UNITED STATES
DEPARTMENT OF AGRICULTURE
CONSERVATION
SOIL ~~EROSION~~ SERVICE

Pullman, Washington
November 29, 1935 WTW:ON

MEMORANDUM TO MR. ROCKIE:

There is attached hereto the erosion range survey report of the Squaw Creek watershed of Umatilla County, Oregon. Maps and vegetative type quadrats are shown as exhibits, and a tentative grazing management plan is attached at the back.

Yours truly,

L.E. Spence
Assistant Technician

W.T. White
Range Examiner

Approved

W.A. Rockie
Regional Conservator

Brief of Findings and Recommendations for Squaw Creek Project
Umatilla Indian Reservation

The surveys made by the Soil Conservation Service during the past three months show the following:

1) That accelerated soil losses by both wind and water are serious but can be minimized.
2) That run-off is excessive and destructive and preventable.
3) That there are definite flood and fire hazards.
4) That the primary causes of soil loss and water run-off are
    a) Excessive grazing and trampling.
    b) Grazing at improper season.
5) That soil losses, if allowed to continue at the present rate, are of such magnitude as to render barren, within a comparatively short period of time, critical areas of considerable size.
6) That privately owned forest lands and woodlots within the project should be placed under a planned management, with regulated cutting and timber removals.
8) That it would be profitable to replace many of the horses now on the reservation with cattle as an economic betterment. That the creditable work by the reservation officials in improving the grade of the cattle should be carried on.
9) That upon the reservation there are many head of horses, of which a large percentage are wild horses which have no economic value.

Therefore, the Soil Conservation Service recommends (1) that a controlled grazing system be initiated at the earliest possible moment. (2) That there be a rigid culling of the herd of horses not used and now running the reservation. (3) That plans for regulated planting and maintenance of woodlots on private lands be introduced to establish control of areas best suited to forest use. (4) That the Squaw Creek drainage be fenced into three enclosures, the central portion as a sheep range, the lower portion as a cattle and horse range, and the upper portion as a cattle range. Plans are now being considered which provide for a similar enclosure upon the land of the Squaw Creek drainage, consisting of public domain, tribal lands, and private lands, lying south of the reservation boundary. These lands constitute the upper portion of the project. Some 1500 acres of the Umatilla National Forest have already received some protection and the erosion situation is much improved there. Recommendations for further improvement are being made to the Forest Service. (5) That seeded or revegetating areas be protected by fencing or herding until sufficient regrowth has been made to justify grazing. (6) That water development to spread grazing be undertaken immediately. (7) That a definite plan of salting be begun. (8) That critical slopes in the Squaw Creek area, following detailed soil and engineering surveys by the Soil Conservation Service, be protected by contour trenches to prevent run-off. (9) That spring, reservoir, and seep development may be immediately begun upon definite areas, with the joint approval of agents of the two services now on the ground. (10) that flood control dams, silt, and check dams be installed in the Squaw Creek watershed as fast as the surveys may be made by the Soils and Engineering Divisions of the Soil Conservation Service and approved by the managing officers of the agencies involved.

GIBBON PROJECT

Tabulated Acreage by Type and Slope Class

Type No.	Total Acres	Per Cent of Project Area	Slope Class A Acres	A %	B Acres	B %	C Acres	C %	D Acres	D %
1	5700	26	1710	30%	3420	60%	450	9%	120	2%
2	3282	15					1641	50%	1641	50%
3	4370	20					437	10%	3933	90%
4	5250	24					2100	40%	3150	60%
5	3283	15	328	10%	994	30%	1315	40%	656	20%
Total	21875	100	2038	9.4%	4204	19.5%	5963	27.6%	9500	43.5%

Erosion Range Survey Report
Gibbon Project
Umatilla County
Oregon

I. General description of the area:

Location and size: The Gibbon Project is located on Squaw Creek in Umatilla County, Oregon, approximately 20 miles east of Pendleton. This drainage, subject to change by subsequent surveys, consists of approximately 21,875 acres, falling within portions of townships 1 and 2 North, and ranges 35 and 36 East Willamette Meridian. Of the 21,875 acres, 14,500 acres are in the Umatilla Indian Reservation, 1,515 in the Umatilla National Forest, and 5,860 acres of privately owned land lie outside of these areas.

Topography:

Available maps: Maps of the area were prepared by the Soil Conservation Service, Pullman, Washington, for use in previous reconnaissance and land ownership surveys. These maps were based on the Metaker maps of the area. Additional maps were obtained from the Umatilla Indian Reservation Agency at Mission, Oregon and from the Forest Service office at Pendleton, Oregon.

Elevation: The elevations vary considerably within the area, although the gradation from north to south is quite uniform through most of the project area. U.S. Geological Survey bench marks at the north and south ends of the drainage show a rise in elevation from 1700 feet near the mouth of the channel to 3,800 feet near the summit at Emigrant Springs State Park. It has been estimated that at least 1,000 feet of this variation in elevation occurs within the two miles nearest the south end of the project.

Accessibility: The entire area is more or less difficult to travel by motor car, there being insufficient improved roads available. It is possible to travel up the creek for about five miles, and along the ridges on east and west sides, although these roads are nothing more than trails, and hardly passable by automobile. The ridges are accessible only from the sound end of the area, in the vicinity of Meacham, Oregon, making the road along the creek bottom the only direct entrance into the project from the Soil Conservation Service camp at Gibbon. Horse travel is at present the logical means of transportation within most of the project.

Vegetative Stage: Improper range practices over a long period of years on the Indian Reservation have resulted in a general regression of the vegetation of the area. Bedgrounds, driveways, trails to and from water holes, and many of the more accessible slopes and ridge tops have been divested of perennial grasses, and, in some cases, completely denuded of vegetation.

Weedy annuals dominate over a great majority of the area, and only on the more inaccessible slopes are found any of the once-dominant bunchgrasses. This type of range has been grossly mistreated by constant, long continued overgrazing.

In general the degree of utilization is largely dependent on the accessibility, and management practices, which, as a rule, have been extremely competitive, and without any semblance of proper range management.

Soil: The soil is in general a fine sandy loam, containing many fragments of basaltic rock, which are found on the surface, and generally through the soil layer. Some localized areas of clay loams occur on the ridges and slopes toward the northern end of the area. The soils on north slopes and portions of the area supporting a timber or brush cover, consist largely of typical forest loams, with silt loams or fine sandy loams in the underlying stratum. These soils are undoubtedly of basaltic origin, as numerous outcrops and ledges of basaltic rock are common, and in many places the stratum underlying the surface soil consists of basaltic rock. Considerable range in depth of soil was noted, varying from less than one inch on ridge tops and exposed slopes, to 30 inches and more on some of the protected slopes and ridges. The ridge tops having a thin soil cover are often characterized by the presence of hummocks, or soil biscuits of varying height, size, and number, and by numerous evidences of advanced stages of erosion.

The slopes within the area are generally quite steep, although quite a wide range in actual percent of slope was noted. The per cent of slope on the main ridges bounding the project and on the east and west sides probably does not exceed 15 to 20 per cent, except at the extreme northern end, where the ridges break sharply into the Umatilla valley. A majority of the slopes down to the side drainages from the ridges exceed 40 percent, and in some cases as much as 75 to 80 per cent. These extreme slopes are uncommon, and the greatest proportion of slopes within the area falls between 45 and 65 per cent.

History of Range Use: The Squaw Creek area has been subjected to grazing by Indian horses and wild game for many years before the advent of white settlers in 1860 or thereabouts. Numerous delapitated cabins on the area at present bespeak of its early settlement. These settlers surged into the cattle business, grazing large herds throughout the area of which the Squaw Creek country is part; and gradually choked the Indians from their domain. However, the Government stepped in to set a side a large portion of the Squaw Creek area, and adjacent territory, as the Umatilla Indian Reservation, and thus protect the rapidly diminishing range resources of the Indians. Since that time, the areas have been grazed by increased numbers of sheep. The cattle now on the area are largely I.D. cattle, given to the Indians by the federal government, in return for which each Indian, by the terms of the grant, must repay a calf for each breeding cow within a stipulated length of time. Cattle are marketed at all ages, and at varying weights according to age. Horses are allowed to run loose; the quality of this stock is so low that there is now market demand, except for canning or some such special purpose, and only a few are sold. The sheep on the area are the property of the permittees, and are sold as fall lambs at the age of from six to eight months and an average weight of from 70 to 80 pounds.

II. Climate:

Precipitation: Rainfall records from the Oregon State Highway weather recording station at Meacham, Oregon, are tabulated and presented in Exhibit Ia. The mean annual precipitation of 36.6 inches at this station for the period from 1929 to 1934 is higher than actually exists on the Squaw Creek area because of difference in elevation. Judging from data applicable to similar areas, an estimate of from 20 to 25 inches per annum might be applied to the lower portions of the area.

Snowfall: Snowfall data are recorded in tablular form as Exhibit Ib. These records likewise were obtained from the weather recording station at Meacham, Oregon. An average of 181.1 inches of snow has fallen during the period 1929 to 1934 although from 48 to 50 inches at one time is normal ground cover throughout the winter months. Snow falls on the higher portions of the area throughout the months of October to April, and occasionally later. Evidences of snow drifting are common throughout the area. However, the depth of snow on the ground at any one time is much greater over the upper portion than the lower portion. Actually the upper half of the watershed is snow covered from November to May in many years, while the lower half is often grazed throughout the year.

Critical periods of high winds: Chinook winds are common throughout the winter and early spring months. The prevailing summer winds are soutwesterlies, which attain high velocity at times. The Chinook winds are apt to cause soil loss by excessive run-off from melted snows, or soil drifting from bare patches. The high winds in summer cause some soil drifting, despite the fact the soil does not blow readily.

III. Vegetative Types: Natural: Two distinct sets of environmental conditions have resulted in two natural climax forms dominating the area in the past. A portion of the area may be assigned to the Palouse prairie grassland climax, while at the extreme southern end, the forest type is classed by Weaver as a Petran Montane forest. The species composition given below indicates this area to be in the exeroid portion of this climax.

Grasslands: Over most of the grassland type, the once dominant bunchgrasses have been supplanted by communities of invaders, because of overgrazing, trampling, erosion, and other contributing factors. Important species now found on the area include Bromus tectorum, Festuca pacifica, Poa secunda, Grindelia spp., Madia glmerata, Wyethia amplexicaulis, Cogswellia spp., with sub-dominants of Agropyron inerme, Festuca Idahoensis, Bromus mollis, Bromus brizaeformis, Epibolium spp., Achillea lanulosa, Balsamorhiza

sagittata, Erigonium spp., Amsinokia intermedia, and other species of weedy forage. In localized inaccessible areas, the vegetation consists largely of Agropyron-Festuca-Poa association.

Forests: The dominants of the forest type now present include: Larix occidentalis, Pinus ponderosa, Pseudotsuga taxifolia, Picea engelmannii, Abies grandis, and with some Pinus contorta as a subdominant form in heavily cutover areas. The understory largely consists of Vaccinium species, Symphoricarpos albus and Arctosphaphylos uva-ursi as dominants, with Spiraea corymbosa, Ribes spp., Pulaster malvescens, Odostemon repens, Sericotheea discolor, and Cornus stolonifera as subdominants, together with species of less significance. Forbs in the forest type consist largely of Fragaria spp., Thermopsis montana, Vagnera spp., Thalictrum fendleri as dominants, with Drymocallis glandulosa, Lupinus spp., Galium spp., and Sieversia ciliata as subdominants. Calamogrostis rubescens is the dominant grass, occurring together with Carex spp., and Bromus carinatus as the subdominants.

IV. Range and Pasture Management:

Past – Since the beginning of grazing on the area, the supervision and management practices have been too loosely organized for any benefits to accrue from such practices. From 4,000 to 8,000 head of sheep, together with 600 to 1,400 head of horses, and 800 to 1,000 head of cattle have greatly overgrazed the forage of the area. Using as the minimum numbers of livestock grazing the area, approximately four surfaces acres have been allowed per animal unit per season. This heavy use has been given range having a very low percentage of ground cover. It has given rise to erosion of the thin rocky soil, accelerated run-off, reduction of the carrying capacity, and vegetative regression. Water development has been neglected. It is a common practice to bed bands sheep in one spot near a spring for three or four weeks at a time, resulting in varying degrees of denudation of these bedground areas. No drift fences have been built, and no attempts made to secure the optimum utilization by proper salting practices. All in all, it appears that little consideration has been given to the upkeep of range for future use.

Present – At present the numbers of stock have been somewhat decreased, principally because of a lack of forage rather than any consideration of future benefits. The land on the Indian reservation is leased to one sheep company, who are supposedly bonded to take care of the range. Aside from this stipulation, no limitations as to the number or season of use are set by the Indian service. The practice of early spring grazing and over-stocking has destroyed much of the original forage cover. Heavy fall grazing has reduced the amount of vegetation left on the area to hold the snow and retard run-off. In addition, the Indian allottees have run many horses on the range. None of the area is fenced, so all of the stock except herded sheep roam freely over the range.

The Forest Service regulations have halted the regression of the vegetation within the boundaries of the Umatilla National Forest. However, evidences of excessive trailing and bedding for too long a time in one place are found in the forest. Twelve hundred head of sheep normally graze this area.

The privately owned land south of the Reservation is generally fairly well cared for. A few of the springs on this area have been partially developed, some drift fences constructed, and a few salt grounds established to afford better utilization of the area. The area is an example of the improvement possible even under a loose grazing plan. Small herds of cattle and flocks of sheep, and some pasture stock are now using the area. The late date at which the snow leaves the area, and the earliness of snow in the fall have protected this range to a large degree. Eighty-five cattle and 400 to 600 sheep in small flocks are grazed on this portion of the area. Stock is put on the area too early in the spring, and this practice has accelerated erosion of the ridge tops and higher slopes.

Future Management

Carrying capacity data, according to vegetative type is herewith presented:

Type	Forage Area Factor	Surface Acres	Forage Acres
1	.0454	5250	238.35
2	.0685	3150	215.77
3	.0792	4200	332.64
4	.0146	5250	76.65
5	.0083	3,150	27.81
Total			891.22

This area of 21,875 surface acres has approximately 891.22 forage acres which are at present 8,750 animal units for the season of use, or 1,750 animal units for a five-month season. This figures out approximately .1 forage acres per animal unit, or 12.0 surface acres per season. These figures bear out the assumption that the area as a whole is greatly over-utilized at present.

Future management must include, first of all, not less than a 50 per cent reduction in stocking the area, with special limitations made in numbers of sheep and horses. The overlapping of grazing of these two classes of stock must be watched and checked as far as possible. The practice of trailing and bedding for weeks at a time in one place must be remedied. Water developments and development of salt grounds to generalize the grazing of the area must be included in a management program. Spring grazing must be drastically reduced, and a careful rotational system adopted to allow recovery of desirable grasses. Drift fences, or at least proper herding practices, will add to utilization of the more inaccessible slopes. Summarily, the range is at such a stage of depletion that a complete change in policy is necessary in supervisory and management principles, especially on that portion with Reservation boundaries. The National Forest land, and privately owned land that is not at present so urgently in need of corrective measures, but steps in the right direction taken now will greatly diminish the erosion hazard in the future. These practices will result in a much more valuable range, capable of at least doubling the amount of forage obtained. When it has become fully establish, erosion will at the same time have been controlled. The range is endowed with ample springs and water, if they are developed, for all stock on the area, but at present few of these are useable throughout the year chiefly because of the lack of development. Salting practices vary from the poorest to the best, with no reason apparent for lack of universal adoption of better methods. The Indian Reservation should be fenced to protect private landowners from trespassing stock, and stock trails established to and from watering sites. All in all, the range as it now exists in its varying stages of depletion presents a problem to those interested in its rejuvenation for the future welfare of all concerned. It must have immediate attention and effective correction of present bad practices if the range is to be preserved for any economical future use.

V. Erosion

Kind: Run-off from rainfall and from melting snows results in the general prevalence of sheet erosion over the area, especially on the exposed ridge tops. Gully erosion is present, but not so generally conspicuous as the sheet erosion. Some small “finger gullies” are found, especially near cattle trail to and from water. Occasional evidences of wind erosion were found, especially where trampling is heaviest.

Severity: Sheet erosion is very severe and active over the exposed ridges and ridge tops. Gully erosion is largely confined to the drainage ways, or other channels carrying a concentrated run-off. These are generally down to bedrock or are filled with loose rock, so their chief harm is through side cutting and occasional head erosions. These drainages are two to four feet or less in depth and width. They occur at a rate of from tow to six to the linear mile. Especially noticeable on ridge tops are areas of small soil hummocks from two to six inches high, held in place by roots of the remnant vegetation. The adjacent soil has been washed away to depths theoretically as great as the height of the hummocks. Wind erosion is not noticeably severe, but undoubtedly some soil is lost through this agency.

Control: The control of sheet erosion should consist chiefly of restoring and maintaining the proper vegetative cover over the area. This can best be accomplished by sequence of proper range management practice to be conducted over a period of years, which should restore an erosion resisting vegetative cover. Also, development of water holes and salting grounds may enhance a more uniform utilization of the area, which is essential. The drainages in general have sufficient vegetation to protect them from erosion, but concentrated run-off from the exposed ridge tops adjacent creates the necessity of spreading this water if possible to prevent any further cutting of the drainage channels. Contour furrows on or near the ridges, with a re-established vegetation, will entirely change the run-off problem. Many of the slopes are prohibitive to dam structures, etc., making it essential to prevent the concentration of run-off in these channels. Clearing the main drainage channel of fallen timber, brush, and other obstructions may stop the side cutting. A flood problem is now present in the lower six miles of the main channel. This channel has been incised to bedrock subsequent to unretarded run-off, and the water when diverted by debris cuts new channels. In this process, small areas of cultivated land have often been subjected to removal of all loose soil by floodwater, and new channels have been cut through them.

Geologic erosion: Physiographically, this area is one of uneven topography due to uplift subsequent inundation of the surface lava flows. This uplift initiated a cycle of rapid geologic erosion. However, with the exception of a few talus slopes below disintegrating outcrops of geologically exposed strata, the vegetation has been, previous to the grazing use by white men, such as to have controlled the run-off and to have maintained a smooth contour in all drainage channels and on all slopes. The unregulated grazing us has given rise to accelerated erosion. In this area the equilibrium between vegetation, slope, soil, and climate is readily destroyed by reduction of the vegetative cover. The progress of accelerated erosion is rapid and the end result evident.

VI. Work Program:

VII. Private cooperation and association possibilities:

VIII. Government Agencies in the field:

IX. Remarks:
The Squaw Creek project presents a definite and serious problem due primarily to its advanced stages of depletion and the difficulties represented by the topographic, edaphic, and cooperative conditions.

Submitted November 12, 1935

William B. Nelson

Survey made;

October to November 1935.

Gibbon Project
Types

The types into which the Gibbon project is divided are discontinuous in areal distribution, but in the aggregate the component parts of each type present a similar complexity of use, vegetative condition and composition, soil, and erosion control problems. Each type is different from the others in these and other respects.

Type I

1 – C – 2.85
4-77 – AD – 2
none

I. Size and Location within the project:
Type I includes all the ridge tops and many of the adjacent slopes. It is estimated that about one-fourth of the project area may be considered for this type.

II. Slope:
Slope gradients from 5 to 70 per cent are found in this vegetative-type area. The estimated proportion of the type and project area falling within each slope glass is given below.

Slope Class	% of Type Area	% of Project Area
A. (0-7%)	30%	7.0%
B. (7-15%)	60%	14.0%
C. (15-40%)	8%	2.0%
D. (40%+)	2%	0.5%

III. Soil.
The topsoil is commonly not over 3 inches in depth. In some areas, there is practically none, and here the parent rock is exposed. Where present, the soil is characterized by a reddish-brown color. It may be classed as a fine, sandy-loam, with a variation, in some areas, to heavy clay loam. Both phases are low in organic matter content. Small fragments of basaltic rock are common throughout the soil. Occasionally, large fragments are also present. At present, many of the eroded slopes are more or less covered with a litter of these rock fragments. Investigation shows that these are present in the soil below, but in greatly less numbers than on the surface. On comparable slopes where erosion has not been so greatly accelerated, the accumulation of these materials is proportionately less. This evidence indicates that erosion has caused these accumulations of fragments on the surface. The significance of these accumulations is discussed under erosion.

IV. Erosion
Accelerated erosion is evident in the area given over to this type. It consists largely of sheet erosion, but gully erosion is also occurring. The seriousness of erosion in this type is emphasized by the topographic and edaphic conditions. Its cause is found in the common use of ridge tops as trails and bed grounds, in intensive preferential grazing due to topography, and in the overgrazing of the vegetation within this type. Where vegetation is present in this type, despite the present predominance of Poa secunda, reduction of this species and destruction of other soil binding, climax forage species have resulted in the serious stage of erosion now evident. This partial to complete denudation has exposed the surface of the soil to removal by freely flowing water. As the finer material has been removed from between the rock fragments, they have accumulated on the surface. The disintegration of basaltic ledges and outcrops has added to this loose material on the slopes. In the absence of vegetation, these materials have been exposed to the effects of runoff, gravity, and trailing by stock. They are moved down the slope by these forces, and, as they progress, scour off all the vegetation not previously grazed off. In this way, erosion, beginning on the ridge tops, has spread down over the slopes leading to them. The overgrazing of these slopes alone, in all cases, sufficient to have resulted in accelerated erosion. The intensification of erosion on these slopes, as described above, has in many cases resulted in gullying.

Corrective measures consist chiefly of protection from grazing and trampling, adoption of a proper bedding out system, and proper regulation of grazing. These practices will lead to increase of the vegetative cover and proportionate decrease in erosion. In many portions, complete protection and immediate revegetation of this type must be achieved before any control of erosion can be affected by the slopes below.

V. Vegetation.
The climax vegetation is the Agropyron-Festuca association. Over most of the type, relicts of this association are to be found. There are, of course, rocky outcrops and ledges which have never supported a grassy vegetation. The present cover consists of Poa secunda, annual bromes, and such forbs as Grindelia, Verbascum thapsus, Erodium eicutarium, Antennaria lazuloides, Erigonium spp., and Artemesia tridentata. The presence of the last species indicates great regression from the climax, due to continued overgrazing and trampling. Even this species is greatly dwarfed and hardly recognizable, so distorted is it from the effects of erosion and mechanical injury. Where this species is present, the area is on the verge of complete denudation. The soil has been almost completely removed by sheet erosion and, in local areas, the shallow soil hardly covers the underlying rock.

A quadrat representative of this type area (Exhibit III) has a total ground cover of 4.17% of the quadrat area. The average ground cover of all quadrats established in this type is 2.85% of the quadrat areas. The average species composition of the area by percentages of total ground cover is as follows: Artemisia tridentata (50%); grasses, Poa Secunda (42%); annual bromes (Bromus mollis, B. tectorum, B brizaeformis) (0.72%) and traces of Festuca pacifica, F. Idahoensis, and Agropyron inerme. Other forbs than Artemesia tridentata are Erigonium spp. (2%) , Grindelia spp. (2%), Sedum stenopetalum (0.9%), Helianthella douglasii (0.5%), and traces of Achillea lanulas, Antennaria lazuloides, Erodium cicutarium, Verbascum thapsus, and many others of still less importance (Exhibit VII) which altogether constitute 1.68% of the total ground cover.

VI. Carrying capacity:
At present, this type is generally overstocked. In the immediate future, grazing should be abolished entirely on these barren ridge tops. The preferential grazing of these ridge tops, not due to the palatable forage but to the ease of accessibility, must be controlled by fences, in necessary.

Further use of this land will render it totally unredeemable by accentuating erosion, now in an advanced stage. If this control is not affected, the areas lying below must eventually reach the same condition, regardless of any attempt to control erosion of them.

VII. Land Use:
Mush of this type is so badly depleted of both vegetation and soil that it is suited only for stock driveway. Other portions are essentially range land, and should not be used for any other purpose because of slope and nature of the soil.

Type II

$$\frac{1 - C - 4.81}{\frac{3.77}{0} - CD - 2.3}$$

I. Size and location:
This type includes chiefly the west ridge (east exposure) and the northern part of the west ridge (west exposure). The total area of this type is approximately 1 per cent (3,280 acres) of the project area.

II. Slopes:
Quadrat data show that the slopes range from 26 to 68 per cent. These are distributed as follows:

Slope Class	% of Type Area	% of Project Area
C. (15-40%)	50%	7.5%
D. (40%+)	50%	7.5%

III. Soils

The soil of this type area is of the same basaltic origin as that of Type I. It is higher in organic matter content as is indicated by the dark buff color. Occasional outcrops and exposures of the parent material occur, but in general soil covers the underlying strata to a depth of 5 inches or more. In texture it varies from fine sandy loam to loam, and is rather loose and friable. Rock fragments are intermixed with the soil. There is some accumulation of these on the surface due to a removal of the surface soil, in which they were embedded, by sheet erosion. Where this erosion has been more sever, the more reddish underlying soil is exposed, and in these locations the accumulations of rock fragments are greater.

IV. Erosion

Most of this type supports a vegetative cover more efficient in preventing erosion than does Type I. However, the cover is not now sufficient to have completely prevented the acceleration of erosion. Sheet erosion is general throughout this type. This shown by the "worn spots" where the reddish, underlying soil has been exposed, and rock fragments have accumulated on the surface, and by the varying depth of the darker buff colored top soil. This layer is deeper where the stand of vegetation is more complete and there has been less erosion. The soil is rather loose, and small finger gullies have started. These indicate the progression of the erosion cycle which, in this type, is definitely associated with their use. Their development is directly connected with the partial to complete denudation of the area in which they occur and of those areas higher on the sloe from which unretarded run-off has entered the gully portions.

In this type, stock trails which converge on springs and waterholes, are developing into gullies. There is no evidence of wind erosion.

Control measures must be directed toward increase in the stand of the soil-binding, climax vegetative cover. The annual, weedy grasses now predominate do not prevent erosion. Their presence in this area indicates destruction of the climax vegetation and acceleration of erosion. There are a sufficient number of relicts in this type to reoccupy the soil and to reduce and eventually to prevent all accelerated erosion if revegetation is made possible. This can be accomplished by deferment of use, regulation of seasonal use, and control of the intensity of use. The soil conditions are such that mechanical control as gully structures will give immediate benefit. The prevention of run-off may also be aided by contour furrows. The conservation of this water and its penetration into the soil will favor the rapid and effective reoccupation of the area by erosion-controlling climax species.

The development of watering facilities will reduce the travel over any one trail, and thus make for reduction of gullying in stock trails. With a general increase in vegetation to control erosion, the development of new gullies in stock trails will be prevented.

V. Vegetation:

Relicts of Agropyron inerme and Festuca idahoensis point to the former bunchgrass climax prevelant over the area. However, at present, 75% of the forage cover is composed of annual grasses, largely Bromus tectorum, Bromus mollis, Bromus brizaeformis, and annual festuca (Festuca pacifica). The prinicpal weedy forbs are Grindelia spp., Cogswellia spp. and Amsinokia intermedia. Other species occur in lesser numbers. Browse species comprise only an estimate 1% of the vegetation.

The quadrats typical of the area show that the ground cover is 3.03% of the surface area. It is composed of Poa secunda (53%), Agropyron inerme (23%), Festuca Idahoensis (8%), Bromus tectorum (2%), and traces of Bromus mollis, Bromus brizaeformis, and Festuca pacifica. Chief among the forbs are Erigonum spp. (9%), Achillea lanulosa (1%), Lupinus (1%), and Epilobium spp. (0.5%) Antennaria lazuloides, Hleanthella douglassii, Balsmohiza sagitatta, Wyethia amplexicaulis, Grindelia spp., Madia glomerata, Phacelia heterophila, Pentstemon spp., and others are present in varying proportions. One per cent of the

vegetative cover is made up of browse species, including Artemesia tridnetata, Opulaster malvescens, Symphoricarpos albus, Rosa nutkana, Amelanchier alnifolia, and Sericotheca discolor.

VI. Carrying Capacity:
If no considerations were given to erosion control, examination of this type would lead to the conclusion that it is not generally fully utilized under the present rate of stocking. However, all evidence shows that erosion is now occurring. This means that, although in some portions part of the forage is unutilized at the end of the spring grazing season, it is necessary to secure a greater and a continuing increase in the percent of ground cover. When it becomes evident that regulation of use has been sufficient to control erosion processes, the rate of stocking may thereafter be revised.

VII. Land Use:
No recommended changes in land use are possible because of slope and soil characteristics.

TYPE III

$$\frac{1 - B - 3.93}{3.77 - CD - 2.3}$$
0

I. Size and Location within the project:

Type III includes most of the inaccessible areas on the project, as well as very steep slopes, rocky areas, and areas afforded a measure of protection from lack of water. It is estimated that 20% of the project area (approximately 4,200 acres) is found in this type.

II. Slopes:
Slopes in this type range from those of 34% to those of 74%. The relative areas in the various slope classes are given below.

Slope class	% of type area	% of project area
C. (15-40%)	10	2.0
D. (40%+)	90	18.0

III. Soil:

The soils of this type are typically of the fine sandy loss to loam to loam class, and from 3 to 10 inches in depth. Small basaltic rock fragments are commonly present at all depths, and the soil is loose because of their presence. Color varies from a dark buff topsoil to a reddish-brown subsoil. In organic matter content and other characteristics the soil of this type is similar to that of Type II.

IV. Erosion:

Sheer erosion is prevalent over the area, and finger gullies are common. The present sparse vegetative cover is not sufficient to prevent erosion. The loose soil is readily removed by erosion processes and favors the development of gullies. This is especially true on the steeper slopes. It is evident that erosion in this type has reached a critical point in those portions where finger gullies are to be found. If their development is not arrested and sheet erosion not controlled, the complete removal of vegetation and soil from these slopes will soon have been accomplished.

Soil conservation in this type must be preceded by an analysis of the conditions, which have given rise to accelerated erosion. Certain facts are readily apparent. The vegetation now present is not in all cases fully utilized, and a fairly good ground cover is often present. Indications are that parts of this type have in the past been more severely used than at present. However, the vegetation now present is not representative of the most effective erosion-retarding, climax vegetation. Rel-

icts of the climax are present in sufficient numbers to effect vegetative reoccupation of the type. This requires complete regulation of use and is essential, if these soils are to be brought under control. Preferential grazing has obviously occurred. The steeper slopes and the steeper parts of slopes in this type are generally less used than the less steep ones. The vegetative cover of the latter is more severely reduced, often these areas lie above the steeper ones. Runoff from them is in many cases the direct cause of gully development on the lower and steeper parts of these lopes. With due caution, attempts should be made to get more use from the steeper parts. Thus the complete protection necessary for the other portions will have been somewhat compensated. Retardation of runoff by gully control structures, contour furrowing, water spreading, and revegetation must be accomplished a rapidly and completely as possible.

Maximum development of water supplies, strategically located, will be of great value in securing more even distribution of use and in the consequent reduction of preferential grazing. Present distribution is largely due to the fact that the only present source of water is in the main channel of Squaw Creek. If water development is not adequate to the need for distribution, it may be necessary to secure it by erection of drift fences.

V. Vegetation:

In this type the vegetation is composed mainly of climax bunchgrasses and forbs, but invasion of non-climax species of grasses and forbs is apparent. The average total ground cover occupies 3.98% of the surface area. In the order of their frequency Poa secunda, Agropyron inerme, and Festuca idahoensis together make up 60% of the ground cover. Forbs and browse species compose 9% and 1% respectively. A representative quadrat has a total ground cover of 4.50%, composed of Bromus tectorum (60%), Festuca pacifica (33%), Poa secunda (5%), and Bromus brizaeformis (.2%) with traces of Agropyron inerme and Bromus mollis. Forbs listed are Madia glomerata, Epilobium spp., Cogswellia spp., which together comprise .6% of the cover, although on an average the forbs compose 9% of the ground cover. Lactuca app., Amsinokia intermedia, Balsamorhiza sagittata, Wyethia amplexicaulis, and Grindelia spp. are species prevalent in this type. Other forbs occur commonly, but in fewer numbers.

VI. Grazing Capacity:

Despite the apparent under-use of portions of this type, even distribution of use can be secured, and period of use completely regulated by the controls suggested, it will probably be impossibly to effect erosion control without reduction of the rate of stocking below the carrying capacity indicated by quadrat data.

VII. Land Use;

Slopes are prohibitive to any other use than grazing. There are no indications that any other cover than range forage grasses can be established or maintained.

TYPE IV

Formula: $$\frac{6 - B - 2.59}{\frac{2\,(77)}{0} - BC - 23}$$

I. Size and Location:

Type IV includes approximately 5250 acres on the north slopes above the main channel and tributaries of Squaw Creek and the portions of the project area comprising the drainage channels. Twenty-four per cent of the project area is found in this type.

II. Slopes:

Measured slopes range from 28 to 65 per cent. It is quite likely that many unmeasured slopes in this type exceed the maximum figure. The gradient of the drainage's probably nowhere approaches the steepness of the north slopes, except in the case of small gullies which extend down these slopes. The natural channels, resulting from diastrophism, have generally lower gradient.

Th e real relationships by slope classes are given below:

Slope Class	% of type area	% of project area
C (15-40%)	40%	9.6%
D (40% plus)	60%	14.40%

III. Soil:

The soil of most of this type is classified as forest loam, although there are small areas of fine sandy loams and silt loam. The color of the dark brown to black topsoil is due to the incorporation of decomposition products of leaves and plant duff into it. This soil layer ranges from 3 to 6 inches in depth. It has a relatively high organic matter content as is indicated above. The underlying soil material varies in depth from 12 to 20 inches. Rock fragments are common throughout the soil layer. The subsoil varies in color from a light brown to reddish. The streams flow over rocks, boulders, and bedrock strata. All of the tributary channels show that previously the runoff had passed down smooth flowed broadly U shaped, natural drainways. Since erosion has been accelerated, these have been incised and the floor of these drainages consist of loose water-worn basaltic rock and boulders.

IV. Erosion:

Sheer erosion is largely controlled by the nature and density of the vegetation. However, runoff from the non-wooded south slopes and ridge tops has caused gullying in the majority of the drainage channels. The areas above the heads of these drainages are generally characterized by hummocks of soil held in place by plant roots. Severe runoff from melting snows is indicated. The channels are in most instances down to rock, or are at least partially stabilized by loose rocks in the channel beds. Some side cutting is prevalent, especially along the bed of Squaw Creek, where debris accumulated during flood season has partially obstructed the channel of the stream and caused formation of new watercourses. Where severe cutting of timber has occurred, acceleration of erosion is evident. Head erosion is evident in gullies.

Control of erosion such as exists in this area is largely dependent on the feasibility and suitability of gully structures and revegetation. Numerous small dams would certainly aid in erosion control in the main channel of the streams; all debris should be cleared out to give the stream an unimpeded flow; at the same time diminishing the hazards and damages normal to flood waters. Reduction of contributory runoff into the drainage channels I very important. Those areas from which timber has been completely removed should be revegetated, and further cutting should be judiciously done.

V. Vegetation:

This browse-timber type is the climax stage as near as can be ascertained. Variation of climatic conditions influenced by topography and elevation has resulted in this distinct vegetative type. There is some utilization by browsing livestock and cutting of timber by man has caused regression from the climax stage. At present, the ground cover averages 2.59% made up of 30% grass, 10% forbs, and 60% browse and timber, largely coniferous. The predominate species consist largely of Calamagrostis rubescens and the bunchgrass dominants Agopyron inerme, and Festuca idahoensis, and 41 species for forbs, none of which assume a position of dominance. There are many species of browse plants, chiefly Sericotheca discolor, Oplaster malvescens, Symphoricar-

pos albus, Prunus emarginata, Rosa nutkana, Spiraes corymbsa, and others. Trees include Pseudotsuga taxifolia, Pinus ponderosa, Larix occidentalis, Abies grandis, and some Pinus contorta. Cottonwood trees (Populus balsamifera) and Alder (Alnus spp.) are common along the creek is Acer glabrum. A quadrat chosen to represent the type has a ground cover of 2.50% composed of 21.2% grasses, 12.8% forbs, and 66% browse. Caamagrostis rubescens (13.6%), Heuchera glabella (10.4%), and Opulster malvescens (38%) are most frequent in each respective class, and make up 62% of the total ground cover. The species, Agropyron inerme (6.8%), Poa ampla (.8%), Sieversia ciliata (1.6%), Cogswellia app. (.4%), Epilobium app. (.4%), Symporiacarpos albus (8.8%), Sericatheca discolor (7.6%), Prumus emarginata (7.2%), and Spirasa scynbosa (4.4%), constitute the reminder of the actual cover. Outside species are listed in quadrat 51, (Exhibit IV).

VI. Carrying Capacity:

As evidenced by the present stage of the vegetation, utilization has not been too great in the past. There is a tendency, especially of cattle and horses on the area to "shade up" in this brush during hot summer months, but little, if any, of the vegetation is eaten by this class of stock. Sheep are generally herded on the ridges, and do not graze to any great extent in the brushy areas. The bulk of the springs and the other water sources are found in this type. The development of these is essential in securing proper use in areas adjacent to this type if erosion is to be controlled.

VII. Land Use:

No changes in land use can be recommended.

TYPE V

Formula: $\frac{6 - A - 2.55}{2 \quad (37) \ AD - (2\text{-}3)}$

I. Size and location within the project:

Type V includes approximately 3150 acres of private, state, and federal land in the south end of the project. It extends eastward from the Emigrant Springs State Park, and on the southeast is roughly bounded by the Old Oregon Trail.

II. Slopes:

The slopes within this forest type are not generally so steep as elsewhere in the project. A range of 5 to 48 per cent has been listed, although slopes of from 65 to 70 percent do occur. Th e relative area distribution of the slopes is shown below:

Slope Class	% of type area	% of project area
A. (0-7%)	10	3.1
B. (7-15%)	30	4.2
C. (15-40%)	40	5.6
D. (40% plus)	20	2.8

III. Soils:

Typical forest loam soils prevail generally throughout the area, with some variations in localized areas to lighter sandy loams and silt loams. The topsoil is from 6 to 18 inches in depth, and of a dark brown to black color. The subsoil extends 12 to 24 inches below the topsoil and is occasionally deeper. A light brown color is prevalent in this mineral subsoil. A few small rock fragments are occasionally found in the topsoil and are generally common throughout the subsoil layer. The third stratum is that of the parent basaltic rock. Organic matter is present in the top soil. It is derived from plant duff which covers the topsoil to a depth of 2 to 5 inches throughout this type.

IV. Erosion:

Erosion in this type is confined principally to the drainage channels. It is caused by the runoff from melting snows and heavy rains. That it is accelerated is shown by cutting to the rock stratum when it has become stabilized by loose rocks in the channels. Sheet erosion is present, but is not series or conspicuous. Side cutting of the channels is common where debris has impeded the normal flow of the water.

Control measure, as in the previous type, consist largely of structures, where feasible, and continued protection of the vegetative cover which, in general, by shading the surface, prevents rapid melting of snows and the foliage breaks the impact of even the heaviest downpours. Most of the erosion is due to runoff from areas higher up the slopes where the forest cover has been more reduced. These areas should be revegetated. Further side cutting should be prevented by clearing the debris from present channels.

V. Vegetation:

The climax forest species for the region, as listed by Weaver, are more or less typical of the climax. The present species are much the same as those he listed. Pseudotsuga taxifolia, Abies grandis, Larix occidentalis, Pinus contorta, and some Pinus ponderosa, constitute the bulk of the timber. The area has been cut over. The remaining timber is made up of poor quality trees and regrowth. The forb species are much the same as those listed: and, in addition, some browse species are found generally over the area. The total cover occupies 2.55% of the surface area. It is composed of 30% grass, 105 forbs, and 60% browse and timber.

A quadrat chosen as representative of the type has a ground cover of 2.74% made up of Calamagrostis rubescens (28.47%), Fragaria spp. (2.55%), Arstostaphyles uva-ursi (22.63%). Thalictrum fendleri (.73%), Drymocallis glandulosa (.73%), Vaguera spp. (.36%) Galium spp. (.36%) Sypmporicarpos albus (12.4%) Odostemon repens (7.3%), Pachistim myrsinites (4.38%), Vaccinium spp. (2.19%), Rives spp. (1.095%) and Spiraea corymboss (.36%). Species found in the area but not included in the quadrat selected are shown on quadrat 56 (Exhibit V).

VI. Carrying Capacity:

Owing to the fact that much of this land is state, federal, or privately owned, it has not been subjected to serious over-utilization, and is not overstocked at present. Grazing practices now in effect point toward the future welfare of the area; as most of it is utilized by cattle, with only few sheep and horses. Ample water is to be had. Salting is used to distribute the use and thus prevent concentrated grazing. Development for future use should include improvement of springs and careful supervision to prevent overstocking. The type of forage is better suited to sheep, but such use is not recommended. It is likely that a mixed grazing system would be more profitable and without harm.

VII. Land Use:

The land is best adapted to grazing and production of timber, firewood, fence posts, and poles. In the cutting of these, a woodlot management program should be planned and adhered to in order that acceleration of erosion may be avoided. Present trends in sue indicate that cutting has and will proceed indiscriminately unless some section is taken. Such actin would of necessity be directed to prevent erosion.

GRAZING AND SOIL CONSERVATION PLAN FOR SOIL CONSERVATION IN THE INDIAN RESERVATION PORTION OF THE SQUAW CREEK, OREGON, WATERSHED

A. Suggested grazing plan to effect erosion control and range improvement.

1. That for the purpose of excluding trespass stock and regulating use by roving sheep, horses, and cattle within the area that boundaries of the watershed may be established, it is recommended that:
   a. The entire watershed, with the exception of certain small areas in the northern part, be enclosed by fence.
   b. For purposes of control of the Squaw Creek watershed, the soils, vegetative cover, and grazing use suggest four control divisions.
      1. A central portion now used as sheep range.
      2. A north area now grazed by cattle, horses and sheep.
      3. A south part now grazed by cattle.
      4. Some /500 acres of the Umatilla National Forest, on the upper limits of eastern slopes overlapping the divide from Meacham Creek.
   c. The fences be built to divide the watershed into the following units.
      1. The area of the Squaw Creek watershed occupied by the Umatilla Indian Reservation. This fence will extend across the watershed at the southern boundary of the reservation and extend northward along the east, and west limits to points that will embrace the present sheep range. These points will be connected by fence, thus enclosing some 14,000 acres of range.
      2. The portion of the watershed north of said fence.
      3. The portion of the watershed south of said fence.
      4. The area forming a fraction of the Umatilla National Forest.

2. That the grazing plan will involve the following regulatory measures:

   a. Deferment of grazing until the perennial grasses have seeded (about July 20) in the years 1936 and 1937.
   b. Such regulated light grazing after and before this date each subsequent year as will allow growth and increase in vigor the relic climax plants to the point that increased grazing may be eventually realized.
   c. After the growing period, an intensity of grazing will be maintained which will leave not less than 30% of the seeds stalks of the perennial grasses. The foliage so left will prevent the most rapid removal of rainfall and will retard runoff.
   d. All stock will be removed from the range by November 20 or at an earlier date if it is evident that more than 30% is being grazed or destroyed by trampling.
   e. On critical areas stock will be excluded year long until revegetation occurs.
   f. That driving of sheep be along trails to be established.
   g. That bedding practices will be devised and followed to remedy the evil effects of present bedding practices. In general, the same bed round will not be used more than two nights during the grazing season and never on successive nights.
   h. That the areas to be utilized by grazing flocks will be planned in advance, marked, if necessary, and strictly followed by herders.
   i. That grazing trails to watering places be laid out and that flocks on approaching and leaving waterholes will follow these courses.
   j. That such salting practices as will contribute to erosion control and aid in the above be determined and followed.

B. Plan for erosion control by methods to supplement grazing control.

1. Mechanical Controls.
    a. Contour furrowing – to be protected by fence.
    b. Water spreading devices – to be protected by fence.
    c. Gully control structures.
        1. Silt dams.
        2. Weeping dams of various types.
    d. Storage reservoirs – these are proposed primarily for the purpose of holding water on the watershed and will also be of value as stock watering places.
    e. Flood control to protect erosion and cutting away of home sites and roadbed in the main channel of Squaw Creek.
        1. Removal of the debris in the channel.
        2. Diversion structures to direct flow.
        3. Dams and other structures in main drainages to impede flood flow and to smooth out flood peak.

2. Control by vegetation.

    a. Reseeding denuded and depleted range areas to forage species.
    b. Seeding and planting of
        1. Contour furrows.
        2. Areas for protection of gully structures
        3. Filled gullies
        4. Areas contributory to gullies – such of these areas as necessary must be protected by fence.
    c. Replanting timber areas where erosion is accelerated because of removal of cover.

C. Plan for establishment of investigational areas to determine

1. Value of various species for reseeding different types of denuded areas
2. The effect of various degrees and kind of protection in
    a. Increasing ground cover in different types by vegetative growth.
    b. Increasing ground cover by natural reseeding.
3. To determine the proper time and method of seeding
4. The value of the above in terms of erosion reduction.
5. The relation between the departure of edaphic factors from “climax condition” and the successional stage from which reseeding must start.

Nelson, W.B. 1935. Erosion-Range Survey Report, Gibbon Project, Umatilla County Oregon. Soil Conservation Service. Pullman, Wa.