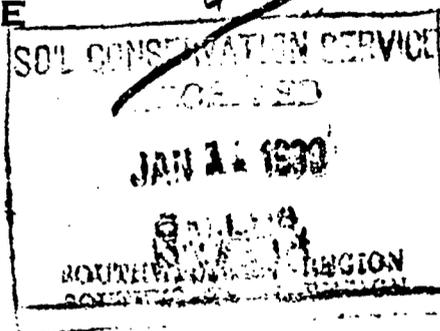


UNITED STATES
DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE
NAVAJO SERVICE
Window Rock, Arizona
January 9, 1939



MEMORANDUM FOR ROBT. V. BOYLE, District Manager, Navajo
District

FROM: John H. Provinse

SUBJECT: Sub-watershed Plan for the Hopi Land
Management District

We appreciate very much the helpful comments concerning the
above Plan. We have made the suggested changes as follows:

1. The extent of overstocking is shown on pages 9 and 10, and we have added a statement indicating the degree of over-utilization. Range use adjustment will be made on the basis of Working Agreements with cooperating Indian groups, insofar as possible according to the schedule shown under VI-b-1 - "Proposed Land Management and Erosion Control Measures - Range Management".
2. Field tests actually conducted will be studies of treatments authorized by Working Agreements. We have added a fuller description of critical areas on page 8, but the more detailed definition of critical erosion areas will necessarily be based on detailed surveys made preliminary to drawing up Working Agreements.
3. It was assumed that stream bottom fencing would be authorized under fencing of severely eroded areas but we have added a statement specifically mentioning this treatment.
4. We have made the corrections suggested.

We are submitting original and five copies of corrected manuscript, three of which have been bound in the attached copies

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1-9-39

of the report and three for the other three copies originally submitted. Also we have revised the Table of Contents.

John H. Provinse
John H. Provinse
Reservation Division Assistant
Navajo District

Attachments

WR 8469

SUB-WATERSHED PLAN
NAVAJO DISTRICT, REGION EIGHT
THE HOPI LAND MANAGEMENT DISTRICT

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submitted for prior approval to the General Superintendent,
Navajo Reservation.

A large portion of the information presented herein was collected in the field by a Soil Conservation Service land management survey party. On the basis of present use of range and farm land, topography, and administrative expediency, the field report on which this plan is based subdivided the District into three sub-units, numbered 1 to 3 on the maps. Some further breakdown of these sub-units into village or group units with which cooperative work can be carried on will be necessary, but as a guide for planning the three sub-units are retained.

II. Description of the Unit

a. Topography, Climate, Soils, Vegetation

Topographically, the Hopi District is a series of broad, alluvial valleys confined in the upper portions between high, elongated finger-like extensions of Black Mesa, and widening out between rolling hills in the lower two-thirds of the area. Elevations range from 5,400 feet to 6,400 feet above sea level: Keams Canyon is 6,184 feet; Polacca, 5,800 feet; Oraibi 5,700 feet; and Hotevilla, 6,363 feet. The general slope is to the southwest.

Climate is largely a function of elevation and topography. Records are available at Keams Canyon, Jeddito, and other points from which, on the basis of average elevation, data can be extrapolated for the entire unit approximately as follows:

The latter is a constant menace to valuable irrigation structures and farm land, but a very large and important amount is carried into the Little Colorado and thence into Boulder Dam.

The Jeddite and Polacca Washes contribute to the increasing flood menace at Loupp Indian Agency and Boarding School, and wild flood water often destroys farms, stock water reservoirs, roads, and bridges.

Critical erosion areas include Five Houses and a portion of First Mesa (marked 1 and 2 on the attached Critical Area Map) where severe wind erosion caused by concentration of stock around long established waters is threatening to encroach upon surrounding lands; two areas draining into Dinnebito Wash (3 and 4), and a strip along the Polacca in the vicinity of Coyote Springs (5) where deep, active gully heads with accompanying severe sheet erosion are progressing up productive valleys; an area just northeast of Blue Lakes (6); some side drainages of the Oraibi just southwest of the point of Second Mesa (7), and a drainage tributary to the Polacca south of Wind Terrace Butte (8) where shallow gullies and sheet erosion are active in the valleys; a strip of country along the Oraibi Wash just south of Oraibi (9), and a valley tributary to the Oraibi along the northern boundary (10) where deep head cuts are advancing laterally from Oraibi Wash and wind erosion is active; a large area on Second Mesa (11) and an area near the Hopi Sun Altar (12) where shallow, intermittent gullies are just starting to injure exceptionally

high-grade, productive grasslands.

c. Land Use

The grazing of livestock is the principal use of the lands lying beyond the farming areas around the villages. Approximately ninety-six per cent (469,500 acres) of the Kogi District is range land, of which about five per cent is woodland from which a limited amount of wood products can be obtained. Farming is important and intensive. Only one per cent (1,521 acres) of the area is cultivated at present; this probably could be increased by half. Waste land occupies 20,000 acres, making up nearly four per cent of the entire District. The limited farming land necessitates intensive land use practices.

The carrying capacity of the range in the District is 17,360 sheep units yearling. The dipping vat records, reliable only with regard to sheep and goats, show the present stocking of all classes of stock at around 21,500 sheep units. The number of horses, cattle, and burros in the District is, however, inadequately recorded on the dipping records and no count round-up in the area has been made. From the house to house schedules of the human dependency survey the horse, cattle, and burro population for the District is probably in excess of 2,000 head, or 10,000 sheep units. Adding to this the 16,000 sheep and goats, a present stocking of 26,000 sheep units is shown, an overstocking

of approximately 9,000 sheep units. This indicates that the area is some fifty per cent over-utilized, an indication which is borne out by observations of range conditions.

Depletion of range is most severe in sub-unit 3 where an average of thirty-five acres is required to produce enough feed for one sheep unit yearlong. The range in sub-units 1 and 2 is in slightly better condition; even here, however, twenty-five to twenty-eight acres are required to support a sheep unit yearlong.

As a result of continued over-use there are no live woodland materials and very little dead woodland materials available at present; of necessity, brush plants have been or are being used for fuel at the expense of range forage and watershed protection.

Farming is practiced at present on two-thirds of the suitable land. The development by the Hopis of small farm and garden plots on rock-walled terraces and silt fills above check dams has required a large amount of effort per unit of return.

d. Land Status, Population, and Home Dependency

All land within this district is Indian land, being a part of the Executive Order Reservation established in 1862 for the use of Hopi and other Indians. Administration, except for certain overall Indian Service functions of Roads and Irrigation, is carried on from the Kaibab Agency by a superintendent separate and independent from the Navajo administration at Navajo Central Agency.

Though technically all the land within the district is in the same status, being held in trust by the Government for the use of the Indians, in reality the land picture is a fairly complex one from the standpoint of achieving cooperative conservation in land use. Hopi social and economic life is organized on a clan basis and though ownership of land in fee is a foreign concept, clan and family use rights are of a definite nature. Only with a knowledge of these clan claims can any program anticipating Hopi cooperation be accomplished.

The concept of clan ownership or right of use does not, however, extend to all lands in the district. For the most part traditional clan rights and claims exist for the lands in fairly close proximity to the small mesa villages; as the farming and livestock activities have expanded individuals have established themselves on lands not controlled by any clan and a recognition of right due to prior use is accorded these individuals. In these peripheral areas cooperation can be sought and secured on an individual basis; on the lands more centrally located, clan and village rights and relationships need to be considered.

The border areas also bring up the important and practical problem of Navajo-Hopi relationships. Until the claims and counter-claims of these two opposite groups can be carefully reviewed and settled the establishment of district boundaries is

impracticable. When the claims have been sifted and a demarcation of use made, the use boundaries will serve as a satisfactory delimitation of the Hopi land management district.

The total population of the District is 2,760, of whom 160 are Navajos. The Hopi population of 2,620 (1,173 consumption groups*) is concentrated largely in eleven villages on three southward extensions of Black Mesa, known in order from east to west as First Mesa, Second Mesa, and Third Mesa. Second Mesa, with 1,070 people, has the largest population but the fairly recently established village of Hotevilla on Third Mesa, with a population of 500, is the largest single village. Old Oraibi, on Third Mesa, has been in existence at its present site for six or seven hundred years. Though a long continuous period of occupancy can be established for the Hopis in this area, it is unlikely that at any time their use of the area was any more extensive than at present.

The relative importance of various income activities of the district is shown in the summary table of income for the year 1936:

* A consumption group is an economic unit based on funding and sharing of income, generally, but not necessarily, coincident with the biological family.

TABLE III **TOTAL AND PER CAPITA INCOME**
BY SOURCE FOR 1936

Source	Commercial		Non-commercial*		Total		Per- cent
	Amount	Pr.Cap.	Amount	Pr.Cap.	Amount	PerCap.	
Wages	\$165,120	\$59.53	\$	\$	\$165,120	\$59.53	36
Livestock	38,710	13.93	11,830	4.26	50,540	18.19	11
Agriculture	5,110	1.95	216,350	77.85	221,460	79.80	49
Hags	6,180	2.22			6,180	2.22	1
Miscellaneous	11,800	4.27			11,880	4.27	3
Totals	\$227,600	\$81.90	\$228,180	\$82.11	\$455,780	\$164.01	100

*Calculated on the basis of local selling price of commodities consumed.

Agriculture, the bulk of which is of the subsistence type, is the most important and most stable source of income. During 1936, when government work was fairly widespread, about a third of the income was derived from wages, the average family receiving something over \$300 from this source during the year. Livestock is relatively unimportant in total income, accounting only for slightly more than ten per cent of the total. Hags and miscellaneous, the latter including baskets and pottery, total only four per cent.

Of the commercial income, wages were the most important item in 1936. The bulk of these came from the Indian Service Agencies of Roads and ECR, only about one fifth, or \$35,000 being derived from relatively permanent employment with traders or the Government. Of the cash income from livestock products, two-thirds was obtained from the sale of wool and skin, the balance deriving from the sale of meat and the live animals.

Very few agricultural products were sold, though it is likely that some considerable exchange of Hopi agricultural products for Navajo rugs, jewelry and livestock took place. No satisfactory record of this exchange is yet procurable.

Rugs furnished only three per cent of the total cash income, being closely followed by the sale of piñon nuts which brought in over \$5,000. Of the other miscellaneous items which account for three per cent of the commercial income, wood, pottery, jewelry, and baskets are the most important in the order listed. It is apparent at once that the Hopi crafts bear but a small burden in the whole economic picture, almost the entire dependence going back to the land resource.

Analysis of the total consumption in the District shows that slightly more than two-thirds of the total goods consumed were produced at home, indicating the high degree of self-sufficiency which obtains in the area. Of these home-grown goods consumed, ninety-five per cent were agricultural products, chiefly corn, squash, beans and fruits (peaches, apples, melons, apricots). The per capita annual consumption of corn in the District in 1936 was something over 1,000 pounds; of peaches, over 200 pounds.

Available records show only a small consumption of home-owned livestock but it is probable that this meat consumption is supplemented by exchange of Hopi agricultural products, such as

corn and peaches, for Navajo mutton and beef. Even with allowance for this trade the dependence of the Hopis upon their agricultural land resources is striking.

Of the goods purchased for consumption, about one-third of those consumed, nine-tenths are imported into the District and sold by the traders. Of these imported products, foodstuffs represent sixty-five per cent and of these foodstuffs probably a third can be produced in the area if suitable land is made available. An additional thousand acres of cultivated land would supply the producible foodstuffs now imported.

The agricultural nature of Hopi economy, largely on a non-commercial level, is apparent to all who have visited the area and is given objectivity in the above figures. Excluding wage work the per capita income is \$104.00, of which \$80.00 is from agriculture. Wage work boosted this per capita income during 1936 to \$165.00, but cessation of certain Government work since that time has reduced this wage income considerably. If a conservation and proper land use program is to be successful in the District, careful consideration must be given the problem of maintaining or raising the level of subsistence. Human dependency survey material, not yet fully analyzed, is available for further study and it is urged that contemplated adjustments in land use be carried out only after further analysis of the social and economic factors involved.

e. Land Management Activities

An SCS Hopi liaison officer is to be supplied by the Soil Conservation Service to work in close association with the Hopi General Superintendent. All planning and work operations conducted by the Soil Conservation Service or any of the Indian Service Divisions will be thoroughly discussed and cleared with the Soil Conservation Service and with the Hopi Administration. Administration and extension land use activities will be handled by the Hopi Superintendent with the aid of Indian Service personnel. The Indian Service is recognized as the agency having administrative responsibility for the Hopi lands, and the Soil Conservation Service is recognized as the agency conducting erosion control operations and authorized land management development work in the area, and for such work will prepare necessary plans. Indian Irrigation will assume the responsibility for the subjugation and development of irrigated farm land. The Soil Conservation Service program is designed to establish proper use of both range and agricultural lands and will provide supplemental structural improvements necessary for such proper use.

III. Objectives

1. Curbing of accelerated erosion on range lands by improvement of the vegetative cover by means of (a) elimination of general over-stocking; (b) proper livestock distribution, particularly near the Hopi villages, along the main valleys, and adjacent to long-established water supplies; and (c) through proper

woodland utilization practices.

2. Protection of farm lands from wind and water erosion through (a) improved farming practices; (b) supplemental structural works; (c) retirement and revegetation of sub-marginal farm lands.

3. Reduction of flood hazards to Leupp Agency, along the Little Colorado, and, insofar as possible, by improvement of local watershed conditions and diversion of flows from the main drainages, reduction of the silt load carried by the Little Colorado to Lake Meads.

4. Reduction of excessive siltation of stock water reservoirs, spreading areas and farm lands in the Hopi area and in Land Management District 5.

5. More efficient use of available water by increasing ground water storage.

6. Improvement of human conditions through (a) securing higher returns from livestock and agriculture made possible by better range and farm management; (b) securing economic utilization of crop and livestock yields through improved harvesting, storing, and marketing; and (c) development of suitable new agricultural lands.

IV. Considerations Basis to a Program for the Entire District

a. Need and Practicability of Adjustments in Land Use and Tenure

Livestock adjustment, improvement of the agricultural

system, and general improvement of the welfare of the Indians will require some adjustment of land use which can be effected with very little physical transplantation of people. Contemplated necessary adjustments should recognize the operating unit organization of the Indians. Livestock outfits are mobile and probably can be handled from established residences; the automobile has made it possible for some operating units to farm land twenty-five to thirty miles from home. Since farming is by far the most important source of subsistence income, agricultural expansion probably will be one of the most practical means of effecting economically sound conservation and land use adjustment if used both as compensation for livestock reduction and for general human improvement.

The Hopi concept of land ownership and tenure is fairly complex, and imperfectly understood. Individual, family, clan, village, and mesa rights need further consideration and clarification before any plan of land use adjustment can be furnished which will be acceptable to the Hopis. The problem is complicated further by changing concepts of use and ownership brought about by contact with western culture. All plans covering land use adjustments should be worked out carefully in connection with the Hopi Tribal Council, the Hopi Superintendent, and the operating unit concerned. It should be emphasized that cooperative effort will be required to set up and operate a program of land

management, and every opportunity should be taken to work directly with existing organized groups on the basis of the group itself. The responsible Hopi leaders should be identified and recognized and all phases of the program should be explained fully to them. Understanding and approval by these leaders, as well as the Hopi administrators, should be secured. It is believed that this is essential and basic to any successful soil and water conservation program.

b. Need for Further Cooperative Agreements

The care and maintenance of all land improvements, such as stockwaters, agricultural developments, and erosion control structures, and the continuance and enlarging of the conservation program through the schools and extension work will be the responsibility of the Indian Service.

The interdepartmental Memorandum of Understanding and its Clarifying Statement provide for a cooperative conservation program for the Navajo and Hopi Reservations, and the Detailed Annual Statement for 1939 defines responsibilities until June 30, 1939. This sub-watershed plan, when signed and approved, will authorize and outline generally the work in the Hopi Land Management District; Working Agreements will be prepared to cover detailed operations.

c. Detailed Surveys and Studies, Field Tests Needed

1. A study should be made of the economic and social

organization of the Hopis to obtain adequate information relative to the logical Hopi cooperating unit.

2. A study of Hopi ability and willingness to cooperate in conservation work is needed, such study to include the collection of information concerning items the Hopis are best able to contribute, and native conservation methods now practiced by them.

3. Detailed surveys must be made for field operations as approved.

4. Adequate soils investigations should be made prior to all construction planning and on all agricultural projects.

5. Field tests should be set up to evaluate applications and practices on which further information is needed. The selection of these applications and practices will be made on the basis of cooperative working agreements.

6. Further studies should be made on flood irrigated and dry farm lands to determine suitable methods of controlling wind and water erosion.

7. The investigation regarding the boundary line, and the determination of the necessity for fencing the District should be prosecuted as rapidly as possible.

8. Critical erosion areas should be defined more sharply. This will be done in connection with detailed surveys conducted preliminary to drawing up cooperative working agreements. Treatments outlined by these agreements will be based largely on the definition of locally critical areas.

9. An investigation should be made of the feasibility of using coal for fuel to relieve pressure on woodland and shrub plants.

10. As occasions arise special studies and investigations for land use purposes should be made.

d. Ability of Inhabitants to Cooperate

The economic status of the inhabitants probably limits contribution principally to labor and teams. This will ordinarily be on a village, clan, or other operations unit basis and will vary with type of work. Up to fifty per cent may be expected on farms; no more than twenty-five per cent may be obtained on range lands.

The greatest amount of cooperation will probably be secured if the Hopi people, through their Council, are brought into the program at its inception. This should be done by presentation to the Council, through the Hopi Superintendent, of the proposed plans. The Council members (or other recognized leaders) should be taken into the field by competent Soil Conservation Service personnel and all proposed work carefully explained to insure understanding.

V. Erosion Control Measure Now in Effect Under Soil Conservation Service or Other Agencies

As brought out in the annual statement of contributions for 1939, the Soil Conservation Service is assuming responsibility for all types of developmental and conservation operations in the Hopi District and District 4, with the exception of the construction of deep wells and certain irrigation projects. The

Indian Service is contributing similar work as planned by the Soil Conservation Service in the other sixteen land management districts of the Navajo-Hopi Reservations. This arrangement will necessitate the participation of the Soil Conservation Service in a wide range of activities.

a. The present attempt is the first to develop a complete work area plan for the Hopi District. Miscellaneous jobs have been done in the past on the basis of immediate needs with as much consideration as possible being given to probable requirements of a future program.

b. Work Completed (See Map of Work Completed, Pa. 3)

1. Range Waters completed by Indian Service, ECW, and the Irrigation Divisions:

Government surface tanks	15
" shallow dug wells	8
" drilled wells	23
" artesian wells	2
" developed springs	<u>30</u>
Total waters completed	78

2. Desilting Flots Fenced by Soil Conservation Service:

6-1-8.....	100	acres
6-1-20.....	30	"
6-1-37.....	40	"
6-1-55.....	<u>40</u>	"
Total	210	"

3. Dipping Vat with Corrals Constructed by Indian Service at Kopo Springs.

4. Spring Developed by Soil Conservation Service

at Keams Canyon.

5. Erosion Control Work Completed by Soil Conservation Service:

85,900	sq. ft.	bank protection on	Keams Canyon Wash
48,100	"	"	Wepo Wash
290,100	"	"	Polacca Wash
290,100	"	"	Orabi Wash

Two gully control structures, 52 lineal feet, affecting 200 acres at Keams Canyon.

Repair of 5 gully control structures, affecting 500 acres at Keams Canyon.

Range fencing at Keams Canyon.

177,000 (approximate) trees and shrubs planted in Keams Canyon, Wepo, Polacca, and Orabi Washes.

160 acres of range reseeding near Taylor Springs.

6. Prairie dog control completed by BCR in cooperation with the United States Biological Service:

1,225	acres	on Orabi Wash north of Orabi in 1934
3,165	"	" Polacca Wash in 1934
23,170	"	located west from Keams Canyon to Second Mesa and south from Wepo Springs to the divide between Polacca and Talahogan Washes in 1935
3,715	"	retreated south of Badger Butte in 1936
6,650	"	treated along Talahogan Wash in 1936

7. Two combination soil-saving-water-spreading dams were constructed by Soil Conservation Service in 1938. One of the structures, built to stabilize the streambed and protect a highway bridge on the Orabi-Keams Canyon road, was damaged by flood in August 1938. The other structure, still in place, is located just below the junction of the Polacca and the Wepo. It

is the first lift of a multiple-life structure. Additional sections are planned to raise the bed of the stream so that certain sized floods will be partially diverted to both sides of the wash and spread on large flats.

c. Approximately two hundred acres of land at Keams canyon were fenced, planted, and treated with engineering structures by the Soil Conservation Service in 1935. The plantings have made excellent growth and with the structures have reduced erosion, particularly side cutting, in the main wash, and have protected orchards from partial destruction. This work has been of definite demonstrational value and necessary follow-up work should be carried on.

d. A Soil Conservation Service camp has been established at Keams Canyon with two foremen, sufficient personnel and equipment to carry on work scheduled for the coming fiscal year (1939). Additional Soil Conservation Service work will be contingent upon future appropriations and upon ability of the Indian Service to continue the program.

VI. Proposed Program

a. Proposals for Land-Use Adjustment

The execution of proposed land management and erosion control measures should be in cooperation with the Hopi Administration and the Hopi people. Consideration should be given to organization of the District on the order of a Conservation District.

recognizing the Superintendent, the Hopi Council, and other Hopi leaders, as being primarily responsible for the conservation of their lands. It is believed that such an organization would simplify the work of the Soil Conservation Service by making possible close compliance with standard policies and procedures. It should be recognized, also, that the program is concerned with a subsistence type of agriculture, and that adjustments in land use must provide a secure living for the local population as well as conservation of soil and moisture.

b. Proposed Land Management and Erosion Control Measures

1. Range Management

(1) Range control should be established through proper stocking as to numbers, kinds and classes, livestock distribution, seasonal use, and with necessary supplemental works and educational extension in animal husbandry. Water developments, wage work, farm developments, and the production of supplemental feed should be used as inducements to secure range control.

(2) Cull and excess livestock should be marketed through a marketing agent authorized to assist the Hopi cooperating units. Stock should be sold according to the following classes in the order listed:

Horses: defective and old first.

Cattle: steers, old cows, old bulls, and inferior animals first.

Goats: wethers and old animals first.

Sheep: wethers, old animals, and inferior animals first.

(3) Stream bottom fencing is recommended to prevent concentration of livestock along drainages.

(4) Stock waters should be constructed and maintained as necessary for proper range use.

(5) Grazing should be excluded from the sand dunes on First Mesa and at Five Houses.

(6) Grazing should be deferred during the summer growing season on range lands adjacent to the villages.

(7) Grazing should be excluded from critical wind erosion areas near farms.

(8) A dipping vat should be constructed in the south central part of the District at Well 6-4-35.

(9) Approximately 500 acres below the proposed Palanca Diversion should be fenced for hay production.

(10) A ram pasture should be constructed for controlled breeding purposes. The proposed pasture location should be cleared with the Hopi Council.

(11) Denuded range lands should be reseeded where feasible.

2. Farm Management

(1) Sub-marginal land should be retired from cultivation and cooperating families should be settled on new, properly-

developed land where conservative farming practices can be followed. Special consideration should be given to the development of the Jeddite and Uraibi (Hard Rocks) flood irrigation projects; studies are now being made to secure data relative to District boundaries, use, and feasibility of the projects. The assignment of new land probably should be begun at First Mesa. In all work of improving or developing agricultural land careful study should be made of the customary Hopi practices. It should be borne in mind that for many generations the Hopis have been able to maintain an agricultural life in an extremely poor environment, and that many of their practices doubtless have considerable merit. All lands broken out should be used so far as possible to relieve grazing pressure on range lands.

(2) In conjunction with funds and personnel of the Indian Irrigation Service, assistance should be given in the development of nearly 2,000 acres of agricultural land, including 10 acres at Taylor Spring, 600 acres on Polacca Wash, 300 acres on Hapo Wash, and various, suitable, small, scattered areas.

(3) Erosion should be controlled by structural improvement and better farming practices on 1,137 acres of present cultivated land.

(4) Proper erosion control, water conservation, and flood irrigation practices, including strip-cropping, fall

plowing and listing, preservation of crop residue and litter, pest control, improved seed, soil binding crops, should be introduced and supplemented with structural improvements, such as terraces, contour-spreaders percolators, contour borders, water-spreaders and diversions, gully control works, and windbreaks. Certain lands should be retired to permanent pasture.

3. Woodland Management

(1) Cutting of green trees (except those diseased) should be eliminated until sufficient reproduction and growth have taken place to insure permanency of woodland. Diseased trees will be marked for cutting by qualified technicians. Coal should be made available for use as fuel by Hvals.

(2) R_g production should be protected from livestock damage.

(3) Community enterprise should be organized whereby firewood, posts, and poles can be obtained in designated woodland areas in Navajo Districts 4 and 7.

(4) Woodland plantings should be made for windbreaks, control of gullies, and to produce wood products.

4. Wildlife Management

(1) Vegetation must be improved generally before a favorable wildlife habitat will be established. Introductions of quail might be successful at Kease Canyon and Blue Bird Springs. Erosion control plantings should include plants of value as food and cover for wildlife. Fenced desilting plots G-1-23,

and 6-8-28, should be planted for erosion control and wildlife.

(2) Kangaroo rats should be controlled where abundant on agricultural lands.

5. Roads

Land use administration will be facilitated by the completion of one mile of highway west of Kama Canyon, approximately five miles of road east of Mangopevi, and a road from Kotevilla to Dinrebite. A sandy road near Telacca should be plated, and a general road maintenance program should be carried on. Provisions should be made to include erosion control measures in all road construction, particularly in handling water at the discharge end of drainage structures.

6. Supplementary Erosion Control and Conservation Measures

(1) Approximately 5,600 acres of critically eroding sand dune areas, and at least 500 acres of hay land should be fenced and planted to grass and woody plants, and treated with suitable structures. The supplemental feed produced on the hay land will be necessary in order to establish range control. The effectiveness of this work in the stabilization of sand dunes should be studied by means of field tests.

(2) Combination water-spreading and headcut structures are recommended to protect farm and range lands and to conserve run-off water, control erosion, and increase vegetative

growth and forage production. Treatment of roads and trails with thank-u-sams to divert concentrated road water onto adjacent lands, and the use of bladed ditches placed on non-eroding grades carrying road-ditch water onto adjacent lands, also are planned.

(3) Dams to divert water to agricultural lands should be constructed with necessary adjustments in the distribution system to reduce erosion and increase production.

(4) Certain suitable areas of range land can possibly be treated to good advantage with contour and gradient furrows.

(5) Windbreaks are recommended to protect farms, hay lands, diversions, reservoirs, and other areas from erosion, and to improve agricultural production. Erosion control plantings should be made to stabilize gullies, to revegetate severely depleted range lands, and to increase the effectiveness of de-silting plots.

(6) Combination silt barriers and water-spreading structures should be built to conserve water, reduce silt contribution, and increase vegetative growth.

(7) Erosion control provisions will be planned on newly constructed highways and roads, and along old abandoned roads.

Table IV summarizes the costs, priorities, and contributions by the cooperating agencies to the proposed control measures and suggested work areas. Stock water maintenance and develop-

ment are given first priority. Actually the order in which work will be done will be outlined by cooperative working agreements covering operating units. Naturally, it is to be expected that future detailed surveys and planning in terms of cooperating Hopa units will modify this list of projects.

c. Future Participation

1. By individuals

Individual participation by Hopis will be restricted largely to labor contribution or to the adoption of improved practices in livestock and agricultural activities. Voluntary stock reduction by operating units is highly desirable. The amount of cooperation which can be expected from the individual Indians is as yet indeterminate, ranging probably from 25 to 30 per cent of the labor involved.

2. By Federal Agencies

The Indian Service participation, following the provisions of the Memorandum of Understanding previously referred to, will be largely in terms of administration, maintenance, education, and extension work. Some new developments of agricultural land will be undertaken with irrigation and subjugation included, and designated stock waters will be constructed and maintained. Proper stocking and range management will be obtained at the earliest possible date. All activities by the Indian Service of land management nature will be integrated with the general program as approved by the cooperating agencies, and

an effort will be made to direct these activities so that the establishment of proper land use will be brought about as soon as possible.

3. The Soil Conservation Service will participate under the terms of the Memorandum of Understanding in making further detailed studies as listed and in furnishing additional plans. Further studies of a technical nature dealing with special problems as they arise will also be undertaken. The Soil Conservation Service will aid in securing stock reduction; conduct range management demonstrations; carry on approved conservation operations on farm lands and watershed areas; develop stock water; and furnish technical advice and assistance. In accordance with the Annual Statement of Contributions of the Co-operating Agencies for the fiscal year 1959, the Soil Conservation Service will assume for that period responsibility for a very large proportion of operations of a land management nature.

Participation in the program will involve, except as noted elsewhere, Soil Conservation Service contribution, if need be, of all materials and equipment, and part or all of the supervisory, skilled, and unskilled labor required for the execution of certain approved operations. It is pointed out that such contribution is to be matched against whatever amount of labor may be secured free from the Indians and against the various conservation operations carried on by Indian Service agen-

cies as outlined in the Annual Statement of Contributions by the Navajo Service for the fiscal year 1939.

d. Benefits

1. There should be stabilization of agricultural lands and income, the most important source of subsistence livelihood for the Hopi Indians.

2. The present progressive depletion and reduction of range and woodland resources will be arrested and the land will be preserved and the livestock income stabilized.

3. The life of stock tanks, springs, the Tolani irrigation project, and lake heads should be prolonged by decrease in amounts of silt contributed from this area.

4. The local flood hazard at Leupp and at the Tolani irrigation project should be reduced.

5. There should be better appreciation by the Hopi Indians of the need for conservation of natural resources.