ton	2 tons

TABLE VIII. Agricultural Land Status in Land Management Unit No. 2

Land Status	Present Acreage	Potential Acreage	Total
Irrigated	203	30	233
Flood Irrigated	341	210	1,051
Dry Farmed	53	0	53
TOTALS	1,097	240	1,337

Farming Practices

"It is a very common practice of the Indians to go out in the spring and plant their crops on the land just as it was left the previous fall after harvesting. Then, during the summer, the crop will probably get one or two cultivations with the horse-drawn blade or hoe. The crop is then harvested in the fall and the ground left until the next spring. It is very evident that this is a shiftless, lazy way of producing farm crops. The farmers should plow their land in the fall. This will increase the moisture penetration, reduce the spring run-off, and decrease the cutworm damage. In the spring, a proper seed-bed should be prepared by harrowing, and where the land is rough, leveling. In the planting

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operation, instead of throwing a handful of seed in each hole, the corn hand-planter or a lister planter should be used. Both of these are inexpensive implements and would soon repay their investment.

"In this Unit the crops should ordinarily be planted between April 25 and May 15. Just as soon as the weeds begin to show up, cultivations should begin and continue throughout the summer. When the crops are harvested the field could be pastured, providing it is not stocked to death. The field should then be plowed in the fall before freezing weather sets in."

Suggested Improvements

1. An extension program in cultural practices
   (a) To improve crops.
   (b) To increase duty of water.
   (c) To improve cropping methods.
   (d) To introduce methods of retaining water on land, etc.

EROSION

The west and north portions of Land Management Unit No. 2, with the lone dominating peak of Navajo Mountain in the extreme north, presents an area of normal heavy geologic erosion. High, rounded, closely-spaced domes and deep, narrow canyons create an impression of a barren billowy waste of remarkable scenic grandeur.

The central and southern portions of the Unit, with their soil and vegetative cover accessible to man and livestock, are susceptible to accelerated erosion. However, erosion in this vicinity is slight at present.

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Low annual rainfall and light-textured soils, in conjunction with moderate to severe overutilization of the vegetative cover, have resulted in a predominance of wind erosion north and east of Navajo Mountain and along the north side of Klethla Valley. Partially stabilized sand dunes are common to both these areas. The entire Unit is susceptible to wind erosion. However, a fairly adequate cover, at present only moderately overutilized, is protecting the readily blown soil, particularly in the central portion. Localized areas are severely wind-blown.

The heavier soils of Klethla Valley, their vegetative cover severely overutilized and depleted, are ravaged by the consequent rapid run-off. Sheet and gully erosion are severe in this area.

Excessive use has measurably thinned the stand of plant species most valuable for the control of erosion on Black Mesa, resulting in accelerated sheet and gully erosion. The increase in run-off is ruining land and vegetation in Klethla Valley below.

Innumerable short valleys throughout the Unit are being rendered valueless by gully-heads, gradually extending into valuable soil areas in the vicinity of Inscription House.

Erosion-Control Recommendations

Erosion varies directly with the degree to which the vegetative cover has been depleted and the surface soil disturbed by stock. Insofar as low annual rainfall will permit, the soils of this Unit will respond readily to a range-management program.

The immediate control of numerous gully-heads invading valuable range and agricultural soils in the vicinity of Inscription House and in

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Klethla Valley is recommended.

The potential seriousness of further topsoil loss in Klethla Valley warrants immediate mechanical control and an intensive revegetative program. The soil is highly erodible and the loss of vegetative cover by continued intense grazing has accelerated erosion.

Range Utilization

The longevity and vitality of range plants are influenced by the amount of available moisture and the seasonal intensity of grazing which they receive.

Field observations indicate that the Unit is considerably overstocked. Proper or underutilization exists only in those areas normally inaccessible to livestock, which are of little range value due to their inaccessibility. Use over the remainder of the Unit varies from moderate to severe overutilization, depending upon population concentration.

Erosion conditions correspond closely to range utilization. Piute Mesa and the vicinity of Shonto are moderately overutilized, but the plant cover is still sufficient to protect soils otherwise easily eroded by wind.

Agricultural concentration has resulted in severe overutilization of range resources in Klethla Valley, consequently the soil is exposed to severe water erosion.

Proper range management, including proper numbers and distribution of livestock, should result in a conservative use of the forage resources and stop the destructive erosion cycle induced when the soils lose their protective cover.

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Artificial Revegetation

Low annual precipitation and a high rate of evaporation limit revegetative possibilities in Unit No. 2. Lack of vegetation in Klethla Valley justifies artificial planting to eliminate the complete loss of a valuable soil area. Adequate moisture will allow intensive tree planting in Shonto and Cow Springs Washes and below Badger Springs to prevent further gullying and bank cutting. Numerous side canyons in the north, with their productive soil now endangered by extreme overutilization and consequent accelerated erosion, might be fenced and revegatated, thus conserving the soil and eventually increasing the forage resources of the Unit.

Due consideration must be given vegetative adaptation to soil conditions and other environmental features in all planting sites to insure satisfactory results from artificial plantings.

Artificial Structures

Although artificial retention and detention structures have a place in the solution of the erosion problem on this Unit, it is evident, from consideration of the degree of plant and soil depletion and the cost of construction of control measures, that restoration and maintenance of more nearly normal surface conditions are of paramount importance.

No major retention structures are contemplated, but several small detention structures are justified in the vicinity of Inscription House and in Klethla Valley. Gully-head control is essential in both locations to protect valuable range and agricultural soils. Numerous other small gully-heads, scattered throughout the Unit, warrant immediate attention.

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Specific adaptation of the soils for construction purposes is discussed under Soil Groups. Structure locations are shown on the attached map.

SOILS

The soils of the Unit have been systematically classified into series and types according to origin, profile characteristics and surface texture. The soils have been further classified according to land use, slope, erosion and potential adaptability to proper range and agricultural practices. Ten series and 16 types, exclusive of miscellaneous rough broken and rough stony land classes, are mapped.

The majority of the soils originate from sandstone. The inherent sandy characteristics of the soils account for a high susceptibility to wind erosion, and when the plant cover has been depleted, disturbed and modified by long-continued excessive grazing and trampling by livestock, severe erosion is inevitable.

General Geology and Soil Relationships

*"The surface of Rainbow Plateau and Segi Mesa is formed largely by the Navajo sandstone and nearly complete sections are exposed in Navajo and San Juan Canyons. The Navajo sandstone in this Unit weathers into rounded domes, many of them several hundred feet in height.

"The Carmel, Entrada and Morrison formations form patches on the Navajo sandstone in the vicinity of Navajo Mountain and along the edges of Cummings Mesa, and the Dakota formation forms the cap rock of Navajo Mountain and Cummings Mesa. The Dakota is the only Cretaceous formation on the Unit.

*Geology Report, L.M.U. No. 2.

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"In Navajo Canyon, and in other canyons in the western part of the Unit, the Navajo sandstone forms the entire wall of the canyon, but in the eastern margin where the Navajo sandstone thins, the Kayenta, Wingate, Chinle, Shinarump and Moenkopi formations are exposed in the walls and floors of the canyons.

Formations present in this Unit range from the Cutler formation of Permian age to the Mesaverde formation of Upper Cretaceous age. The older formations are confined to the eastern part of the Unit and are exposed in the canyon of the San Juan and its tributary canyons. The rocks throughout the district are dominantly of sandstone, although siltstones and shales are also abundant. The dominant color of the formations is red, but grays and buffs are also common."

The greater portion of the soils of Unit No. 2 are derived from grayish white to pink Navajo sandstone. From this sandstone, composed of medium-sized rounded quartz grains loosely cemented with calcium carbonate, originate the coarse-textured, calcareous, easily wind-blown Floy, Todilto and Kayenta soils. Thin beds of greenish gray sandy limestone on the foot slopes of Navajo Mountain give rise to the gravelly, highly calcareous Rainbow soils. The heavier Concho soils develop on alluvium from the Mancos shale of Black Mesa and are severely affected by water erosion. The Dinnehotso and Tolani soils, highly susceptible to wind and water erosion, develop on the alluvium from the Navajo and associated sandstones. Those undifferentiated soils developed from the Mancos shale on the slopes of Black Mesa are easily eroded by water when their plant cover is disturbed.

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The major portion of the soils of the Unit are typically coarse-textured, loose, and very susceptible to wind erosion.

Residual soils occupy the greater portion of the area and constitute the better classes of rangeland. The Floy and Todilto soils are the most important of the five residual series mapped. Of the six alluvial soils mapped, postions of the Concho, Dinnehotso and Tolani are important agriculturally.

The soils have been classified into five groups on the basis of range adaptation. Their location is shown on the land class map.

RANGE GROUPING OF SOILS

The soils of Land Management Unit No. 2 are essentially range soils. Seasonal moisture is the chief factor limiting the density and growth of vegetation. Soils vary greatly in their capacity to absorb and hold moisture for plant growth. Basic factors influencing soil moisture and plant growth are slope, erosion, permeability and water-holding capacity of the surface soil and subsoil, and the concentration of water-soluble salts.

Soils in the greater portion of the Unit are readily permeable and make maximum use of rainfall in plant production. However, with a mean annual precipitation of approximately 8.5 inches and the paucity of clay to stabilize the coarse-textured soils, wind erosion is always a menace.

GROUP A SOILS

Group A includes soils which within the limits of normal precipitation are regarded as excellent from the standpoint of their potential

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range capacity under a sound range-management program, and which will most readily produce sufficient vegetation to largely stabilize accelerated erosion.

In Unit No. 2, Group A soils have the following limitations:

Slope: 0 to 3%.

Erosion: Class 1 or 2 sheet erosion, occasional shallow gully, P wind removals, K accumulations.

Alkali: Less than 0.2 of 1%.

Drainage: Good or high water table if no alkali present.

Soil: Permeable surface soil, good water-holding capacity.

Portions of the following soil types comprise the A Group range soils:

ALLUVIAL

Bonito sandy loam
Concho sandy loam
Dinnehotso sandy loam
Dinnehotso clay loam

Moisture Penetration

These soils are readily permeable. However, because of the torrential character of some rains, slight run-off may be expected, but these soils will absorb a high percentage of the moisture.

Water-holding capacity:

All Group A soils have a relatively high water-holding capacity. Inherent subsoil characteristics of these soils are such that moisture is readily available to grasses and other plants of similar root growth habits.

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Vegetative Adaptation

The vegetative type is closely correlated with the degree of accelerated erosion, due in part to the greater protective value of certain plant cover. The native vegetation on the soils of this Group consists of blue grama, galleta, snake weed and browse, which now afford an adequate protective cover. However, injudicious grazing of these vegetative types will prove a potent factor in accelerating erosion, at present negligible.

Value of Soils for Construction Purposes

The medium-textured to moderately light soils of the sandy loam and clay loam types are very good for construction purposes if standard approved engineering practices are observed. Due to large-scale reconnaissance investigation on this Unit, all sites should be carefully investigated before any large structures are built.

Erosion

With a few exceptions, erosion on Group A grazing land soils is slight, and may be expected to remain so provided the range is not subjected to excessive use.

Improvement Program Feasible from a Soils Standpoint

Bonito, Concho and Dinnehotso sandy loams in Klethla Valley are well adapted to water spreading. Maximum use should be made of the run-off from adjacent Black Mesa.

The appearance of snake weed on portions of Group A soils seems to indicate that overgrazing is inducing the deterioration of the grass types, consequently a range-management program is essential to the

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maintenance of an adequate cover.

Areas in Need of Mechanical Control*

Active gully erosion 5 miles southwest of the Inscription House Trading Post and 1/2 mile west of the Tonalea road is destroying a valuable soil area. Mechanical control is needed to protect an area of grade A soil and a reservoir.

Immediate control of potentially serious gully-head erosion is recommended to protect several acres of excellent range and agricultural land and to insure the water supply for a reservoir adjacent to the area. The area lies 4-1/2 miles south of the Inscription House Trading Post and 3/4 mile east of the Tonalea road.

GROUP B SOILS

This group will probably produce sufficient vegetation to control accelerated erosion within a somewhat longer period of time and may have a lower ultimate carrying capacity than Group A grazing-land soils. Group B grazing-land soils have the following limitations:

Slope:	10% or less.
Erosion:	Class 3 sheet, occasional small gullies, P to S wind removal, depending upon soil depths, L accumulations.
Alkali:	0.2 to 0.3 of 1%. Slight carbonates.
Drainage:	Relatively good, high water table harmful only if alkali present.
Soil:	Moderately permeable; moderate water-holding capacity.

*See Branch of Eng. Report L.M.U. No. 2 for details.

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Portions of the following soil types are included:

RESIDUAL	ALLUVIAL
Todilto loamy sand	Concho sandy loam
Floy sandy loam	Dinnehotso sandy loam
Floy loamy sand	Rainbow loamy sand
Buell loamy sand	Kayenta loamy sand

Moisture Penetration

Moisture is the chief factor limiting the depth of water penetration in these soils, with the exception of shallow Rainbow loamy sand. Portions of Concho sandy loam show evidence of dispersion, consequently the subsoil may be more or less impervious.

Water-Holding Capacity

Coarse texture and deep uniform profiles of portions of Group B soils are indicative of a relatively low water-holding capacity. However, laboratory analyses of similar profiles show that the inherent qualities of some sandy types permit a moderately high water-holding capacity. Low annual rainfall and a high rate of evaporation are the chief factors limiting the moisture content of these soils. A shallow profile materially reduces the moisture-holding capacity of Rainbow loamy sand.

Vegetative Adaptation

A good stand of pinon and juniper grows on Floy sandy loam and loamy sand. Interspersed among the woodland species are good growths of galleta, blue grama, big sage and some yellow brush. Such areas in the vicinity of Shonto represent the best range on the Unit.

Concho sandy loam and Concho clay in Klethla Valley now support only Russian thistle, snake weed and some browse. This area clearly shows that overutilization is probably one of the most potent factors

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causing accelerated erosion.

The Rainbow loamy sand mapped on the lower slopes of Navajo Mountain supports black brush and mixed grasses.

The wind-blown Kayenta soils are partially stabilized by Mormon tea and sage, with sparse growths of black brush, yellow brush and snake weed. Here again may be seen the close correlation of plant type with accelerated erosion.

Todilto loamy sand and sandy loam are protected to some extent by blue grama, browse and three-awn grasses.

Extensive stands of pinon and juniper occur on nearly all Group B residual soils.

Value of Soils for Construction Purposes

The construction value of Group B soils is similar to that of Group A. Concho soils should be carefully investigated prior to any proposed construction, as they are commonly dispersed and often have a high alkali content. Loamy sands of Group B should be used only with special designs, such as linings, cut-off walls, French drains, etc.

The torrential character of the rains will make heavy demands on the structures in this Unit, consequently careful studies of soil conditions should be made to insure successful structural design.

Erosion

Sheet and gully erosion is negligible on most of the soil area of this group. However, mechanical treatment of isolated gullies is warranted, particularly on the Concho sandy loam in Klethla Valley and on the Dinnehotso sandy loam in the vicinity of Inscription House.

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Wind erosion is prevalent on Todilto and Kayenta loamy sands. Floy loamy sand and Floy sandy loam, with their single-grained structure and coarse texture, are susceptible to wind erosion. However, with present plant cover they are adequately protected.

The Rainbow soils support a meager vegetative cover at present, and consequently are subject to severe erosion.

Improvement Program Feasible from a Soils Standpoint

Vegetation is most effective in preventing excessive run-off and erosion, but, because of climatic conditions, natural revegetation in this area will be slow; consequently, a program of conservative range utilization is important. The greater portion of these soils is loose and friable, and susceptible to wind erosion.

Gully-heads south and west of Inscription House should be controlled.

Areas in Immediate Need of Mechanical Control*

East of the old Piute Canyon Demonstration Area near the head of Nakai Canyon a small gully-head threatens the eventual loss of several thousand acres of good range. Immediate control is recommended to prevent further loss within the area.

Several small active heads 1-1/2 miles south of the Shonto Trading Post will eventually destroy the entire valley. Immediate control is justified to protect several acres of valuable agricultural land.

Numerous scattered small gullies southeast of Shonto, on the north side of Kaèthla Valley, are destroying good rangeland. Small earth dikes,

*See Branch of Eng. Report L.M.U. No. 2 for details.

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spreaders, etc., are needed to control excessive gully-head erosion.

Precautions

Because Group B soils are predominantly loose and subject to wind action, maximum vegetative cover should always be maintained.

GROUP C SOILS

Soils of Group C are composed of fair rangeland soils that may require a long time to produce sufficient vegetation to even partially control accelerated erosion.

Limiting factors established for Group C soils are:

Slope:	20% or less.
Erosion:	3 sheet, occasional deep gully, S wind erosion, depending upon soil depth, NL accumulations.
Alkali:	.3 to .5 of 1%.
Drainage:	Fair, high water table with moderate alkali.
Soil:	Fair permeability, fair water-holding capacity, susceptible to wind erosion.

Portions of the following soil types are included in Group C:

RESIDUAL	ALLUVIAL
Todilto loamy sand	Concho clay loam
Floy loamy sand	Concho clay
Floy sandy loam	Dinnehotso loamy sand
	Dinnehotso sandy loam
	Dinnehotso clay loam
	Rainbow sand
	Tolani loamy sand
	Kayenta loamy sand

Moisture Penetration

Moisture penetration is moderately rapid in Concho clay loam, Concho clay and Dinnehotso clay loam types. The coarse-textured soils

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of the Todilto, Floy, Dinnehotso, Kayenta and Tolani series are readily permeable. Depth of penetration in Rainbow loamy sand is limited by a shallow profile.

Water-holding Capacity

Coarse textures limit the water-holding capacity of the sandy types in the Group. Concho clay loam, Concho clay and Dinnehotso clay loam have a moderately high moisture-holding capacity. Some sandy loams exhibit a comparatively good water-holding capacity. A shallow profile limits the moisture-storage capacity of the Rainbow loamy sand. Low rainfall limits the amount of water available to plants in all soils.

Vegetative Adaptation

Group C soils support vegetation similar to those of Group B. Russian thistle is common on the severely overutilized Concho soils in Klethla Valley. Snake weed, big sage and Mormon tea grow on the heavier soils of Black Mesa. The overutilized and consequently wind-blown Todilto and Kayenta loamy sands support a sparse cover of yellow brush, black brush, blue grama and snake weed.

Value of Soils for Construction Purposes

The fine-textured and generally dispersed Concho soils with high colloidal clay and alkali content are generally unsuited for construction purposes. Caution is recommended if the coarse-textured sandy soils are used in construction, because of excessive permeability.

Erosion

The hummocky surface of the coarse-textured soils of this group is typical. Areas of active dune sand occur north and west of Navajo

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Mountain and along Klethla Valley.

Sheet and gully erosion occur on the almost barren Concho soils of Klethla Valley and on the steep slopes of Black Mesa.

Denudation in Klethla Valley, as a result of overgrazing and acceleration of erosion, has greatly reduced the value of this area.

Improvement Program Feasible from a Soils Standpoint

Revegetation of the severely denuded soils of Klethla Valley will be slow because of the accelerated stage of erosion and low rainfall. Water-spreading devices utilizing run-off from Black Mesa are recommended to hasten recovery of this area.

Recovery of a normal soil and plant condition will be slow on severely wind-modified areas of the Todilto and Kayenta soils.

Mechanical treatment of gully-head erosion on the Concho, Dinnehotso and Tolani soils is justified for the protection of valuable range and agricultural soils.

Areas in Immediate Need of Mechanical Control*

A large active gully-head at the north end of Piute Mesa will eventually destroy several acres of farmland and thousands of acres of range. Immediate control of the gully-head is essential to protect the entire valley.

Immediate control of several gully-heads at scattered localities in Klethla Valley is essential.

GROUP D SOILS

Group D soils include poor range soils which are not expected to produce more than a limited vegetative cover.

*See Branch of Eng. Report L.M.U. No. 2 for details.

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The following limitations are recognized:

Slope: 40% or less.

Erosion: 4 sheet, 8 deep type gullies, S removals, N accumulations.

Alkali: Greater than .5 of 1% neutral.

Drainage: Permanent water table 6" or less from surface, low forage value of vegetation. Not a limiting factor in this Unit.

Soil: Low permeability, low fertility or water-holding capacity.

Portions of the following soil types are included in Group D:

RESIDUAL	ALLUVIAL
Todilto loamy sand	Dinnehotso loamy sand
Floy loamy sand	Kayenta loamy sand
St. John's clay	

Rough broken and rough stony land with intermittent cover of Todilto and Floy loamy sand, etc.

Moisture Penetration

Areas of Floy sandy loam, Todilto loamy sand and Kayenta loamy sand, all having a fairly deep profile, are readily permeable. The frequent occurrence of barren rock in the soils of this group materially increases run-off. The St. John's clay from which most of the topsoil has been removed is slowly permeable and run-off is high.

Water-Holding Capacity

The shallow soils of this group, scattered among exposures of Navajo sandstone, have a low water-holding capacity. The coarse-textured Kayenta and Todilto soils also have a low water-holding capacity.

Vegetative Adaptation

The frequency of rock exposures and shallow soil cover permits the

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growth of only a sparse vegetative cover. A light stand of juniper has become established in the soil-filled cracks of extensive bare rock. Small scattered patches of blue grama and s. .. y muhly occur on Floy sandy loam.

Value of Soils For Construction Purposes

In general, the construction value of these soils is low. All materials proposed for construction purposes should be analysed.

Erosion

Severe normal geologic erosion and all phases of accelerated erosion occur within the Group.

Steep slopes, exposed geologic material, and loose, coarse-textured soils, in conjunction with excessive grazing, have resulted in severe erosion.

Improvement Program Feasible from a Soils Standpoint

Present conditions point to the necessity of restoring the plant cover and initiating improvements in range and livestock management to relieve areas particularly susceptible to erosion. This applies not only to this group but also includes portions of other groups.

GROUP E SOILS

Group E soils are defined as soils and soil materials of practically no present or potential value for range purposes, on which erosion control will be impractical.

The following limitations are recognized:

Slope: Greater than 40% or barren because of slope.

Erosion: Severe geologic or otherwise destroyed.

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Alkali: Greater than 1% neutral salts or more than .2 of 1% carbonates.

Drainage: Ephemeral lakes (none mapped on this area).

Soil: Very droughty or otherwise unfavorable to any type of plant growth.

Moisture Penetration and Water-Holding Capacity

The predominance of bare rock in this group results in almost complete run-off and low water-holding capacity.

Vegetative Adaptation

Juniper and pinon take root among the rocks and grow on seemingly barren geologic material. Sparse growths of grasses and browse occur in scattered areas.

Erosion

Erosion in this group has been classed as geologic. Deep, narrow canyons, high mesas and rounded sandstone domes are dominant.

Value of Soils for Construction Purposes

No value other than as a source of rock.

Improvement Program Feasible from a Soils Standpoint

No improvement program is recommended, other than the development of natural reservoirs, springs, etc.

AGRICULTURAL SOILS

Land Management Unit No. 2 is primarily adapted to grazing, and livestock production is of primary importance. Cultivated land occupies less than 0.1% of the total area, or approximately 1095 acres.

Moisture and temperature are undoubtedly the chief factors limiting agriculture. The limited amount of water available for irrigation

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confines agriculture to favorably located gully fans or alluvial valleys. Agricultural concentrations are centered in Navajo and Piute Canyons, Shonto Wash and portions of Klethla Valley.

Potential agricultural land is abundant and production could be materially increased by development and conservative use of the available water and soil through improved cultural practices.

As detailed reports are available for the two larger agricultural areas in Navajo and Piute Canyons, and because the remaining agricultural soil areas are small, scattered and consequently unsurveyed, no attempt is made to discuss agricultural soil groups in this report. However, the adaptability of each agricultural type surveyed is briefly discussed.

Soil types more or less adapted to agriculture are:

Concho sandy loam
Concho clay loam
Concho clay
Dinnehotso loamy sand
Dinnehotso clay loam
Tolani loamy sand
Bonito sandy loam

Despite a very unstable irrigation water supply there is no doubt that the acre yield of agricultural soils could be increased. However, the lack of any definite basis upon which average yields are now estimated necessarily precludes any but general statements bearing upon the potential productivity of a given soil. Agricultural soils, therefore, may only be tentatively graded until a definite comparative basis can be established. Following is a tentative evaluation of the agricultural soils from information obtained by this survey:

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TABLE IX BASIC AGRICULTURAL GRADES AND MODIFYING FACTORS OF CERTAIN SOILS IN L. M. U. NO. 2

Soil		Limiting or Modifying Factors
Field No.	Basic Grade	
55-7	B	1. Erosion* Grade A - less than 25% A horizon removed by sheet erosion. Grade B - 25% to 75% A horizon removed; occasional gullies. Grade C - More than 75% A horizon or upper B horizon removed; frequent shallow gullies. Grade D - Removal of lower B or C horizon, frequent deep gullies. 2. Moisture Penetration Grade A - Rapid Grade B - Moderately slow Grade C - Slow Grade D - Very slow 3. Water-Holding Capacity Grade A - High, drainage excellent. Grade B - Moderate to high, drainage good. Grade C - Moderate to low, drainage fair to poor. Grade D - Low, drainage poor. 4. Alkali Grade A - Of no consequence, white, less than 0.2% no carbonate. Grade B - Low, not affecting vegetation. Grade C - May be high enough to limit crops to more tolerant plants. Grade D - High, very poor or no crops possible.
55-13	B	
55-16	C	
57-1	C	
57-7	A	
57-13	B	
68-1	C	
75-7	A	

*The modifying erosional factors are set up for a soil of moderate or mature development; for a less developed soil a like erosional class is proportionately less detrimental to the irrigation potentialities, but it must be remembered the zone of highest organic-matter content is lost in both instances.

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TABLE X. NUMERIC DESIGNATION OF SOIL TYPES

Soil Series		Textural Class	
Name	No.	Name	No.
Concho	55	Sand	1
Dinnehotso	57	Sandy loam	7
Tolani	68	Loam	10
Bonito	75	Clay loam	13
		Clay	16

The combination of a series number and a textural class number constitutes a soil type number. as 55.1 for Concho sand.

Agricultural soils of Land Management Unit No. 2 have been graded from reconnaissance field data into four groups on the basis of irrigation adaptability. Basic factors in such a grouping are the conditions of the soil, slope, erosion, alkali,* and drainage.

Group A soils have a comparatively low water requirement and a wide range of crop adaptation. Conditions are excellent for plant growth.

Group B soils are those in which the physical conditions are less favorable than those in Group A soils. Crop adaptation is somewhat limited, water requirements higher and the ultimate productivity under the same cultural conditions is lower. Group B agricultural soils are classed as good for irrigation purposes.

Group C soils have less desirable features such as extremes in

*See section on Alkali.

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texture, an alkali content that may limit crop adaptation, steeper slopes, or others that lower the productivity to such a degree that they are classed as fair to poor irrigable soils.

Group D soils may have excessive slopes, shallow profiles, excessive porosity, unreclaimable alkali conditions and other factors that class them as nonirrigable.

The following soil types are briefly discussed with reference to their adaptability to irrigation and are tentatively graded as A, excellent; B, good; C, fair to poor; D, nonirrigable.

CONCHO SOILS

These soils are derived from deep alluvium of the Mancos shale formations. A slightly compact, calcareous surface soil and a compact fine-textured slowly permeable subsoil with visible lime accumulation, are common.

The predominating finer-textured soils occur on the level floor of Klethla Valley and the coarser-textured types are located at higher levels on the slopes.

The soils are at present almost barren because of improper use. Sheet and gully erosion are active on a large portion of the area.

Concho sandy loam

The surface soil readily absorbs water but the subsoil is slowly permeable. The water-holding capacity of the sandy loam is variable, but the average for the type is moderate. This soil is well adapted to irrigation, but subjugation is limited by an insufficient water supply. It is rated a B agricultural soil.

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Concho clay loam

Subsoil characteristics are deciding factors in the grading of this type. A friable subsoil places this soil in the B grade, while a dense fine-textured subsoil places it in the C grade. A dense impervious subsoil is conducive to alkali concentration and consequent high dispersion ratio. The major portion of this soil has a friable subsoil and a low alkali content and is graded B.

Concho clay

A fine-textured, slowly permeable surface soil and subsoil characterize this type. The speed of water penetration is low and the water-holding capacity is high. Extended droughts would materially affect crops. With an adequate supply of irrigation water this soil should be productive. A low alkali content, slow rate of water penetration and moderate water-holding capacity place this type in the C grade.

DINNEHOTSO SOILS

The profile is characterized by alternating layers of sandy loam and fine-textured materials, and exhibits very little development. The surface soil is friable to moderately compact, slightly calcareous, and light reddish brown in color. Fine-textured materials may locally restrict subdrainage and cause concentration of alkali salts. These soils may show a high dispersion ratio but in general alkali and dispersion are not limiting factors.

The coarse-textured types are susceptible to wind erosion.

Dinnehotso sandy loam

The surface is loose and friable; the subsoil more compact and

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slightly heavier. The surface soil is readily permeable and the water-holding capacity is relatively high. Dinnehotso sandy loam is well adapted to irrigation, but lack of water limits its utilization. The alkali content is generally low with a correspondingly low dispersion ratio. This soil is consequently rated an A agricultural soil.

Dinnehotso clay loam

The surface is moderately permeable and the soil has a high water-holding capacity. Local areas of high clay content may cause alkali concentration and necessarily put this type in the next lower grade, but it is rated as B agricultural soil. This soil is well adapted to irrigation. It will absorb water more slowly than Group A soils and water-logging and resultant alkali concentration should be avoided.

Precautions

Low annual rainfall and a high rate of evaporation increase the susceptibility of the coarser-textured soils to wind erosion. An adequate plan for wind-erosion control, including windbreaks, cover crops, etc., should be prepared and initiated prior to subjugation of these soils.

Floods, common to this Unit, necessitate special care in controlling existing gullies. These soils are susceptible to water erosion because of a friable subsoil.

Tolani Loamy sand

Tolani loamy sand is characterized by a light reddish brown, calcareous, friable surface soil. The subsoil is similar in color but highly stratified, with the lime uniformly distributed. The subsoil is predominantly light-textured. It is a well drained soil, commonly free of

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alkali; however, local areas on Shonto Wash are impregnated with alkali and highly dispersed. It is susceptible to severe wind erosion and has a low water-holding capacity, consequently it is rated a C agricultural soil.

Alkali-impregnated and dispersed areas of Tolani loamy sand in Shonto Wash near Shonto should be avoided both in subjugation and construction.

Bonito sandy loam

A small area of Bonito sandy loam is located in the extreme southwest corner of the Unit on the lower slopes of Black Mesa. This type at present supports a good growth of blue grama and galleta.

The surface soil is readily permeable and the water-holding capacity is estimated to be high. This type is well adapted to irrigation. Where a permanent supply of irrigation water is not available, water spreading or flood irrigation may be practiced.

Bonito sandy loam is susceptible to gully-head erosion.

SUMMARY OF FACTORS SIGNIFICANT TO AGRICULTURAL SOILS

The quantity of water for irrigation is one of the chief factors limiting further agricultural development in Unit No. 2. Agricultural soils are generally of the better grade; however, the susceptibility of some types to wind erosion lowers their value and necessitates protective measures.

A program of education in the efficient and conservative use of irrigation water and the use of improved crop and cultural methods should be initiated.

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ALKALI

Alkali, with the exception of limited areas, is not sufficiently concentrated to be harmful; however, local areas in the Tolani sands, particularly in Shonto Wash near Shonto, are impregnated and the soil is dispersed. Such a condition renders the areas unsuitable for construction and agricultural purposes. If any construction is proposed in Klethla Valley the Concho soils should be more carefully investigated. Analysis of general samples in this area shows only a trace of alkali and a dispersion ratio of less than 15%; however, these samples were taken at random and merely indicate a general condition.

VALUE OF SOILS FOR CONSTRUCTION PURPOSES

Thorough soil investigations in Shonto Wash and Klethla Valley are recommended prior to construction.

The greater portion of all soils in Unit No. 2 may be considered normal in their adaptability to structural uses.

The scope of this survey was such that only a general statement as to structural adaptability may be given. It is recommended that all structural sites be carefully investigated to insure as far as possible the safety of the structures.

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SUMMARY

Area

Land Management Unit No. 2 is located in the northwest portion of the Navajo Reservation.

Extent

It comprises 1,094,976 acres, of which 372,292 acres are classed as inaccessible and barren; 721,587 acres as rangeland; 1,097 acres as agricultural land.

Population

Living within the Unit are 915 Indians, comprising 116 consumption groups.

Climatological Data

The estimated annual precipitation for the Unit is 8.5 inches; for Black Mountain, 10 to 12 inches. The length of the growing season varies from 169 to 231 days. The elevation ranges from 3200 feet at the junction of the San Juan and Colorado Rivers to 10,250 feet atop Navajo Mountain.

Erosion

Wind erosion is predominant on the Unit. The extreme north portion presents a vast area of normal heavy geologic erosion. Sheet and gully erosion are common in the south, particularly on rough rugged Black Mesa and in Klethla Valley.

Soils

The soils are primarily derived from sandstone and are coarse-textured. Soils on Black Mesa and in Klethla Valley are largely fine-textured.

Land Use

The greater portion of the area is classed as rangeland. Agriculture occupies a very small portion of the total area.

Crops

Corn is the principal crop and represents 64% of the acreage farmed. Other crops are squash, melons, alfalfa, beans, a few vegetables and oats.

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TABLE XI. Analysis of Soil Samples Collected in Land Management Unit No. 2. 1937

Lab. No.	Field No.	Soil Type Represented	Depth	Total Salts %	Na_2CO_3 p.p.m.	Sand %	Silt %	Clay %	Dispersion %
4966	S-10	Concho clay	0-6	.125	0	20.9	25.5	53.6	6.0
4967	S-11		6-12	.11	0	50.5	12.9	36.6	6.4
4968	S-12		18-40	.08	T*	58.9	13.7	27.4	6.1
4969	S-13	Floy sandy clay loam	0-6	.075	0	53.0	23.4	23.6	3.4
4970	S-14		6-12	.075	0	56.3	22.8	20.9	5.5
4971	S-15		12-30	.105	0	62.2	17.5	20.3	4.7
4972	S-16	Concho sandy clay loam	0-6	.095	0	57.0	17.0	26.0	2.9
4973	S-17		6-18	.105	M*	37.2	21.4	41.4	2.2
4974	S-18		18-30	.085	M	54.2	16.3	29.5	6.2
4975	S-19		0-6	.105	T	29.3	29.8	40.9	8.5
4976	S-20		6-24	.215	0	23.2	27.4	49.4	7.0
4977	S-21		24-40	.135	0	20.9	35.6	43.5	6.0
4978	S-22	Concho Clay	0-8	.14	0	10.4	33.6	56.0	13.7
4979	S-23		8-16	.02-	0	16.4	25.0	58.6	9.0
4980	S-24	Concho sand	0-8	.02-	T	80.6	4.6	14.8	13.4

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TABLE XI (cont'd)

Lab. No.	Field No.	Soil Type Represented	Depth	Total Salts %	Na_2CO_3	Sand %	Silt %	Clay %	Dispersion %
4981	S-25		8-24	.02-	T	85.9	2.9	11.2	9.3
4982	S-26		24-40	.02-	T	87.6	2.7	9.7	20.0
4983	S-27	Tolani sand	0-12	.14	64	94.4	2.0	3.6	45.0
4984	S-28		12-24	.05		93.9	2.1	4.0	10.9
4985	S-29		24-36	.035	T	90.7	4.2	5.1	2.3
4986	S-30	Floy sandy loam	0-12	.07	0	77.4	7.7	14.9	2.9
4987	S-31	Floy clay loam	0-12	.07	0	49.0	27.9	23.1	4.5
4988	S-32	Floy sandy loam	0-12	.07	0	73.8	10.3	15.9	9.3
4989	S-33		12-24	.095	0	55.6	22.3	22.1	2.1
4990	S-34		24-36	.055	0	88.7	2.1	9.2	5.6
4991	S-35		36-40	.125	0	55.7	14.9	29.4	3.2
4992	S-36		40+	.18	0	82.0	6.4	11.6	2.7

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TABLE XI (concluded)

Lab. No.	Field No.	Soil Type Represented	Depth	Total Salts %	Na_2CO_3 p.p.m.	Sand %	Silt %	Clay %	Dispersion %	Gravel %
5025	S-37	Floy sand	0-10	.02-	0	81.7	5.8	12.5	6.7	
5026	S-38		10-25	.02-	0	79.8	10.0	10.2	5.0	
5027	S-39		25-38	.02-		82.9	8.0	9.1	8.3	
5028	S-40	Kayenta sand	0-6	.02-	0	92.0	1.6	6.4	6.3	
5029	S-41		6-12	.02-	0	89.4	2.0	8.6	18.9	
5030	S-42		12-24	.02-	0	86.3	2.7	11.0	9.8	
5031	S-43	Rainbow sandy loam	0-4	.02-	T	77.3	10.2	12.5	5.5	24.5
5032	S-44		4-12	.02-	T	72.0	12.6	15.4	2.3	31.5
5033	S-45		12 +	.02-	T	68.4	13.9	17.7	3.8	68.8
5034	S-46	Dinnehotso sand	0-12	.02-		80.6	5.6	13.8	9.5	
5035	S-47		12-24	.02-		82.	5.4	12.6	7.6	
5036	S-48		24-36	.08	0	82.4	4.9	12.7	0.6	

*T = Trace by phenolthalein test.
M = Moderately strong reaction by same test. pH probably 8.5 .

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TABLE XVI

GENERAL CHARACTERISTICS OF SOIL TYPES IN L. M. U. NO. 2 by grazing land soil Groups.

SOIL TYPE	FIELD NO.	EROSION				% SLOPE	PERMEABILITY		WATER-HOLDING CAPACITY		RUN-OFF & Silt Contribc
		Water		Wind			Surf	Subsoil	Surf	Subsoil	
		Sheet	Gully	Removals	Accum.						
-A-Group											
Bonito sandy loam	75-7	1	7	P	F	0-3	High	M.High	Mod.	Mod.High	I.A.
Concho sandy loam	55-7	2	7	P	F3	0-3	High	Slow	Mod.	High	III A
Dinnehotso sandy loam	57-7	2	7 ✓				High	Mod.	Mod.	Mod.High	III A
Dinnehotso clay loam	57-13	2	7 ✓	P	F	0-3	Mod.	Mod.	Mod.	High	III A

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TABLE XII continued

SOIL TYPE	FIELD NO.	EROSION Water Sheet	EROSION Water Gully	EROSION Wind Removals	EROSION Wind Accum.	% SLOPE	PERMEABILITY Surf	PERMEABILITY Subsoil	WATER-HOLDING CAPACITY Surf	WATER-HOLDING CAPACITY Subsoil	RUN-OFF & Silt Contrib.
Todilto loamy sand	21-1	2-3	7-7	P-S	F-K^1-L^3	0-10	Mod.	Mod.	Low	Mod.	III A-B
Floy loamy sand	26-1	0-2	0-7	P	K^3	0-10	High	"	Fair	"	I A
Floy sandy loam	26-7	2	7-7	0-P	0-K^2	0-10	Mod.	Mod.	"	"	II-III-B
Floy loamy sand	26-1	0-3	0-7-7-7	0-S	0-F-K^3-L^3	0-10	High	"	"	"	I-IIIA-IIIB
Buell loamy sand	38-1	2		P	K^2	3-10	"	"	"	"	IIIA
Concho sandy loam	55-7	2	0-7	P-R	F^2-K^3	0-3	"	Slow	"	M.High	II-III A
Dinnehotso sandy loam	57-7	2	7	P	F	0-3	"	Mod.	Mod.	Mod.	III A
Rainbow sand	77-1						"	Slow	Mod.	Fair	II B
Kayenta loamy sand	80-1	2	7	P	F^3-K^2	0-10					

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TABLE XII (Continued) C GROUP

SOIL TYPE	FIELD NO.	EROSION Water Sheet	EROSION Water Gully	EROSION Wind Removals	EROSION Wind Accum.	% SLOPE	PERMEABILITY Surf.	PERMEABILITY Subsoil	WATER-HOLDING CAPACITY Surf.	WATER-HOLDING CAPACITY Subsoil	RUN-OFF & Silt Contrib.
Todilto loamy sand	21-1	0-3	0-7	P-S	K-L	3-10	High	Mod-High	Low	Fair	I-IIA-IIB
Floy Loamy sand	26-1	0-3	0-7-(7)	P-S	0-L	3-20	"	"			II-IIIA-B
Floy sandy loam	26-7	2-3	7-(7)	0-P	0-K	3-20	Mod.	Fair	Fair	Fair	IIIA-B
Concho clay ~~sandy~~ loam	55-13	2-3	7-(7)	0-P	0-K	0-10	"	Slow	Slow	Mod.	IIIA-B
Concho clay	55-16	2-3	(7)	P	F	0-3	Slow	"	Fair	High	IIIA-B
Dinnehotso loamy sand	57-1	2-3	(7)	P-R	F-L	0-3	High	Mod-High	Low	Fair	IIIA-B
Dinnehotso clay loam	57-13	2	(7)	P	F^3	0-3	Slow	Fair	Slow	Mod. High	III-A
Dinnehotso sandy loam	57-7	3	7	--	--	0-3	Mod. High	Mod.	Mod.	Mod.	III-B
Rainbow sand	77-1	3	(7)	P	F^3	10-20	Mod.	Slow	Fair	Mod. High	III-B
Tolani loamy sand	68-1	-	-	--	--	0-3	High	Mod. High	Low	Fair	I-A
Kayenta loamy sand	80-1	0-2	0-7-(7)	P-S	K-N	3-20	"	"	"	"	I-IIA-IIIB

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D GROUP

TABLE XII (Concluded)

SOIL TYPE	FIELD NO.	EROSION Water Sheet	EROSION Water Gully	EROSION Wind Removals	EROSION Wind Accum.	% SLOPE	PERMEABILITY Surf.	PERMEABILITY Subsoil	WATER-HOLDING CAPACITY Surf.	WATER-HOLDING CAPACITY Subsoil	RUN-OFF & SILT Contrib.
Todilto loamy sand	21-1	4-5	0-7	R-T		10-20	High	Mod. High	Low	Mod. Low	IVA-B
Floy loamy sand	26-1	0-4	0-8	0-S	0-L2	10-40	"	"	"	"	III-B
St. John's clay	29-16	4	7	---	---	10-20	Slow	Slow	Low	Low	IV-B
Dinnehotso loamy sand	57-1	---	---	---	---	0-3	High	Mod. High	"	Mod. Low	I-A
Kayenta loamy sand	80-1	0-2	0-7	P-S	K-L	3-20	"	"	"	"	I-IIA IIIB
Rough Broken Land Undifferentiated	DB	4-5	8-6	---	---	10-20	Low	Low	Low	Low	IV-B
Rough Stony Land Undifferentiated	19S	4	7	---	---	10-20	"	"	"	"	IV-B
				E GROUP							
Rough Broken Land	19B	GEOLOGIC		over 0.40% impervious					Low	Low	IVB
Rough Stony Land	19S			impervious					Low	Low	IVA

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