

LAND CLASSIFICATION  
IN THE  
UNITED STATES.

NATIONAL RESOURCES' PLANNING  
BOARD . LAND COMMITTEE

1941

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**LAND CLASSIFICATION  
IN THE  
UNITED STATES**

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**MARCH 1941**

**NATIONAL RESOURCES PLANNING BOARD**

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**LAND CLASSIFICATION  
IN THE  
UNITED STATES**

**REPORT OF THE  
LAND COMMITTEE  
TO THE  
NATIONAL RESOURCES PLANNING BOARD**

**UNITED STATES GOVERNMENT PRINTING OFFICE - - - - - WASHINGTON: 1941**

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EXECUTIVE OFFICE OF THE PRESIDENT  
NATIONAL RESOURCES PLANNING BOARD  
WASHINGTON, D. C.

*December 20, 1940.*

THE PRESIDENT,  
*The White House.*

MY DEAR MR. PRESIDENT:

We take pleasure in transmitting herewith the report on Rural Land Classification, prepared by the Land Classification Subcommittee of the Board's Land Committee. This report includes (1) a comprehensive exposition of the status, methods, and geographic coverage of land classification in the United States, (2) an interpretation made from this information, indicating the importance of certain characteristics common to all land-classification work; and (3) a list of general and specific recommendations directed to scientists, administrators, and land-planning technicians.

This report represents an important step in the development of land-planning techniques and thus a significant contribution to sound land-use planning. Dissemination of the findings of this report will, we believe, be of distinct value to all those who are concerned with problems of land utilization and land planning.

Respectfully submitted,

FREDERIC A. DELANO  
*Chairman*  
CHARLES E. MERRIAM  
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# LAND CLASSIFICATION IN THE UNITED STATES

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NATIONAL RESOURCES PLANNING BOARD

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EXECUTIVE OFFICE OF THE PRESIDENT  
NATIONAL RESOURCES PLANNING BOARD  
WASHINGTON, D. C.

October 7, 1940

MR. FREDERIC A. DELANO, *Chairman,*  
*National Resources Planning Board,*  
*Washington, D. C.*

DEAR MR. DELANO:

The Land Committee submits herewith a report on Rural Land Classification in the United States. The inquiry on which the report is based was initiated in January of 1939. It emphasized a four-point question in regard to land-classification work, namely, what techniques are being employed, in what areas, for what purposes and with what results. In addition, the inquiry gave much attention to the form in which the results appear. Subsequently, the returns from this broad inquiry were tabulated and analyzed to bring out both their practical and scientific values.

The report is the first comprehensive exposition of the status, techniques, methods, and areal coverage of land classification in this country. It gives both chronological and areal perspective in this highly technical field. In addition, it points out for the first time the existence of five distinct types of land classification. The recognition of these types should do much to define and clarify the field of action of land classification, to bring about agreement in its terminology, and to broaden and intensify its usefulness in the solution of land-use problems and in the development of land-use programs.

In its exposition, the report points out the notable progress in land-classification techniques in recent years, and shows that the use of aerial photographs and mosaics as bases for recording field data has led to greater accuracy and speed in land-classification work.

The report deals with both general and specific considerations: pointing out gaps in our knowledge of land resources; indicating useful directions in which land-classification activities can be expanded; and evaluating the techniques by which and the channels through which land-use adjustment recommendations, implicit in certain classifications, can be carried out. Although the present report is confined to a discussion of rural land classification, the Land Committee recommends that a companion study of urban land classification be made.

The inquiry was made and the report prepared by a Subcommittee of four, with Charles C. Colby, a member of the Land Committee, as Chairman. Dr. C. P. Barnes, of the Department of Agriculture, and Mr. J. F. Deeds, of the Department of the Interior, were designated to represent the land-classification activities of their respective departments. The fourth member of the Subcommittee, Professor G. Donald Hudson, of Northwestern University and, until recently, Chief of the Land Planning Division of the Tennessee Valley Authority, cooperated with Professor Colby in planning the inquiry and in analyzing the tabulated results. The Subcommittee was fortunate in having as consultants, Professor K. C. McMurry, Chairman of the Department of Geography at the University of Michigan, and Dr. A. B. Lewis, Senior Agricultural Economist of the Farm Credit Administration. Throughout its deliberations, moreover, the Subcommittee enjoyed the interested and able cooperation of men from many Federal and State agencies and from other specialists in the field of land classification.

The Land Committee regards this report on land classification with enthusiasm both as an important step in the development and evaluation of land-planning techniques and as a vital part of sound land-use planning. We believe that its findings will be of value to technicians, administrators, and others in the broad field of land utilization and land planning.

Respectfully submitted,

#### THE LAND COMMITTEE

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## CHAPTER I. POINT OF VIEW AND SCOPE OF THE INVESTIGATION

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Land classification in the United States covers a multiplicity of activities. Uniformly, however, there appears a connotation of interest in the wise use of land resources or of a desire to promote their wise use. Even in the early days of land classification in this country, when the work was going forward in unsettled areas previously unmapped, the underlying motive was the hope and expectation that the surveys would aid in the settlement and use of the land. Today, most of the arable land has been settled, but to aid in the solution of land problems is still the concern of land classification. The broad objective of promoting wise use of land resources remains, but the problems of land use and the techniques which assist in their solution change from time to time and from place to place.

In keeping with the multiplication and intensification of land-use problems, land classification has become increasingly varied in technique and application. In pioneer days, before the areas under survey were settled, land surveys were concerned primarily with the land itself. Land qualities and land resources were the center of interest. Today, to this center of interest has been added solicitude for the welfare of the people who have settled the land. Land uses, actual or potential, now claim major attention. As the scope and the character of land problems widened, the demands on land classification multiplied. New types of land classification came into being, and the services rendered by land surveys developed accordingly. This widening scope and increasing diversity of land classification activities furnish both the occasion and the point of view of this report. The occasion is emphasized by a rising tide of interest in land classification, and the point of view is comprehensive, both in projects included and activities reviewed.

### **Definition of the Land-Classification Process**

For the purposes of this report, land classification is defined broadly. The intention is to provide for all types of work regarded as land classification by any agency or person with reasonable authority in this field.

In order to facilitate compilation and analysis of materials and ideas, the committee responsible for this report found it desirable to develop a working definition or concept of the land-classification process. Under

this definition, the land-classification process assigns each body or tract of land in an area to its proper class in a system of classes. The classes in the system are defined in terms of the qualities or characteristics with which the classification is concerned.

In thinking of the land-classification process it should be kept in mind that, in order to be meaningful, the classes or categories into which the bodies of land are segregated are related, that is, they represent groups or parts of a system. Tidal marshes, sandy soils, oil fields, and golf courses might be present in an area, but they are not related phenomena and can not be assigned to classes in a logical system of classes. Tidal marshes, rocky headlands, and sand dunes, however, are related phenomena and can be assigned to classes in a systematic division of shore features. In similar fashion, golf courses, railway yards, and airports are classifiable in terms of the several categories of urban land use.

In common practice, the process of land classification involves a map record. This record shows the size and shape of each parcel of land and the class to which it has been assigned. In most cases, the classes in the system are named and described in the legend of the map or in the accompanying text. Experience shows that to a marked degree the utility of land classification maps depends on the skill with which the legend is made. In far too many cases the description of the classes fails to present clearly the similarities and differences which characterize and distinguish the classes. The classification may have been soundly conceived and the field work expertly done, but poor map work may reduce or destroy its effectiveness.

### **Land-Classification Activities**

Although this survey of land-classification activities in the United States aims to be comprehensive, it is not inclusive. The objective is an over-all view of land-classification activities which illustrate some challenging phase of land classification or which contribute facts, ideas or recommendations useful in the formulation of land policies and programs. To keep within reasonable bounds, the survey is limited to land classification under government auspices, Federal, State, and local. The selected lines of work are presented in the accompanying tabular statement (chapter V). This table covers 75 projects, the surprisingly large

number illustrating both the wide range of land problems and the extent to which land classification is being utilized in their solution.

In addition to the land-classification projects listed in chapter V, there are many short-term governmental inventories and surveys which belong in the broad field of land classification. For a complete coverage of land classification in the United States, moreover, a survey would need to consider the output of consulting engineering services, and the work initiated by insurance companies, banking institutions, public utility organizations, and other corporations owning land or holding mortgages on land. Investigations by oil companies and other organizations prospecting for minerals also would claim attention. The special staffs of these financial and industrial corporations gather and map in the aggregate a large volume of data in regard to the land resources and the land conditions affecting the corporations' business and decisions.

A complete record of all land-classification activities of private, State, and Federal agencies would include discussions of many land-classification activities which are of little value today except for their historical interest. For example, the reconnaissance land-classification reports of early explorers of the vast unknown western region are of little value in planning land activities today. Their principal purpose was to encourage the migration of pioneers who were responsible for the early development of the United States. That purpose long since has been attained. The significance of some of the work of the past, however, continues to the present either because it is basic to some phase of present land use or because it represents a vital link in the evolution of land classification in this country. Examples of such work appear in chapter III.

Many of the land-classification projects described in this report are associated with other lines of investigation and are in the hands of long-established Federal agencies, such as the United States Geological Survey. Some of the projects, however, originated in connection with new land-use programs, such as that of the Soil Conservation Service. These recent developments have stimulated interest both in the technique and methods of land classification and mapping, and in the application of the materials and findings of land-classification surveys to new types of land-use problems. Some of the Federal projects call for cooperation with State agencies. Some of the projects which illustrate significant aspects of the methodology and theory of land classification are wholly under State agencies.

Up to the present, a notable part of land classification under Federal auspices has been connected

with the public domain. Even today, as shown by this report, the public domain calls for much attention by Federal agencies. State-owned lands, moreover, have called for considerable attention by State land-classification surveys. Much of the land remaining in the public domain, and a considerable part of the land under State control, is handicapped by aridity, ruggedness, poor soil, or some other natural quality, and the land-classification work in such areas necessarily is concerned with lands of low utility. As a general rule, land classification in the public domain has been undertaken for some special land-use program, and in many areas two or more surveys have been made. Therefore, in obtaining a comprehensive knowledge of the resources of these areas, it is necessary to consult the materials produced by several land-classification surveys.

Land classification in the United States is not restricted to poor lands. Land problems affect all grades of land and, in some cases, are as acute and as difficult of solution on good land as on poor land. The welfare of the Nation is concerned with the wise use of good land even more than with the wise use of poor land. Many of the good lands, moreover, are affected by Federal, State, or local land-use programs. It is to be expected, therefore, that agencies of any of these levels of government do, and properly should resort to land classification as a means of appraising the assets and liabilities of the lands affected by their programs.

From the standpoint of administration, the status of land-classification projects varies notably. In some cases, land classification has been specifically recognized by acts of Congress. In others, it has been employed by agencies charged with the responsibility of some special land-use program. In still others, it has been an essential part of authorized programs of public works. Fortunately, land classification, in many instances, has been a part of long-range programs of investigation with both practical and scientific implications.

Although this investigation of land classification in the United States emphasizes activities rather than administrative agencies, the tabular statement and the individual chapters show the bureaus or other organizations which are responsible for the land-classification work and the departments of which the bureaus are a part. This procedure makes for a balanced treatment and facilitates a study of land classification from the administrative viewpoint. Primarily, however, the materials were selected and presented to emphasize land-classification activities. This emphasis on activity led to the recognition of the five types of land-classification activities described in the following chapter.

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## CHAPTER II. TYPES OF LAND CLASSIFICATION

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Land-classification activities in the United States fall into five categories, each representing a distinct type of land classification. The recognition of these five types is largely the result of the point of view and scope of the report. As previously stated, interest was centered primarily on what is done in land classification and how it is done, that is, on the activities and procedures, rather than on separate projects or administrative agencies.

The first step in the investigation leading to this report was a review of land-classification work in all parts of the country. From this review, 75 projects were selected for further analysis. In order to facilitate the analysis, the projects were brought into as nearly comparable terms as possible by organizing their major features in tabular form (chapter V). Thus, in the seven columns of the table reading from left to right, each project is identified by number (column 1), by title (2), and is described according to the agency conducting the project (3), the purpose of the work (4), how the work is done (5), the materials produced (6), and the area covered (7). In this form, major land-classification activities can be studied horizontally by projects, or vertically by features. For example, each individual project can be studied by itself, or each individual type of activity can be studied as it appears and reappears through the various projects. Furthermore, administrative units can be readily reviewed as to the sorts of activities with which they are concerned.

Since the center of interest in this investigation is in the activities of land classification, the columns in the tabular statement headed "Title" and "Procedure" take on special significance. In recognizing the five types of land classification, materials were drawn mainly from these two columns supplemented by the extended statements in the separate chapters of part III. Subsequently, the logic and utility of the five types were substantiated by reference to the literature and by the experience of the committee and the specialists it consulted. The five types are as follows:

Type I. Land Classification in Terms of Inherent Characteristics.

Type II. Land Classification in Terms of Present Use.

Type III. Land Classification in Terms of Use Capabilities.

Type IV. Land Classification in Terms of Recommended Use.

Type V. Land Classification in Terms of Program Effectuation.

It is believed that the recognition of these five types does much to clarify the field of land classification by providing a frame of reference in which each phase of work finds a logical place.

### Type I. Land Classification in Terms of Inherent Characteristics

Land classification in terms of inherent characteristics classifies and maps the qualities given to the land by nature. More specifically, type I classification deals directly with the soils, the slopes, the minerals, and similar surface and sub-surface features. It also deals with various characteristics of native vegetation, as well as with water resources and features of the climate. The processes of type I classification involve field observations. The end results are maps that display the nature and the distribution of natural land qualities. The classification of land in these terms is the unique function of the first type of land classification.

Of the 75 projects analyzed in this survey, 68 consist of or include type I classification. Although these projects do not deal with every known inherent characteristic of the land, they do deal with the major characteristics, particularly those that have a more direct bearing on land use. Furthermore, the characteristics that are dealt with are not given the same amount of attention. Thus, soils and topography are listed more frequently and, in most cases, are treated in greater detail than other natural land qualities.

Knowledge and understanding of land classification in these terms is probably broader and more thorough than it is in other types of land classification. To cite only three examples, topographic mapping has covered approximately 50 percent of the United States; published soil surveys cover a comparable portion of the country; and large areas have been covered by inventories of forest and water resources. The maps and reports growing out of these surveys typify the results of type I land classification. They also illustrate how separate surveys consisting of this type of land classification tend to concentrate on one or a small group of closely allied qualities of the land.

Interest in the natural qualities of the land is of long standing, both in and outside of governmental agencies. These land qualities constitute the physical resources which underlie all land use. They also impose certain limitations within which our activities must be confined. At the present time, in spite of numerous examples to

the contrary, we recognize that, on the whole, our lands have been used none too wisely. In some instances they have been abused; in other instances their full potentialities have not been realized. Some land has been destroyed, beyond cultivation, by erosion; the carrying capacity of range lands has been reduced; serious problems have arisen because of misguided settlement in cut-over areas. As a result, both individual land-owners and governmental agencies are centering their attention on an understanding of the natural qualities of the land. Present land-classification surveys must deal with the natural qualities of the land so definitely that they may be used in programs of land rehabilitation and, if possible, programs of settlement, resettlement, and industrial development.

## **Type II. Land Classification in Terms of Present Use**

The second type of land classification is concerned with the present uses of the land. It envisions a portrayal of these uses on maps. Since substantially every human activity can be regarded as involving some use of the land, the land-use features dealt with in type II classification are correspondingly numerous and varied. In fact, among the projects studied, which include this type of land classification, present land use is expressed in literally scores of different ways. It would be impracticable, if not impossible, to portray on a single map all significant facts of land use. In most cases, therefore, this type of land classification is undertaken for some major objective. To this end, most land-use maps deal with some major land use such as agriculture, forestry, recreation, settlement, or transportation. In some type II classifications there is included a body of statistical data dealing with relevant economic, social, and political matters.

Land-use facts portrayed in a use classification fall into three categories comprising, (1) kind of use, (2) characteristics of use, and (3) status of occupancy. In practice, a single type II undertaking may include one or two or all three categories. But to understand the processes of type II classification, it is helpful to consider each category individually.

With respect to kind of use, type II classifies the land, area by area, or field by field, according to how it is used. Areas are delimited from the point of view of the particular use classification being made. Where the objective is an agricultural-use classification, cultivated areas, pasture areas, highways, houses, and any other features related to agriculture are mapped. Where the objective is a mineral-use classification, mines, quarries, oil wells, and similarly related features are mapped. This approach emphasizes the delimita-

tion of land occupied by each use or group of related uses and the facilities on the land.

The items mapped in the second category of land-use facts emphasize the particular characteristics of the kinds of land use covered in the first category. Again, the system of classes adopted depends upon the objective of the classification being made. Thus, where the objective concerns agricultural land use, the types and yields of crops on cultivated lands are mapped. A classification concerned with mineral lands maps the types and current production of mining activities. Farmsteads, factories, roads, and other facilities on the land differ as to type, size, and condition. The characteristics of these features also are included in the second category of land-use facts.

In connection with status of occupancy, the third category of land-use facts, type II classification includes the collection of statistical information related to ownership, tax status, mortgage indebtedness, assessed valuation, and other associated data. These characteristics of an area are transitory and are not themselves visible in the landscape. Some of them have areal distribution and can be shown on maps. Others can be best portrayed in tabular forms. These characteristics of an area have a bearing on the uses of land. They may even be the determining factors in how individual parcels of land are used at a given time. As such they are used in connection with special land classifications. Because of their transitory nature, the records obtained for one purpose are of value for other purposes only as they disclose trends in use characteristics.

Fifty-three of the 75 projects listed in the tabular statement include type II land classification. Some deal with one category of land-use facts, whereas others deal with more than one. As a group, these 53 projects exemplify the variety and complexity of land-use studies. In some projects, the aim is to map as nearly all of the visible uses of the land as is practicable. Others are concerned with only one use, such as residence or recreation. Further, different projects deal with the same land uses but map them from different points of view or in different degrees of detail. Of the 53 projects, more deal with agricultural land use than with any other land use. The classifications within the agricultural bracket include such varied items as cropped land, grazing uses, agricultural land values, and farm operating units. Work related to other major groups of land use also is widely varied and, in some sections, more prominent than agricultural classifications.

Among the statistical data collected and mapped, those relating to economic conditions are enumerated more frequently than those relating to social and political matters. These data are as varied in nature and treatment as the other data employed in type II work.

No one project, nor all type II work for that matter, includes all of the possible lines of investigation. Relatively few type II classifications have been carried very far in terms of area covered, amount of detail included, or even in the recognized needs for such classification. Examples of programs of national scope which utilize type II classification include the Nation-wide forest survey of the United States Department of Agriculture, and the cooperative surveys of parks, parkways, and recreational areas of the National Park Service and State and local agencies. In contrast with these, much type II work is regional or local in scope. The Soil Conservation Service, to illustrate, has completed land-use surveys over scattered areas totaling nearly 60,000 square miles as part of its conservation surveys; rural land-classification surveys by the Tennessee Valley Authority have covered roughly 23,000 square miles; and land-use studies are in progress on Indian lands under the jurisdiction of the Office of Indian Affairs.

All of the type II work apparently recognizes the proper use of land resources as vital to the avoidance of waste. This is evident in the titles and purposes of the projects which include this type of land classification. Attention is given to testing the degree to which land use is integrated with the natural qualities of the land and adjusted to the opportunities and limitations of economic, social, and political factors. Where, through misuse of land resources, areas are less valuable than in their natural state, or have been abandoned, explanations are sought as to why and how land uses have led to the failure. An understanding of the uses of the land is essential to these ends. Therein lies the purpose of type II classification.

In preparation for the discussion of other types of land classification, a significant point should be noted at this juncture. There is one element common to type I and type II land classification which distinguishes them from other types. Both deal only with existing conditions: one, the inherent characteristics of the land; the other, the present uses of the land. As a result, both are primarily inventories. Appraisals of potentialities are not involved; no recommendations are made; and no programs of action are formulated. As inventories of existing conditions, both type I and type II consist primarily of actual field observations and the collection of original statistical data. Further, since both are concerned with existing conditions, they are basic to other types of land classification. If it is to be done systematically and accurately, other work in land classification necessarily involves either type I or type II, or both.

### **Type III. Land Classification in Terms of Use Capabilities**

In type III land classification bodies of land are classified in terms which show their capabilities for use.

More specifically, type III classification answers these two questions: What will be the probable results if a given body of land is put to a particular use; and, conversely, what land-use practices are necessary to bring about a given result? This type of classification, therefore, does not recommend any particular uses, nor does it single out any use as best or desirable. It is entirely objective in its treatment, predicting what can be expected of the land if it is used in one way or another. What use is believed to be good or desirable plays no part in the classification.

In this third type of land classification it should be understood that a given body of land may be classified from more than one point of view. The use capabilities of rough, mountainous land, for example, may be appraised and classified from the standpoint of forestry, or recreation, or as a catchment basin for a municipal water supply. In terms of forestry the land might be rated as poor, in terms of recreation as excellent, and in terms of water supply as medium. Whether the same body of land is classified from one point of view or from several points of view, and whether the same or different natural qualities of the land are appraised in each case, the use-capability map in terms of one use is not interchangeable with the use-capability map in terms of any other use. The appraisal in every type III classification is unique and the classification made is strictly individual.

The classes in a type III classification are defined either in relative terms or in quantitative terms. The former is illustrated by bodies of land classified as first, second, third, or fourth-grade farm land. This classification shows that, if the land is used for farming, some areas will be most productive, others least productive, and between the two extremes are two intermediate grades. In this instance no standards or criteria are given to show on what basis the different grades of lands were segregated. It can be assumed, however, that appraisals of the land in terms of the objective of the classification accompanied or preceded the classification. Defined quantitatively, bodies of land are classified, for example, according to the expected yield of spring wheat if the wheat is rotated with summer fallow. This classification shows that some bodies of land can be expected to produce 22 or more bushels per acre, some from 16 to 21 bushels per acre, some from 12 to 15 bushels per acre, etc.

The foregoing illustrations are of the same general form in that the land is classified according to the various results which can be expected under a given use. Under the other form of type III classification the land is classified according to the practices necessary to bring about a given result. In one such instance, areas are classified according to the practices which can be expected to give moderate-to-high crop

yields, and, at the same time, avert erosion. It should be noted that this is not tantamount to classifying the areas according to the uses to which they are suited. There are areas where the practices necessary to give moderate-to-high crop yields and avert erosion would be so costly as to be wholly impractical.

Two bodies of knowledge are essential to type III classification: (1) a knowledge of the natural qualities of the land being classified, and (2) a knowledge of the results of using lands having these natural qualities. In other words, a type III classification of an area should be preceded by or accompanied by a type I classification of the same area. Furthermore, the type I classification must deal with those natural qualities of the land which have a bearing on the particular use in terms of which the use-capability classification is made. The knowledge of use experience need not be drawn from the area for which the type III classification is being made. As a matter of fact, it can be derived from any area which possesses natural qualities comparable with the land being classified. To illustrate, let us assume that the purpose of the classification is to grade an area from the standpoint of its capabilities for recreational uses. The natural qualities of the land are appraised from that point of view. Drawing on accumulated experience, each body of land in the area is classified according to how nearly it measures up to the standards for recreational development.

The basic principle of type III classification has long been followed by farmers in gauging the capabilities of their fields and by others in weighing the results of putting land to one use as compared with another. But type III classification is relatively new as a scientific process of land classification; it has had to await the accumulation of a broad knowledge of the land and a mass of data concerning the results of using the land in a wide variety of ways. As a result, projects including type III classification are current and of recent origin. Comparatively few areas have been covered, and these represent only a few of the many possible points of view.

Though relatively new as a land-classification process, interest in type III classification is active. Of the 75 projects in the tabular statement (chapter V), 53 include type III work involving use-capability classifications relating to agriculture, forestry, recreation, mining, wildlife, and water resources. Typical illustrations of this type of classification drawn from agricultural land uses are furnished by the productivity ratings of the Soil Survey made in cooperation with the State agricultural experiment stations, and certain phases of the work of the Soil Conservation Service. Examples of other major lines of land use are furnished by certain phases of the work of the United

States Forest Service, the Tennessee Valley Authority, the National Park Service, and the Bureau of Reclamation. The land-classification activities of all of these agencies are described in later chapters of this report.

#### **Type IV. Land Classification in Terms of Recommended Use**

In the fourth type of land classification, bodies of land are assigned to classes according to recommended use. Naturally, the character of the recommendations and the complexity of the classification vary with the purpose of the classification. In some cases, as in the selection of county forest reserves around a city, the purpose centers in only one kind of land use. In other cases, as for example in county zoning, the purpose and thus the recommendations may extend to all or nearly all kinds of land use in the county.

Although the complexity of the work varies from one example of type IV land classification to another, the considerations in the classification process are essentially the same in all cases. In theory, and commonly in fact, recommended use involves a consideration of the inherent characteristics of each body of land, its present use, and its use capability in terms of each use to which it might be put. This is tantamount to saying that type IV land classification is based on the results of each of the previously described types of classification, or at least involves all three of them.

As is true of other types of land classification, most type IV classifications are expressed in the form of a map. Commonly, the recommended use classes which have governed the classification are listed and described in the legend of the map. If the classification has been concerned with but one kind of land use, only those bodies of land for which this particular use is recommended will be shown on the map. If, however, the classification is concerned with all kinds of land use in an area, the map or maps probably will indicate the recommended use for all bodies of land.

In cases where type IV classification involves only one kind of recommended use, the classification goes forward in terms of the technical knowledge and experience which are associated with that kind of land use. A map of recommended uses in a national forest, for example, is an expression of well-matured technique tempered by years of managerial experience. The same holds true for recommended land-use classification as practiced in the development of an irrigation project. The resulting maps recommend that water be delivered to some bodies of land and not to others. The classification involves an expert knowledge of land qualities and of crop behavior under irrigation on land of each quality.

Land classification in terms of recommended use becomes more complicated where two or more kinds

of use are involved. Each use calls for a reasonably expert classification in terms of that use. This means that the several possible uses for the same body of land must be appraised and coordinated. For each body of land, one of the recommended uses must be selected and a final map of recommended uses be prepared. Good examples of this coordinated phase of type IV classification are furnished by the recommended land-use plans which guide the action program of reclamation projects (chapter XII), by the land-use plans made by county agricultural land-use planning committees (chapter XXIII), and by the reservoir marginal plans of the Tennessee Valley Authority (chapter XVIII).<sup>1</sup>

In the long run, land-use recommendations resulting from type IV classification by governmental agencies are addressed to the general public as a public service. More specifically, however, the recommendations are addressed to individual farmers, business organizations, and other users of privately owned land; to legislative bodies; to local communities through their constituted boards or committees; and to other governmental agencies which have management responsibilities on publicly owned lands. Where the recommendations aim to guide management on publicly owned land, they commonly represent the work of technical staffs experienced in land-classification activities. Where they lead to legislative action or affect privately owned land, the recommendations represent both the practical experience of local people and studies by competent technicians. Back of any or all recommendations should lie appropriate facts and experience. Ahead of them inevitably lies the question of approval by the organizations or the communities concerned.

The number of agencies avowedly carrying on land classification in terms of recommended use is small in comparison with the number carrying on classification in terms of inherent characteristics or of present land use. Of the 75 projects listed in the tabular statement (chapter V), more than twice as many are described as classifying the land in terms of present use than in terms of recommended use. An even greater number classify land in terms of inherent characteristics. The smaller amount of classification in terms of recommended land use is, however, somewhat more apparent than real for, in their declaration of purpose, every project in the list of 75 stated or has implied that it either makes recommendations or that its work leads to recommendations. In this connection it should be remembered that many of the time-honored agencies concerned with land classification were established, and have been continued, as fact-finding

agencies. More recently land-classification surveys have been launched in organizations which are charged with development programs. It appears logical and appropriate that such agencies are emphasizing land classification in terms of recommended use.

The increasing acquisition of public lands by several of the States through tax delinquency or other channels may increase the general interest in type IV land classification. It is conceivable that classification of such lands in terms of recommended use might set in motion programs which would change them from state liabilities into state assets. Land classification in terms of recommended use is based on the constant search for new methods and practices of land use which will promote higher economic and social benefits. The present survey of land-classification activities in the United States has revealed a considerable body of evidence which shows that the benefits heretofore obtained give promise of further benefits in the future.

#### Type V. Land Classification in Terms of Program Effectuation

The end-purpose of land classification contemplates some form of action which puts desired land uses into effect. This action may involve a modification or a complete change in existing uses. Therefore, its accomplishment involves decisions as to the time when recommended land uses will be carried out, and decisions as to how they will be carried out. Type V classifies the land according to these management decisions and expresses them in the form of maps that show for each body of land when and how the effectuation of land-use recommendations shall take place.

##### The Element of Time

After land-use recommendations are adopted there arises the problem of when the land-use recommendations shall be put into effect. In some cases, economic considerations are of dominant importance, as, for example, what the cost of the contemplated change will be, and when the funds will be available. In other cases, decisions may rest on the availability of materials. If, for instance, a land-use plan indicates that a body of land now devoid of any timber should be planted to trees. An inventory shows that there are available enough seedlings to plant half the area immediately and that sufficient seedlings will be available by the next planting season to complete the program. A management plan is drawn up which shows precisely when each parcel of land is to be planted in accordance with the supply of seedlings. These and similar allocations of action to definite parcels of land illustrate the time element of type V land classification.

The time element also may be involved in other ways. To illustrate, though seedlings may be ready, it may

<sup>1</sup> See also, Crossman, Christian C., "Determining The Purchase Boundaries And The Use Of Reservoir Properties," *Economic Geography*, Vol. 15, No. 3, July 1939, pp. 260-264.

not be feasible immediately to carry out the planting recommendations because some portions of the land are so cut with erosion that planting must be delayed until check dams and other erosion-control works have been built. The completion of these works will cover a year. Planting cannot take place until the second year. These matters, including the planting schedule for the second year, constitute the management plan. Expressed areally for the land in question, this management plan is land classification in terms of program effectuation.

To illustrate further, let us assume that the program involves population resettlement. Suppose the land to be planted to trees consists of cleared fields within a large forest purchase area. The cleared fields have been cultivated. Although these lands have been sold by their farm owner, it has been agreed that the present residents can continue to live on and farm their former properties for the remaining years of their lives. This procedure is followed because there is no immediate pressure to get all portions of the purchase area into timber and there are advantages in disturbing the residents as little as possible in making the shift from nonforest to forest uses. It is desirable to postpone the application of the land-use recommendations. The classification of the land along management lines in the light of these factors is another example of type V classification.

#### The Consideration of Methods

The problem of putting land-use recommendations into effect rests on the circumstances existing in each particular case. In some cases the most expedient method may be a matter of administrative decision. This applies to those instances in which an agency performs both the planning and management function and has full control of the land through ownership. In such cases, studies are made to discover possible areas for development (type I); present uses are examined and use capabilities are ascertained (type II, type III); recommendations for development are made and recorded in the form of a land-use plan (type IV). The effectuation of the plan involves complicated problems of population resettlement, land purchases, and the like. Assuming adequate funds and personnel, and normal circumstances in other respects, these problems can be solved within the organizational framework of the agency. When recorded on a map the management decisions for specific bodies of land constitute a type V classification.

The further removed the agency is from managerial responsibilities and powers, the more complex become the problems of how to put the recommended land uses into effect. Some agencies have recognized planning functions but have limited powers of management and

development. These agencies must rely upon others for program effectuation. How these processes operate can be illustrated by certain phases of the recreation program of the Tennessee Valley Authority.

Complete land-use plans are developed by the Authority for properties it owns adjacent to the reservoirs constructed along the Tennessee River system. In these land-use plans every parcel of land is accounted for, including land recommended for recreational uses. The carrying out of some recommendations relating to recreation requires the operation of boat docks, the building and operation of tourist accommodations, the development and maintenance of public parks, and similar activities. With some exceptions these activities involve the participation of citizens, commercial organizations, and other public agencies. Whether or not these land uses become effective depends, among other things, upon whether or not proper agreements can be worked out between the Authority and the operating agency, public or private. Assuming that agreements are reached, appropriate designations are made in the program of effectuation. These designations applicable to specific bodies of land are part of the type V land classification of the reservoir properties.

In those cases where the planning agency does not own the land, it is without direct powers of management. How recommended land uses can be effected in these cases presents a variety of problems. The solution of these problems rests on such factors as the legal limits of local governmental units; the legislative authority under which new agencies may be organized; local customs, practices, and traditions; spendable income; and other matters of a social, economic, and political nature.

In many cases, however, effectuation is in the hands of private individuals. In such cases education and demonstration are useful devices. This is illustrated by much of the work of the State agricultural colleges, extension services, and experimental stations. Problems of effectuation also are solved through agreements entered into by groups of private citizens, such as the organization of grazing districts. In other cases the solution lies in public-private agreements, as between the Soil Conservation districts and local farmers. But, however the problem of effectuation is solved, once it is solved and the decisions are applied areally to bodies of land, such designations constitute type V land classification.

The objective of program effectuation is to transform recommendations into actuality. It draws heavily, therefore, on the results of type IV land classification. A given program of effectuation, however, may draw on the materials and results of any of the other types of land classification. For example, a reexamination



of type II materials relating to political matters may be made in order to discover means by which effectuation can be implemented through existing governmental channels. Or, if no means can be found to implement recommended uses in their entirety, a re-examination of type III land classification may be necessary to ascertain what land uses, other than those recommended, may be practicable.

Eleven of the seventy-five projects treated in this survey of land classification are described as dealing with program effectuation. Some of these projects are concerned only with publicly owned land allocated to a governmental agency for administration. Typical of these projects are those conducted by the National Park Service and the United States Forest Service on lands set aside, respectively, as national parks and national forests. In both cases, plans for development are adopted and land classification is carried on as part

of the management plan for each park and each forest. Thus, in some parts of the country, type V classification has been utilized for some time and over areas of considerable size.

Prominent among the projects dealing primarily with privately owned land is the County Agricultural Land-Use Program. This program gives special attention to the particular measures, devices, lines of public, group, and individual action needed to accomplish the land use, land conservation, and rural rehabilitation goals or plans formulated under the area-planning and classification work. The participation of local farmers is an essential element in each step of the program. The decisions reached by these farmers, with the aid and advice of technicians, are expressed in operations on their own land. These decisions for action reduced to map form constitute type V classification.

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## CHAPTER III. PERSPECTIVE

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### Land Classification in the Nineteenth Century

#### Surveying Land for Sale

Some phase of land classification has occupied the attention of the Federal Government ever since the adoption of the Constitution. The first phase, or as some see it, the preliminary phase, consisted of the segregation, measurement, and subdivision of land for sale. The new Government needed income desperately and land was its major resource.

When the Union was established the Government became custodian or trustee of lands ceded from the States, in part under the Confederation and in part under the Constitution. These lands, known as the public domain, were organized into geographic divisions and under the ordinance of May 20, 1785, were ordered surveyed.<sup>1</sup> The ordinance stipulated that the land should be divided into 6-mile squares called townships and that the officer in charge was to be known as the "Geographer of the United States." Serving under him were several surveyors and these men carried out the subdivision of land preparatory to sale. Although the famous ordinance with its bare provisions and its lack of reference to scientific methods of procedure was crude and indefinite, nevertheless it was authentically strong and clear-cut in purpose.<sup>2</sup> It established the rectangular system of land survey as the framework of land use over much of the United States. This system marked the initial legal step in land surveying under the new Government. From the outset, therefore, land classification was concerned with the survey of land areas for sale, in other words with the creation of a pattern of property units which could be owned by individuals and on which they could live and work.<sup>3</sup>

The adoption of the rectangular system of land survey represented an important step in the evolution of land classification and in the development of a land policy. It was preceded and followed by other steps. The

significance of the matter is shown by the Congressional debate over the Ordinance of 1785. Opinion was about equally divided between those who advocated the survey and identification of land by a fixed and accurate system and those who adhered to the older method of indiscriminate location.<sup>4</sup> The latter had been the common practice in most of the Colonies but the former was favored by most of the delegates from New England where the more accurate rectangular system of land disposal had been in the process of formation for more than a century.<sup>5</sup> In 1784 the survey plan was recommended by a special committee of the Continental Congress under the chairmanship of Thomas Jefferson, and later by such influential leaders as James Monroe, William Grayson, Rufus Putnam, and Thomas Hutchins.<sup>6</sup> After prolonged and forceful debate the bill became a law on May 20, 1785.

The period between 1785 and the creation of the General Land Office in 1812 demonstrated that effective land surveys depend upon efficient administration and an evolving technique as well as upon acts of Congress. As has been stated previously, the Act of 1785 was phrased in general terms and Thomas Hutchins, the first administrative officer, did much to clarify the issues. In 1796 Congress changed the title of Geographer to Surveyor General, and Rufus Putnam was appointed to the post. At this time the surveys were confined to Ohio, and Putnam introduced the present system of numbering sections, or running their boundaries on the ground, and of "throwing the excess and deficiency of measurement on the north and west exterior boundaries."<sup>7</sup>

To Putnam's successor, Jared Mansfield, appointed by President Jefferson in 1803, goes the credit for introducing scientific method into the survey. He

<sup>1</sup> Proudfoot and Johnson, *op. cit.*

<sup>2</sup> *Ibid.*, pp. 12-13. The origin of the idea of mathematical land surveys carried back to Colonial days in New England. When settlements spread to the Merrimac and Connecticut valleys it became evident that a definite and just plan of land disposal should be formulated. Such a plan was developed in Massachusetts where grants of land known as "towns" were made after the land had been surveyed and recorded. Experience showed that an area of about 36 square miles was a practical size and the first grant in the form of a 6-mile square was made in 1656. Although the boundaries of this town were not run on the cardinals, in shape and area, it was the first township. Not until 1749 in New Hampshire was the first 6-mile square town laid out with boundaries bearing north and south and east and west.

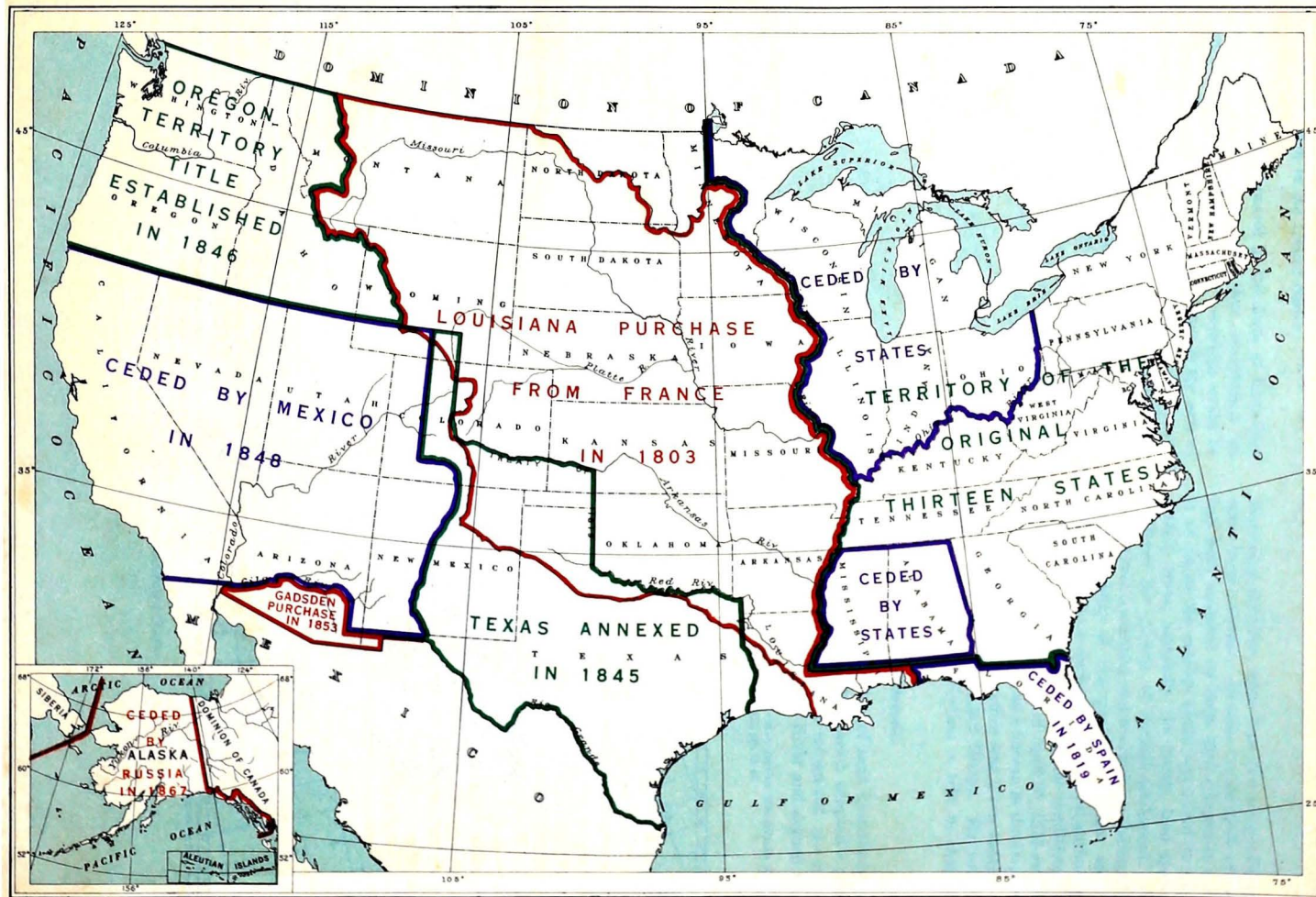
<sup>3</sup> William Grayson of Virginia had the responsibility of framing the ordinance and guiding it through Congress. General Rufus Putnam had been chief of engineers of the Continental Army and a practical surveyor; Thomas Hutchins had served as geographer-general under General Greene and had published, *Topographical Description of Virginia, Pennsylvania, Maryland, and North Carolina* (1778), and *History, Narrative, and Topographical Description of Louisiana and Western Florida* (1784). After the adoption of the rectangular system of survey he was appointed to the post of "Geographer of the United States."

<sup>7</sup> Proudfoot and Johnson, *op. cit.*, p. 15.

<sup>1</sup> Donaldson, Thomas, *The Public Domain*, H. R. Ex. Doc. 47, Part 4, 46th Congress, 3d Session, Washington, 1884, pp. 65-81, 170, 178, and 196-197.

<sup>2</sup> Proudfoot, S. V., and Johnson, F. M., *Public Land System of The United States*, General Land Office, Department of the Interior, Washington, 1924, p. 12.

<sup>3</sup> Although land surveying of this sort may not be regarded as land classification by some, others argue that a definition of the boundaries of the sovereign domain is the oldest form of land classification. They contend that this form of land classification began when man abandoned a nomadic existence to establish permanent homes and subsequently evolved into the elaborate pattern of artificial boundaries which today subdivide substantially the entire world into nations, states, communities, and small individual property ownerships. The initial step in this classification is the establishment of boundary marks on the ground. It is followed by the preparation of suitable maps and field notes to establish a permanent record of these locations. Elaborate procedures usually are established by law not only for recording the boundaries but the designation of successive ownerships of lands within the various types of boundaries.



MAP SHOWING THE ACQUISITION OF THE PUBLIC DOMAIN

introduced primary control in the form of base lines and principal meridians and thus established an accurate framework in which the townships could be laid out. However, no provision, either in the acts of Congress or the administrative procedure, was made for offsetting the effects of convergency of meridians. This important addition was introduced by Edward Tiffin, the first Commissioner of the General Land Office under the Act of April 25, 1812. The work of these men acting under the acts of Congress developed the land survey which one authority has called "The most thorough and effective system of land identification ever devised."<sup>8</sup>

The subdivision and survey of the public domain went rapidly after 1803 but not rapidly enough to keep pace with settlement and with the ever-increasing land problems. Settlers moved into the public domain in

<sup>8</sup> *Ibid.*, p. 9. In the process, many technical improvements have been made. During one period, moreover, the demand of the public for land was so great that the practice of orienting the major lines of the surveys to latitudinal and longitudinal lines "appears to have fallen into desuetude." The resulting absence of accuracy in pattern led to many disputes and to costly litigation and in time the system of accurate measurement was reintroduced. See Wheeler, Capt. Geo. M., *Report upon United States Geographical Surveys West of the One Hundredth Meridian*, Engineer Department, U. S. Army, Vol. I, *Geographical Report*, Washington, 1839, pp. 407-408; and Powell, John W., *On the Organization of Scientific Work of the General Government*, Washington, 1885, pp. 1, 10, 12, 15.

increasing numbers, some from the eastern States and some from overseas. In some States much of the land had been acquired by large land companies who held it at prices the settlers could not afford to pay. In certain areas, especially the South, land speculation hindered the growth of normal settlement. Almost everywhere conflicting and overlapping claims added to the complexity of the problem.<sup>9</sup> These and other problems led to a demand for a central authority with power and personnel to meet the conditions. As a result Congress by its Act of April 25, 1812 established the General Land Office as a bureau of the Department of the Treasury. This office was given charge of the public lands of the United States. Its subsequent relation to land classification is told in chapter VII of this report.

**Acquisition of the Public Domain**

Even before the system of land identification and disposal was perfected the Nation adopted a policy of land acquisition. Jefferson recognized the great importance of the Mississippi River and argued that the

<sup>9</sup> Conover, Milton, *The General Land Office*, Service Monographs of the United States Government, No. 13, Baltimore, 1923, pp. 15-17.

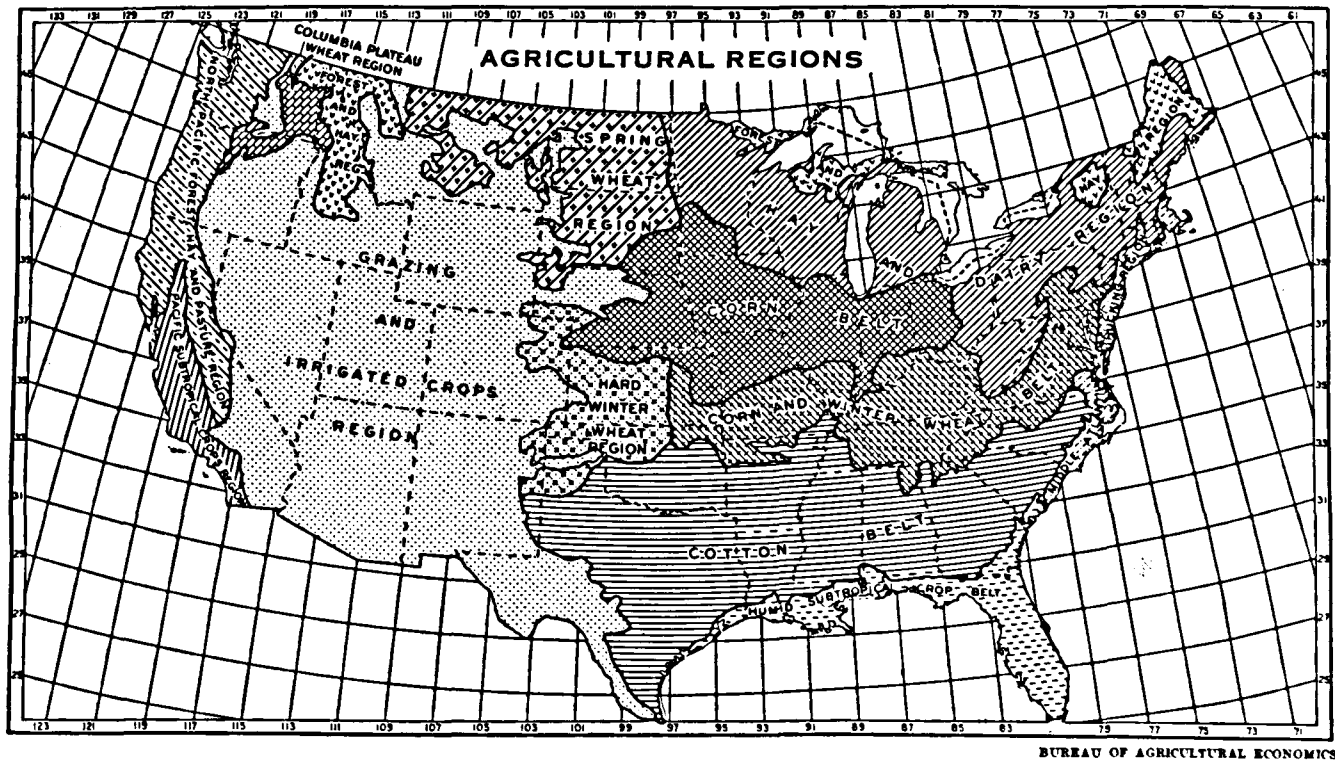


FIGURE 1.—Agricultural Regions of the United States

Gulf of Mexico was the only natural southern boundary of Eastern United States. In the fifty years following the Louisiana Purchase of 1803, five other large additions were made to the area of the public domain (map facing p. 10). Texas, never a part of the public domain, was added to the Union in the same period. Taken together, these acquisitions produced a huge national unit within middle latitudes and with a long frontage on both the Atlantic and Pacific Oceans.

The new territory not only increased enormously the area of the public domain but added greatly to our land resources and our land problems (figs. 1, 2, 3, and 4). The Louisiana Purchase, for example, added, among other things, the areas which now contain the western section of the Corn Belt, the Spring and the Winter wheat regions, and the vast grasslands of the northern and central Great Plains. The purchase from Texas added another large section of the Great Plains, a section included in the "Dust Bowl" of recent memory. The Oregon Territory gave us the vast lumber resources and, eventually, the grain economy of the Pacific Northwest. The Mexican cessions meant California with its gold rush, its exotic climate, its varied agriculture, and its present acute land problems, and, by way of good measure, also included the copper deposits of Arizona, Utah, and Nevada, and the grazing and irrigated industries of the interior basins and pla-

teaus. These are by no means all that the additions to the public domain brought into the national scene. Other areas with other resources and subsequent land-use problems were included. Rich lands in need of drainage and others in need of irrigation, and climates in variety ranging from that of the winter playgrounds of Florida to that of the mountain section of Montana were acquired. Fertile prairies, grassy plains, arid wastes, and forest-covered mountains add to the diversity. Inherent in this diversity was a wealth of opportunity for settlement and development, but inherent also were the perplexing land-use problems now confronting the Nation. It is not surprising, therefore, that the Federal Government charged with the administration of these lands resorted to land-classification surveys as a means of learning about the resources and opportunities of these vast areas. In fact the names of such Government organizations as the General Land Office, the Geological Survey, the Forest Service, the Soil Survey, the Soil Conservation Service, and the National Park Service suggest not only the resources contained in the public domain but the use of the survey method in describing and delimiting them.

Following the Louisiana Purchase, the Lewis and Clark expedition dispatched by Jefferson initiated a period of exploration and discovery. The striking

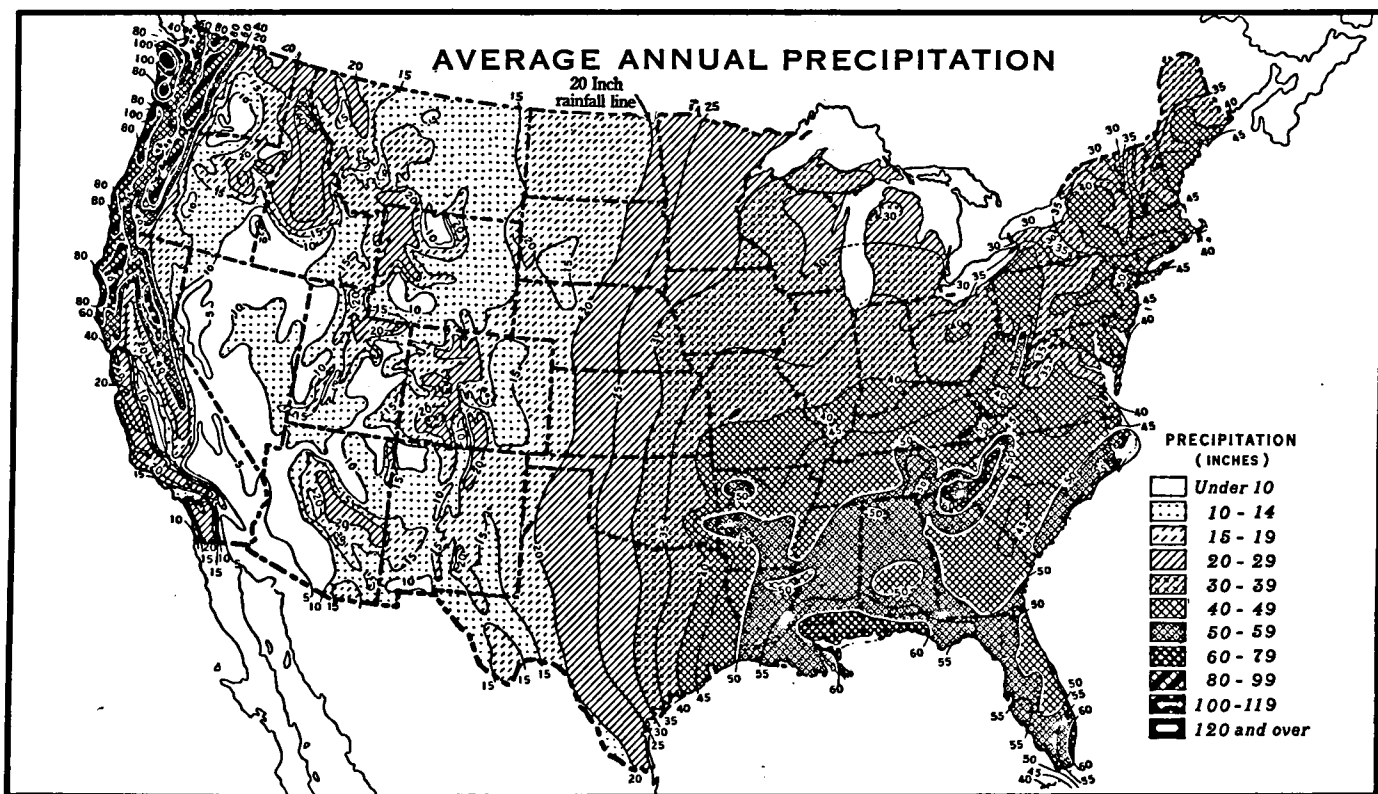


FIGURE 2.—Average Annual Precipitation in the United States

results of the early expeditions excited the curiosity of the country and men of widely varying interests gave their time, their money, and in many cases their lives to the exploration of the "Great West." From these explorations came books, pamphlets, and reports in great number. Much of the writing, however, was fragmentary in coverage and vague as to locality, and thus was contrary to the edicts of good land classification. These documents were useful in filling in the chasms in the maps, but they gave little or no real information about resources and the conditions to be met from locality to locality.<sup>10</sup>

#### Segregation and Survey of Land Areas

The idea of segregating land areas for particular uses appeared early in the history of the Nation. The idea found expression in the policy of segregating the Indian tribes in definitely delimited areas, most of which were carved out of the public domain (chapter XIII). It also found expression in 1832 when Congress, in order to prevent private exploitation of a particular natural resource, set aside the Hot Springs area of Arkansas for use by the people of the United States (chapter XIV). These beginnings of the idea

<sup>10</sup> Colby, Charles C., "Changing Currents of Geographic Thought in America," *Annals, Assoc. Am. Geogr.*, vol. XXVI, No. 1, March 1936, pp. 4-7.

of land segregation foreshadowed important developments of later times in which land classification has had and is having an active part.

Toward the end of the first half of the nineteenth century spectacular events, like the war with Mexico and the discovery of gold in California, and great questions, like the hope for railroad connection with the Pacific coast, created a demand for reliable information about the West. As a result several land surveys came into being. Two of note were the joint survey of the United States and Mexican boundary in 1854-56 and the survey of possible railway routes to the Pacific in 1853-55.<sup>11</sup> These undertakings added to the developing of the technique of field mapping and to the description of areas. During the Civil War work of this kind was suspended, only to appear in great quantity and quality after the war was over.

The first great flowering of land classification, as we think of the term today, occurred in the twelve years from 1867 to 1879. The work took form in the four

<sup>11</sup> Emory, Maj. William H., *Report on the United States and Mexican Boundary Survey, Made under the Direction of the Secretary of the Interior*, H. P. Ex. Doc. No. 135, 34th Congress, 1st Session, Washington, 1857, vol. I, and *Reports of Explorations and Surveys to Ascertain the Most Practical and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, 1853-55*, S. Ex. Doc. No. 46, 35th Congress 2d Session, Washington, 1855-56, 12 vols.



FIGURE 3.—Relief Map of the United States

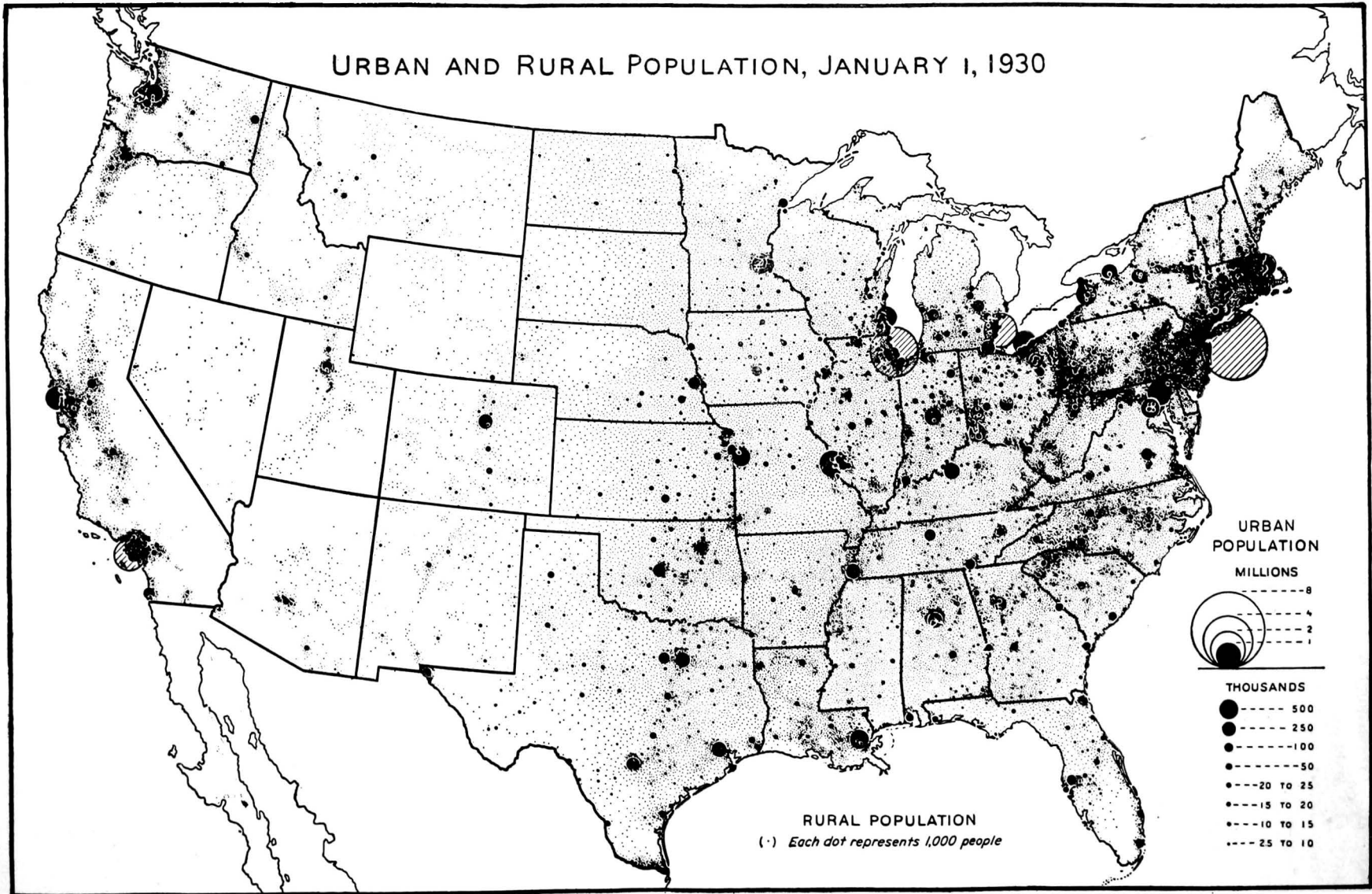


FIGURE 4.—Distribution of Population in the United States

famous geographical and geological surveys under Hayden, Wheeler, King, and Powell.<sup>12</sup> In terms of land classification the surveys under Hayden, Wheeler, and Powell produced results of much significance. Their surveys were in the arid, semiarid, and mountainous sections of the public domain. These surveys mapped the areas which they covered, and all were interested in the uses of the land, both actual and potential. Wheeler points out that, "As early as 1872 the instructions required observations upon the various natural resources of the area being surveyed topographically. The systematic classification of the land over conjoining areas was attained in 1874, and continued with increasing detail until the close of the field work."<sup>13</sup> As might be expected the classifications of the three surveys differed as to the items segregated, but all of them dealt with agricultural and irrigable lands, timbered tracts, grazing or pasture lands, mineral lands, and wastes or barrens. They presented their results in finely executed maps accompanied by volumes of description. Wheeler, for example, devotes the first of seven volumes to a *Geographical Report* and brings out the relation of the growth of population to water supply, the percentage of arable land to the total area surveyed, the position of agricultural land on valley floors and plains, the relation of irrigation to the chemical and mechanical quality of the water, the need of drainage in irrigated areas, and the importance of unity of ownership of land and water in irrigated communities. Major Powell, likewise, gave much time and thought to land problems. In his classic report on the lands of the arid region he presented a plan for "The Land System needed for the Arid Region." Subsequently he attempted to interest Congress in legislation for the wise use of the western lands. These two notable volumes, together with Hayden's "Report on the Arable and Pasture Lands of Colorado," take high rank among the publications dealing with land use and land classification in this country.<sup>14</sup> Their maps, drawings, panoramic sketches, engravings, and photographs of these surveys are remarkable for their artistic values as well as their scientific merit.

<sup>12</sup> Hayden, F. V., *United States Geological and Geographical Survey of the Territories, 1867-1879*; Wheeler, Capt. Geo. M., *United States Geographical Surveys West of the One Hundredth Meridian, 1869-1884*, Engineer Dept. U. S. Army; King, Clarence, *Geological Exploration of the Fortieth Parallel, 1870-1880*; and Powell, Maj. J. W., *United States Geological and Geographical Survey of the Rocky Mountain Region, 1874-1879*. For list of publications of the King, Hayden, Wheeler, and Powell Surveys see Schmeckebier, L. F., *Catalogue and Index of the Publications of the Hayden, King, Powell, and Wheeler Surveys*, U. S. Geological Survey, Series G., Miscellaneous 26, Bull. 222, Washington, 1904.

<sup>13</sup> Wheeler, Capt. Geo. M., Vol. I, *Geographical Report*, op. cit., p. 223.

<sup>14</sup> Wheeler, Capt. Geo. M., *Report on United States Geographical Surveys West of the One Hundredth Meridian, Topographical Atlas*, including land-classification maps of parts of seven States, and *Geographical Report* (Vol. I), including Chaps. III and V and Appendix B; Powell, Maj. J. W., *Lands of the Arid Regions of the United States*, Washington, 1879, pp. 27-45; Hayden, F. V., *Geological and Geographical Survey of the Territories, Geological and Geographical Atlas of Colorado*, 3 pages, 20 maps. Washington, 1877, and "Report on the Arable and Pasture Lands of Colorado," *Tenth Annual Rept.*, Washington, 1878, pp. 313-347.

History repeats itself in land classification, as in many other things, for just as this report of 1940 indicates interest in purposes, organization, methods, personnel, and results, so do the reports of the land surveys of 1867 to 1879. Wheeler, for example, writes, "Hence the nature of the survey, its organization, methods and results, should be held subordinate to the industry to be assisted or (to) the specified want. . . . In the main, then, the extent of the survey should be governed by the requirements . . . while the quality of the results should in every instance be dependent upon the amount of exactness and detail necessary, but will in great measure, however, be governed by the skill of the individuals secured for the task."<sup>15</sup>

That land classification has scientific values and perplexing technical problems was demonstrated by the manner in which the four surveys of 1867 to 1879 were superseded by a single organization. In 1878, in connection with the discussion of appropriation for the four surveys then under way, Congress in the sundry civil bill of June 30, 1878, asked the National Academy of Sciences to prepare a plan for ". . . surveying and mapping the Territories of the United States on such general system as will, in their judgment, secure the best results at the least possible cost; . . ." In December of the same year the Academy submitted its report and made recommendations which led to the discontinuance of the four surveys and the establishment of the present United States Geological Survey.

The momentum in land classification gained in these surveys, unfortunately, did not carry immediately and fully into the new survey, even though both the scientific and congressional sponsors of the new survey intended that it should. The committee of the Academy in its report recommended, among other things, that in the disposition of the agricultural, mineral, pastoral, timber, desert, and swamp lands, a thorough investigation and classification of the public domain was imperatively demanded.<sup>16</sup> Furthermore, Clarence King, the original director of the new survey, pointed out that the legislation creating the bureau imposed two special and distinct branches of duty, namely, "1. The classification of the public lands; and 2. The examination of the geological structure and mineral resources."<sup>17</sup> The first of the two duties was not carried out for many years, however.

<sup>15</sup> Wheeler, Capt. Geo. M., Vol. I, *Geographical Report*, op. cit., p. 417.

<sup>16</sup> The committee included such famous men as Marsh, Dana, Rogers, Newberry, Trowbridge, Newcomb, and Agassiz. See *Centennial Celebration of the United States Coast and Geodetic Survey*, Washington, 1916, pp. 47-48; see also Smith, George Otis, and Others, *The Classification of the Public Lands*, U. S. Geological Survey Bull. 637, Washington, 1913, pp. 11-13; and Woodruff, G. W., "Classification of the Public Lands," *Annals, Am. Acad. Pol. and Soc. Sci.*, Vol. XXXIII, Jan-June, 1909, pp. 605-610.

<sup>17</sup> King, Clarence, *First Annual Report U. S. Geological Survey*, Washington, 1880, p. 5.



## Land Classification at the Turn of the Century

### Land Exploitation versus Land Conservation

The idea of settlement and development permeated the land laws of the country at the turn of the century. The three decades following 1880, for example, were characterized by rapid settlement of arable lands and by an accompanying development of timber and mineral resources.<sup>18</sup> The railway pattern of the country was completed, irrigation was introduced in the West, and the wheat regions and the corn and dairy belts appeared in the national scene. All of these things contributed to and modified the national economy. Much of the national strength springs from them.

The three decades preceding 1910 contributed largely of liabilities as well as assets. Settlement moved too fast and too far. With a sublime faith that the national resources were unlimited, land was despoiled and resources exploited. Agriculture was carried to semiarid, to cut-over, and to other submarginal land where the odds were against rather than in favor of the settlers. The inevitable awakening occurred with organization of a vigorous conservation movement which claimed public attention just after the turn of the century, although it had begun to take form much earlier. In 1866, for example, the Commissioner of the General Land Office directed attention to the fact that the reserve of timber in the Lake States was diminishing rapidly, and that the trend in this connection was a matter of serious concern to the Nation. At the time, his statements and others in kind were like lone voices raised in a wilderness, but at length the conservation movement, supported by a vigorous President, awakened interest in the formulation of new land policies and incidentally in the services of land classification.

Although land classification probably lost rather than gained ground in the two decades preceding 1900, the years just preceding and following the turn of the century witnessed the beginnings of several important developments in land classification. These developments were associated with the growing idea that land resources should be utilized on a long-run basis. Thus, practically every phase of the conservation movement called for some form of land classification, and in several instances the need for classifying the land was recognized specifically by Congress or by certain of the State legislatures.

### Land Classification in the Reclamation of Arid Lands

Land classification has played and is playing a vital part in the reclamation of the arid lands of Western

<sup>18</sup> Smith, George Otis, and Others, *The Classification of the Public Lands*, Bul. 537, U. S. Geological Survey, Washington, 1913, p. 7.

United States. As early as 1878 Major Powell focused attention on the water problems of the arid West.<sup>19</sup> Later (1888), when he was director of the Geological Survey, he secured authorization for an inventory of sites which might be used for reservoirs and of the lands which would be made susceptible to irrigation if such reservoirs and associated facilities were constructed.<sup>20</sup> Powell organized a large force and segregated 127 reservoir sites and large areas of irrigable land in five different basins. Public sentiment in the West, however, did not support segregation on such a large scale, and in 1890 the Act of 1888 was repealed, except as to reservoir sites. The maps produced were of enduring value and the idea continued. It found expression in the Cary Act of 1894, in the Reclamation Act of June 17, 1902. Under the terms of the latter, land classification became a part of the Federal program of reclamation. In this program, land classification performs various functions among which are the segregation of areas suitable for irrigation projects and the delimitation of the quality and quantity of arable lands within a given project. Experience has shown that both good land and good water are essential for successful irrigation. The economic and social elements also are important, and reference to the accompanying chapter XII shows that in the development of a modern reclamation project all types of land classification may be called into action.

### Land Classification within Forested Areas

Land classification within forested areas has been closely associated with the administration of the national forests. The first forest reserves were designated under the provisions of the Act of Congress of March 3, 1891.<sup>21</sup> This act authorized the President to set aside forest reserves from the public domain. Although it provided for the reservation of land for timber purposes, it did not provide for the administration of the reserves. In 1897, however, Congress provided for the survey of the public lands that have been or may hereafter be designated as forest reserves by "Executive proclamation" and specified that the

<sup>19</sup> Powell, Maj. J. W., *Report On The Lands Of The Arid Region Of The United States*, pp. 25-45.

<sup>20</sup> Joint Resolution of Congress on March 20, 1888, and Act of Oct. 2, 1888 (25 Stat. L., 526). See Smith, George Otis, and Others, *The Classification of the Public Lands*, U. S. Geological Survey, Bull. 537., pp. 14-15; and *The U. S. Geological Survey, Service Monographs of the United States Government*, No. 1, New York, 1918, pp. 17-21.

<sup>21</sup> As early as 1870, societies and associations were formed to develop public sentiment for forest conservation, and in 1873 the American Association for the Advancement of Science memorialized the Congress on this subject. In 1875 the American Forestry Association was founded specifically for the purpose of advancing the principles of forestry. In 1876, Congress authorized a Federal Commission to study ways in which timber in the existing forests might be protected and timber growing encouraged. Five years later Congress established the Division of Forestry in the Department of Agriculture. In this connection it should be remembered that land disposal was still the rule, and practical forestry as known today continued to lag. The investigations of the division, however, helped to arouse public opinion, and the act of 1891 resulted.

surveys should be made under the supervision of the Director of the United States Geological Survey. The need for land classification in part grew out of the fact that, under the Act of June 4, 1897, lands chiefly valuable for their minerals or for agriculture were not to be included in the forest reserves. Work was begun in the Pacific Northwest by the Division of Geography and Forestry under Henry Gannett.<sup>22</sup> In the next eight years this division classified and mapped 110,000 square miles. This was the largest land-classification project attempted in the United States up to this time. The maps and reports have stood the test of long use and are highlights in the record of land classification in this country.<sup>23</sup> During this period the administration of the reserves was vested in the General Land Office. In 1905, however, the land-classification work and all other Federal forest work was consolidated in the Bureau of Forestry of the Department of Agriculture and this bureau became the present Forest Service.<sup>24</sup>

Until 1911 all national forests were set aside from the public domain. In that year Congress passed the Weeks law which authorized Federal purchase and administration of forest lands. This led to the establishment of national forests outside of the public domain, more especially in the eastern parts of the country. Naturally this brought the land classification and other activities of the Forest Service into new areas of operation.<sup>25</sup> One of the outstanding land classification activities of the Forest Service is described in chapter IX.

#### Soil Surveying

Soil surveying, one of the most significant forms of land classification, also came into evidence at the turn of the century. The idea of soil surveying, insofar as it concerned the soils of the United States, originated with Milton Whitney, the first director of the Soil Survey. In 1897 the Survey sketched the outlines of a system of soil classification.<sup>26</sup> In March of 1899, Congress appropriated money "to enable the Secretary of Agriculture to map the tobacco soils of the United States." Experimental work was carried forward in a small area in Virginia by differentiating soils on the basis of the fineness or coarseness of the particles of which the soil is made. Mapping also began in the tobacco-growing section of the Connecticut Valley.<sup>27</sup> By the end of 1900 soil surveys had been made of 12

areas. During the following years the surveyors learned that other characteristics of soil were of great importance, and these were added to texture as a basis for soil differentiation.<sup>28</sup>

Credit for the study of soils, as distinguished from the survey or mapping of soils, does not belong alone to the Federal Government. The first work appears to have been done in Albany County, New York.<sup>29</sup> Subsequently the record shifts to Philadelphia in 1826; to Massachusetts in 1841; to New York (first agricultural map) in 1846; and to Kentucky in 1854, the latter being considered the beginning of the systematic study of the soils of the country by means of chemical analysis.<sup>30</sup> Later studies were carried on in Alabama in 1881-82, in Wisconsin in 1882 (first map in which soils were classified according to their physical characteristics) and in Maryland under Milton Whitney in 1891. All of these undertakings were part of the geological or natural history investigations.

Another current of interest in soils started in the Weather Bureau shortly after it was transferred to the Department of Agriculture in 1889. This Bureau studied the relation of temperature and precipitation to soils and in 1894 created a Division of Agricultural Soils. Meanwhile, the results of Whitney's work in Maryland had been published by the Department of Agriculture, and in 1895 the soil work of the Weather Bureau was made a separate division in the Department, with Professor Whitney as its head. The name was changed to the Division of Soils in 1897 and to the Bureau of Soils in 1901.

The development of soil surveying in the United States illustrates the close inter-relation of technique and science. As the work in soil classification progressed, it made important contributions to soil science and conversely, as soil science advanced, its basic understandings and assumptions profoundly affected soil classification.

The early work in soil surveying was closely associated with geological investigations and was based on the assumption that soils were merely geological formations utilized by nature for the growth of plants<sup>31</sup> and that there was a close relationship between the geology of a region and the characteristics of its soils. Under these assumptions the geological formations of the region furnished a basis for grouping the soils in the early work of the Soil Survey. A so-called province map was constructed in 1907 and 1908 on the basis almost entirely of geological characteristics with practically no

<sup>22</sup> In this work Gannett capitalized his experience in the Hayden survey, especially his study of land classification in Utah. See Gannett, Henry, "Report on the Arable and Pasture Lands of Colorado," *Tenth Annual Report of the Geological and Geographical Survey of the Territories*, Washington, 1878, pp. 311-347.

<sup>23</sup> See, for example, *United States Geological Survey, Professional Papers*, No. 4, series H, Forestry, 1 and No. 9, series H, Forestry, 6.

<sup>24</sup> The U. S. Geological Survey, *Service Monographs of the United States Government*, *op. cit.*, p. 22.

<sup>25</sup> Chew, Arthur P., *The Response of Government to Agriculture*. Washington, U. S. Government Printing Office, 1937, pp. 43-44.

<sup>26</sup> *Ibid.*, p. 34.

<sup>27</sup> *Ibid.*

<sup>28</sup> Weber, Gustavus, A., *The Bureau of Chemistry and Soils*, *Service Monographs of the U. S. Government*, No. 52, Baltimore, 1928, pp. 84-102.

<sup>29</sup> "A Geological Survey of the County of Albany," *Memoirs of the Board of Agriculture*, New York, vol. I, 1821, *Miscellaneous Papers*, pp. 1-51.

<sup>30</sup> Weber, *op. cit.*, pp. 85-88.

<sup>31</sup> Marbut, C. F., *Soils of the United States*, Part III, *Atlas of American Agriculture*, Washington, 1935, p. 2.

reference whatever to soil characteristics.<sup>32</sup> Work on this basis continued to 1917, but after 1917, partly as the result of growing acquaintance with the work of Russian soil scientists and partly as the result of investigations by soil scientists in this country, the old assumption was replaced by one founded on the characteristics of the soil itself. Soil is no longer looked upon merely as a geological formation utilized by nature for the growth of plants but instead as a dynamic natural body in equilibrium with its environment.<sup>33</sup> In harmony with this idea, the present classification of soils, like that of any other natural bodies having distinctive characteristics, is based upon the inherent characteristics of the soils being surveyed.<sup>34</sup> This concept is far-reaching in its effects, for it means new vision in the use of soils, in the methods of soil conservation, and in farm-management programs. That all this advance in soil science rests in considerable part on the understanding gained in classifying and mapping soils in different sections of the country and in different parts of the world is probably a conservative claim.

#### Classification of Mineral Lands

Classification and mapping the mineral lands of the country constitutes one of the long-range land-classification functions of the Federal Government. The work has been carried on by the Geological Survey for more than a half century. The results, published in the form of maps and reports, make an illuminating, though far from complete, record of the nation's mineral resources.

Public interest in the classification and segregation of the mineral lands within the public domain was stimulated by the discovery in 1905 and 1906 that, by means of agricultural entries, large areas of valuable coal land had been obtained from the Federal Government.<sup>35</sup> Revelation of such facts shocked the public and in consequence the Secretary of the Interior, acting on Presidential order, withdrew from entry and settlement large areas of public lands which were known to be, or from geological evidence were thought to be, valuable for deposits of coal, petroleum, phosphate rock, or other minerals. These withdrawals protected the Government's interests pending examination and classification as to their mineral or other resources and the enactment of legislation providing for their disposition. At the time, this action led to considerable opposition, but the perspective of years

has shown that it was abundantly justified.<sup>36</sup> The areas involved were so large that the classification of the land could not be carried on fast enough to prevent interference with settlement under the agricultural land laws. This conflict of private and public interests led to the developments in the mineral land laws and the classification of mineral lands described in chapter VIII.

#### Classification of Scenic Resources

Exploration of the West revealed areas of surpassing scenic beauty and of great scientific interest. The idea of setting aside such areas as national properties for the good of all the people developed about 1870 in connection with the surveys of the area now included in Yellowstone National Park. Congress recognized the value of the idea and created this Park in 1872. By 1899, four more national parks had been established and by the turn of the century the idea of parks for public use had become a national policy. In 1900 the idea was broadened to include "American antiquities" and, following a series of opinion-forming conferences in 1911, 1912, and 1915, the National Park Service was established by act of Congress.<sup>37</sup>

As time went on the concept of recreational areas was added to the original idea of scenic parks and national monuments. States and even some counties became interested. As a result State parks, county forest reserves, and other recreational areas have been set aside for public use. The segregation and development of these areas under Federal, State, and local agencies have called for studies and plans involving land classification in one or more of its types. A review of this work in terms of the Federal Government is contained in chapter XIV.

#### Classification of Grazing Ranges

Settlement in large sections of the West depends upon the quantity and quality of the natural forage on the grazing ranges. Large portions of these ranges are still under the Federal Government as national forests, grazing districts, Indian reservations, or as otherwise reserved public domain. For many years livestock were grazed on the public lands by whoever got there first or could hold the range against others.<sup>38</sup> The law establishing the national forests, moreover, did not provide for control of grazing in these forests, but control was established by administrative function and subsequently was upheld by the courts. Beginning with the great geographical and geological surveys of the

<sup>32</sup> Marbut, C. F., in Weber, *op. cit.*, pp. 91-98.

<sup>33</sup> Kellogg, Charles E., *Development and Significance of the Great Soil Groups of the United States*, U. S. Department of Agriculture, Miscell. Pub. No. 229, Washington, 1936, p. 9.

<sup>34</sup> *Ibid.*, p. 7.

<sup>35</sup> Smith, Geo. Otis, and others, *The Classification of the Public Lands*, U. S. Geological Survey, Bull. 537, p. 36.

<sup>36</sup> *Back of The Buffalo Seal*, Department of the Interior, Washington, 1936, pp. 50-51.

<sup>37</sup> *Ibid.*, *op. cit.*, pp. 86-94.

<sup>38</sup> *Ibid.*, *op. cit.*, p. 99.

"seventies," men have recognized that these public grazing lands were in danger of deteriorating through overgrazing and wind and water erosion. The issues were complicated by laws looking to the settlement of the ranges as, for example, the Dry-Farm Homestead Act of 1909 and the Stock-Raising Homestead Act of 1916. Under the latter the Geological Survey began a classification of lands in the public domain to determine their suitability for grazing homesteads of 640 acres each. The experience of settlers under these laws combined with investigations of governmental and private agencies finally led to the enactment of the Taylor Grazing Act by Congress in 1934. Under this act all public lands were withdrawn from public entry or selection until they could be classified into grazing districts as described in chapter XVI.<sup>99</sup> As several Federal agencies are charged with administration of range areas and as land classification is necessary to their administration these agencies have agreed on the range survey procedures described in chapter XV.

#### Conservation and Classification Under State Auspices

The developments in land policies, land laws, and land classification under the Federal Government during the conservation movement were paralleled to some extent by activities under State auspices. Several States established conservation commissions or departments of which a few have continued to the present. Geological and natural-history surveys have been and still are active in many States. Most of these, however, antedated the conservation movement by many years. Several States developed soil surveys, others made progress dictated by their special resources. States with large cut-over areas, like Michigan, Wisconsin, and Minnesota, became active in the forestry movement. This interest, however, did not stop settlement in the cut-over lands, for the "land boomer" insisted that agriculture was the best use of these lands. In Wisconsin, for example, the recommendations of forestry were pushed aside in favor of creating a "second dairy empire". It cannot be argued that land classification *per se* was a part of the work of all of these state agencies, but in many cases it was. In some cases the early work led eventually to some form of land classification.

#### Present Situation and the Future

The World War and the multiplicity of events which followed it profoundly disturbed the national economy and added enormously to land-use problems. Inflated values and speculation turned men's minds away from, rather than toward, the essentials of wise land use. The years of depression following 1930, however, witnessed striking developments both in the technique of land classification and in the application of the re-

sults of land-classification surveys to land-use problems.

As might be expected, in the attempts to find cause and cure for these troubles, some of the long-range surveys of land resources were accelerated and new systems of inventory and appraisal were developed. These newer surveys have arisen in part out of programs for the correction of the misuse of resources and in part out of attempts to stabilize the national economy. Thus, when the public welfare is the issue, we turn again to the tools of intelligence and the findings of science.

#### Current Federal Developments

In terms of administration and in large measure in terms of the underlying motivating ideas, the expansion of land classification during the last decade has been of a dual nature. Part of this expansion has been in the long-established bureaus where land surveys are a recognized and definitely authorized part of the program. Another and very challenging aspect of the expansion has been associated with new "action" agencies which have come into being to meet the grave land-use problems of recent years.

Among the interesting current developments in land classification in long-established bureaus are the inventory and appraisal of forested areas in the "Nation-Wide Forest Survey" of the United States Forest Service (chapter IX); the development of range surveys in the West under a cooperative agreement by four governmental agencies (chapter XV); the land survey by the Office of Indian Affairs in connection with the new policy of adding land to the Indian Reservations in order to bring the reservations to reasonable working units in terms of the welfare of the Indians (chapter XIII); the recent developments in soil surveying under which use capability is emphasized; and the authorization of a Nation-wide classification of lands for recreational purposes under the Park, Parkway and Recreational Study Act of 1936 (chapter XIV).

Examples of land surveys organized to meet the needs of newly launched programs under recently established agencies are furnished by the work of (1) the Soil Conservation Service (chapter XI), (2) the Tennessee Valley Authority (chapter XVIII), (3) the "Area Land Use Planning in Montana" under the Montana State College and the Department of Agriculture (chapter XX), and (4) the land-classification work in which local people are cooperating as a part of the "County Agricultural Land Use Planning Program" (chapter XXIII). Each of these developments has made important contributions to land-classification technique.

#### Present Status Under State Auspices

Land Classification wholly or partially under State auspices is a part of State land-use programs in many

<sup>99</sup> *Ibid.*, pp. 98-102.

States. The tabular statement (chapter V) contains a selection of work from 19 different States, but this by no means completes the list. State agricultural colleges or their associated experiment stations carry on some of the land-classification activities; in some States the universities sponsor it, and in others some land-classification work is done by the State geological surveys. The interest of State planning boards represents a new factor in the land-classification activities of several States.

The purposes of the land-classification work, if one may judge by the statements of the agencies concerned, vary greatly. Interest in soil productivity for land-use planning or for land-use adjustments is a purpose mentioned in many cases, but other stated purposes include land classification looking toward improved tax assessment, recommendation as to the use of marginal farm land or as to land desirable for settlement, information concerning the nature and extent of mineral and water resources, and inventories of physical characteristics and economic conditions. In Wisconsin, land classification proves to be a useful part of the county zoning movement, and in some of the other States the work reflects special resources and special problems.

In general land-classification surveys of any particular type in any given State are incomplete. This makes it difficult to judge the full utility of the land-classification activities. In California, for example, air photographs of uniform scale and standards were available at the beginning of 1940 for only 28 percent of the State, and topographic maps considered adequate were available for only 21.4 percent of the State. Soil surveys considered adequate for present and future requirements were available for only 21 percent of the State. Vegetation surveys and maps, in terms of field work, have been completed for 30 percent of the State, but adequate maps are published for only 2 percent of its area. Furthermore, less than 4 percent of the State is covered by adequate geological surveys and maps, and the soil-conservation surveys are only well started.<sup>40</sup> These facts suggest that, in spite of the large amount of land-classification work under way, the results fail to give a State-wide picture in any important respect.

Highly significant current developments in land classification come from New York and Michigan. The work in the former represents the contribution of agricultural economists, soil scientists, and others confronted with problems of research in farm management, with controversial questions connected with submarginal land purchase, with the improvements of rural roads, with the extension of electric power lines, and other problems in kind (chapter XIX). In Michi-

gan the legislature authorized a land and economic survey in 1917. The survey was devised as a basis for the solution of the serious land-use problems which had developed in the cut-over areas in the northern part of the State. The work enjoyed the cooperative interest of many of the leading scientists of the State and of business men and others interested in land-use problems. The original survey ended in 1933, but recently land classification has attained new status in connection with the expansion of the State Department of Conservation (chapter XVII).

#### Objectives and Utility of Present Programs

Broadly speaking, the objective of land classification is to influence people to make wise decisions about land and its use. A more definite objective than this broad general one, of course, will be needed to show what form a particular land classification project should have. Indeed, a clear understanding of purpose in definite, concrete terms always is essential to efficient procedure.<sup>41</sup>

Land classification, in one form or another, has been and is being undertaken for a host of special purposes. It is being used to determine the location of small-water facilities (Project 3); to tell which national forest lands could be alienated for farming (Project 9); to determine the number and distribution of livestock to be permitted on national forests (Project 11); to select areas for national parks (Project 18); to locate desirable irrigation and power projects (Project 22); to select areas to be irrigated within irrigation projects (Project 23); to locate the sources of minerals (Projects 32 and 34); to secure more equitable assessment of land for taxes (Projects 60 and 74); and to help prevent undesirable uses of land through the exercise of rural zoning (Project 75). These are but a very few of the special purposes to which land classification is committed.

Interest in the objectives of land classification is evidenced by such current questions as: Is it good procedure to classify the land with the idea of serving only a single purpose? Would it not be better practice to design the classification to serve a whole series of purposes? Would not the latter avoid the necessity of going over an area again and again, first to classify the land for one purpose and then for another?

In reply to the foregoing questions it may be said that a land classification designed for a single purpose usually succeeds in serving its purpose, because when only a single purpose governs the work, that purpose is likely to be clearly understood and definitely stated. In this connection it should be understood that much of the really active and serious interest in land classifica-

<sup>40</sup> *Surveys and Maps in California*, California State Planning Board, Sacramento, 1940.

<sup>41</sup> For a more extended treatment of this subject the reader is referred to Barnes, C. P., *Land Classification: Objectives and Requirements*, Resettlement Administration Land Use Planning Publication No. 1, Washington, D. C., February 1936, pp. 1-44.

tion has arisen on the part of agencies with a job to do that required some form of land classification for its execution. For the most part this kind of interest was concerned only with the kind of land classification necessary to carry out the task in hand and not with the subject of land classification as a whole.

There can be no doubt, however, that many land-classification procedures can be and should be designed to serve a number of purposes. Some of the 75 projects described in this report have been used successfully for a whole series of related purposes. Project 59, Land Classification by the Cornell University Agricultural Experiment Station, will illustrate this point. By helping the State acquire poor farming areas for public forests, this land classification has helped to avoid the waste of human labor and capital which inevitably result from attempts to farm such poor areas. It has been used to help highway departments improve roads in areas where the intensity of land use justified it, and to discontinue roads in other areas where they were no longer needed. It has been of assistance to electric power companies in planning their lines so as to service areas where the land uses require power and to avoid areas where power is not needed. It has helped credit agencies avoid losses by delineating the high-risk areas, and it has aided the State Extension Service in planning its programs by delineating the areas where different types of extension programs are required. Finally, it has helped individual farmers by pointing out lands which are suited to intensive farming uses, other lands which are suited to extensive farming uses, and still others unsuited to farming at all.

Land classification of the sort employed in New York tends to aid in the integration and coordination of land-use activities. It does this by pointing out the land-use goals toward which all the different measures, programs, and activities affecting land use should be directed. While this form of land classification serves a variety of related purposes, it, of course, may not serve purposes of a different sort. In fact, it can be said with assurance that no one land-classification procedure has ever been or is likely to be devised to answer all the particulars about the use of land.

#### Looking Forward

Perspective is not easy to attain in terms of the present and is even more difficult in terms of the future. Nevertheless, certain trends in land classification are sufficiently discernible to warrant the hope that they will be developed and accelerated.

Systems of classification have been devised for each of the Nation's major land resources. Some are more advanced in technique and in coverage than others. All of them have produced beneficial results, and all of

them promise more important results in the future. It is hoped and expected, therefore, that these basic surveys will be continued and accelerated in the future.

The trend toward the multiple and integrated use of water, mineral, forest, and other land resources is likely to quicken interest in land classification. Integrated use calls for long-range planning and involves all types of land classification. This should mean increased coverage for types I and II and increasing use of types III, IV, and V.

The future probably will witness a clearer understanding of the importance of securing adequate coverage in land-classification projects within given time intervals. Piecemeal classification may help to improve methods and technique but may fail to furnish the materials and understanding needed for the development of land-use policies and programs. When this idea of adequate areal coverage within a given time interval becomes more widespread, legislative bodies may allocate funds for land-classification work on a long-term basis. Such budgeting may increase the utility of land-classification work out of all proportion to the cost.

Although many workers are expert in some phase or phases of land classification, it is to be expected that an increasing number of men will become more widely experienced in land classification than at present. A broader understanding of all types of land classification might promote efficiency in the administration of land-classification projects. To this end it is to be hoped that the maps and other results of land-classification activities will be more widely and readily available than at present.

Finally it is hoped and expected that time will bring greater use of land-classification work. The utility is there if only it can be brought out and applied in the solution of land-use problems.

#### Land Classification's Debt to Congress

Land has been and still is the greatest natural asset of the country. Settlement and use by a vigorous and diverse people brought forward perplexing legal, technical, financial, and administrative land problems. In the solution of these problems the Congress has drawn on many techniques but probably upon none more persistently than land classification.

The record of land classification shows that commonly each important phase of the work has developed in a longer or shorter period of evolution. As a rule the evolution has progressed from the original stage of idea, to an authorization by the Congress or a State legislature, and then to a period of trial and error in which administration is set up, purposes clarified, technics and methods developed, results checked, and public reactions tested. Subsequently, the program of

which the land classification is a part may be redrawn and returned to the Congress or other legislative body for new authorization. In some instances, in deference to public opinion the Congress has repealed the original legislation. In most cases, however, it has enacted new legislation allocating the program and the land classification work to a reorganized existing agency or to a new

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agency organized for this special purpose. Throughout the century and a half in which this process has been going on, the Congress by its debates, its special commissions, and its enactments, has shown a commendable insight into land problems and a persistent determination to use land resources for the good of the individual and the welfare of the Nation.

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## CHAPTER IV. RECOMMENDATIONS

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The accompanying study of land classification in the United States is a report of present status. It attempts to show what types of work are being done, how, where, and how much is done, by what agency it is done, and for what purpose. During the progress of the investigation, certain conclusions in the general field of land classification have become sufficiently clear to justify the recommendations which follow. These divide into three groups: (1) recommendations of desirable developments in the objectives, technics, and utility of land classification; (2) recommendations calling for accelerating the basic surveys of land resources; and (3) recommendations of desirable further work in the general field covered in this report.

It is recommended:

1. That land classification be recognized as desirable and in many cases essential in the appraisal of land resources, in the solution of land-use problems, in the formulation and execution of land-use programs, in the integration of different programs of land use, and in the development of policies under which the country's land resources will be utilized for the good of local, State, regional, and national interests.

2. That in the future, as in most cases in the past, land-classification surveys be staffed by competent personnel and directed by administrators experienced in the organization of land-classification surveys and in the application of the results of land-classification work to specific problems and programs. In this connection, it should be understood that land classification and mapping call for specialized technics, good judgment, honest execution and scientific knowledge.

3. That land-classification maps be made a matter of mature cartographic effort to the end that they may reveal clearly the classes which they aim to express, and that the associated reports be so planned and executed as to lead to prompt and effective utilization of the results of land-classification activities. In this connection, it should be understood that accuracy and comparability contribute to public confidence in land-classification maps and reports and thus to the public's use of them.

4. That within a given system of land classification an effort be made to define the land classes in terms which are comparable in the different areas or regions where the work is done. However, standardization in the definition of the classes should not be carried so far as to force the use of a rigidly defined classification in areas to which it is poorly suited.

5. That agencies conducting land classification examine their work in terms of the five types of land classification defined in this report, to the end that (a) the validity and utility of these types in the field of land classification may be tested under practical circumstances, (b) agreement in land-classification terminology may be more nearly achieved, and (c) the definition of the field of land classification may be further clarified.

6. That, as a working rule, recurring efforts be made to clarify objectives of land-classification projects and that land classification be tested as to its effectiveness for its recognized objective. Even though the land classes are defined in quantitative terms, in many cases testing the work by additional statistical compilations and summarization during its progress may result in greater clarity and effectiveness. For example, a land-classification survey meant to measure the opportunity of farmers to earn income and accumulate capital (such as the New York classification, chapter XIX) should be accompanied by studies of incomes received and capital accumulated in different land classes. It is believed that such testing will lead to improvements in methods of classification and mapping.

7. That the data on each item dealing with the qualities of the land (Type I) and each item dealing with the use of the land (Type II) be recorded in such a way that (a) the two sets of data are kept separate, (b) individual items in both sets of data can be mapped and studied separately, and (c) the individual items in either set of data can be studied in relation to all other items for a specific area or throughout the distribution of the items.

8. That the matter of timing of programs of work be given sharper consideration both by agencies concerned with land-classification surveys and by the legislative bodies which authorize and finance them. In general, the sooner the results of land-classification surveys are available the greater the value they will have.

9. That the facts and findings of land-classification surveys be utilized in planning and effectuating land-use programs. To this end every agency or part of any agency engaged in collecting facts and stating findings concerning land classification should have a full understanding of the needs for planning and effectuating the land-use programs for which such work is undertaken. Likewise, every agency or part of any agency engaged in planning or effectuating land-use



programs requires adequate facts and findings as a basis for action. The principle involved in this recommendation requires active cooperation and mutual understanding between the personnel engaged in land-classification activities and the personnel engaged in administration of land-use programs.

10. That in Type IV land classification, which directly concerns the public, care should be taken to state the recommendations so that they are recognized mainly as directional guides. The avoidance of an implication that the recommendations call for immediate action will do much toward the acceptance of the recommendations as intended.

11. That in recording the results of their surveys those in charge of specific land-classification work in local areas recognize that the maps and other materials produced by their surveys have scientific and historical, as well as immediate utilitarian values and should be prepared, as far as practicable, with these ends in view. Also, if it is practical for them to make these materials available for consultation, that they notify the recommended continuing committee and other appropriate agencies as to when and where these materials may be consulted.

12. That, although no one system of land classification for all purposes is practicable or desirable, leaders in land classification consider ways in which and the extent to which the results of land-classification surveys may be displayed and discussed in comparable terms. Such consideration might take the form of periodic conferences sponsored by interested organizations.

13. That research and experimentation in methods of obtaining materials to supplement field observations be encouraged, more especially in gathering data having social, economic, and political implications.

14. That appropriate government agencies and interested scientific groups outside of government circles be encouraged:

(a) To develop methods of reconnoitering an area before a decision is made as to which type or types of land classification will serve best the needs of the land-use problems of the area. How to view an area in terms of existing or prospective problem programs? What to look at? Where to stop? With whom to talk? What are the critical items of visual evidence? These and other questions in kind are some of the considerations involved in this type of work. The preparation and publication of a well worked-out document along this line is recommended;

(b) To develop methodology for rapidly classifying and mapping selected features of the land over wide areas. Something more accurate than reconnaissance is needed, but the method must secure coverage of large areas, in limited time intervals, and at low cost.

In some cases, this type of work might be useful in supplementing maps based on county or minor civil division census data.

15. That land-classification maps be more widely used in making studies of the effect of variations in the character of the land upon such direct and indirect land-utilization activities as crop and livestock production, farm and home management, land taxation, marketing, rural electrification, road improvement, farm fire insurance, and agricultural credit. By relating such studies to land-classification maps, it becomes possible to generalize and apply to entire land classes facts observed in representative portions of these classes. These studies, and the experience gained in applying their results, are also valuable tests of the practical value of land-classification methods.

16. That the National Resources Planning Board invite the cooperative effort of interested State, Federal, and other agencies in securing and subsequently maintaining adequate aerial photography of all parts of the country. Many of the areas remaining unphotographed are those in which no one agency has sufficient need for photography to justify its bearing the entire cost, but in which, if several agencies were willing to combine their funds in proportion to the extent of their interest, adequate photography probably could be secured. This recommendation is in accord with the demonstrated utility of aerial photographs and mosaics, not only in land classification and land planning, but in the construction programs and administrative work of both government and private agencies.

17. That basic fact-finding land-classification surveys leading to the discovery and wise development of the land resources of continental United States and outlying possessions, to promote the welfare of the Nation in times of peace and its safety in times of emergency, and to promote the welfare of the several States, Territories, municipalities, and private citizens, should be continued on an increasing scale commensurate with governmental, industrial and other needs. These surveys which are of major importance include the following:

(a) Accurate base maps, which can be promptly made available for areas on convenient scales for all other land-study activities;

(b) Soil resource maps which disclose adequate information to permit planning land-use activities without avoidable depletion of soil resources;

(c) Mineral resource maps which disclose distribution, character, and economic value of all mineral deposits;

(d) Recreational resource maps which adequately cover the needs of the people and show irreplaceable scenic and historical sites of national importance which should be preserved;

(e) Native vegetation resource maps which disclose native forage and forest types and stands;

(f) Water resource surveys which will permit planning maximum economic beneficial use of such resources without impairment in their quantity or quality.

18. That soil types or other physically defined land types be classified according to yield expectancy of given crops under stated types of management practices. This form of classification is especially important in farm management budget analysis, in land appraisal for taxation or for credit extension, and in predicting returns from various alternative cropping systems and practices.

19. That land classification in terms of recommended use be made on a cooperative basis where practicable. It should be recognized that in the long run the effectiveness of this type (IV) of land classification often depends on the extent to which it is understood and accepted by local people. It is recommended that in such cooperation every effort be made to develop the recommendations in terms comprehensible to all parties concerned. The policy should envision group discus-

sion in an effort to reach a common understanding among the various levels of interest, individual, local, State, or national, together with experts in land classification and other technicians.

20. That the Land Committee of the National Resources Planning Board undertake a survey of urban land classification. In this connection it should be noted that the original plan for this report called for a chapter on Urban Land Classification, but preliminary scouting showed urban land classification to be too complex, and its materials too diffused and fragmentary for an effective summation. As a result work on the urban chapter was suspended. The preliminary study showed, however, that a considerable amount and variety of urban land classification is under way in Federal, city, or private organizations, and that in the hands of a competent working committee a valuable and constructive report would be forthcoming.

21. That the National Resources Planning Board establish a continuing committee to act as a central clearing house for land-classification information and for land-classification organizations.

# CHAPTER V. TABULAR STATEMENT OF LAND-CLASSIFICATION ACTIVITIES IN THE UNITED STATES

## FEDERAL AGENCIES I. DEPARTMENT OF AGRICULTURE

Project No.	Administrative unit	Activity	Purpose	Procedure <sup>1</sup>	Resulting materials <sup>1</sup>	Area covered to July 1, 1939
1	Bureau of Agricultural Economics.	County agricultural land-use planning (in cooperation with all land-use agencies of the Department and with State land-grant colleges; farmer committees work cooperatively with local representatives of Federal, State, and local agencies).	To provide local guidance and integration of Department of Agriculture, State and local land-use measures and programs.	(1) Delimitation of areas homogeneous in physical features, present use, and land problems, (2) classification of these areas according to the major uses to which they are suited, (3) recommendation of land uses and land-use adjustments for each area. ( <i>Land-Use Planning Work Outline No. 1</i> , U. S. D. A., Feb. 1939).	County maps showing land-use areas classified according to the major use to which they are suited, accompanied by reports describing the areas and making recommendations which apply to them.	Work in progress or in prospect in 423 counties this year; none completed (ch. XX III).
2	do.....	Area analysis and classification (in many cases in cooperation with State land-grant colleges).	To develop land-use planning procedures, test techniques and uses, and check practicability and accuracy of county land-use planning work (primarily an adjunct to county land-use planning program).	Except that studies and recommendations are made by technicians, procedure is the same as county agricultural land-use planning program.	County maps showing the classification of land-use areas and accompanying reports which describe the areas and make recommendations concerning them. ( <i>A Land-Use Classification of Benewah County, Idaho</i> , Land Economics' Reports No. 2, Bur. Agr. Econ., U. S. D. A., 1939.)	Fergus County, Mont., Benewah County, Idaho, and Forest County, Wis. (ch. XX).
3	do.....	Area planning for water-facilities program.	To determine what facilities (wells, ponds, etc.) will promote good land use in project areas in the arid and semiarid portion of the United States.	(1) Mapping of physical features, present land use, operating units, and water resources, tax delinquency and (2) classification of land according to grazing capacity, recommended land uses, and suitability for development of water resources.	Reports including text, maps, charts, etc., covering areas of water facilities project, which are turned over to Soil Conservation Service ( <i>Water Facilities Area Plan for Subarea I, Cherry-Sulphur Creek Watershed, S. D.</i> , Bur. Agr. Econ., U. S. D. A., Feb. 1939).	Work in progress or in prospect in 110 areas in arid and semiarid portions of Western States.
4	do.....	Flood-control examinations and surveys (in cooperation with Foreign Service and Soil Conservation Service).	To determine type of treatment that should be applied to individual watersheds in the interest of flood control.	(1) Preliminary surveys of watersheds to determine whether a detailed survey is necessary; (2) detailed surveys of, and formulation of plans for correcting conditions in "flood sources" portions of watersheds.	(1) Reconnaissance reports and maps, by watersheds, based on data drawn largely from secondary sources. (2) Detailed maps and reports of flood source areas, based on field work.	Detailed surveys in progress in 20 watersheds.
5	do.....	Special land-utilization study.	To make recommendations concerning the use and management of land, and the relation of public policies thereto.	(1) The classification of land suited to farming and land not suited to farming on the basis of soils, topography, farm income, and cost of community service, and (2) the estimation of forest and recreational opportunities.	Report containing text, maps, etc. ( <i>Economic Utilization of Marginal Lands in Nicholas and Webster Counties, W. Va.</i> U. S. D. A., Tech. Bul. 303, May 1932).	Nicholas and Webster Counties, W. Va.
6	do.....	Land-use classification (in cooperation with Farm Security Administration).	To provide for a guide for land use and land settlement.	(1) Analysis of soil types, topography, present land use, location with respect to markets, etc., and (2) classification of land according to recommended use.	Report containing text, maps, etc. ( <i>Land-Use Classification for Livingston and Tangipahoa Parishes, La.</i> , Farm. Sec. Adm. and Bur. Agr. Econ. Reg. VI, U. S. D. A. Mimeograph No. 3, Nov. 1937).	Livingston and Tangipahoa Parishes, La.
7	Bureau of Plant Industry.	The soil survey (in cooperation with State Agricultural Experiment Stations).	To supply soil data and to discover the areal distribution of soil features which are important in agricultural production, soil conservation, and land-use planning.	(1) Detailed mapping and classification of soils according to their internal and external characteristics, such as soil profile, slope, or lay-of-the-land, drainage condition, stoniness, kind and degree of erosion; (2) the classification of soils according to uses to which they are best suited—crop, pasture, forests; (3) the rating of soil types according to the prospective yield of individual crops under given treatment. ( <i>Soil Survey Manual</i> , U. S. D. A. Misc. Pub. 274, Sept. 1937).	Maps and reports, by counties or areas, showing the distribution of soils and presenting a full discussion of the nature and uses of each kind of soils; tables showing the rating of soil types according to prospective yield. ( <i>Soil Survey of the Price Area, Utah</i> , Bur. Pl. Ind., U. S. D. A., Feb. 1939).	978,000,000 acres covered by 1,457 published reports and maps; 77,000,000 acres additional in which field work is completed, but reports not published (ch. X).

<sup>1</sup> References are noted in cases where reports are available in published form. Those noted under *Resulting materials* in parentheses are samples of a number available.

I. DEPARTMENT OF AGRICULTURE—Continued

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
8	Forest Service.....	Nation-wide forest survey.	To provide a basis for the formulation of forest policies and programs.	(1) Inventory forest resources, rate of growth, and rate of drain, in the West by compiling existing data from timber cruises supplemented by field surveys, in the East by line plots with samples every 10 miles apart; and (2) make estimates, by regions, of forest industry requirements.	Progress reports, by regions, with texts, maps, etc.; final report to present national summary; for West, detailed forest-type maps.	Half the forest area of the country covered by field work (ch. IX).
9	do.....	Classification of land under forest homestead law.	To ascertain which national-forest lands, reserved from the public domain, are suitable for agricultural settlement.	(1) Examination of national-forest lands as to soil, lay of the land, location, etc.; and (2) reaching decisions as to which are suited to farming ( <i>Principles and Procedures Governing the Classification and Segregation of Agricultural and Forest Lands in the National Forests</i> , For. Ser., U. S. D. A., May 4, 1914).	Reports containing text, maps, etc., on file in offices of U. S. For. Ser.	Virtually completed on national-forest land reserved from public domain.
10	do.....	Land-use planning, national forests.	To provide a sound basis for the best use and management of all national-forest resources.	Determination is made on the basis of the need for a particular type of national-forest use. Management plans are made for such uses as timber utilization, grazing, recreation, wildlife, or various combinations of these uses.	Detailed maps, with supplementary material, covering national-forest properties and, for some properties, composite land-use and management plans.	Land-use and management plans have been made for some national-forest properties and others are in preparation.
11	do.....	Range surveys.....	To provide a guide for range-stocking and range-management practices.	Similar to that described under Soil Conservation Service— <i>Range surveys</i> .	Administrative maps and reports filed at National Forest Supervisors' headquarters. <sup>1</sup>	Work either completed or in progress on virtually all national forests having important grazing use <sup>2</sup> (ch. XV).
12	Soil Conservation Service.	Conservation surveys, including the classification of land according to use capabilities.	To provide a guide to the Soil Conservation Service, soil-conservation districts, and farmers in setting up and maintaining desirable land uses and practices.	(1) Detailed mapping of soils, erosion, slope, land use, etc.; and (2) classification of tillable land and grazing land according to how intensively it can be used ( <i>Survey Handbook</i> , Soil Con. Ser., U. S. D. A. Misc. Pub. 352, Aug. 1939).	Maps and reports, by soil-conservation districts and watersheds, covering present land use and land-use conditions and recommended practices and adjustments ( <i>Erosion and Related Land Use Conditions on the Reedy Fork Demonstration Area, N. C.</i> , Soil Con. Ser. U. S. D. A., 1938).	Detailed conservation surveys cover about 37,000,000 acres, and are in progress on about 46,000,000 more. Reconnaissance surveys cover about 285,000 square miles (ch. XI).
13	do.....	Physical and economic surveys of soil-conservation districts.	To provide a basis for soil- and water-conservation plans for soil-conservation districts.	(1) Soil-conservation districts are subdivided into homogeneous areas; (2) economic studies are made on sample farms in each area; and (3) findings are used in developing land-use adjustments.	Mimeographed or dittoed reports containing maps, charts, etc.	Completed in about 5 soil-conservation districts.
14	do.....	Watershed surveys.....	To determine, by watersheds, the relative urgency of land problems in Southwestern United States in terms of need for soil- and water-conservation programs.	Mapping and analysis of (1) physical features—soils, precipitation, etc.; (2) land use—grazing, crops, etc.; (3) social and economic factors—land tenure, taxation, etc.; (4) erosion-control requirements.	Maps and reports, by watersheds in Southwestern United States, presenting and interpreting conditions relating to erosion control in terms of relative need for remedial programs.	Watersheds covered: Price-San Rafael, Utah; upper Colorado, Rio Grande, Virgin-Meadow Valley Wash. Utah-Nevada.
15	do.....	The study of problem areas.	To reach decisions as to the farming systems and practices that are desirable in the interest of soil and water conservation and safe land use.	(1) Thorough analysis and appraisal of present and potential land uses and land conditions; (2) classification of land into homogeneous subregions; and (3) recommending adjustments in farming systems and practices.	Map and report presenting current conditions and problems and recommendations covering changes in farming systems and practices. ( <i>Problem Areas Groups of Land in the Southern Great Plains</i> , Soil Con. Ser., U. S. D. A., Feb. 1939).	Completed on 96,900,000 acres in the Southern Great Plains and in progress in remainder of United States.
(9)	do.....	Flood-control examinations and surveys.	See material under Bureau of	Agricultural Economics.		
(9)	do.....	Studies relating to the water-facilities program.	Do.			
16	do.....	Range surveys.....	To provide basic information on forage resources; problems of management, needs and possibilities of measures for the improvement of range conditions; and economic factors affecting management agencies and local stockmen, for use in promoting proper use of range lands.	Preparation of (1) a map, showing forage types, carrying capacity of areas determined on basis of density of vegetation, forage value of individual plant species, and degree to which they can safely be utilized; and (2) plans for proper number of livestock, correct seasonal use, development, range riding, etc., and, in the case of sheep, proper bedding and herding practices ( <i>Instructions for Range Surveys</i> , Inter-Agency Range Survey Com., U. S. D. A., U. S. D. I., Apr. 24, 1937).	Maps and reports showing range resources, their condition and plans for improvement and management, and agreements with other governmental agencies (Federal and State) and individuals which will effectuate these plans.	Completed on 59,411,000 acres in western range States; includes work done under cooperative western range survey in San Benito County, Calif., Gem and Oneida Counties, Idaho., Petroleum County, Mont., as well as, work in soil conservation districts and demonstration areas (ch. XV).

<sup>1</sup> A number of counties completed under the Cooperative Western Range Survey, an interagency arrangement under which range survey reports were compiled for entire counties, following standard procedure. <sup>2</sup> Included for cross reference and not as separate projects.

## II. DEPARTMENT OF THE INTERIOR

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
17	Bureau of Biological Survey. <sup>4</sup>	Classification of land in wildlife management.	To provide basis for land use and management plans, and maintenance of national wildlife refuges.	(1) Preparation of land use and cover map; (2) determination of deficiencies in needs for particular species of wildlife; and (3) development of land use plans in the interest of wildlife management.	Maps and supplementary information which become part of management plans.	Under way on approximately half of the system of national wildlife refuges; remainder to be completed.
18	National Park Service.	Surveys for park, monument, recreational, and similar use reservations.	To provide an adequate and comprehensive national park system.	Analysis of areas selected for study by administrative and technical experts as to (1) location; (2) accessibility; (3) characteristics—physical, historical, etc.—(4) present ownership, value, use; (5) practicability; and (6) potentialities.	Reports with maps, pictures, etc., mainly for service and departmental use, carrying descriptions, conclusions, and recommendations.	152 public reservations covering approximately 20.5 million acres set apart for recreation (ch. XIV).
19	do	Cooperative surveys of park, parkway, recreational area studies.	To provide a coordinated national program of recreational facilities, adequate for national, State, and local recreational requirements.	Nationwide (1) inventory of present facilities and uses; (2) analysis of needs; (3) inventory of potential areas; (4) classification of areas on basis of best use; and (5) formulation of recommendations.	Reports, usually by States, with maps, descriptive material, plans, etc., and recommendations covering financing, administration, legislation, and similar matters.	24 States completed; all but 4 remaining States in progress of completion (ch. XIV).
20	do	Classification of historic sites and structures.	To provide for the preservation of sites and structures of historical and educational values.	Inventory and analysis of historic and archeological sites and buildings; and the classification of sites according to natural significance, historic interest bearing on recreation and educational values.	Reports and memoranda with maps, etc., mainly for service and departmental uses carrying final recommendation for action.	600 existing or proposed sites scattered throughout the United States (ch. XIV).
21	do	Master plan studies.	To develop National Park Service properties to the end that their objectives will be realized.	Detailed field and office studies covering topography, roads, and trails; general development; fire control; forest types; and compilation of plans for convenient realization of natural scenic and recreational values with a minimum disturbance of natural conditions.	Reports (by projects) showing in map, pictorial and text form the nature of the area, plans for treatment, and factors involved.	Current plans cover all established national park areas (ch. XIV).
22	Bureau of Reclamation.	Reconnaissance surveys under Federal reclamation laws.	To locate irrigation and water power projects of adequate merit to warrant detailed investigation.	Reconnaissance field studies and analysis of data otherwise available to determine (1) engineering feasibility; (2) amount of water required and available; (3) nature and extent of soil resources; and (4) amount and quality of irrigable land.	Reports, memoranda (by projects) with maps, charts, etc., primarily for bureau and departmental use as a basis for appraising feasibility of project and preliminary location of project boundaries.	Several hundred projects examined, all in public land States (ch. XII).
23	do	Inventory and appraisal of land within approved project areas.	To classify the irrigable lands within project areas, to determine the cost of irrigation, and to apportion costs on an acreage basis commensurate with benefits obtained so that settlers on the irrigated land may repay construction charges out of profits from irrigation or water-power development.	Detailed mapping of inherent characteristics of soils with special reference to salt content and other physical features related to problems of irrigation; and classification of land on the basis of practical agricultural utility.	Reports (by projects) with maps, charts, etc., primarily for bureau and departmental use, presenting a thorough analysis of present conditions and potentialities and plans for administrative management.	See index map of projects selected for development (ch. XII).
24	General Land Office.	The rectangular surveys.	To identify and record the type, location and characteristics of lands in the public domain.	Lands are surveyed in township units of 36 square miles each containing 36 sections of 1 square mile each; and field notes are made describing soil, timber, topographic, mineral and cultural features.	Plat maps, by townships at scale of 2 inches to 1 mile, with field notes, are on file in the Washington, D. C. office. State and U. S. maps are published.	(Ch. VII.)
25	do	Tract-book records of all classifications formally promulgated.	To maintain a record on all public lands until title passes from the Federal Government.	Assembly and maintenance by 40-acre tracts of all records pertaining to applications, issues of patents, names of patentees, fees paid, legal description, character of the land, etc.	On file in Washington are 9,500 volumes containing the records for 6,000,000 40-acre tracts including land classification data as required by law.	Tract books cover all present and former public land areas (ch. VII).

<sup>4</sup> The Bureau of Biological Survey was transferred from the Department of Agriculture to the Department of the Interior by Reorganization Plan No. 2, effective July 1, 1939. The Bureau of Biological Survey was combined with the Bureau of Fisheries (transferred from the Department of Commerce to the Department of the Interior at the same time) to form the Fish and Wildlife Service, by the Reorganization Plan No. 3, effective June 30, 1940.

II. DEPARTMENT OF THE INTERIOR--Continued

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
26	General Land Office.	Classification of revested railroad and wagon road grant lands.	To provide a basis for conservation and development of natural resource values.	(1) Assembly of available information on present land conditions and land uses; (2) field surveys of power sites, timber and agricultural resources; and (3) classification of land according to power, timber and agricultural values.	Reports, memoranda, maps, charts, etc., describing lands and recommending types of use and management in file in Washington office.	Preliminary field studies are substantially complete (ch. VII).
27	Grazing Service.	Classification of agricultural utility of public lands.	To furnish information for administration of public land laws involved in applications for surface entries.	Assembly of data on land conditions and land uses from all Interior Department land agencies, and from supplementary field surveys.	Unpublished reports, memoranda with maps, etc., describing conditions and making recommendations concerning policies of land utilization and management.	In progress on all vacant, unappropriated, unreserved public lands of the United States (ch. XV).
28	do.	Range surveys.	(See Dept. of Agr., Soil Conservation Service.)	Assembly of all cadastral, topographic, soil, and other land classification data covering grazing district lands; and field surveys covering vegetative types, density, palatabilities of forage, needed range improvements, etc.	Reports primarily for division and departmental use, memoranda with maps, etc., describing conditions and making recommendations concerning policies of land utilization and management.	(Ch. XV.)
29	Office of Indian Affairs.	Survey of legal status of Indian lands.	To determine forms and condition of tenure so that legal authority and regulation can be adjusted accordingly.	Assembly of all available records, reports, court rulings, legal transactions, and the like covering property ownership; classification of properties according to ownership status; and plotting of classification on record maps.	Maps, with textual interpretations of legal status, covering tenure forms and conditions by divisions of Indian lands; for use, primarily, in office and department.	In progress on all Indian reservations (ch. XIII).
30	do.	Survey of land conditions and land uses.	To provide factual basis for programs of land use including irrigation farming, dry farming, grazing, timber culture, and mineral production.	Assembly of available data on soils, water supply, climatic conditions, mineral resources, etc., supplemented by detailed field surveys covering these and similar factors.	Reports with maps, charts, etc., describing land and land use conditions and recommending policies and plans covering land use and management.	In progress on all Indian Reservations (ch. XIII).
31	Geological Survey.	Topographic mapping.	To show surface configuration, water features, and works and structures erected by man.	Theodolite triangulation and transit traverses to establish horizontal control for locations within the area to be mapped, and spirit leveling to establish a vertical control. Supplemental horizontal control and planimetric details are obtained by aerial photographs. Plane table surveys or aerial photographs may be used to complete the map.	Engraved topographic maps of a convenient scale for general use printed in three colors on sheets measuring about 16 1/4 by 20 inches. The three colors used are black for culture, brown for relief and blue for water features. Each map consists of a quadrangle bounded by parallels of latitude and meridians of longitude and covers a section of a topographic atlas of the United States.	(Ch. VIII.)
32	do.	Geologic mapping.	To study the formations of the earth to ascertain the available sources of mineral fuels, to locate other mineral raw materials necessary in the mineral industries and to locate sources of potash and phosphate necessary for use in preparing fertilizer for depleted soils.	Field studies of rock formations outcropping in the area selected for classification, collection of rock samples for laboratory analysis, correlation of surface formations with those in other areas as a basis for inference of subsurface characteristics where direct evidence is not available.	Land classification reports and maps published in 22 annual reports between 1880 and 1901, 186 professional papers, 900 bulletins, 55 monographs and 225 folios of a geologic atlas corresponding to quadrangles of the topographic atlas.	General areal geologic information is available for the entire United States and detailed studies have been completed in extensive areas of industrial significance in the mining of precious or semiprecious metaliferous minerals, iron, stone, road materials, cement and lime, clay and shale, sand and gravel, coal, oil, and gas. See index of publications issued by the Geological Survey (ch. VIII).
33	do.	Survey of water resources.	Inventory of the quantity, and quality of surface and ground water supplies available for maintenance of the plant, animal and industrial life of the nation; determination of methods and practices to obtain maximum utility for available water resources; and classification of land with reference to water utilization for hydroelectric development for irrigation for flood control, and for navigation.	Establishment and maintenance of gaging stations on surface streams on lakes and reservoirs and in wells at points where water supply conditions require critical analysis in aid of land use activities and field and office studies of all natural and artificial water supply phenomena including laboratory studies to determine quality of water and geologic studies of ground water resources.	Statistical records of stream flow; scientific hydraulic engineering reports; and ground water reports including land classification information concerning areas of special utilitarian values for water development activities. Published periodically in water supply papers of which 850 have been issued to date.	Index of publications issued by the Geological Survey (ch. VIII).

## III. TENNESSEE VALLEY AUTHORITY

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
34	Department of Commerce.	Valley-wide inventory of mineral resources (in cooperation with U. S. G. S., U. S. Bur. of Mines, State departments of conservation).	To provide data covering nature and extent of mineral resources with reference to (1) the effect of the Authority's construction program on these resources and (2) the role these resources are likely to play in the Authority's program of regional development.	Field investigations and library research checking, refining, supplementing and reinterpreting existing data; office analysis and recording of data; publication of maps and reports.	Reports with maps, tables etc. ( <i>Iron, Chromite, and Nickel Resources of the Tennessee Valley Region</i> , T. V. A., Knoxville, Tenn. 1938).	Valley-wide areal coverage; partial topical coverage.
35	Department of Forestry Relations.	Valley-wide inventory of forest resources.	To provide data basic to the policies and programs related to the effective use of lands best suited to timber production to the end that the economic interests of the valley and the protection of watersheds will be served to the fullest extent.	Field mapping (minimum units of 100 acres) of forested areas by type and volume, and sample plots for specie distribution, growth, mortality and cull; office computations, tabulations, analysis; and preparation of maps and reports.	Active file of data and maps; reports with maps and other illustrations presenting current conditions by counties and watersheds; and complete regional reports.	Major portions of the Basin (ch. XVIII).
36	do	Detailed survey of forest resources.	To determine, in connection with land use plans for reservoir properties, the present status and potentialities of forest resources on the margins of T. V. A. reservoirs.	Detailed field mapping of (1) forested areas according to forest types by volume classes, timber species distribution, timber growth by species, accessibility and (2) unforested areas best suited to timber production according to physical features; office computations and tabulations; and preparation of maps. (See Department of Agriculture, <i>Bureau of Plant Industry</i> ).	Active file of data covering items noted; unpublished maps and reports presenting current conditions and recommendations covering future forest development.	Reservoir areas; Gilbertsville, Pickwick, Wheeler, Guntersville, Chickamauga, Hiwassee, Norris (ch. XVIII).
37	Department of Agricultural Relations.	Soil survey of reservoir properties (in cooperation with U. S. Bur. of Plant Ind. and Sta. Exp. Sta.) <sup>6</sup>	To provide soil data covering T. V. A. reservoir properties for use in developing interdepartmental land use plans.		Active file of data and maps covering soil conditions and uses to which soils are best adapted.	Reservoir areas: Pickwick, Wheeler, Guntersville, Chickamauga, Watts Bar, Coulter Shoals, Norris, Gilbertsville (in progress) (ch. XVIII).
38	Department of Regional Planning Studies.	Scenic resources inventory. A functional Classification of present resources and potential recreational developments.	To provide a catalog of factual information as to the nature and extent of those natural resources—lakes, forests, streams, etc.—that are suited to recreational uses in the interest of regional development.	Complete coverage of the Valley with field observations by trained technicians supplemented by local interviews and library research; building up of active data file, photographs, and field notes; and preparation of maps and reports.	<i>The Scenic Resources of the Tennessee Valley</i> , T. V. A., Knoxville, Tenn., 1937. Also unpublished data, records, maps, and pictures on file in T. V. A. Knoxville offices.	Full coverage of Valley (ch. XVIII). 27,000 sq. miles.
39	do	Detailed survey of recreation resources.	To determine the nature and extent of recreational developments, present and potential, on lands bordering reservoirs. Used in the development of land use plans for reservoir properties.	Detailed field investigations of reservoir margins with mapping of present and potential recreational areas classified as to type and function; office analysis of data; and the preparation of maps and reports covering present conditions and potentialities.	Unpublished reports containing maps and other illustrations, analyses of present conditions, and recommendations for future developments. Circulated only in T. V. A. and cooperating agencies.	Reservoir areas covered: Gilbertsville, Pickwick, Wheeler, Guntersville, Chickamauga, Hiwassee, and Norris. Watts Bar and Coulter Shoals to be completed (ch. XVIII).
40	do	Detailed inventory and classification of reservoir margins.	To provide data for use in establishing boundaries for reservoir properties and in developing land use plans to be put into effect after purchases are completed.	(1) Detailed survey of land resources as to present and potential uses; (2) the delimitation and analysis of problem conditions involving the land; (3) the development of land use plans; and (4) the determination purchase boundaries. <sup>6</sup> Field data are recorded on aerial mosaics in form of a fractional code so that items can be studied separately or in combinations for either single units or for large areas made up of many units.	Maps, atlases and reports presenting analyses and interpretation of land conditions, and recommendations covering purchase boundaries and land uses. No data published.	Studies completed for Wheeler, Pickwick, and Guntersville Reservoirs; in progress on others (ch. XVIII).
41	Department of Regional Planning Studies.	Unit area classification of nature and extent of land resources.	To provide a factual basis for a regional understanding of land resources and to provide data for use in direct planning activities.	(1) Field mapping of; slope erosion, and similar land conditions; urban, non-urban land uses; distribution of retail trade; and the like; (2) computation and tabulation of field data; (3) presentation in map form. (Hudson, G. D., "Unit Area Method of Land Classification" <i>Annals, A. A. G.</i> , vol. 26, June 1939, No. 2.)	Aerial mosaics and planimetric maps with field data plotted in full; Holzhirth cards carrying field data and acreages; tables, charts, and maps prepared for report purposes. Materials available in Knoxville office, T. V. A.	Field work completed over 27,000 square miles in southern and east portion of basin. Tabulations completed over 15,000 square miles (ch. XVIII).

<sup>5</sup> Soil surveys are also being conducted cooperatively by the T. V. A. and Federal and State agencies by county units as part of the T. V. A. fertilizer program and as part of the national program of soil surveys. For details see ch. X.

<sup>6</sup> Nos. 3 and 4 are carried out cooperatively with other T. V. A. departments.

IV. RESETTLEMENT ADMINISTRATION<sup>7</sup>

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
42	Resettlement Administration. <sup>7</sup>	Mapping of present land use.	To ascertain the pattern of present land use as an aid to land-use planning and land-use adjustment programs.	In most cases maps were made by plotting data from A. A. A. records.	Maps (mostly unpublished) show the present use of land; most commonly on file in offices of State representatives, Bur. of Agr. Econ., U. S. D. A.	Several Western States; scattered areas elsewhere.
43	do.	Mapping of crop yields.	To ascertain the crop yield experience of localities and soil types so as better to predict what types of cropping systems and land uses are best adapted to specific conditions.	Average crop yields during periods from 3 to 5 years taken from A. A. A. records and plotted in place on maps.	Maps showing distribution of average yields on file in Bur. of Agr. Econ., U. S. D. A.	Wheat region of Washington, Oregon, Idaho, Great Plains region of Montana; scattered areas elsewhere.
44	do.	Land-use classification. <sup>8</sup>	To provide guidance for the local application of land use and related programs.	Counties were broken down into homogeneous areas, after an analysis of the distribution of land characteristics, land-use features, and related factors had been made. These areas were then classified as to whether or not they were suited to farms and as to type of land-use problems.	County maps and reports. ( <i>Land Use Classification of Latah County, Idaho</i> ; U. S. D. A., Res. Adm. Reg. XI, June 1937. <sup>10</sup> )	Boundary County and Latah County, Idaho; Snohomish County (western part) and Grays Harbor County, Wash.; Curry County, Coos County, and Tillamook County, Ore.; Great Plains portion of Montana (cooperating with Sta. Agr. Exp. Sta.); and Albemarle-Pamlico Peninsula and Caswell County, N. C.
45	do.	Classification of operating units, as to their adequacy. <sup>9</sup>	To aid in determining how the land acquisition and development programs of the Administration could be applied locally, so as to effect reorganization of operating units.	Operating units were mapped; income expectancy was estimated; and inadequate units were segregated. These units subclassified according to whether or not more crop land, more grazing land, or both were needed.	Maps and reports covering relatively small areas, representative of larger "problem areas." ( <i>Land Use Problems in Southwestern North Dakota</i> ; U. S. D. A. Re. Adm. Reg. VII, June 1937. <sup>10</sup> )	All of Montana; scattered areas elsewhere.
46	do.	Classification of land according to its productivity, value, and intensity of use to which suited, etc.	To provide a guide for certain public land-use programs.	Procedures differed between regions and States. In most cases the land was divided into fairly broad classes according to productivity, value, intensity of use to which it was adapted or similar features.	Most commonly county maps, sometimes accompanied by explanatory reports.	All of Florida, many counties in Virginia, South Carolina, Georgia, Alabama, Mississippi.

STATE AGENCIES

I. STATE AGRICULTURAL COLLEGES, AGRICULTURAL EXPERIMENT STATIONS, AND EXTENSION SERVICES

47	California Agricultural Experiment Station.	Rating of California soils.	To provide information on soil productivity for land-use planning.	Each soil type is given a percentage rating which expresses its favorableness with respect to agriculture. Ratings are derived by multiplying percentage factors expressing the favorableness of the individual characteristics of soil types to agriculture. ( <i>An Index for Rating the Agricultural Value of Soils</i> , R. E. Storie; Calif. Agr. Exp. Sta. Bull. 556, Sept. 1933.)	Maps and report: <i>A Rating of California Soils</i> , W. W. Weir and R. E. Stone; Calif. Agri. Exp. Sta. Bull. 599, 1936.	Rating of virtually all soil types mapped in California.
48	do.	Land-use planning in the northern Sierra Nevada foothills.	To guide the application of land use and other related measures and programs.	Counties are divided into physical land types. After analysis of costs and returns in different enterprises, lands are classified as to use or combination of uses likely to give highest return.	Bulletins, setting forth conclusions and recommendations. ( <i>The Utilization of Eldorado County Land</i> , David Weeks, et al.; Calif. Agri. Exp. Sta. Bull. 472, May 1934.)	Portions of Butte, Yuba, Nevada, Placer, Eldorado, Amador, Plumas, and Sierra Counties.
49	Georgia Experiment Station.	Classification of land in four piedmont counties (in cooperation with U. S. D. A. Bur. of Agr. Econ.).	To indicate for general use, the relative desirability of different areas for agriculture.	Field examinations of areas, leading to placing the land into classes according to agricultural productivity.	Bulletin with maps: <i>Georgia Land Use Problems</i> , W. A. Hartman and H. H. Wooten; Ga. Exp. Sta. Bull. 191, May 1935.	Jasper, Jones, Morgan, Putnam Counties.
50	Illinois Agricultural Experiment Station.	Soil survey.	To supply soil data and to give geographical expression to the features of the soil, which are important in agricultural production, soil conservation, and land-use planning.	Detailed mapping and classification of soils according to their internal and external characteristics, such as soil profile, slope, or lay-of-the-land, drainage condition, stoniness, kind, and degree of erosion.	Maps and reports by counties, showing the distribution of soils, and presenting a full discussion of the nature and uses of each kind of soil ( <i>Jackson County Soils</i> , Ill. Agri. Exp. Sta., Soil Report, 55, June 1933).	Work completed and reports published for 13 counties.

<sup>7</sup> The Resettlement Administration was incorporated into the Department of Agriculture in 1937. Shortly thereafter its name was changed to Farm Security Administration. A considerable number of the land studies have been discontinued; others have been carried on by other agencies in the Department of Agriculture.

<sup>8</sup> Some of this type of work was begun under the Resettlement Administration and continued under the Bureau of Agricultural Economics as part of the program of *Area Analysis and Classification*. Such work is included under Bureau of Agricultural Economics.

<sup>9</sup> In some cases operating units were simply mapped and classified as to type, size of business, etc., without being classified as to their ability to support a family.

<sup>10</sup> While these reports bear the title of the Department of Agriculture, most of the work was done prior to the time the Resettlement Administration was incorporated into the Department of Agriculture, and is therefore listed under "Resettlement Administration."

<sup>11</sup> Certain activities, which are cooperative with the Department of Agriculture, as, for example, the soil survey and county agricultural land-use planning, are listed under *Department of Agriculture*. Activities such as the type-of-farming area studies are not included because they are not commonly considered to be land classification.



**I. STATE AGRICULTURAL COLLEGES, AGRICULTURAL EXPERIMENT STATIONS, AND EXTENSION SERVICES—  
Continued**

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
51	Purdue University Agricultural Experiment Station (Indiana).	Study of marginal farm land, southern Indiana.	To identify and make recommendations concerning the use of marginal farm land.	A study of the following types of data was made as a basis for the land classification: (1) present and past land use; (2) present organization and financial returns of individual farms; (3) type of soil; and (4) economic problems of maintaining local institutions.	Report: <i>Marginal Farm Land in Southern Indiana</i> , G. E. Young; Purdue Univ. Agri. Exp. Sta. Bull. 376, Mar. 1933.	Gibson Township, Washington County.
52	Iowa Agricultural Experiment Station.	Classification of land according to productivity as a basis for land appraisal and equalization of tax assessments (in cooperation with Res. Admin.).	To develop a procedure of land classification which might be useful in getting more equitable land appraisals.	Soil types and phases were mapped and rated according to agricultural productivity by estimating the annual feed unit production from both crop land and pasture (considering rotations commonly used). Ratings were then correlated with assessed valuations.	Report: <i>Land Classification as a Basis for Land Appraisal and Equalization of Tax Assessment</i> , A. J. Englehorn; Res. Adm., Land Use Planning Pub. No. 8, Dec. 1936.	Nevada Township, Story County.
53	Kentucky Agricultural Experiment Station.	Land-use classification.	To furnish guidance to land-use and related programs and activities.	Considering soil, topography, present land use, and condition of buildings, the land is classified as to its suitability to farming. Classes are similar to those used by Cornell Univ. Agri. Exp. Sta.	Report, with maps: <i>Family Income and Land Utilization in Knox County</i> , W. D. Nicholls, et al.; Ky. Agri. Exp. Sta. Bull. 375, Nov. 1937.	Knox County.
54	Michigan Agricultural Experiment Station.	Classification of land types.	To provide a guide to land-use and related programs and activities.	Areas having a distinct combination of soil types, relief features and topographic forms were outlined, and their agricultural value appraised; individual soil types (minor land types) are characterized and appraised as to agricultural utility.	Report, with maps: <i>Agricultural Land Classification and Land Types of Michigan</i> , J. O. Veatch; Mich. Agri. Exp. Sta. Sp. Bull. 231, Apr. 1933.	Entire State treated in this bulletin; however, field mapping of land types under way in counties lacking detailed soil surveys (ch. XVII).
55	University of Minnesota.	Land-use study (in cooperation with U. S. D. A., Bur. of Agri. Econ.).	To provide a guide for agricultural settlement and land use.	The establishment of conservation zones (zones not suited to farming) on the basis of physical land characteristics, location with respect to community services, etc.	Maps and reports in: <i>A Program of Land Use in Northern Minnesota</i> , O. B. Jesness and R. I. Nowell; Univ. of Minn. Press, 1935.	14 counties in northern Minnesota. Work was extended to cover 8 more counties by the Resettlement Administration, which completed the cut-over part of the State. Entire State (ch. XX).
56	Montana Agricultural Experiment Station.	Study of needed farm adjustments (in cooperation with U. S. D. A., Bur. of Agri. Econ.).	To furnish a guide for land-use adjustments and adjustment programs.	On the basis of maps showing distribution of land characteristics and land use features, counties were divided into homogeneous land use adjustment areas. Analysis of the characteristics and problems of these areas lead to recommendations for land use adjustment in each.	Reports for type-of-farming areas. ( <i>Farm Adjustments in Montana: Study of Area VII, Its Past, Present, and Future</i> ; N. W. Johnson; Mont. Agri. Exp. Sta. Bull. 367, Mar. 1939.)	Entire State (ch. XX).
57	do	Land classification based on soils and production.	To furnish estimates of the expectable production from different soil types for use in farm management and land use planning.	Wheat yield records and grazing capacity estimates were obtained for each of the soil types mapped in a reconnaissance soil survey. The soil types were then graded according to expected wheat yields or grazing capacity.	Maps showing the different grades of land.	27 counties in Great Plains region of Montana (ch. XX).
58	New Hampshire Agricultural Experiment Station.	Study of land-use problems.	To develop a guide for land-use adjustment measures, and related programs.	Analysis was made of farm organization, family living, land use and land use trends, and public services; on this evidence areas were subdivided into areas which were classified according to priority of opportunity, taking account of public service costs.	Report with maps: <i>Land Utilization in New Hampshire—I. Problems in the Back Highland Areas of Southern Grafton County</i> ; Harry C. Woodworth et al.; N. H. Agri. Exp. Sta., June 1937.	Southern Grafton County.
59	Cornell University Agricultural Experiment Station (New York).	Classification of land according to the intensity of use to which it is suited.	To provide a guide for activities concerned with land use and public facilities and to further the development of the economic resources of each grade of land.	Considering soils, topography, elevation, present land use, size and condition of buildings, and results of farm management research, land is put into classes according to the intensity of use to which it is suited. Distinguished are 2 classes of land better suited to forestry and recreational uses and several classes adapted to different degrees of intensity of agricultural uses. ( <i>Methods Used in An Economic Study of Land Utilization in Tompkins County, N. Y.</i> , A. B. Lewis; Cornell Univ. Agri. Exp. Sta. Memoir, 160, 1933).	County reports with land classification maps and tables showing differences between classes. ( <i>An Economic Study of Land Utilization in Tompkins County, N. Y.</i> , A. B. Lewis; Cornell Univ. Agri. Exp. Sta. Bull. 590, 1933.)	Tompkins, Montgomery, Broome, Chemung, Chenango, Cortland, Tioga, Steuben, Genesee, Wyoming, Monroe, Clinton, Schuyler, Rensselaer, Otsego, Yates, and Chautauqua Counties (ch. XIX).

I. STATE AGRICULTURAL COLLEGES, AGRICULTURAL EXPERIMENT STATIONS, AND EXTENSION SERVICES—  
Continued

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
60	North Dakota.....	Classification of rural land on the basis of producing power.	To provide a basis for improved tax assessment.	Natural land types were mapped and rated according to their productivity for cropping or for grazing, depending on which of these 2 uses is best suited to the land. Each ownership tract was then classified as a cropping or a grazing unit, and each tract was rated according to its relative value for 1 of these 2 uses or a combination of the 2. In the rating, account was taken not only of physical productivity but location, availability of water, and other related factors. A standard was determined for the county. Ratines for each piece of property in the county were expressed in terms of percentages of this standard.	A table is supplied to county officials giving, in terms of percentage, the final rating for each "forty" (quarter of a quarter section) according to the lines of the General Land Office. The county officials fix the money value of ideal cropping land and then appraise each piece of land at the percentage of this value given in the final rating.	(Ch. XXII.) McKenzie, Billings, and Morton Counties.
61	Oregon Agricultural Experiment Station.	Land-use classification of Willamette Valley lands (in cooperation with U. S. D. A., Bur. of Agri. Econ. and Res. Admin.)	To provide a guide to farmers and others in the choice of farm enterprises.	Land types (areas having a distinct pattern of soil types) were delimited, characterized, and their suitability to various enterprises indicated.	Report: <i>Willamette Valley Land Adaptability</i> ; H. E. Selby and Leland Fryer; Oreg. Agri. Exp. Sta. Cir. 120, Mar. 1937.	Willamette Valley.
62	Pennsylvania Agricultural Experiment Station.	State-wide reconnaissance land utilization map.	To represent the differences in classes of agricultural areas for general use in land-use planning and policy formation.	Classification based upon an index of crop productivity derived by combining yield with intensity of use, and an index of farm returns per acre of land in farms. Basic data for both indices were taken from the census.	Report, with map: <i>Land Use in Pennsylvania</i> ; P. J. Wrigley; Pa. Agri. Exp. Sta. Bull. 317, May 1935.	Entire State.
63	do.....	Farm management study in Wyoming County.	To study factors bearing upon the success of farming systems in different types of farm organizations.	Thorough mountainous portion of the county was set off from the rest as not suited to farming because of its nonagricultural character.	Bulletin: <i>Land Utilization and Farm Management in Wyoming County</i> , P. J. Wrigley; Pa. Agri. Exp. Sta. Bull. 357, May 1930.	Wyoming County.
64	Vermont.....	Reconnaissance land-use classification.	To provide a guide for land use and related programs.	Four classes were distinguished in terms of soil features, topography, agricultural income, and suitability to agricultural or other uses; field observations were supplemented by interviews with local residents.	Map and accompanying discussion: "An Agricultural Classification of Vermont Lands," John A. Hitchcock; <i>Farm Business</i> , vol. 4, No. 6, Dec. 1937.	State-wide.
65	Virginia.....	Classification of land according to the intensity of use to which it is suited (in cooperation with Res. Admin. and State Planning Board).	To furnish a guide to land-use and related activities and programs	On basis of observations of topography, soil, present land use, and condition of farm buildings (made by driving the roads) land is placed in classes ranging from areas not suited to farming to areas suited to intensive farming.	Maps showing land classes. ("Land Utilization in Bannister River Drainage Area," <i>Virginia Farm Economics</i> , No. 38, May 1937, pp. 596-604).	27 counties.
66	West Virginia.....	Classification of land according to value for agriculture.	For general use, and to provide a guide for land use and related programs.	Generalized slope and soil and soil maps of the State were prepared from topographic maps and county soil maps; considering soil, climate, slope, erosion, costs of production and marketing, and costs of public services, land classes were distinguished in terms of the value of the land for agricultural purposes.	Report with maps: <i>Land Classification in West Virginia, Based on Use and Agricultural Value</i> , G. G. Pohlman, W. Va. Agri. Exp. Sta. Bull. 264, Nov. 1937.	Entire State.
67	Wisconsin College of Agriculture, extension service.	Survey of Langlade County (in cooperation with Sta. Dept. of Agr. and Markets, Sta. Cons. Comm., Sta. Geol. and Nat. Hist. Sur., and Lake Sta. For. Exp. Sta.).	To guide land use and land-use activities and related programs.	Analysis was made of geology, lakes, climate, soil, land cover, forests, and wood utilization; county was divided into good, fair, and poor agricultural land; operating and abandoned farms were located; recreational lands were identified; tax delinquency was mapped; public finance was studied; and use districts for zoning were outlined.	Report: <i>Langlade County, A Survey of Its Natural Resources and Their Utilization</i> , Wis. Agri. Ext. Ser. April 1934.	Langlade County.
68	Wisconsin College of Agriculture, extension service.	Survey of 6 counties (in cooperation with State Dept. of Agri. and Markets, State Cons. Comm., State Geol. and Natural Hist. Sur., and State Dept. of Public Instr.)	To provide a guide for land use and land-use activities and related programs.	Similar to above, except there is no analysis of geology, lakes, or land cover, and counties are not divided into good, fair, and poor agricultural areas.	Reports on 6 counties ( <i>Making the Most of Forest County Land</i> , Wis. Agri. Ext. Ser., 1930).	Marinette County, 1929; Ashland County, 1930; Forest County, 1930; Oneida County, 1931; Taylor County, 1931; Washburn County, 1933.

## II. PLANNING BOARDS

At some time during its activities, virtually every State planning board has been connected with studies involving a consideration of land resources. In some cases there is no other evidence of planning board participation than that the board acted as the publisher of reports covering the work of other agencies. In some cases the record shows that the planning board not only held the role of publisher, but participated in the work reported. There is clear evidence in other cases that the planning board took the leading role in the work reported and published the results, as well. In a few cases the planning board apparently worked and reported independently of other agencies. In all these cases and others where there apparently was no participation by the planning board, it is well known that the State planning boards performed what is perhaps their major functions of stimulating, encouraging, coordinating, helping to plan, and financing the work of other agencies.

The following are only a few examples of the almost innumerable studies to which planning board attention has been given:

Project No.	Administrative unit	Activity	Purpose	Procedure	Resulting materials	Area covered to July 1, 1939
69	Idaho.....	General study of land ownership and use (publication of work of other agencies).	To make data more readily available to public and private agencies whose programs involve the consideration of factors of land resources and land use.	Compilation and tabulation of data from the Bureau of the Census, county court records, and similar sources.	Reports, in most cases for circulation in the State, covering such topics as tax delinquency, wheat yields, and public services.	Complete State coverage.
70	Iowa.....	A study of land, economic, and social problems and methods of attack (participated in group including other State, as well as Federal, county, and private agencies).	To develop methods of surveying any analyzing county problems, working out programs for their solution and putting remedial measures into effect.	A complete assembly and analysis of field and office data covering present land and use conditions, economic problems, problems of public health and services, etc.; formulation of remedial programs.	<i>An Approach to County Planning</i> , Iowa State Planning Board, Des Moines, Iowa, 1936.	Complete coverage of Appanoose County.
71	Massachusetts.....	Survey of land resources and land uses (leading role in group including other State and private agencies).	To provide factual information concerning the nature and extent of land resources, land conditions, land uses, and some physical facilities for use in local and State planning programs.	Assembly and analysis of data mainly from field surveys covering topography, soil classifications, land uses, highway pattern and conditions, etc., and the presentation of results in graphic form.	For each minor political unit, 6 maps: topography, roads and buildings, land utilization, soil classification, roads and waterways, and complete legend.	Complete coverage of State.
72	Virginia.....	Classification of land according to intensity of use to which it is suited (carried on in large measure independently).	To provide factual information for use in developing general overall programs of land planning but more particularly to aid other State agencies in their specific planning problems (ex: the extension, maintenance, and improvement of highways).	Field mapping by trained technicians of land uses, land conditions, and potentialities; checking of data with local county land use committees; and supplementary analysis of tax delinquency, ownership status, tenancy, etc.	Maps, scale 1 inch equals 1 mile, presenting by counties, summaries of items covered in the field.	10 counties (approx. 18 percent of area that is to be covered).

## III. MISCELLANEOUS

73	Michigan Department of Conservation.	Inventory of physical characteristics and economic conditions.	To provide data for use in the administration of State public domain, in guiding the administration of conservation programs (fire control, forestry, fish, game) in public education and in the guidance of public agencies engaged in solution of land use problems characteristic of northern portions of the State.	Using General Land Office maps and (after 1930) aerial mosaics: (1) Soils are surveyed according to Department of Agriculture standards; (2) land is classified according to lay of the land; (3) cover is mapped in detail; (4) an inventory is made of economic conditions; (5) general geology is mapped; and (6) hydrographic conditions are surveyed.	Lithographed and blue print county maps showing (1) base, soil, lay of land, (2) base and farm forests, and (3) base only.	Maps for 7 counties have been lithographed; maps for the additional counties are available in blue print form (ch. XVI).
74	Michigan Tax Commission.	Rural survey of taxable property.	To provide map and tabular data for use of tax assessors in the adjustments of real property assessments.	Field mapping and office tabulations of data covering land ownership, physical characteristics of the land, character of farm buildings, capital equipment, land utilization, and cover.	Blue print maps of ownership, physical characteristics, and land utilization in township units and in generalized form in county units; compilation of maps and data in ledger form for use of counties for county, township, and State tax officials.	Entire State.

## COUNTY AGENCIES

## BOARDS OF SUPERVISORS OR COMMISSIONERS

75	Wisconsin.....	Zoning of rural land for agriculture, forestry, and recreation.	To lay a basis of action leading to the control or preventing of uses harmful to property values or burdensome to other taxpayers.	Under county zoning law (secs. 59, 97, Wis. St., 1929) and with advice of State agencies, classification, on county-wide basis, of lands according to physical character and use condition into unrestricted use areas, areas restricted to forest use, and areas restricted to recreation.	County zoning maps which are basis for enforcement of land-use classes.	24 counties.
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## CHAPTER VI. AERIAL PHOTOGRAPHS IN LAND CLASSIFICATION

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### Importance of Aerial Photographs

Until the last 20 years systematic mapping work of all kinds, such as topographic mapping in the Geological Survey, field operations of the Division of Soil Survey, and mapping of the Coast and Geodetic Survey, have depended almost wholly on ground work for essential base data. Particularly with reference to land classification, the recent advent of photography has radically altered the entire situation. The use of aerial photographs, aerial mosaics, and planimetric maps as base materials has greatly increased the accuracy and decreased the cost of work, has facilitated the procuring of standard data, and has made possible the procuring of land-classification data heretofore relatively unobtainable.

The principal advantages which derive from aerial photography are:

- (1) Accuracy in delineation and mapping of base data, with a minimum requirement of ground control;
- (2) Provision for a degree of detail in many sorts of distributions impossible by any other means;
- (3) Provision of limited possibilities for obtaining interpretations directly from the photographs, and almost unlimited possibilities when photographs are used in conjunction with ground analysis and checking;
- (4) Greater speed in obtaining a base for mapping in the field and plotting field data in the office;
- (5) Relative economy as compared with other methods of securing comparable base materials;
- (6) Greater speed and economy in field mapping and office work;
- (7) Opening of new and challenging methods of land inventory and classification.

### Current Use of Aerial Photographs

The application of aerial photography to survey methods is so broad that it is only possible to cite a few illustrative cases. Essentially, all of the standard survey agencies have adapted aerial photographs to their uses, and in several cases the new methods developed have largely superseded old methods. In addition, many entirely new forms of inventory have been made possible and feasible, and the aerial photograph has become the fundamental base of operations. A few examples of survey and mapping operations employing aerial photographs can be noted as follows:

- (1) Geological Survey (ch. VIII);
- (2) Soil and Conservation Surveys (chs. X and XI, respectively);
- (3) Nation-Wide Forest Survey of the U. S. Forest Service (ch. IX);

- (4) Land Inventory and Mapping in Michigan (ch. XVII);
- (5) Land Classification in the Tennessee Valley Authority (ch. XVIII);
- (6) County Land Use Planning of the Department of Agriculture and Land Grant Colleges (ch. XXIII);
- (7) Range Surveys (chs. XV and XVI);
- (8) Agricultural Adjustment Administration, Compliance Checking;
- (9) Operations of Commercial Photographic Companies.<sup>1</sup>

### Technical Phases of Aerial Photograph Uses

It must be remembered that an aerial photograph is not a map but a picture. In the hands of the beginner it remains just a picture. But study pays remarkable dividends. Reading all that can be seen in the photographs requires many days of checking in the field, determining in what fashion field items have been reproduced photographically. Assuming correct scale and a general knowledge of the area, the experienced worker can distinguish certain crops, forest types, eroding areas, and even the boundaries of some soil types; he can tell which roads are paved and which are unpaved; when the pictures are viewed stereoscopically, he can even read the lay-of-the-land, and many other things.

Making a map from the aerial photograph is possible, but presents complexities that mount according to the degree of accuracy attempted. If there are relief features and no tilt in a photograph, lines of correct orientation can be drawn from the center point of the photograph to the image of any point on the ground, using one of the adaptations of the radial-line method, so that images of points on the ground can be plotted on a map in true position. If there is tilt but no relief features in a photograph, plotting on a map in true position can be accomplished by drawing lines of correct orientation from the nadir (plumb) point of the photograph, assuming it can be located, to the image of any point on the ground. If there are both relief features and tilt on the photograph, there is no point on the photograph from which lines of correct orientation can be drawn. But if the tilt is not too great, it is usually possible to draw lines from the isocenter (a point about halfway between the center and nadir points) which are near enough to true directions to satisfy

<sup>1</sup> Edgar Tobin Aerial Surveys of San Antonio, Tex., has made aerial photographic mosaics of a large part of Texas, Oklahoma, and Louisiana, largely for oil companies. Most of the land data are compiled according to property units, but the photographs in mosaic form offer the land classifier an admirable vehicle on which to plot land classification based on any other system or code desired. Fairchild Aerial Surveys has photographed the entire State of Connecticut and made mosaics from these photographs on which all of the land ownership data have been compiled in what the Fairchild Co. calls "tax maps."

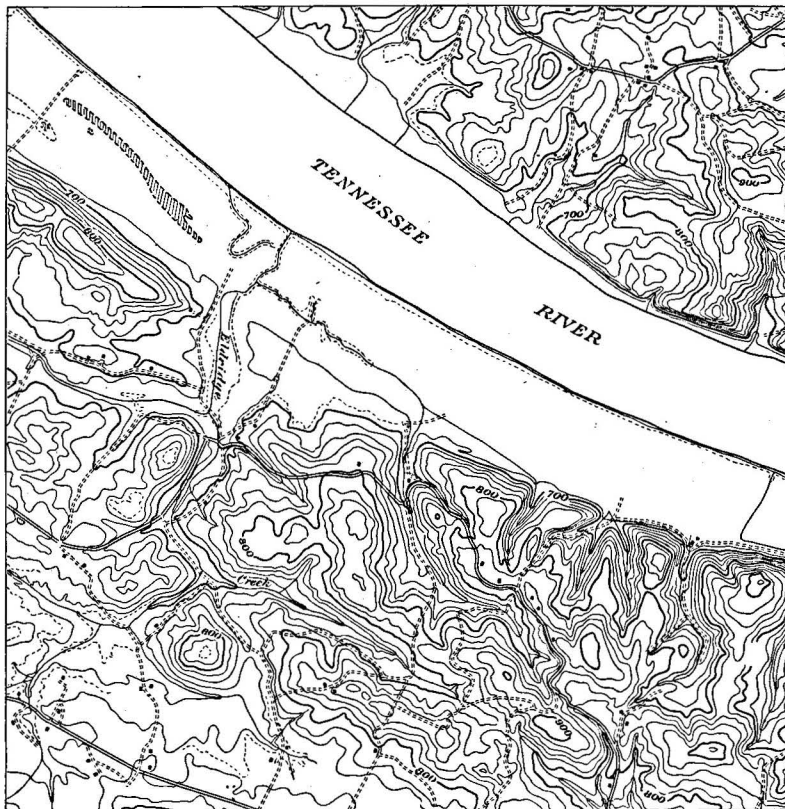
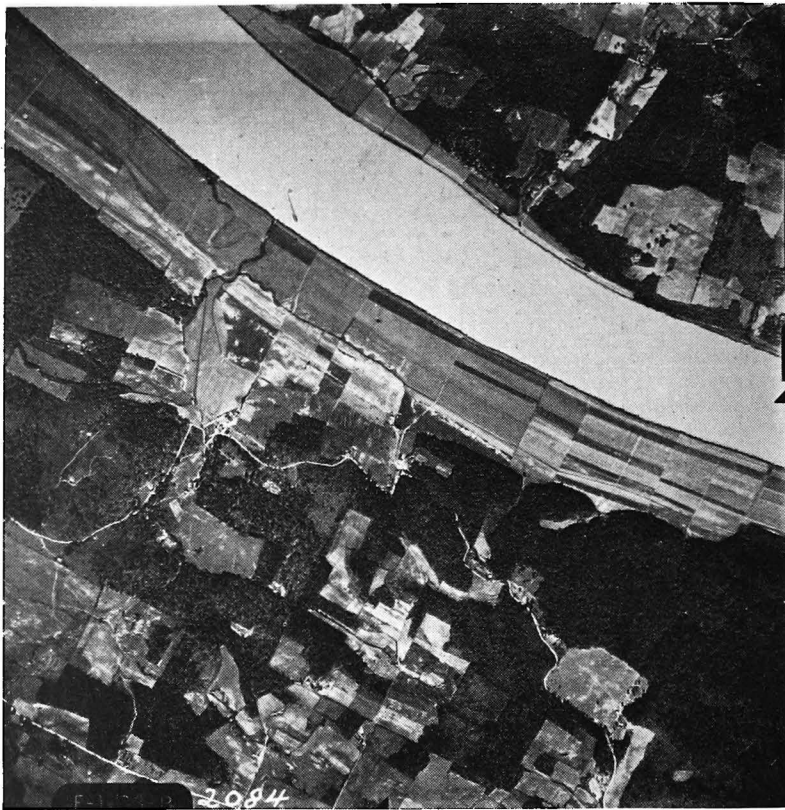


FIGURE 5.—Aerial Photograph and Corresponding Topographic Map Showing a Portion of Hamilton County, Tenn., near Chattanooga

most radial-line work so far as the planimetry is concerned. Naturally, the ideal way is to draw the planimetry in one of the stereoscopic plotting instruments, in which perfect outlines of the plane features of the map can be drawn, provided the required ground control points have been located and identified on the photographic negatives.

The problem of making a mosaic of aerial photographs is much the same as making a map from aerial photographs. The attempt here is to fit a series of pictures exactly into a definite grid so that the distances between all ground images are true in scale to the distances on the ground. It is a question not only of getting all ground images into the grid that should be there, but getting them also in exact relation to each other.

One cannot make a true scale mosaic of rough country because the distance from the camera lens to the ground is shorter to positions of higher elevations than to positions of lower elevations. The resulting photograph will have many scales, not a single scale. Absolutely true distances on such a mosaic are, therefore, impossible. It is possible, however, to make a mosaic that is close enough for most practical purposes, if the mosaic compiler will project each plane of elevation above sea level, and then join together and re-photograph the assembled projections. Most photogrammetrists do not attempt to do this, but simply project the negative to fit three or four plotted control points, the images of which have been identified on the negative.

Furthermore, the problem of preparing a mosaic is to produce one on which the features on the land surface can be identified in position sufficiently correct to permit their classification with the required degree of accuracy. If a perfect base is made by good stereoscopic plotting operations, and if a mosaic is needed, a semicontrolled mosaic will be satisfactory. If a good base map is not available, it may be desirable to make what is called a controlled mosaic. However, if it is intended to publish the mapped data on an accurate base, it will ordinarily be more efficient to map on individual prints and then compile both base map and land classification from these prints. This method has been followed in nearly all of the detailed soil erosion, land use, and cover surveys of the United States Department of Agriculture.

### **Field Use of Aerial Photographs and Mosaics as Base Maps**

Land-classification data can be plotted in the field on individual aerial photographs or on aerial mosaics. If accurate base maps are available, and it is the intention to use them in publishing the land-classification data, it is not worthwhile or necessary for most methods of land classification to compile mosaics, although mosaics can be used if they happen to be available. Field records can be made directly on the individual photographs and later transferred to the base maps.

When rapid, less detailed field mapping is required, there are some advantages in using aerial mosaics, since they cover relatively large areas. This was the case in much of the land classification work done by the Tennessee Valley Authority. The sample offered from that work covers a portion of Hamilton County, Tenn., near Chattanooga (fig. 5).

The mosaics used in the Authority were among the first to be used over a large area. They were made from transformed five lens photographs. This selection of illustrations does not mean that transformed five lens aerial photographs are the best type to use for making mosaics. In fact, they are about the poorest type to use, because all of the wing (outside) prints are taken at an angle and must be transformed from the oblique to the horizontal plane before they can be matched together into a mosaic. Copying these transformations results in considerable loss of detail. By far the best type to use is that of single-lens aerial photographs printed on matte paper so that the cartographer can draw on them with pencil and ink.

It has been stated that aerial photographs have been found to be readily and usefully adapted to the purposes of nearly all survey work. These purposes, however, have differed very broadly as between the agencies involved. For example, the Geological Survey has found them extremely valuable in connection with the production of planimetric maps, topographic maps, and a complex series of studies in geological mapping and investigation. The Forest Service has carried out an extensive photographic program devised to assist in forest classification, acquisition, etc. The Soil Conservation Service has used aerial photographs in its conservation and range surveys and in its operations program, and has worked out methods of land classification of various types and scales for many purposes. The Soil Survey now uses aerial photographs almost entirely as base for its soil mapping activity. The Agricultural Adjustment Administration has expanded its coverage enormously, but uses the pictures exclusively for the determination of field measurements in connection with the program of crop acreage adjust-

ments. Objectives have ranged from the specific, simple, and narrow single purpose use, to very inclusive and detailed land classification.

### **Coverage of Aerial Photography to Date**

For several years following the war the War Department engaged in photographing considerable areas in various parts of the country for strictly military purposes, and, in cooperation with other agencies of Government, for a variety of other uses. In addition, there was a very rapid expansion of the private aerial surveying industry, with many areas being photographed for oil and mining companies, for municipalities, and for Government agencies. In 1934 an index map was prepared in the Geological Survey summarizing all available data on aerial photography. This showed the areas covered, the type and scale of photographs, and the ownership and place of deposit of the films. The index map has been kept currently up to date through the succeeding years.<sup>2</sup> More recently the Geological Survey, Soil Conservation Service, Agricultural Adjustment Administration, and several other agencies have added greatly to the areas covered through very broad programs of aerial photography. Now the actual material existing from all sources provides coverage for a very large portion of the country. All aerial photographic work now carried out under the Department of Agriculture programs conforms to the standard Government specifications. Almost all of it is on the scale of 1:20,000—the scale considered by the Department to be best suited to map work and land studies in the agricultural areas of the country. The clearance procedure now in effect minimizes duplication, and insures that all interested agencies within the Department are consulted and given an opportunity to secure extensions in area covered or other modifications of surveys about to be undertaken by any one agency.

### **Availability of Aerial Photographs**

The early work done by the Army for its own use generally was not available readily for private or general use. In Michigan, some of this work, done in cooperation with the State and the Geological Survey, became available at reasonable cost through files of the photographs in State offices, and in township mosaic form (scale 2 inches to the mile). Similar conditions prevail in some other States. The rapid rise of the use of aerial photographs developed a serious problem of film storage, particularly in Government agencies. As a result, in many cases of Government orders the films

<sup>2</sup> Information can be secured through the Map Information Service, the Geological Survey, Interior Building, Washington, D. C.

were left in the ownership of the contracting companies, and could be secured only at relatively high prices. More recently this difficulty has been overcome by the provision of film storage facilities, and by the retention of ownership of all films by the contracting Federal agency. During the past year arrangements have been made by which State agencies, educational institutions, and cooperating groups may get direct copies of any of the Department of Agriculture photographs at very reasonable costs. Similar arrangements are being perfected as to availability of photographs owned by other Federal agencies.

#### Potential Uses of Aerial Photography

Aerial photographs have been found to be highly useful and adaptable to many of the objectives of land inventory and classification. The work of the geographers in the Tennessee Valley Authority, as an example, shows conclusively that their use speeds up the attainment of objectives and lowers the costs very materially. Hence, many types of operation only recently precluded from consideration because of limitations of time and money, have become readily feasible. Geographic work in the Authority also illustrates how the availability of aerial mosaics has given rise to the rapid development of new land classification technics, new methods of application, and a greater variety of applications. In fact, developments in this field have taken place so rapidly that there has been little opportunity for the preparation of official publications describing them.

The large areal coverage of aerial photographs now available, or becoming so, and the certain rapid expansion of coverage in the immediate future accentuate the importance of aerial photography as a new tool of research and the need for an immediate summary of findings. There is an immediate need for a reappraisal of practically all forms of land inventory and classification, a careful study of the various techniques and objectives attained to date, and a major reorientation

of current notions as to possible future procedures in this field.

#### Appendix A: Reproductions of Aerial Photographs From the Department of Agriculture

Reproductions of photographs and maps in connection with the authorized work of the United States Department of Agriculture may be purchased from that Department. The Agricultural Adjustment Administration, Forest Service, and Soil Conservation Service have aerial photographic laboratories which may furnish reproductions as follows:

1. Whenever possible, orders should be addressed to the bureau which has the film from which reproductions are desired. Photographs must be identified by designating alphabetical symbol and number. Orders may be taken by, or order blanks obtained from, County Agricultural Conservation Associations, and local offices of the Forest Service and Soil Conservation Service. If the information desired cannot be obtained locally, or if it is not known which bureau has the film, orders or inquiries should be addressed to the Office of Plant and Operations, Department of Agriculture, Washington, D. C.

Requests regarding aerial photographs made by agencies other than the Department of Agriculture should be addressed to the Map Information Office, Federal Board of Surveys and Maps, North Interior Building, Washington, D. C. Legislative authority does not exist for other Federal Agencies to sell photographic reproductions, but the Map Information Office can probably advise in regard to whether commercial agencies who have Federal or other negatives in their possession can quote prices.

2. Only reproductions of such aerial or other photographs, mosaics, and maps as have been obtained in connection with the authorized work of the Department are available.

3. Maps and mosaics will be sold at prices determined by individual bureaus. If maps or mosaics are desired, write the bureau concerned for a quotation.

4. Since regular Department activities must be given precedence, there may be some delay in filling orders. Normally orders will be filled within 30 days after receipt by the bureaus.

5. Photographic reproductions showing fortifications, military or naval defenses, or other restricted areas will not be sold.

6. Purchasers shall not use photographic reproductions obtained from the Department to show, by implication or otherwise, that the Department endorses any commercial product. The Department will not furnish reproductions when it is believed they may be used for such purposes.

7. Price lists of aerial photographs may be obtained from the Office of Plant and Operations, Department of Agriculture, Washington, D. C.

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## CHAPTER VII. SURVEYS OF PUBLIC LANDS BY THE GENERAL LAND OFFICE

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### Origin of Functions

Following the ratification of the Constitution, the unoccupied lands extending westward to the Mississippi River were ceded to the Federal Government at various times from 1781 to 1802 by the States claiming them. These lands, usually styled "public lands," constituted the first area of the public domain. The public domain was increased by the areas included in the Louisiana Purchase, Oregon Territory, Florida Purchase, Mexican Cession, Texas Purchase, Gadsden Purchase, and the Alaska Purchase. At its maximum extent, the public domain included Alaska and all the States except the original thirteen and Kentucky, Maine, Vermont, West Virginia, Tennessee, and Texas. The maximum area amounted to 1,820,366,080 acres (see map facing p. 10).

The administration of the public domain made it necessary, first of all, to design a system for the survey of the lands. The rectangular system was devised, and adopted by an ordinance of the Continental Congress on May 20, 1785 (fig. 6). Subsequent modifications were approved by congressional enactments.

The Act of August 7, 1789 (1 Stat. 49), gave the Secretary of War supervision over the granting of lands to persons entitled to them for military services rendered the United States. By the Act of September 2, 1789 (1 Stat. 65), the Secretary of the Treasury was charged with the execution of such duties relative to the sale of the lands belonging to the United States as might by law be required.

The Act of May 18, 1796 (1 Stat. 464), covered the sale of lands in that part of the Northwest Territory now in the State of Ohio. It defined the duties of the Surveyor General, under whom these surveys were made, and directed that plats of survey be sent to the Secretary of the Treasury who thereafter gave notice of sales and performed other executive duties. After 1810 the Secretary became the executive power or agent in the sale or disposition of the public domain, issuing patents for grants of land with the aid of registers and receivers of the district land offices. He remained in this capacity until the organization of the General Land Office in his department, as provided by the Act of April 25, 1812 (2 Stat. 716).

### Establishment of General Land Office

The General Land Office was created by the act of Congress dated April 25, 1812 (2 Stat. 716), which

provided, "That there shall be established in the Department of the Treasury an office to be denominated the General Land Office, the chief officer of which shall be called the Commissioner of the General Land Office, whose duty it shall be, under the direction of the head of the department, to superintend, execute, and perform all such acts and things touching or respecting the public lands of the United States, and other lands patented or granted by the United States, as have heretofore been directed by law to be done or performed in the office of the Secretary of State, of the Secretary and Register of the Treasury, and of the Secretary of War, or which shall hereafter by law be assigned to the said office."

By Act of March 3, 1849 (9 Stat. 395), Congress created the Home (now Interior) Department, and by section 3 of the law provided that the Secretary of the Interior "shall perform all the duties in relation to the General Land Office of supervision and appeal now discharged by the Secretary of the Treasury."

The General Land Office has since remained a bureau under the supervision of the Secretary of the Interior.

The duties of the Commissioner of the General Land Office are defined in Sec. 453, Revised Statutes, as follows:

The Commissioner of the General Land Office shall perform, under the direction of the Secretary of the Interior, all executive duties appertaining to the surveys and sale of public lands of the United States, or otherwise respecting such lands, and also such as relate to private claims of lands and the issuing of patents for all grants of lands under the authority of the Government.

### Objectives

The primary purpose of the General Land Office when organized in 1812 was to sell the public lands in order to pay the debts of the Revolutionary War. No consideration was given to the conservation of the national resources.

A different situation exists today. The public lands valuable for oil, gas, coal, sodium, potash, etc., are now developed through Government leases which will insure a compliance with sound conservation policies. The classification of these lands is made by the U. S. Geological Survey. Grazing leases on the public lands, outside of the established grazing districts under the jurisdiction of the Division of Grazing, are issued by the General Land Office under section 15 of the Taylor Grazing Act of June 28, 1934 (48 Stat.



1269). The Division of Investigations examines these lands and reports on the grazing capacity of the areas as the basis for the issuance of the leases.

The Act of August 28, 1937 (50 Stat. 874), provides for the conservation of land, water, forest, and forage resources of approximately 2,800,000 acres of land in Oregon, title to which reverted in the United States under the acts of June 9, 1916 (39 Stat. 218), and February 26, 1919 (40 Stat. 1179). The act provides for management of these lands on a permanent basis, for the prudent utilization of their resources for the purpose to which they are best adapted and for the realization of the highest current income consistent with maintenance of permanent value of the land. The General Land Office is charged with administrative responsibility for this act and, under its direction, the land is being classified as to its power, timber, and agricultural value.

Steps are also being taken to conserve the natural resources of these areas. The timber is being logged in accordance with sound principles of sustained-yield management and the lands are dedicated to such uses as may be determined to be appropriate.

The present administration of the public domain involves careful study and classification of its remaining areas, in order to insure utilization for the best possible purpose to which it can be put. As the means of carrying forward this prudent conservation program, practically all of the remaining public lands have been withdrawn from entry, pending classification.

### Type of Work

The land-classification work of the General Land Office has been in progress since that bureau was organized under the Act of April 25, 1812 (2 Stat. 717), for the survey and sale of the public lands. It is of interest to note that in 1880 the Public Land Commission, of which the then Commissioner of the General Land Office was president, reported to the Congress that the area of the remaining public domain, excluding Alaska, embraced 794,416,838 acres,<sup>1</sup> classified as follows:

	<i>Acres</i>
Timber lands.....	85, 000, 000
Coal lands.....	5, 529, 970
Precious metal and other valuable mineral deposits..	64, 800, 000
Arable lands.....	17, 800, 000
Lands in southern States, not classified.....	25, 585, 641
Irrigable lands.....	30, 000, 000
Pasturage, grazing, desert, and other nonagricultural lands, unsatisfied private land grants, Indian and Military Reservations.....	565, 701, 227

The initial step in the land-classification activity of the General Land Office is the identification of the land by means of the rectangular system of survey. The

<sup>1</sup> The area of the remaining public domain June 30, 1938, is approximately 400,000,000 acres in Continental United States and 376,000,000 acres in Alaska.

primary purpose of the General Land Office surveys is to mark out on the ground the boundaries of the public lands for disposal and administrative purposes. The original surveys create the boundaries of these lands and provide the basis for their descriptions in terms of legal subdivisions and for the computation of all areas.

In addition, land classification is authorized in connection with the administration of the Oregon and California railroad grant lands and the Coos Bay Wagon Road lands, under the provision of the Act of August 28, 1937 (50 Stat. 874). This involves the classification of approximately 2,800,000 acres of land in Western Oregon. The classification work required under the act includes the determination of the timber-producing capacity of the lands, the subdivision of the lands into sustained-yield forest units, the classification of the lands with respect to their relative suitability for agriculture, forests, stream-flow protection, recreation or other uses, and the determination of the lands which may be leased for grazing without interfering with timber production.

Recently a Division of Land Classification was established in the General Land Office. The new division is developing its procedures, and has not yet attempted any general or systematic land classification, although it is making recommendations concerning the suitability of particular tracts of the public domain for entry under various provisions of the Taylor Grazing Act.

### Methods

The rectangular system of survey is based upon existing laws and was devised with the object of marking upon the ground the boundaries of the townships, sections, and minor subdivisions for purposes of description and disposal of the public domain under the general land laws of the United States. The first public land surveys were made under the ordinance of May 20, 1785, which provided for townships 6 miles square, containing 36 sections of 1 mile square. Additional authority and instructions pertaining to the basic laws for the original surveys are contained in the Acts of Congress approved May 18, 1796, May 10, 1800, February 11, 1805, April 24, 1820, and April 5, 1832.

For the purpose of disposal of the public domain, the law provides in general terms, for its description, subdivision, and identification, in conformity with the following general scheme of survey:

The township, 6 miles square, containing 36 sections, each 1 mile square.

The numbering of the townships meridianally into ranges and latitudinally into tiers.

The establishment of guide meridians and correction lines or standard parallels at intervals sufficiently near each other to maintain a practical workable adherence to the legal definition of the primary unit, the township 6 miles square.

The subdivision of the townships into 36 sections by running parallel lines through the township from south to north and from east to west at distances of 1 mile.

The townships are numbered to the north or south commencing with number 1 at the base line, and with range numbers to the east or west beginning with number 1 at the principal meridian.

The 36 sections into which a township is subdivided are numbered commencing with number 1 in the north-east section of the township, proceeding thence west to section 6, thence south to section 7 thence east to section 12, and so on, alternately, to number 36 in the southeast section.

In making the public land surveys, monuments are established to mark the four corners of each section, as well as the quarter corners on the boundaries of the section. These monuments furnish the foundation for the subdivision of the sections as contemplated by law and the identification of the boundaries of the section.

The cadastral surveys are executed in accordance with the *Manual of Instructions for the Survey of the Public Lands*. The General Land Office engineers, in connection with the survey of the public lands, observe the characteristic features of the area being surveyed and describe them in the field-note record.

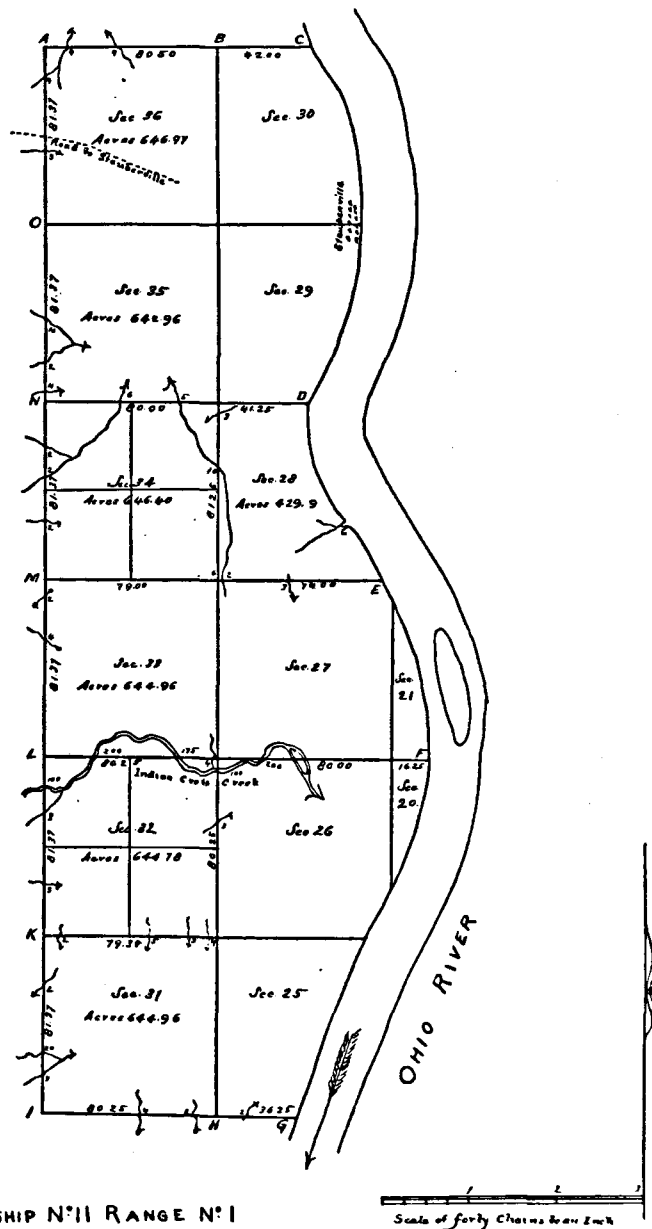
In classifying the 2,800,000 acres of land included in the Oregon and California railroad and Coos Bay Wagon Road lands, a detailed cruise and field examination is made of each section to determine the physical and economic facts, such as soil conditions, timber volume, forest types, topographic features, climatic conditions, distance from population centers, accessibility to roads and schools, grazing capacity, agricultural development and abandonment history, adaptability of the various soils to specialized crops, cost of clearing the lands, water supply, and logging conditions.

**Form of Results**

The plats and field notes representing the public land surveys are filed in the General Land Office in Washington, D. C., and are available for reference by any interested person. These records, on June 30, 1938, represented the survey of 1,317,511,553 acres, or over 91 per-

cent of the total area of the public land States, and 2,106,839 acres in Alaska.

The field notes and plat of a survey not only furnish a technical record of the procedure, but also of equal importance a report upon the character of the land, soil, timber, topography, minerals, and cultural features. The important map features are shown on the maps by the standard symbols adopted by the Board of Surveys and Maps. The hachure is used in most cases to show relief (fig. 7).



TOWNSHIP N°11 RANGE N°1

Original survey in 1786, by  
Abraham Martin from New Jersey

Re-Surveyed by Alex<sup>r</sup> Holmes December 1802.  
Subdivided by Benjamin Hough AD 1805

FIGURE 6.—Plat of One of the Earliest Township Surveys of the Public Lands

The information obtained in making a survey of a township as to the land, soil, timber, evidence of minerals, watering places, drainage, settlement, and industry is summarized by townships in a general description which is the concluding part of the field notes of every survey.

State maps are compiled on a scale of 1 inch equals 12 miles for the public land States, showing the areas covered by the rectangular surveys, national forests, national parks, railroads, cities, and principal physiographic features. A map of the United States on a scale of 1 inch equals 37 miles also is published.

The tract-book records of the General Land Office, consisting of more than 4,000 volumes, show base title record or status of every 40-acre tract of present and former public lands of the United States. These volumes are the index to the millions of original record

files of applications for public land. Copies of more than 6,000,000 patents issued are bound in approximately 9,500 volumes, and the case records for each patent include the land-classification information required by law as a basis for issuance of the patent.

From the records it can be ascertained when the first application was received for each particular subdivision; the date patent was issued; the name of the person to whom it was patented; the act of Congress under which title was granted; the fees incidental to securing title; the legal description and area, and appropriate information as to the character of the land, including in many cases reports of field study by a land examiner. The records also show lands included in Indian Reservations, National Parks, Forest Reservations, Grazing Districts, etc. The dates of all Executive orders and proclamations pertaining to the public lands are noted in the

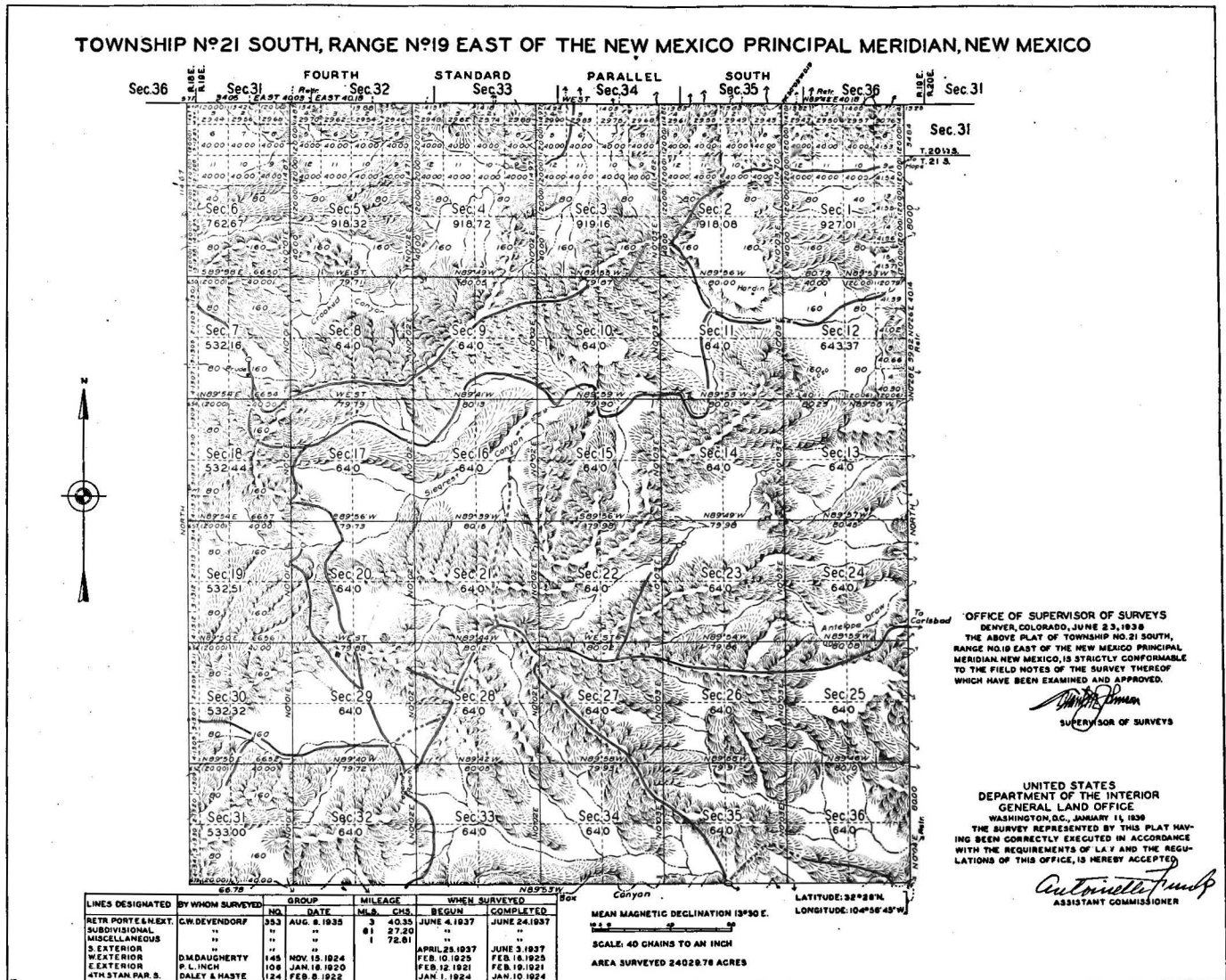


FIGURE 7.—Township Plat of a Modern Public Land Survey

tract books. They also show lands included in mineral leases and lands classified as valuable for mineral. In fact, the General Land Office is the office of record of all Federal action pertaining to each particular subdivision, and such action is noted in the tract books.

District Land Offices are maintained at Anchorage, Fairbanks, and Nome, Alaska; Phoenix, Ariz.; Los Angeles and Sacramento, Calif.; Denver and Pueblo, Colo.; Blackfoot and Coeur d'Alene, Idaho; Billings and Great Falls, Mont.; Carson City, Nev.; Las Cruces and Santa Fe, N. Mex.; Bismarck, N. Dak.; Lakeview, Roseburg, and The Dalles, Oreg.; Pierre, S. Dak.; Salt Lake City, Utah; Spokane, Wash.; and Buffalo, Cheyenne, and Evanston, Wyo., where dupli-

cate information can be obtained as to the status of the lands in those States.

No record is kept by the General Land Office as to the ownership of the lands after title has passed from the Government. The present ownership of a tract of land which has been patented must be determined from the proper local records.

The results of the classification being made of the Oregon and California railroad and Coos Bay Wagon Road lands consist of site classification charts, type maps, agricultural land-classification reports, slash disposal reports, timber classification sheets, and, where needed, topographic contour maps on the scale of 4 inches equal 1 mile, with contour intervals of 100 feet.

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## CHAPTER VIII. GEOLOGIC, TOPOGRAPHIC, AND HYDROGRAPHIC LAND CLASSIFICATION BY THE U. S. GEOLOGICAL SURVEY

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### Origin of Functions

Following the Civil War, the Congress, by legislation for the disposal of the public lands, created, in an increasing degree, distinctions between several types of lands. Special legislation was enacted for desert, timber, mineral, and coal and iron lands. The only land studies available for administration of these laws, however, were chiefly exploratory in character. The best known, perhaps, from the exploratory point of view, was the Lewis and Clark expedition of 1804-1806, which ascended the Missouri River to its source and then descended the Columbia to the Pacific Ocean. Also important were Pike's expeditions to the sources of the Mississippi and Arkansas Rivers in 1805 and 1807 and other similar expeditions during the period from 1804 to 1865, particularly the Pacific railroad surveys. The field notes and maps of the deputy surveyors of the General Land Office also were used as a general guide in the administration of the public land laws, and the character of the land involved in any specific transaction was subject to determination in a hearing before designated representatives of the General Land Office.

Between 1867 and 1869, four geographic and geological surveys were started, two by the War Department, one jointly by the Smithsonian Institution and the Department of the Interior, and one by the Department of the Interior (chapter II). The general objectives of three of these four surveys included a classification of lands to obtain information necessary for proper administration of the public domain. The overlapping functions and lack of unified objectives of these surveys were unsatisfactory to Congress, and in the Act of June 20, 1878 (20 Stat. 230), the National Academy of Sciences was directed to study the methods and expenses of conducting all surveys of a scientific character under the War and Interior Departments and to report a plan of procedure which would attain best results at the least possible cost. The report of the Academy, submitted December 3, 1878, discussed various matters concerned with surveys of the national domain and administration of the public domain. It stated that the best interests of the public domain require for the purpose of intelligent administration a thorough knowledge of its geological structure, natural resources and products. The report recommended the establishment of the Geological Survey to obtain the requisite knowledge.

### Establishment of the Geological Survey

Following the report of the National Academy, and based largely upon that report, the Geological Survey was created by an act of Congress dated March 3, 1879 (20 Stat. 377), which established the office of Director of the Geological Survey, and directed:

That this officer shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain.

### Objectives

Clarence King, first Director of the Geological Survey, defined the objectives of the new organization as contemplating: (1) a scientific classification of the national domain for the general information of the people of the country; and (2) the publication of a series of land maps which would show all those features upon which farmers, miners, geologists, engineers, and timbermen might base their operations and which would be of greatest value in the developing of the resources of the United States, as well as being of great service to all students of political economy. Director King regarded the law as ambiguous in that the term "national domain" might be construed as limited to the region of the public lands. He presented a strong plea to the Congress to remove the ambiguity and consequent uncertainty as to the arena of operations by the Geological Survey. The ambiguity was regarded as removed by the language in the Act of August 7, 1882 (22 Stat. 302), which authorized the Geological Survey "to continue the preparation of a geological map of the United States." Since that date the activities of the Survey have extended throughout continental United States and the territorial and island possessions, to the extent that funds have been made available by Congress.

The Survey always has regarded geologic studies as one of its major objectives. Like the other general sciences, geology is a complex group of fields of knowledge, not a single field, and geologic investigations are staff investigations rather than those of an individual. Moreover, geology has many interrelations with the sister sciences of physics, chemistry, astronomy, and biology. Paleontology in its various branches; general evolution, as it may be studied and interpreted through the remains of extinct life, vegetable or animal; sedi-

mentation, its processes and products; mineralogy; petrography as an aid in the study of igneous and altered rocks; metallic ores, the conditions of their deposition and their distribution; nonmetallic deposits of economic value; the evolution of the earth's crust, the structural features that affect it, the surface forms that are impressed upon it, and the agencies that have produced these forms; volcanology; chemistry and physics as they are involved in studies of rocks—all these and other studies fall within the field covered by geology, and all of them have, to some extent, been pursued in carrying out the objectives of the Survey since its establishment. The importance of geology in relation to the mineral industry and land classification is exemplified by the fact that the prospecting of today leans more heavily on scientific guidance than it has in the past. The old easy days, when in an undeveloped mining country the prospector, working at the surface with his pick, could uncover bonanzas, are gone. The rich deposits to be found hereafter lie not at the surface but deeply buried and must be discovered, if at all, by the application of geologic principles.

The preparation of basic three-dimensional contour maps, in accordance with accurate engineering standards, is one of the most widely recognized objectives of the Geological Survey. Such maps are fundamental to accurate land classification, both for national defense and for the planning of internal improvements. They show the actual shape of the land surface, the mountain barriers and the passes through them, the streams and other water bodies; dams, reservoirs, canals, swamps, and marshes; the location and extent of cities and towns, the highways, and the lesser roads and trails; houses and other structures; forests, political boundaries, and a series of other features—all in their proper relations, with correct elevations and on suitable scales. They constitute a graphic record of physical facts essential to the consideration of all contemplated uses of the land. They are of the very essence of the successful conduct of modern military operations. The rapidity of movement of mechanized and motorized forces and the greatly increased range and accuracy of modern weapons make accurate maps a vital necessity in modern warfare. They are essential for the planning and execution of flood-control projects, and river and harbor improvements, for the prosecution of power and irrigation enterprises, for highway location and construction, for forest administration, for city and park planning, for drainage, for erosion control, for mineral surveys, for soil surveys—in short, for most every type of study and development of our natural resources and for practically every phase of administration and use of the land.

Since 1888 the objectives of the Geological Survey have included investigation of the irrigability of the arid

region, to segregate the irrigable lands, and to select sites for reservoirs and other hydraulic works necessary for irrigation and flood prevention. Then began a program of investigating the water resources of the country, including the measurement of the flow of streams, the surveys of the ground waters, the studies of the qualities of waters obtained from the various sources, and other investigations in connection with studies of the best methods of water utilization and the classification of lands with reference to water use. In 1894 the Carey Act (28 Stat. 372) provided for transfer of public lands to the States in the arid region. These lands were not to exceed 1,000,000 acres in each State and were to be reclaimed through irrigation by private enterprise. Investigations of water supplies for many of the Carey Act projects were made by the Geological Survey under cooperative arrangements with the States. Under the enlarged Homestead Act of February 19, 1909 (35 Stat. 639), more than 294,000,000 acres in the western public land States were classified as nonirrigable. Under the Reclamation Act of June 17, 1902, actual construction of irrigation projects was authorized. The administration of this law was a function of the Geological Survey until 1906, when the Reclamation Service was established as a separate office in the Department of the Interior.

The act of June 4, 1897 (30 Stat. 11, 34, 36), which established by law the principles of the present national forest policy for the public lands, provided that the Geological Survey should survey and classify the public lands theretofore or thereafter designated as forest reserves. During the 8-year period from 1897 to 1905, the Geological Survey examined and classified an area of more than 70 million acres in, or with a view to inclusion in, forest reserves.<sup>1</sup> Results were published in map and report form. During this period the national-forest reserves were expanded to include an area of 86 million acres, in accordance with the principles set forth in the 1897 act. This forest survey was discontinued with the transfer of the national-forest administration to the Department of Agriculture by the act of February 1, 1905 (33 Stat. 628). It was revived on a limited scale under the Act of March 1, 1911 (36 Stat. 961), in connection with purchases of lands for eastern forests. The Survey determined the relations of headwater streams to navigable streams in these areas and classified the land surface with respect to permeability, storage capacity, and resistance to erosion.

Under the Stockraising Homestead Law of December 29, 1916 (39 Stat. 862), the Geological Survey began a classification of lands in the public domain to determine its suitability for granting homesteads. This law required a classification not only of vacant public lands

<sup>1</sup> See *Publications of the Geological Survey, op. cit.*, p. 52

but of dependent range lands involved in applications for additional homesteads. The classification was made to determine that such lands were nontimbered, nonirrigable, chiefly valuable for grazing and raising forage crops, and of such character that 640 acres were reasonably required for the support of a family. The public-land policy inherent in that law has been modified by the so-called Taylor Grazing Act of June 28, 1934 (48 Stat. 1269), and the land-classification activity under both laws has been transferred to the Division of Grazing. During the period from the enactment of this law and the enactment of the Taylor Grazing Act, the Geological Survey classified 119,339,332 acres. Much of the data is available in published land-classification maps.<sup>2</sup>

The definite classification of public lands as mineral or nonmineral in character became an urgent administrative necessity in the Department of the Interior with its adoption, in 1906, of the policy of withdrawing from entry lands known or suspected to have value for coal, oil, gas, phosphate, potash, or nitrates, until such value could be appraised. Overnight, practically, the mineral or nonmineral character of each legal subdivision attained an importance in the disposal of Federal lands which has increased both in scope and detail in subsequent years. The early withdrawals were from all forms of filing, entry, selection, location and disposal, and, for a time, the classification and restoration of the lands affected was a necessary precedent to their use and occupancy for any purpose. Because the task of examining and classifying the vast areas under withdrawal (about 150 million acres in the aggregate) was impossible of accomplishment on short notice, serious interference with settlement and development under the agricultural land laws was unavoidable. Such interference resulted in the enactment of the so-called separation acts, of which there are several, in the period 1909 to 1912. These acts permitted the acquisition for agricultural purposes of withdrawn or classified mineral lands with retention in the Government of the mineral title and exploitation rights involved, and practically eliminated the element of urgency from the classification of the areas then remaining withdrawn. Between July 1906 and July 1915, from 18 to 25 field parties of the Geological Survey were engaged each year in the investigation of areas under mineral withdrawal in the public land States. In that period, some 92,000,000 acres were classified as to coal, nearly 5,000,000 acres as to oil and gas, about 4,000,000 acres as to phosphate rock, 3,200 acres as to potash, and some 560,000 acres of Northern Pacific Railroad grant land and 4,900,000 acres of Indian land were classified as to metalliferous minerals. At the end of that period, 48,000,000 acres remained with-

drawn awaiting classification as to coal, 4,800,000 acres as to oil and gas, 2,700,000 acres as to phosphate rock, and 342,000 acres as to potash

During the period of preparedness for and participation by the United States in the World War (1915 through 1918) mineral classification activities practically ceased in the Geological Survey for want of funds and personnel for their prosecution, and since 1920 only nominal progress has been made annually in classifying the areas that remained withdrawn in July 1915. With the wholehearted adoption by the Government in 1920 of the policy of leasing, instead of selling, its holdings of mineral fuels and mineral-fertilizer materials, new forms of mineral classification were required to meet the administrative needs arising under the mineral leasing laws. These include: (1) the discrimination between lands that are properly subject, on the one hand, to prospecting, and, on the other hand, to immediate lease without prior prospecting; (2) the recommendation of appropriate leasehold areas and lease terms; (3) the promulgation of definitions of the "known geologic structure" of producing oil and gas fields; and (4) the making of a variety of findings as to the structural situation and relation of different parcels of land, sought by the same applicant, as to the probabilities of conflict in the simultaneous exercise of agricultural rights and mineral development rights on the same land, and as to the actual value for purposes of mineral development of lands entered under the nonmineral land laws.

Although the volume and urgency of the mineral classifications required for leasing-law administration have to a considerable extent monopolized the available classification facilities in recent years, incidental progress has been made, nevertheless, in the reduction of the areas that were withdrawn for mineral classification more than a quarter of a century ago. As of June 30, 1939, outstanding withdrawals for coal aggregated 26,800,000 acres; for oil and gas, 4,900,000 acres; for oil shale, 6,000,000 acres (withdrawn in 1930); for phosphate, 1,900,000 acres; and for potash, 9,400,000 acres (mostly withdrawn in 1926).

Thus, the land-classification work of the Survey has a two-fold objective, one to furnish information needed for the wise administration and conservation of the natural resources of the public lands under jurisdiction of the Department of the Interior, and the other to furnish information concerning the natural resources of the national domain. Its activities not only cover all of the continental United States but are extended to the island and territorial possessions of this country. The Survey work was extended to Alaska by a special congressional appropriation in 1895. But owing to the magnitude of the problems there involved, the available energies have been largely expended in

<sup>2</sup> See *Publications of the Geological Survey, op. cit.*, p. 53.

reconnaissance investigations with detailed surveys applied only where warranted by progress in development of the resources in that territory.

### **Type of Work**

The land-classification work of the Geological Survey consists of field surveys to obtain basic information concerning land resources and the presentation of such information in the form of maps and reports especially for administrative purposes but also for general technical and nontechnical use. The field surveys involve, first the making of base maps, and second the acquisition of information on the natural resources of the areas mapped.

The topographic base maps show by distinctive symbols the surface configuration; works and structures, such as roads, trails, railroads, bridges, ferries, buildings, churches, cities, towns, villages, canals, pipe lines; civil boundaries and monuments; drainage; such features as overflowed land, marsh, and timber land; hydrographic features, such as shore lines and depth curves; aids to navigation; and military features.

The geologic work involves a determination as accurately as possible by geologic mapping and structural and stratigraphic observations, the known reserve supplies of the mineral fuels and the metallic and non-metallic minerals of the country and the geologic conditions that serve to guide the search for new sources of supply. The geologic work is conducted chiefly under eight categories here named, which indicate the wide diversity of the types of work: (1) areal and non-metalliferous geology, (2) metalliferous deposits, (3) fuels, (4) iron and steel metals, (5) glacial geology, (6) chemistry and physics, (7) paleontology and stratigraphy, and (8) geophysics.

The work in areal and nonmetalliferous geology furnishes information concerning availability and suitability of nonmetallic minerals of increasing importance in building and highway construction, in fertilizers, and many industries. The areal geologic work is one of the best helps in land-use planning, in that it furnishes information concerning the distribution of different rock formations underlying the land as well as their attitude and structure. The work in fuels deals with the three indispensable, closely related sources of energy, coal, petroleum and natural gas, with their separate geologic backgrounds and problems. Iron and steel metals and other metallic minerals are not replaceable to any great extent and search for new supplies is constantly being made. The studies of glaciers and glaciation yields results applicable to land use in many ways through the disclosure of soil characteristics and as an aid in finding supplies of road and other construction materials. Chemical and physical studies aid the geologist in interpreting field and labora-

tory studies of the relations of ore deposits to their associated minerals and rocks. Studies of paleontology and stratigraphy are basic to geologic philosophy in their bearing on time relations and geologic history. Without such interpretations, the search for new supplies of ores would be seriously hampered. The geological observations are supplemented by geophysical investigations which are aids in extending the range of knowledge of the nature, structure, and distribution of earth materials.

The information acquired through these several types of work on the geology and mineral resources of the United States permits the Geological Survey to serve as an efficient clearing house for full and accurate reports for planning programs of land settlement; water supplies for domestic, agricultural, and industrial requirements; soil conservation; flood control, building and highway construction; agricultural; and other industrial activities.

Water is probably the most valuable natural resource and is essential in any land use. In addition to the direct uses of water, important as they are, there are also the limitations which the availability of water imposes upon the utilization of other natural resources, involving the stability of regional and national development. Water determines the limits of agriculture by irrigation and of the practicable operation of mines of all kinds. It controls the location and size of all power plants and industrial developments, and even the rates of growth and the ultimate sizes of towns and cities.

The limitation which the supply of water exercises on agriculture by irrigation is obvious. The extent of arable arid land is greater than the amount of water available for its economic reclamation. It is also obvious that the amount of water power which can be generated at any site or in any region is directly related to the quantity of water and to the head or fall which can be utilized. It must also be recognized that steam power plants are limited in capacity by the amount of available water; that from 600 to 1,000 tons of water are needed in the condensers for each ton of coal burned; that mine-mouth power plants are possible only if there is a nearby river; that it may be practicable to haul coal for generating power, but that it is economically impossible to haul the water needed for the operation of steam power plants; that industries are established in regions of ample and suitable water supplies for the particular industrial processes which may be involved; that the capacities of industrial plants are limited by the quantities of suitable water which may be obtained; and that the sizes of towns and cities are limited by the supplies of water which may be made available for domestic and municipal purposes.



The program of the work of the Survey concerning this resource includes an inventory of surface waters and the determination of the run-off characteristics of the important watershed areas of the country. Thus, a determination is made of the differences in run-off from place to place; the variations from day to day, month to month, and year to year; the average run-off and the range of the variations from the average; the time of occurrence; the characteristics of the water supply in times of floods and droughts; the amount of silt transported by the stream; the facilities available to prevent land damages and losses incident to erosion, floods, and droughts; and the opportunities for water-power development and regulation of stream flow for navigation and irrigation. All of these factors should be taken into consideration in planning for economical and efficient land use. Information is obtained regarding specific floods, droughts, possible water power development, and general water use. Investigations are made of relations of rainfall and other climatic factors to stream flow and water supply with a view to developing fundamental information requisite to wise development of the land and water resources. Studies also are made to determine the quality of water for domestic, livestock, and commercial purposes. During recent years about 2,000 samples of surface and ground waters have been analyzed each year.

The studies of ground-water resources include the mapping and description of the water-bearing formations, their depth below the surface, and the quantity and quality of the water that they yield. Studies are made of the form of the water table, its fluctuations and depth below the surface, areas of artesian flow, the head of the artesian water, the quantities of different mineral substances dissolved in the water, which affect its use, and the areas of fresh and salt water, or hard and soft water. The studies of the ground waters relate to the use of the land for irrigation with water from wells and its use for domestic and public water supplies, industrial water supplies, water supplies for livestock on farms and range lands, and water supplies for travelers in the desert regions.

#### Methods

Land-classification procedures adopted by the Geological Survey vary according to the objective of the classification and to the scientific progress in instrumental facilities available for the classification. For many of these objectives, instruments and methods have been originated and developed in the Survey which are today used throughout the world. The student of land classification will find, in the records of the Survey, land classification methods for studying practically every known physical characteristic of the earth.

The methods for the preparation of topographic maps are set forth in Survey bulletin No. 788 printed in 1928 and now undergoing revision. As defined in this bulletin, a topographic map is a representation on paper (1) that is designed to portray certain selected features of a section of the earth surface plotted on some form of projection and to a certain scale; (2) that primarily depicts the relief of the country mapped, but shows also its drainage and cultural features; and (3) that delineates all features in true latitude and longitude. The maps are printed on different scales depending upon the character of the land-use problems of the area surveyed, a small scale being used where the problems are of minor public importance, such as in remote mountain and desert regions; a large scale where problems of great public importance exist; and an intermediate scale where the problems are of average public importance. The surveys of topographic maps are controlled horizontally by means of locations determined either by theodolite triangulation or by transit traverse or both. These surveys are controlled vertically by means of elevations established by lines of spirit levels.

Supplemental horizontal control and planimetric details may also be obtained by means of aerial photographs. Figure 5 is an aerial photograph of an area and a corresponding topographic map developed in part from the photograph.

The application of aerial photography to the preparation of planimetric and contour maps is regarded as the greatest modern advance in mapping methods, because of the reduced field costs and increased accuracy obtainable in the resulting map. Considerable experimentation has been necessary in the design of instruments and the development of a compilation process that will use aerial photographs advantageously for mapping. This experimentation is still in progress and the instrument and methods now in use may be expected to undergo many changes as experience in the comparatively new art accumulate.

An air photograph, with few exceptions, is not a perfect representation of the terrain and a series of photographs cannot be directly assembled into an accurate map. Rather, each air photograph is a perspective view of the terrain and is subject to all the vagaries of dimension of any perspective drawing although the distortions may pass unnoticed until accurate measurements are attempted. It is, however, this feature of aerial photographs that permits the measurement of relief and the construction of contour maps therefrom. As previously mentioned, the distortions of a photograph will usually pass unnoticed because of their small magnitude. For the same reason, instruments to utilize photographs in map making have to be extremely accurate and precise in order to measure

the small quantities involved within the tolerances necessary for their economic use. Such equipment has been very costly, and its development in this country has been very slow because of the limited market in prospect. On the other hand, European countries with their ever-present military problems have done most of the pioneer work in this field.

The recent development of a successful optical type of apparatus employing stereoscopic principles has at last made possible the practical use of photographs for contour mapping at a reasonable cost. The use of this method is now being extended as rapidly as funds for apparatus are available and personnel can be trained. In the light of present knowledge there will always be varying amounts of field work necessary for the completion of maps of any area. In areas of low relief and small contour intervals it is improbable that photographic methods will ever completely supplant field surveys. A forthcoming bulletin now in preparation in the Survey explains in detail the various compilation methods in use by the Geological Survey for the preparation of planimetric and contour maps from aerial photographs.

The methods employed in connection with geologic work, in the field and in the laboratory, are as varied as are the types of investigations undertaken and the types of problems that are encountered; they include all phases of geology as well as many phases of the allied sciences, chemistry, physics, and biology. In the field, aerial photographs are of great aid in geologic mapping, and are increasingly used in this work. Figure 8 is one of the photographs with the geology of the area shown below.

The picture shown is a part of a single vertical photograph, one from a sequence of about 1,000 such pictures covering a part of the Shoshone National Forest in northwestern Wyoming. In the photograph, one's position on the ground could be determined from such prominent points as at a bend in the road or at stream intersections, and with a little practice individual trees could be recognized by their relative position to other objects on the surface of the ground. A geologist can use the photograph as a planimetric map or base on which to map the different kinds of rock formations. The strata included in the area covered by the photograph are not horizontal, but are inclined or dip downward toward the bottom of the picture at an angle of about 15 degrees. The oldest (lowest) formation exposed at the surface is the Amsden formation. It is overlain by the Tensleep sandstone and the Embar formation, which may be oil-producing when favorably situated beneath the surface. Above them is the Chugwater formation, which is about 800 feet thick and is commonly known as the "red beds." They are overlain by the Sundance formation and above that the

Morrison, which is the youngest (highest) formation shown in the picture. Not only geologic formations, but also coal beds, phosphate horizons, or, as shown in this particular photograph, the position of a thick bed of gypsum can be readily and accurately mapped. The gypsum bed occurs at the top of the Chugwater formation, and although the mapping was not done primarily to show the distribution of the gypsum, nevertheless, the map can be used for that purpose, if desired.

The personnel conducting the geologic investigations are specialists and their methods of work are modified from time to time with the growth of geologic knowledge and the progress of geology and the allied sciences. For the use and convenience of the Survey's specialists and also the public a technical library in which is assembled national and world-wide information concerning geology and related subjects is maintained in the North Interior Building, in Washington, D. C.

The methods used in the inventory of surface waters are described in detail in a manual, *Stream Gaging Procedure*, now in preparation for publication. As defined in a preliminary draft of this manual, "the flow of a stream, or 'the discharge,' is the quantity of water flowing past a selected cross section of a channel in a unit of time." Records of discharge are usually obtained from records of stage by means of the "stage-discharge relation." The stage-discharge relation for a gaging station is determined by means of current-meter measurements made at different stages from low water to high water. The records of stages, therefore, are basic data for use with the results of current-meter measurements in obtaining records of discharge. About two-thirds of the 3,800 or more stream-flow measurement stations maintained and operated by the Geological Survey are equipped with automatic recording instruments for obtaining continuous records of stages of the water surface. Figure 9 shows a typical structure used in obtaining records of river stages on the Potomac River at Paw Paw, W. Va.<sup>3</sup>

The procedure for the classification of the public lands is outlined in detail in bulletin 537, *The Classification of the Public Lands*, published in 1913. Subsequent to the publication of this bulletin, new legislation has revised the methods of disposal of the public lands, mainly by substitution of a leasing system for minerals with the payment of royalties to the Federal Government. The classification procedures have been revised

<sup>3</sup> Descriptions of methods used in determinations of flood discharges are contained in Water-Supply Papers 798, 799, and 800, *The Floods of March 1936*, and in Water-Supply Paper 816, *Major Texas Floods of 1936*.

The methods used for the analysis of water samples are described in Water-Supply Paper 596h, *Notes on Practical Water Analysis* (1937). Some of the methods used in the ground-water surveys are described concisely in Water-Supply Paper 635c, *Outline of Methods for Estimating Ground-Water Supplies* (1932), and in Water-Supply Paper 838d, *Ground Water in the United States, A Summary* (1939), and in more detail in a mimeographed manual issued in 1935.

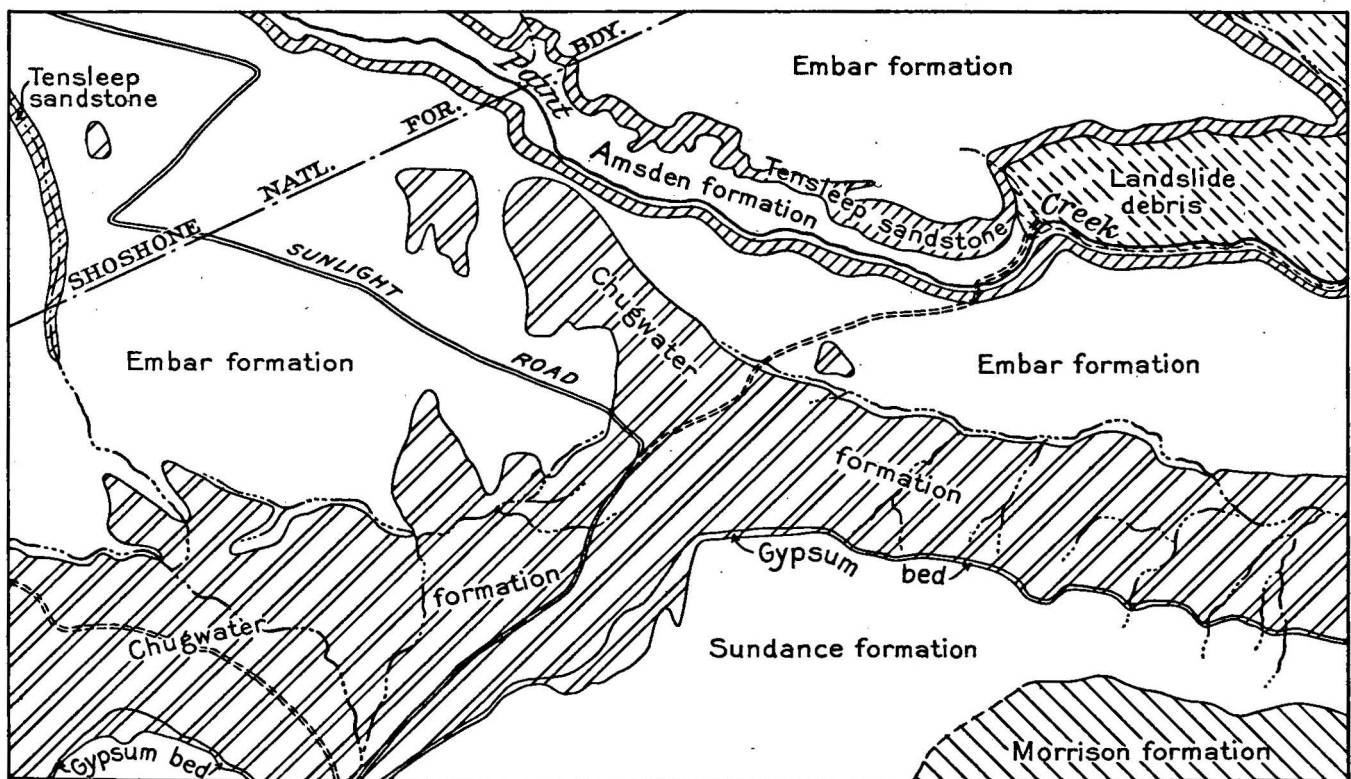


FIGURE 8.—Aerial Photograph and Corresponding Geologic Map Showing a Portion of the Shoshone National Forest in Northwestern Wyoming

accordingly. As a result of the new legislation, the development of the mineral deposits on the public domain involves a direct Federal supervision of operations of private industry to insure adoption of adequate safety precautions for employees, to insure maximum obtainable recovery of mineral values and to fulfill the royalty obligations of the Federal Government. The accomplishment of these objectives requires the maintenance in the field of a trained personnel having expert knowledge of the accepted engineering methods and practices for development of mineral lands to enforce regulations for proper procedures approved by the Secretary of the Interior. As a further precaution against waste of natural resources, the operator is required to post adequate surety bonds to indemnify the Federal Government for any loss that may result from violation of the regulations.

The grazing classifications were initiated following the enactment of the stock-raising homestead law of 1916 and were predicated upon the theory that the density and type of the climax growth of native vegetation affords an integrated characterization of all the natural growing conditions determinative of the utility of the land surface. This theory is sound for the western range lands, but in using this method of classification it is imperative to avoid erroneous conclusions based on observations in an area where unusual drought, cultivation, overgrazing, fire, or accelerated erosion has altered the density or association of vegetative species that characterize normal growing conditions.

### Cooperation

The Geological Survey's land activities are materially aided through cooperation with other organizations, such as the Bureau of Mines, Bureau of Reclamation, the Office of Indian Affairs, the National Park Service, and the General Land Office, of the Interior Department; the Tennessee Valley Authority; the Public Works Administration; and the War and Navy Departments. In addition, much work in geologic and water resources investigations and topographic mapping is conducted in cooperation with the State Geological Surveys and other organizations of many States, counties, and municipalities.

In a communication to a State geologist, in 1880, the first director of the Geological Survey said: "The director desires to announce to you that he urges the inauguration and continuance of State surveys and wishes to cooperate with them to the mutual advantage of both." This basic policy of the Geological Survey guides its relations with other scientific organizations today as it did 60 years ago. Support of State surveys and cooperation with them, to the end that there may be coordination in purpose and in results achieved, is predicated upon a realization (1) that the problems awaiting solution in the field of geology and in other fields occupied by the Geological Survey are almost unlimited and (2) that all the energies, local, State, and National, that can be marshaled for their solution and for the services that can be rendered to mankind through research in these fields will be totally insuffi-

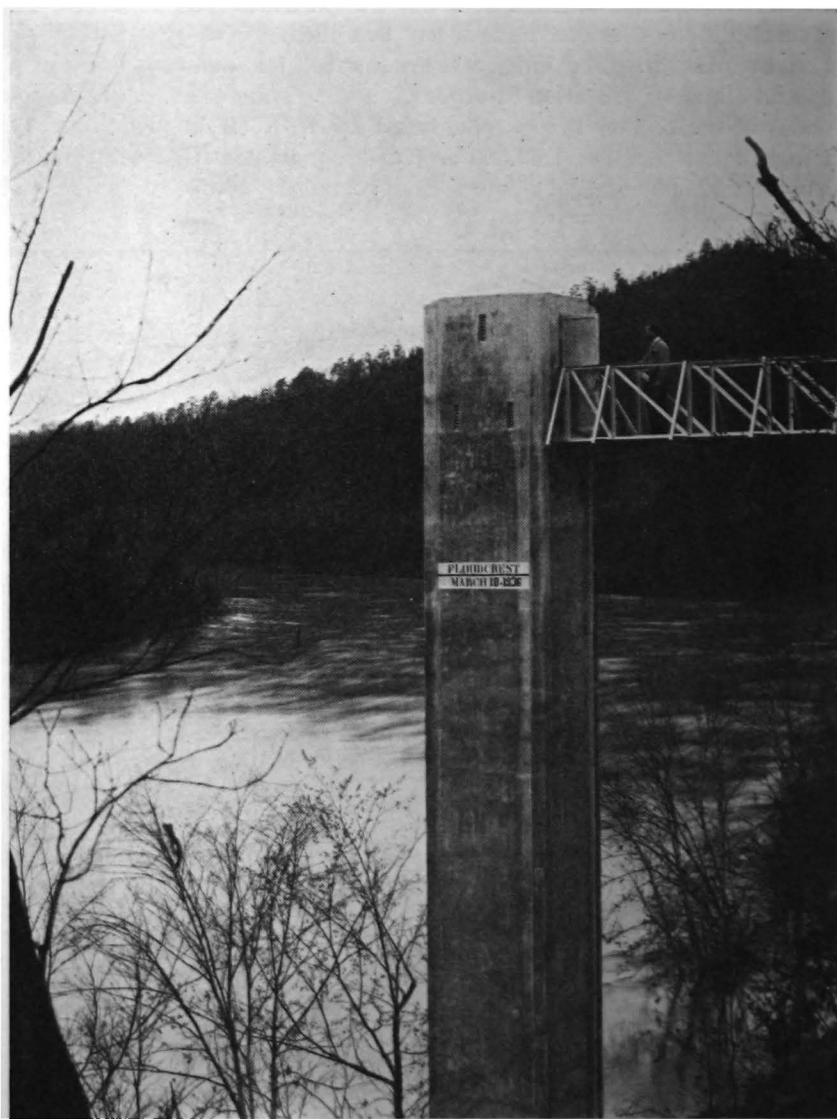


FIGURE 9.—Typical Structure Used in Obtaining Records of River Stages

cient to accomplish the progress that should be made. In 1884 an agreement was made between the Geological Survey and the Commonwealth of Massachusetts for cooperation in the preparation of topographic maps of that State, the costs to be shared equally between the State and Federal Government. Many such agreements, involving topographic mapping, investigations in many of the fields of geology and the study of water resources, have since been executed. Within the past two decades particularly, this method of financing work that both the individual commonwealths and the Federal Government desire to have done has been used extensively and has become a definite policy recognized by Congress in the annual appropriation acts.

### Form of Results

The topographic maps are published in quadrangle units. State maps and maps of the United States on several different scales have been compiled. Occasionally, other irregular unit areas are mapped for some special land-classification purpose. The standard scales of the regular topographic maps are 1:31,680 or 1 inch equals  $\frac{1}{2}$  mile; 1:62,500 or 1 inch equals nearly 1 mile; 1:125,000 or 1 inch equals nearly 2 miles. More

than 4,000 such maps have been printed on paper having a uniform size of about  $16\frac{1}{2}$  by 20 inches. Figure 10 shows the areas for which topographic quadrangle maps have been completed.

The State base maps are compiled on a scale of 1:500,000 or 1 inch equals nearly 8 miles as preliminary bases for the international 1:1,000,000 topographic maps. The general United States base map is compiled on the scale of 1:2,500,000 or about 1 inch equals 40 miles.

The results of the Survey work relating to classification of mineral lands from 1880 until 1901 are published for the most part in 22 annual reports of the Director. Beginning in 1902, the results of that work have been published chiefly in professional papers and bulletins. A total of 186 professional papers and about 900 bulletins have been published to date. Additional material is printed in monographs, 55 of which have been published since 1890. Two hundred and twenty-five folios of a geologic atlas of the United States covering quadrangles corresponding to the topographic atlas sheets have also been published. Much advance information is made available in mimeographed circulars and preliminary maps. Many wall maps that

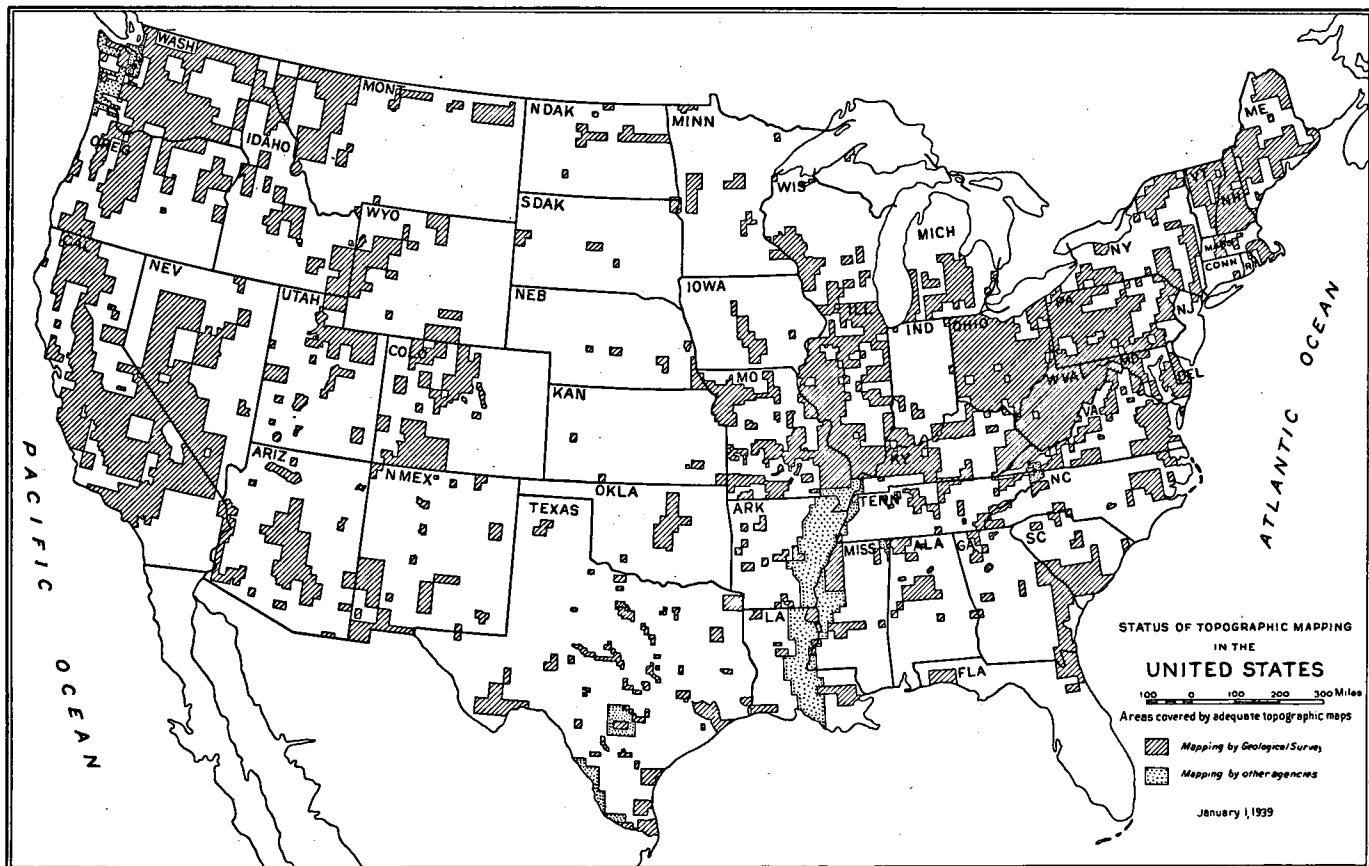


FIGURE 10.—Status of Topographic Mapping in the United States

are not accompanied by reports are published. These include a map of the United States and also separate maps of Texas, California, Oklahoma, and Louisiana which show by colors the location of the oil and gas fields. Another map is one of the United States showing by colors the outlines of the areas containing anthracite coal, bituminous coal, and other ranks of coal. Outstanding among the maps is a colored geologic map of the United States issued in four sheets, each 27 by 47 inches, which, when trimmed and pasted, makes a single sheet, 51 by 90 inches. The more recently published geologic maps of the States include those of Wyoming, Oklahoma, New Mexico, Colorado, and Texas. In addition to the official publications many papers are printed in professional and technical journals and many reports are turned over to the cooperating State Surveys and other cooperating organizations for publication.

The records of stream flow, the reports on ground water, and the quality of water, studies of floods and droughts, and other hydrologic reports, are published in *Water Supply Papers*, of which about 850 have been issued to date. Special land-classification reports are prepared for use in the administration of the public-land laws and the supervision of mineral prospecting and development of the public lands. These reports are not published, but the land-classification information contained therein, in general, is made available to any party owning an interest in the involved land. For the purpose of preparing these reports, complete index records are maintained showing all available land-classification information about the public-land States with reference to mineral and water resources. These activities are directed toward protection of the public lands from improper use, and aiding the timely development of their natural resources. When mines are opened or wells are drilled on the public lands, the physical conditions governing the occurrences of mineral deposits are determined and proper technical methods and practices are required of the operator to avoid injuries to workers, damage to the mineral values of the Federal lands, and payment of the proper rents and royalties due the Federal Government.

The power-site classifications are effectuated by orders

of withdrawal under which public lands valuable for power or reservoir purposes are reserved until required for those uses. Thus, conflicting uses for a less valuable purpose can be prevented. These orders are posted on the tract-book records of the General Land Office, and are further discussed in the section concerning that bureau.

The Survey publications, other than topographic maps, are listed in the index *Publications of the Geological Survey*, which is printed by the Government Printing Office for distribution by the Superintendent of Documents.

### Personnel

Appointments of personnel in the professional and scientific services and in the clerical-administrative-fiscal services of the Geological Survey are made from the lists of eligibles certified by the Civil Service Commission. Vacancies in the higher grades are nearly always filled by promotion of experienced persons selected from the lower grades; therefore, new appointments, especially in the professional and scientific services, are generally made in the lowest, or entrance, grades. A position may be filled by transfer from another Government agency if the applicant's request for transfer is approved by such agency and by the Civil Service Commission and the qualifications of the applicant meet the requirements of the work. A vacancy may be filled by the reinstatement of a former employee if the person is eligible for reinstatement under civil service rules and regulations. A vacancy may occur because of promotion, resignation, transfer, or death, or because of an increase in the work of any district or branch division. One of the recognized requirements for qualification for an appointment in the junior and higher grades in the professional and scientific services of the Geological Survey is that the applicant shall be a graduate of a professional or scientific school of recognized standing. The personnel generally specialize in some particular branch of Survey work, and thus become trained experts and authorities in their individual fields. The Civil Service staff of the Geological Survey includes approximately 1,500 persons.

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## CHAPTER IX. NATION-WIDE FOREST SURVEY OF THE FOREST SERVICE

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### Land Classification in the Forest Service

In the discharge of its responsibilities, the United States Forest Service uses land classification of several kinds and degrees of intensity.

In formulating a Nation-wide plan for national forest acquisition, for example, a broad scale classification of the Nation's forest land is necessary. In this classification, a distinction is made between those forest areas where the general welfare will be best served by Federal ownership, and those where it will be best served by private, county, or State ownership.

In the administration of the national forests, land classification is also carried on as a part of the management plan for each forest. The land classification in this case consists in delineating areas within the forest and designating them for particular types of treatment.

The Forest Service classified the land in the western national forests so as to show the few areas which were suited to agricultural settlement, and therefore could be alienated under the Forest Homestead Law, of June 11, 1906.

About 10 years ago Congress passed legislation for a Nation-wide inventory of our public and private forest resources and an economic analysis of the facts concerning their condition, utilization, and growth. This work, known as the Nation-wide forest survey, although not commonly thought of as land classification, can be said to fall within the scope of a broad definition of that term.

### Objectives of the Nation-wide Forest Survey

The Nation-wide forest survey is undertaking to provide the information for both public and private ownerships which will help in the formulation of policies and measures to keep the Nation's forest land productive, and to insure a continuous supply of wood to meet the Nation's requirements. Three major groups of activities are carried on by the Forest Service to further this objective and to obtain full benefit of the forests in conserving soils and waters, and in preserving the social values of the forests. These are: (1) the protection and administration of national forests, (2) research on problems in forest and range management, on the utilization of wood, and on supplies of and demands for forest products for all forest lands, and (3) cooperation

with States in the advancement of forest protection and forestry practice on State and privately owned land.

The Nation-wide forest survey falls in the research group and will furnish for the first time by actual field studies, facts and figures for the whole of the existing 600 million acres of forest land. The analysis and interpretation of the information will provide a basis essential to forest policies and programs, local, regional and national, public and private. These policies and programs relate to:

1. Proper balance of forest growth and depletion to build up growing stock and bring into effect sustained yield;
2. Correlation and distribution of industrial requirements with the growth capacity of the forest land tributary to proposed and existing establishments;
3. Principles to guide the public acquisition of land for forest purposes;
4. Land rehabilitation programs and regional resource development, such as that undertaken by the Tennessee Valley Authority;
5. The establishment of permanent communities for the people dependent for livelihood upon forest productivity.

More specifically the objectives of the Survey are to make an authoritative Nation-wide study to determine:

1. The extent, location, and condition of forest lands, and the quantity, kinds, quality, and availability of timber now standing on those lands;
2. The rate of depletion through cutting, fire, insects, disease, and other causes;
3. The current and probable future rate of timber growth and the productive capacity of our forest area;
4. The present and probable future requirements for forest products in different parts of the country by all classes of consumers, including major industries;
5. The relation of these findings to one another and to other economic factors as a basis in formulating both public and private policies, principles, and plans of forest-land management and use.

### Methods and Technique

Because of the size, importance, and wide ramifications of the project, special consideration was given to working out in advance as many details of the study as possible. This included a thorough review of methods used abroad to determine their applicability in this country and full use of the consulting services of research leaders from the Washington and regional offices of the Service and from outside the Service. Under this guidance, field and office procedures were worked out so that regional and national objectives and conditions were satisfied and the results could be made to fit together into a national whole.

**Field Work**

The current chart attached shows the size of the undertaking, the location of field work, and the progress to January 1, 1940. Forest experiment stations are responsible for the local direction of the Survey. The work was begun in the Pacific Northwest in 1930. In succeeding years it has been extended to the Northern Rocky Mountain, California, Lake States, Southern and Appalachian regions.

In the West, where the last great reservoir of virgin timber is located, the Survey technique rests primarily on the "compilation" method. This method, which was thoroughly tested before it was applied, consists of compiling and interpreting existing timber cruises both public and private. These cruises are subjected to intensive review and to a field check as a means of adjusting them to survey cruising standards. For the uncruised areas an independent inventory is made. Under the "compilation" method it is possible to prepare detailed forest-type maps which are especially valuable in forest planning as a supplement to the timber volume and area facts. Forest growth is determined from normal yield tables by adjusting the results to correspond with the degree of stocking occurring on the areas under consideration.

East of the Great Plains, where the virgin timber is mostly cut-out, a different technique is necessary. Satisfactory timber cruises, essential to the compilation method, are not available for the remaining old timber, and only few have been made for the vast areas of second growth. Here, after careful checking for sufficiency and accuracy, the "line-plot" method which is being used in Finland and Sweden in comparable work was adopted. Under this scheme an area is gridironed by parallel compass lines 10 miles apart and extending as nearly at right angles to stream courses as possible. Sample plots, a quarter- to a fifth-acre in size, are taken at 10-chain intervals along these travel lines. On these plots detailed information is obtained and recorded, indicating whether the plot is farm or forest land; the kind, volume, age, growth, quality, condition, and type of timber when present; the fire damage and degree of erosion; and other pertinent facts bearing on forest production such as disease, site, and stocking in reproduction sizes. These plots are considered a representative sample of the entire area and from them, total figures are computed. Relative accuracy of the information is computed by statistical methods and by comparison with more intensive cruises and cutting operations when these are available. Only generalized type maps are practicable under this plan. Forest growth is computed from increment borings obtained on the sample plots, thus providing basic measurements not only for calculating the increase in volume but also for determining the movement, as a

result of growth, of the various sizes of trees from their present diameter classes to the next higher diameter classes.

Raw material supplies required by the forest industries as a whole are determined in much the same way in all regions: by visiting all the larger plants, pole and pile operations, etc., and by sampling the smaller ones. The total number of plants is determined from NRA, independent counts, and other records. The requirements for sawlogs, pulpwood, poles, piles, etc., are then translated into the volume of trees required to meet them. This requirement is called the cutting drain or depletion.

The determination of national requirements, both present and prospective, for lumber, timber, and other forest products is being conducted on a country-wide basis from Washington. This phase of the study yields information showing the national volume of wood required and the probable trends in use. These data are then broken down for smaller areas and specific items as found necessary. To carry out this part of the work, it was necessary to develop special techniques to guide the collection, analysis, and interpretation of data. Probably the most difficult of all was the task of correlating the information on forest products consumption with the variable factors which affect it, such as population increase, swings in business cycles, and changing modes in building construction.

**Office Work and Reports**

The final Survey publication, several years in the future, will be national in scope. But interpretative analysis to this specific end was necessarily allowed to lag behind field activity in the early stages of the study, because of the desire to make all possible field progress with the available funds and to cover fairly large areas before attempting to formulate forest and land-management policies. Nevertheless, as the study advanced, impelling demand for forest facts sprang up, making it desirable to prepare preliminary releases as the information became available. These releases, now totaling more than one hundred and fifty, include unit, State, and regional reports on the timber supply situation, and several reports treating the wood requirements phase. This is considered a necessary service to the public, and State and Federal agencies, even though it slows down preparation of the final reports. To satisfy this need and to provide also for regular survey analysis, two general methods of handling survey data are in use.

In the West, under the "compilation" method field information is tabulated in large folders and all special assembly and compilation of data is done by hand. In the East, under the "line-plot" method, punch cards and machine tabulation are used extensively.



For the South, information has been recorded on some three million cards. The use of punch cards facilitates computation and analysis, reduces work, and provides for the assembly and compilation of data for any area desired.

Now that the primary field work is nearing completion in the Northwest, Lake States, and the South, effort is being directed to the final unit, regional, and State reports, and to keeping the survey up to date.

#### Current Status of the Investigation

As originally conceived in 1930, a 12- to 15-year period was estimated as required to cover the vast area of forest land in the United States. More than half of this period has elapsed and one-half of the

forest area has been covered by field work (fig. 11). The report preparation, however, is about two-thirds finished for the area actually studied, which means that less than half of the entire job, including both field and report work, is completed. That such progress has been made on so large an undertaking has been due, in large measure, to special grants of emergency funds no longer available, which accentuates the necessity of larger regular appropriations if the work is to be completed in the allotted time. Amendment of section 9 of the Act of May 22, 1928, now pending in Congress, is necessary before larger appropriations can be made.

Experience to date indicates that first-cost estimates for the project were too modest, as was the anticipated

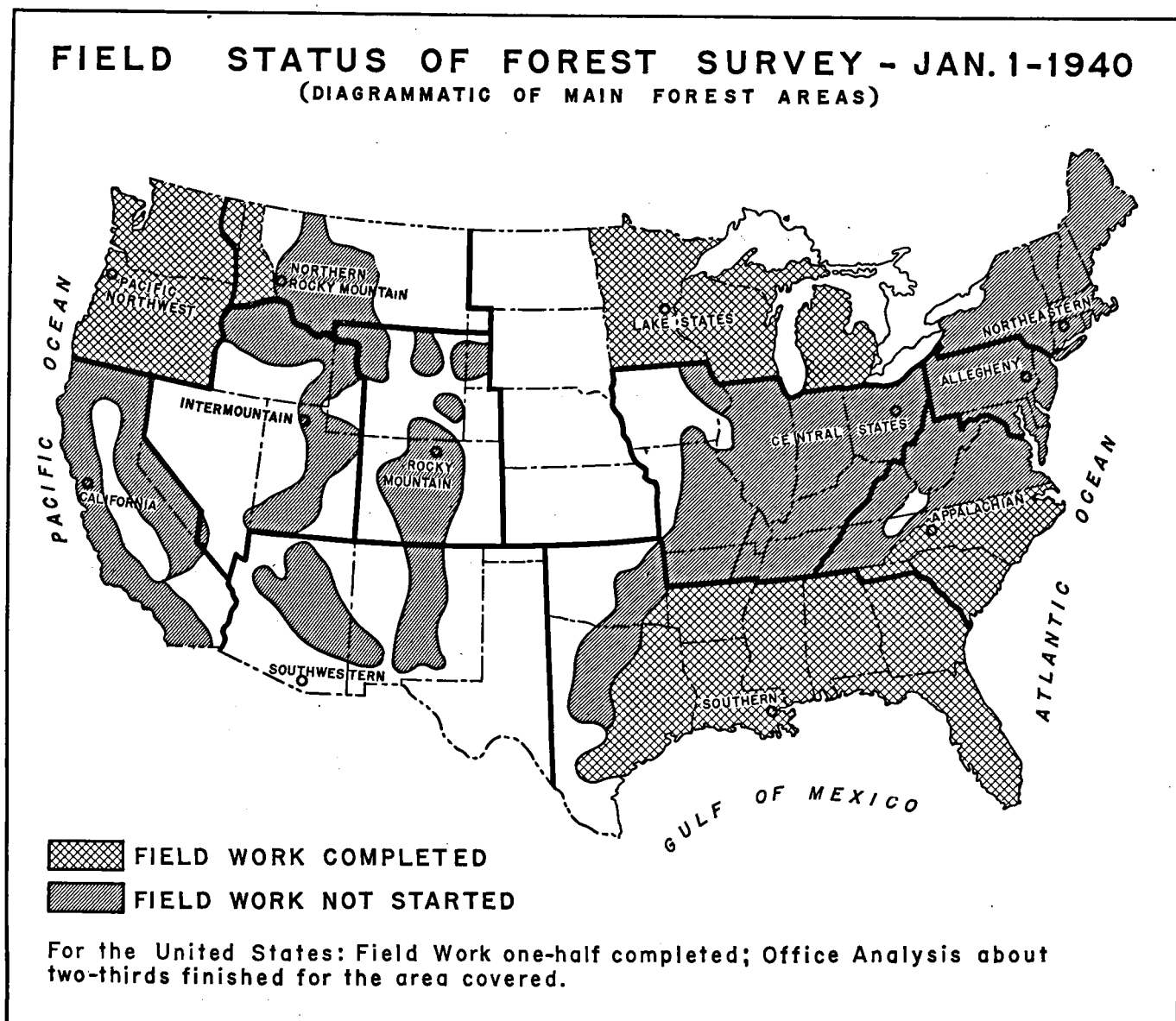


FIGURE 11.—Field Status of Nation-Wide Forest Survey, January 1940

use of the information once it became available. The large amount of time that would be taken away from regular work to satisfy the demands for forest survey data as obtained was also very much underestimated. Expenditure so far per forest acre covered has amounted to about 1.4 cents. At this rate, the total cost will run over 6 million dollars, which seems large, but actually is small when it is realized that one-third the total land area of the United States and about one-half the total of really productive land is forest land, and that our forest area is five times that of Sweden, Norway, and Finland combined.

In more detail, the progress and status of the timber inventory phase, by forest experiment station region, is as follows:

**Pacific Northwest:** Field work finished, reports possibly two-thirds completed. Work to keep the survey up to date required.

**Northern Rocky Mountain:** Field work one-half finished; well started on reports.

**Lake States:** Field work completed; reports possibly one-half finished. Work to keep the survey up to date required.

**Southern:** Field work nearly finished; reports about two-thirds completed. Work to keep survey up to date required.

**California:** Forest type mapping only; timber cruising, growth, and depletion, not yet started but type maps now being prepared. Will speed up this phase when started.

**Appalachian:** Field inventory and forest land-use study one-half completed; data computation in progress and report work well started.

**Plains States:** Some generalized work done; South Dakota and Kansas have been examined in the field by extensive methods. A report has been prepared for South Dakota and Kansas.

Reference to the attached chart will indicate the remaining regions to be examined. In the West these are California, Intermountain, Rocky Mountain, and Southwestern; and in the East, Central States, Allegheny, and Northeastern. It is estimated that the remaining untouched areas contain some 300 million acres of forest land, part farm woodland and part industrial and other forest land, or about one-half our total forest area.

The forest products consumption and requirements phase for the entire country is slightly more than one-half complete. The remaining work is principally office analysis, interpretation of data, preparation of some dozen reports covering the major classes of wood use, and the synthesizing of these into a national picture.

Preliminary releases concerning certain forest areas and special timber items are available at the forest experiment stations, while information on forest products consumption and requirements may be had from the Washington Office of the Forest Service.<sup>1</sup>

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<sup>1</sup> Communications regarding regional forest statistics should be addressed to the director of the station covering the territory in which the writer is interested. The forest survey is in progress in the territory of the following regional forest experiment stations:

Southern Forest Experiment Station, New Orleans, La.  
Appalachian Forest Experiment Station, Asheville, N. C.  
Lake States Forest Experiment Station, St. Paul, Minn.  
N. Rocky Mountain Forest Experiment Station, Missoula, Mont.  
Pacific Northwest Experiment Station, Portland, Oreg.  
California Forest Experiment Station, Berkeley, Calif.

General information on the forest survey may be had by writing the United States Forest Service, Washington, D. C.

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## CHAPTER X. SOIL SURVEY OF THE BUREAU OF PLANT INDUSTRY AND STATE AGRICULTURAL EXPERIMENT STATIONS

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### Origin, Objectives, and Development

The work of the Soil Survey is properly to be regarded as land classification, inasmuch as it classifies bodies of land in terms of their inherent soil characteristics. It is an integral part of a comprehensive study of soils leading to an understanding of their best use. Concurrent with the classification and mapping of the soil units, other research is required to ascertain the responsiveness of specific soils to management and the capabilities of each for use. This research is not a function of the Soil Survey alone, but is conducted by cooperating research groups in the Department of Agriculture and in the State agricultural experiment stations throughout the country. The work of these agencies leads ultimately to a classification of the soil types according to their potentialities for use. This classification, which can be regarded as a type of land classification, is being developed in conjunction with the Soil Survey, and the results will appear in the Soil Survey reports.

Soil survey work was instituted in the United States about 40 years ago for the purpose of defining and mapping important soil types in the country. This research was started in the Department of Agriculture, and consequently had agricultural purposes. The investigations have continued up to the present time in cooperation with the agricultural experiment stations of the States and Territories.<sup>1</sup>

Federal participation in this activity is covered by annual appropriations made by Congress. The department's participation was handled for many years by the Bureau of Soils, later by the Bureau of Chemistry and Soils. In a recent departmental reorganization the function was transferred to the Bureau of Plant Industry.

As an increasing amount of knowledge has become available there has been continued development toward a system of classification based strictly on soil characteristics, with less weight given to the causes of characteristics, and more to the internal soil morphology, although slope, stoniness, and similar external features are essential in defining soil types, and differences in those factors significant to agriculture, are recognized in the classification. From the beginning all features have been taken into account that appeared to influence the suitability of soils for crops.

<sup>1</sup> Except in one or two States where the work is done in cooperation with some other agency.

The system of nomenclature which was set up involved the classification of soils into types. Place names were chosen to designate the different soil types, as for example, "Miami silt loam." There was an implied grouping of the soil types as indicated by the names "Miami silt loam" and "Miami silty clay loam." These groups later came to be known as soil series. The basis of the grouping was not clearly conceived in the early stages of the work. Later the grouping of soil types into soil series had its basis in common geologic origin (not composition) of the parent material. Thus the Miami soil types were grouped into a single soil series (Miami) because they were "derived from glacial drift." The grouping of soils on the basis of the geologic origin of the parent material from which they were developed, resulted in a grouping of soil types within a series that had few soil characteristics in common. The result was confusing, and the purpose of classification was defeated. This defect gradually was corrected, as soil science developed in the United States.

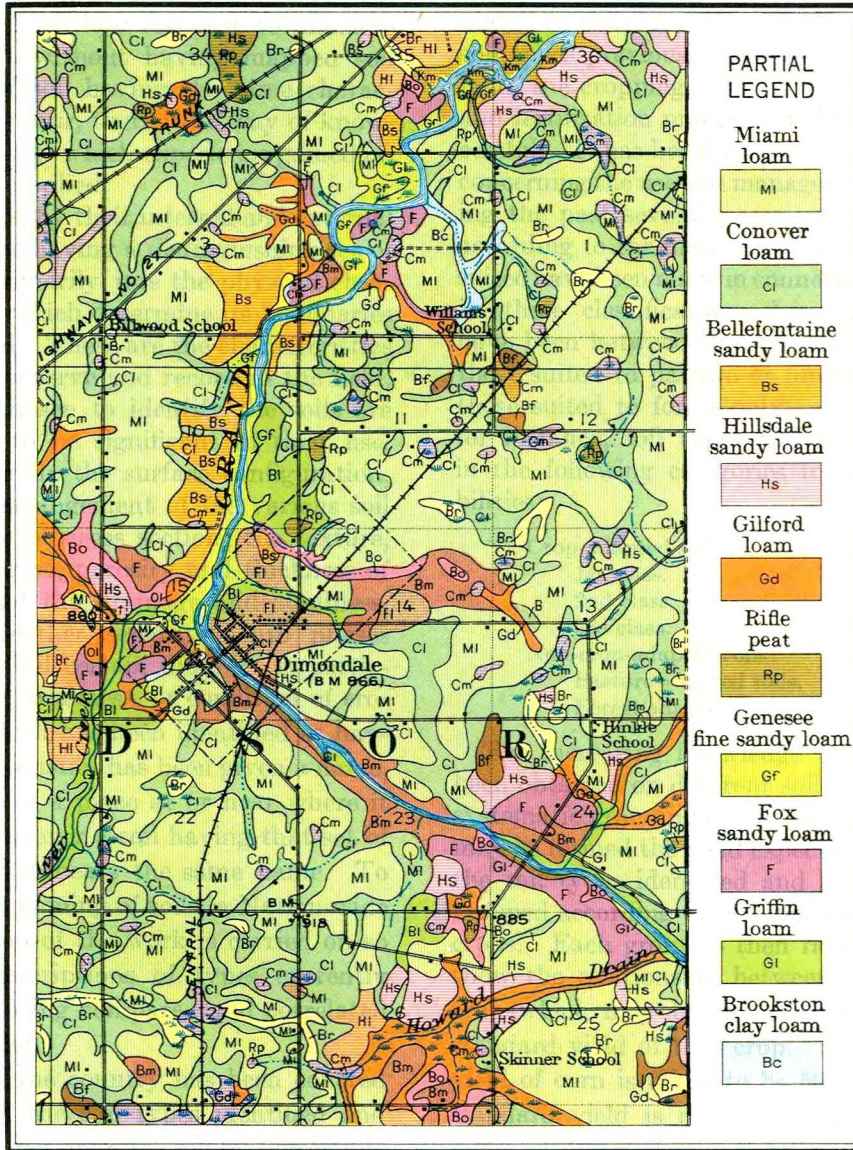
As the work advanced, the correlation of soil types between widely separated areas was attempted. This revealed the necessity of more precise definitions of the soil units if the work was to have wide value, scientifically or practically. There was a gradual shifting from the geologic definition of soil series to one which was strictly in terms of soil characteristics. In 1920 C. F. Marbut, then Chief of the Soil Survey, listed eight features of the soil profile necessary for the definition of a soil unit. These features were:

1. Number of horizons in a soil profile;
2. Color of the various horizons with special emphasis on the surface ones;
3. Texture of the horizons;
4. Structure of the horizons;
5. Relative arrangement of the horizons;
6. Chemical composition of the horizons;
7. Thickness of the horizons;
8. Geology of the soil material.

### Types of Work

The comprehensive study of soils leading to an understanding of their best use proceeds along four general lines:

- (1) The identification and mapping of soils in the field;
- (2) The determination of the morphological, physical, chemical, and biological characteristics of the soil types;
- (3) The determination of the responsiveness of soil types to management;



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REPRINT OF A SMALL SECTION OF A TYPICAL DETAILED SOIL MAP (EATON COUNTY, MICH.)

(4) Determination of the use capabilities of the soil types on the basis of the physical data, and of experience.

These four lines of study are not entirely mutually exclusive, and are carried on more or less concurrently.

The identification and mapping of soil types, with which the Soil Survey is primarily concerned, provides a means of applying to specific geographic areas or individual farms the results of research dealing with the use capabilities of soils and their response to management. It is plain that without having mapped soil types, that is, bodies of soil having the same characteristics, wherever they occur, there is no way of knowing the geographic extent to which experience gained on a particular soil can be applied.

Soil types are identified by their internal and external characteristics, each type having a distinguishing set of such characteristics. Primarily, it is the physical characteristics of a soil type which determine its boundaries when mapped in the field. These are the characteristics which it is practical to observe and record in the field. The physical features chosen to identify the soils are those which are likely to be significant in their use. Such characteristics include the surface configuration, or lay-of-the-land; the arrangement of the various soil layers in the soil profile or cross section; the texture, structure, color, consistence, porosity and thickness of each of these layers; and the drainage and stoniness. Some soil types are further separated into phases to express in greater detail certain differences, particularly in degree of slope, stoniness, or condition of erosion. Each soil type which has been identified as having a given set of characteristics has been given a name, in most cases the name of a place at or near where it was first identified. Wherever a soil having that set of characteristics is found, it bears the same name. To insure consistency in the naming of soils, a Nation-wide inspection and correlation of the work is carried on so that the names and descriptions of types currently mapped are constantly being compared and correlated with those mapped earlier.

As more and more of the country has been covered by the Soil Survey and the soil types identified and classified, it has been possible to relate agronomic research to soil types. This, of course, has greatly broadened the usefulness of such research, inasmuch as it has shown the particular areas to which the results of research carried on in any one locality might have application. Experimental research has been related to soil types, so as to permit the application of knowledge over broad areas similar to that where the research was carried on. In addition, the results of practical farming experience have likewise been related to soil

types so that this information can be applied over extensive areas similar to those where the experience was gained.

There has been an increasing attempt to relate both research and experience to the soil types mapped in the Soil Survey in a systematic fashion. The yield experience of farmers has begun to be analyzed and the yields sorted according to the soil types on which they were obtained. As a result of this body of accumulated knowledge, it has been possible to classify the soil types previously mapped, according to the uses of land, the cropping systems, and the soil management and fertilization practices which have been found successful. It has been possible to make recommendations concerning the use and management of soil types. During the past several years groupings of the soil types according to the major use group to which they appear suited have been made in connection with the Soil Survey. In these classifications the major distinctions made have been between the soils suited to crop production, those suited to pasture or forest but not to crops, and those suited to forest only. In the Tennessee Valley for instance, soil types and phases have been placed in the following categories to express their use capabilities:

Crop-adapted soils:

- 1st class.
- 2nd class.
- 3rd class.

Non-crop-adapted soils:

- Pasture adapted soils.
- Forest adapted soils.

The increasing knowledge of crop yields which has been obtained on different soil types has given rise to a systematic grouping of the soil types according to what may be termed the yield expectancy. In this procedure the soil types identified and mapped in a county are grouped according to the yield experience with different crops. Each group is then rated in such a way as to show the relationship between the average yield of a crop which may be expected on it, and an assumed standard yield of that crop. For example, a standard yield of corn is taken to be 50 bushels per acre. This standard yield is represented by a crop productivity index of 100. If a particular soil type was found to have yielded 40 bushels per acre on the average over a period of years, it would receive a crop productivity index of 80 for corn. In each case, however, the management practices under which the average yields were obtained, are given. The statement at the top of page 60 gives the standard yields which were used in connection with table 1, which illustrates the grouping and classification of soil types according to their productivity for individual crops.

Yield Standards

Crop:	Yield
Corn..... bushels...	50
Wheat..... do.....	25
Oats..... do.....	50
Barley..... do.....	40
Apples..... do.....	200
Potatoes..... do.....	200
Sweetpotatoes..... do.....	150

Crops:	Yield
Timothy and clover..... tons..	2
Alfalfa..... do.....	4
Lespedeza..... do.....	1½
Burley tobacco..... pounds..	1,500
Sorghum..... gallons..	100
Pasture..... cow-acre-days ¹	100

¹ Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here, it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year

rates 360, whereas another soil able to support 1 animal unit on 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days, the rating is 25.

TABLE 1.—Productivity rating of soils and

Soil ¹	Crop productivity index ² for—																				
	Corn			Wheat ³			Oats ⁴			Barley ⁵			Tobacco (burley) ⁶			Timothy and clover			Alfalfa		
	a ²	b ²	c ²	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Huntington silt loam.....	100	100	100	40	40	50	50	50	60	90	90	90	⁶⁰	⁷⁵	⁹⁰	100	100	100	60	70	80
Dewey silt loam.....	60	70	100	70	80	110	65	75	100	55	65	90	70	100	120	70	80	100	80	95	110
Pope very fine sandy loam.....	70	70	90	40	50	60	45	45	60	60	60	70	⁵⁰	⁶⁵	⁷⁵	80	80	100	60	60	70
Dewey silty clay loam.....	50	60	85	50	55	80	50	55	80	50	55	75	30	40	65	55	65	85	60	80	100
Talbot silty clay loam, smooth phase.....	45	55	80	60	60	80	50	55	70	45	55	75	50	70	85	50	65	80	50	65	85
Sequatchie very fine sandy loam.....	50	60	80	60	60	85	45	50	65	45	55	75	50	75	85	45	60	75	45	60	80
Allen very fine sandy loam.....	45	60	75	55	65	80	50	60	70	45	55	80	45	75	85	50	70	85	40	60	85
Lindsdale silt loam (undrained).....	60	60	75	45	45	50	—	—	—	45	45	65	—	—	—	60	60	75	—	—	—
Greendale silt loam.....	45	55	75	40	50	70	35	40	55	40	45	70	40	65	80	50	65	80	35	45	70
Fullerton cherty silt loam, smooth phase.....	30	45	75	35	45	65	20	30	45	30	40	55	40	65	80	30	45	60	20	35	55
Waynesboro very fine sandy loam.....	35	45	65	40	50	65	30	40	60	35	40	60	25	50	60	40	50	70	15	30	60
Hartsells very fine sandy loam.....	30	40	80	25	50	75	25	50	75	25	50	75	25	35	50	30	40	80	15	25	60
Wolftever silt loam.....	35	45	60	35	50	60	25	40	50	35	40	60	25	50	60	35	50	75	10	25	35
Wolftever silt loam, slope phase.....	30	40	60	35	45	60	25	35	45	30	35	55	20	45	55	30	45	75	10	25	35
Leadvale very fine sandy loam.....	30	40	60	35	45	60	25	35	45	25	40	50	25	50	60	30	45	55	15	25	40
Nolichucky very fine sandy loam.....	25	35	50	30	40	60	20	30	55	25	30	50	20	45	55	30	40	60	10	25	40
Sequatchie very fine sandy loam, slope phase.....	35	50	70	40	50	60	35	40	50	35	40	60	40	60	75	45	55	75	30	45	65
Allen very fine sandy loam, slope phase.....	35	50	70	45	55	75	40	50	65	35	45	70	40	65	75	45	65	80	30	60	80
Waynesboro very fine sandy loam, slope phase.....	30	40	60	40	50	65	30	40	55	25	45	55	25	45	55	35	45	65	15	25	45
Talbot silty clay loam.....	30	40	60	40	55	65	30	40	50	30	40	55	30	50	60	35	50	65	25	35	45
Fullerton cherty silt loam.....	25	35	50	30	40	60	20	30	40	20	30	45	20	40	50	30	40	75	15	25	35
Dewey silty clay loam, hilly phase.....	40	50	65	50	60	65	35	45	70	30	40	60	20	40	50	60	60	75	40	60	75
Roane gravelly loam.....	30	35	60	30	40	50	20	30	40	25	30	50	25	45	55	35	45	60	15	25	40
Philo very fine sandy loam (undrained).....	40	50	60	30	35	50	—	—	—	25	35	45	—	—	—	45	60	75	—	—	—
Colbert silt loam.....	30	40	60	35	45	60	20	30	45	30	40	55	25	50	60	35	45	60	20	30	50
Clarksville cherty silt loam, smooth phase.....	25	30	50	25	35	60	15	25	35	25	30	50	20	35	60	25	35	50	10	20	30
Clarksville cherty silt loam.....	20	25	50	20	30	60	10	20	30	20	25	50	20	30	50	20	30	50	10	20	25
Fullerton cherty silt loam, eroded phase.....	20	30	55	15	25	40	15	25	35	15	25	40	15	30	50	20	30	45	10	25	40
Pope loamy fine sand.....	25	35	55	25	30	45	15	25	35	15	25	40	15	30	50	20	30	40	10	20	30
Nolichucky very fine sandy loam, slope phase.....	20	30	50	25	35	60	20	30	55	25	30	50	20	40	50	30	40	60	10	25	40
Apison very fine sandy loam.....	25	30	50	25	30	60	10	15	30	20	25	50	20	40	60	20	30	50	15	20	30
Hartsells very fine sandy loam, slope phase.....	25	35	75	20	40	70	20	40	70	20	40	70	20	30	45	25	35	70	15	25	60
Jefferson gravelly fine sandy loam.....	25	30	45	25	30	50	15	25	40	20	25	40	20	30	45	20	30	45	15	20	30
Nolichucky very fine sandy loam, eroded phase.....	10	20	45	15	25	55	10	20	50	15	20	45	10	25	45	15	25	55	10	20	35
Pope gravelly fine sandy loam.....	20	30	50	20	25	35	10	20	30	15	20	35	10	25	45	20	30	50	10	25	40
Jefferson gravelly fine sandy loam, slope phase.....	20	25	40	20	25	45	10	20	35	15	20	35	15	25	45	15	25	40	15	20	30
Upshur silty clay loam, valley phase.....	40	45	50	50	55	60	35	40	45	35	40	45	⁴⁵	⁵⁰	⁵⁵	50	55	60	40	45	50
Melvin silt loam (undrained).....	30	35	45	—	—	—	—	—	—	—	—	—	—	—	—	25	30	45	—	—	—
Dewey silty clay loam, steep phase.....	30	40	50	30	40	50	25	35	50	25	30	45	20	30	45	30	40	50	20	30	35
Colbert, silt loam, slope phase.....	20	25	35	25	30	40	15	25	40	15	25	40	15	30	40	20	30	35	10	20	25
Fullerton cherty silt loam, hilly phase.....	20	30	45	25	30	40	20	30	45	15	25	40	10	20	30	20	30	35	15	25	30
Colbert silty clay loam.....	20	20	30	—	—	—	—	—	—	—	—	—	—	—	—	20	25	35	—	—	—
Atkins very fine sandy loam (undrained).....	20	25	30	—	—	—	—	—	—	—	—	—	—	—	—	20	25	35	—	—	—
Clarksville cherty silt loam, hilly phase.....	20	25	35	20	30	35	10	20	30	15	25	35	10	25	35	15	20	30	10	15	20
Rough stony land (Colbert and Talbot soil material).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Waynesboro very fine sandy loam, eroded hill phase.....	15	20	40	15	25	50	10	20	40	15	20	45	10	25	45	15	25	50	10	20	35
Talbot silty clay loam, hilly phase.....	10	20	30	20	25	35	15	25	35	15	25	35	10	20	30	25	30	45	15	25	60
Armuchee silt loam.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	25	35	—	—	—
Apison very fine sandy loam, eroded phase.....	10	15	30	10	15	30	10	15	20	10	15	20	10	15	20	10	20	30	—	—	—
Apison very fine sandy loam, eroded slope phase.....	10	15	30	10	15	30	10	15	20	10	15	20	10	15	20	10	20	30	—	—	—
Fullerton cherty silt loam, eroded hilly phase.....	10	20	30	20	25	35	15	25	35	15	25	35	15	25	35	20	25	35	15	20	25
Fullerton cherty silt loam, steep phase.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Clarksville cherty silt loam, eroded hilly phase.....	10	20	30	15	20	30	10	20	30	10	20	30	10	20	30	15	20	30	10	15	20
Clarksville cherty silt loam, steep phase.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rough stony land (Talbot soil material).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hector stony fine sandy loam.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lehew stony fine sandy loam.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Muskingum stony fine sandy loam.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rough gullied land (Fullerton soil material).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rough gullied land (Apison soil material).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rough stony land (Muskingum soil material).....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mine dump.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

NOTE.—Leaders indicate that crop is not commonly grown because of poor adaptation.

¹ Soils are listed in the approximate order of their general productivity under the prevailing current practices and their relative suitability for growing crops, pasture, or forest.

² The soils of Roane County are given indexes that give the approximate average production of each crop in percent of the standard of reference. The standard represents the approximate average yield obtained without the use of fertilizer or amendments on the better soil types of significant extent in the regions in which this crop

is most widely grown. (See Table of Standards above.) Many of the ratings are the results of estimates, as supporting data are incomplete.

³ These indexes refer to yields commonly procured without the use of manure, amendments, or beneficial crop rotation.

⁴ These indexes refer to yields procured under commonest practices of management.

⁵ These indexes refer to yields that may be expected under the best practices of management.

This type of productivity classification is being undertaken in connection with each of the new soil surveys that are initiated. On some soil types sufficient experience has not been had with every crop to show conclusively where the soil type belongs in the classification. In such cases the rating must be estimated from those for soils having the most nearly similar characteristics on which evidence of crop yields is available.

The usefulness of this type of productivity rating in farm management planning is noteworthy. It provides data by which production from different fields on a

farm may be estimated under different cropping systems and practices, and thus enables a more realistic use of the budget method of farm planning.

### Field Methods and Techniques

The county is selected in most cases as a work area for field mapping. Exceptions are made, for example, in the West where most of the agriculture within a county can be concentrated in a few irrigated valleys. In such instances an irregular area encompassing the agricultural parts of a county may be taken as a work area.

classification of land in Roane County, Tenn.

Crop productivity index <sup>1</sup> for—																								Land classification <sup>2</sup>
Lespedeza			Sorghum (sorgo) <sup>3</sup>			Potatoes <sup>4</sup>			Sweet potatoes <sup>5</sup>			Vegetables <sup>7</sup>			Apples <sup>7</sup>			Peaches <sup>7</sup>			Pasture <sup>7</sup>			
a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	
100	100	100	80	90	100	50	50	50	60	70	80	70	70	70	--	--	--	--	--	--	150	150	150	First-class soils (good to excellent cropland).
80	90	110	75	75	75	80	90	100	80	90	100	80	90	100	80	90	100	80	90	100	90	90	110	
80	80	100	70	80	90	45	45	45	45	55	65	60	70	70	--	--	--	--	--	--	90	90	110	
65	75	90	65	65	75	65	75	90	65	75	90	65	70	80	70	75	90	70	75	85	70	70	110	
55	65	80	60	60	70	40	60	75	60	70	80	50	60	70	55	60	75	45	50	60	65	75	110	
60	65	80	55	70	80	50	65	80	65	75	85	60	70	80	65	75	80	60	70	85	65	70	100	
55	70	80	55	70	80	45	65	80	60	75	90	50	60	70	75	80	85	60	70	85	60	70	90	
65	65	80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	90	90	110	
55	65	90	55	65	75	45	60	80	65	70	80	60	70	75	50	60	70	40	50	55	60	65	85	
35	50	80	40	50	70	35	45	70	45	60	75	60	70	80	40	50	60	60	65	80	40	50	75	
40	55	70	35	45	60	35	50	75	45	55	75	50	65	80	35	45	55	45	50	60	35	50	70	
55	70	80	30	50	75	40	50	100	40	55	90	40	60	90	30	40	50	50	60	70	30	50	80	
55	65	80	35	45	55	30	40	60	35	50	65	40	50	60	--	--	--	--	--	--	35	50	60	
55	65	80	30	40	50	25	35	55	30	45	60	35	45	55	--	--	--	--	--	--	35	50	60	
30	50	70	30	45	55	30	45	65	40	55	70	30	40	55	20	25	30	20	25	35	40	50	70	
35	45	60	30	40	55	30	45	70	40	50	70	45	60	80	35	40	60	40	55	60	30	45	65	
50	60	80	50	60	70	40	55	70	45	65	75	60	70	85	60	70	75	60	70	75	50	60	80	
50	65	75	45	60	70	35	55	70	50	65	80	40	50	60	65	70	75	65	65	80	55	65	80	
40	50	65	30	40	55	30	45	65	40	50	70	45	60	80	35	40	55	45	50	60	35	50	70	
35	50	65	45	55	65	30	40	60	45	55	65	30	40	50	45	50	60	40	45	50	40	45	70	
30	45	55	35	45	55	30	40	60	35	45	60	25	30	40	30	40	50	30	40	50	25	35	55	
50	60	80	40	50	60	40	50	60	40	50	60	30	40	50	30	40	60	30	40	60	30	40	85	
35	45	65	40	50	60	30	40	55	40	50	70	40	50	60	--	--	--	--	--	--	40	45	70	
45	50	70	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	50	60	85	
40	50	70	40	50	60	30	40	60	40	55	70	30	40	50	25	30	40	15	20	25	55	60	90	
30	40	50	30	45	55	30	40	50	35	45	50	30	45	50	30	40	50	35	40	45	25	30	45	
25	35	45	30	40	50	25	35	40	30	40	45	25	40	60	30	40	50	35	40	45	25	30	40	
20	35	50	25	35	50	15	25	40	20	30	50	15	20	30	20	30	45	20	30	45	15	20	50	
20	35	50	25	35	50	30	40	60	30	40	60	30	40	60	30	40	60	30	40	60	20	30	50	
35	45	60	30	40	55	30	40	65	40	50	70	40	60	80	35	40	55	40	55	60	30	45	65	
25	35	45	30	40	50	30	40	50	30	40	50	25	30	40	25	30	40	30	35	40	25	30	40	
45	60	70	40	55	65	35	55	90	35	45	80	30	50	75	25	35	45	40	50	60	25	45	75	
25	35	45	30	40	50	30	40	50	30	40	45	25	30	40	25	30	40	30	30	40	25	30	40	
25	30	55	15	25	50	15	30	55	20	35	60	25	45	70	25	30	55	25	40	55	15	30	60	
30	40	55	25	35	40	15	25	35	25	30	50	25	30	50	25	35	55	--	--	--	20	30	50	
25	35	45	25	35	45	25	35	45	25	35	40	20	25	40	25	30	40	30	35	40	25	30	40	
45	50	55	40	45	50	25	30	35	25	30	35	20	25	30	45	50	55	40	45	50	70	75	85	
15	25	30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	70	80	
40	50	60	30	40	45	20	30	35	25	30	35	30	35	40	35	40	50	15	20	25	40	50	60	
30	40	45	25	30	35	20	30	35	30	40	45	30	40	45	40	50	55	45	50	55	30	45	60	
30	40	50	25	35	40	20	30	35	25	30	35	25	30	35	35	40	50	15	20	25	30	40	55	
10	15	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40	45	60	
20	30	40	20	30	35	20	30	35	25	35	45	20	30	35	20	25	30	30	35	40	25	30	40	
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25	30	55	15	25	50	15	25	35	15	25	35	25	35	45	25	30	40	20	30	40	15	30	60	
30	40	55	25	35	40	15	25	35	20	30	40	15	25	30	20	25	30	20	25	30	30	40	60	
25	35	40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	35	40	60	
15	25	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	20	30	
15	25	35	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15	20	30	
25	35	45	20	30	35	15	20	30	20	30	40	15	25	30	20	25	30	25	30	40	20	35	45	
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--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20	20	30	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10	10	30	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

<sup>1</sup> Wheat, oats, barley, burley tobacco, sorghum, potatoes, and sweetpotatoes are rarely grown on soils of the first bottoms. For this reason yield data are extremely scarce, and the indexes in the table were arrived at inductively.  
<sup>2</sup> These indexes for vegetables, apples, peaches, and pasture are largely comparative for the soil types of this and adjoining counties since substantiating yield data are particularly scarce for these items. Although not based on quantitative yield data

or used strictly in reference to the standards, it is believed they are fairly comparable.  
<sup>3</sup> This is a grouping of soil types and phases according to their relative physical use adaptation.  
<sup>4</sup> The quality of these crops is relatively somewhat inferior, taking the average of the county as a standard.

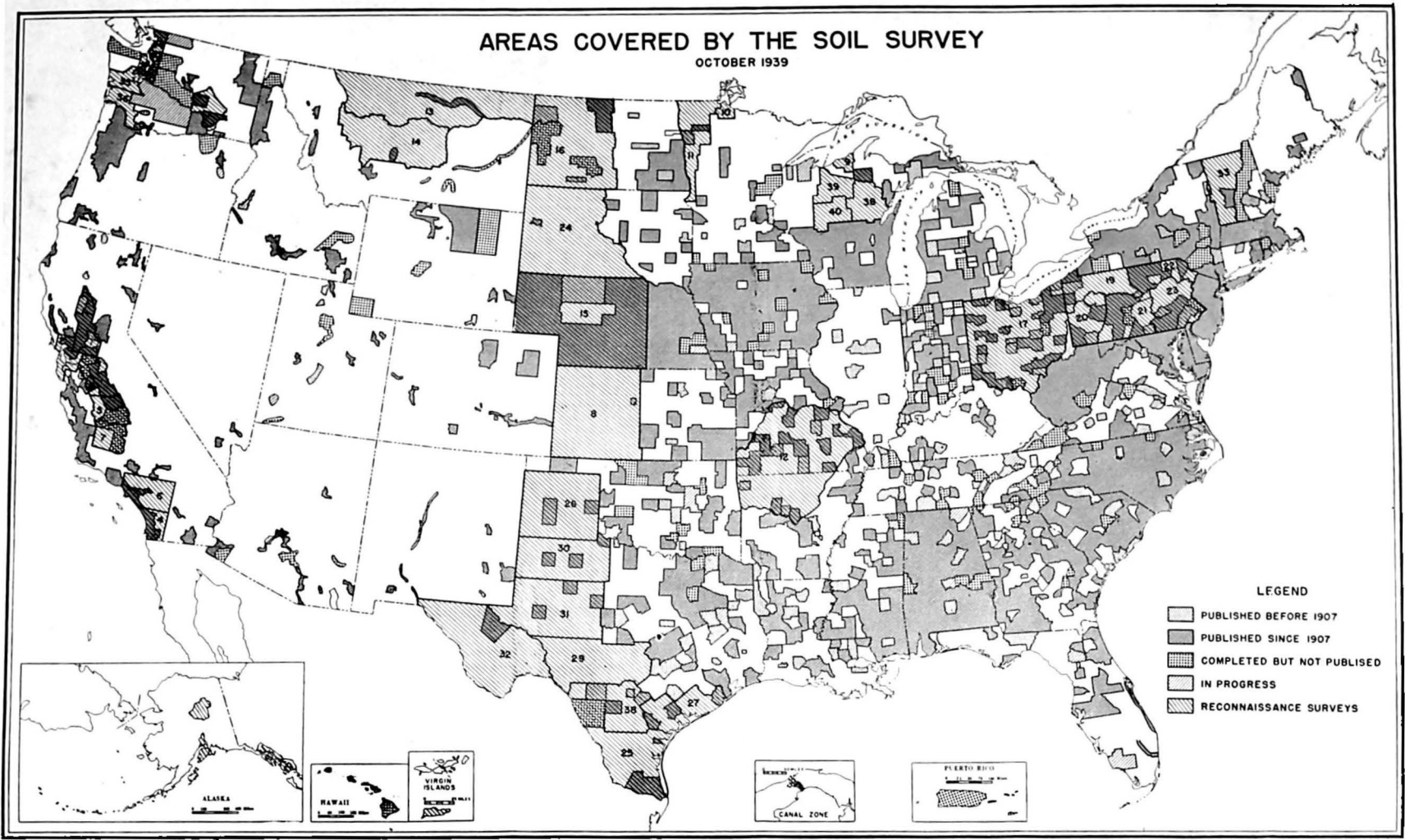


FIGURE 12.—Progress of the Soil Survey, October 1939



Parties of from one to five or six men delineate the soils in detail on base maps by traversing the area intensively enough and in such fashion as to permit them to observe all of the distinct soil areas that occur, and to locate their boundaries.

In ascertaining the soil characteristics of each distinct soil type, profiles are studied carefully, from holes dug with a spade or other appropriate sampling tools. To supplement the observations made by exposing a section of the soil profile, borings are made at more or less frequent intervals with a soil auger, and a section of the soil profile withdrawn and studied.

In order to locate the soil areas properly, it is necessary to have an accurate base map. The most satisfactory base for making detailed soil maps in the field is a single-lens aerial photograph of good quality. Few other base maps provide as many points of reference for the location of soil features. Furthermore, certain soil boundaries appear on the aerial photograph itself and its use greatly facilitates both speed and accuracy in drawing the boundaries of soil types. Because of the greater accuracy permitted through the use of aerial photographs as field base for making soil surveys, it is desirable, if practicable, to delay initiation of detailed soil surveys until aerial pictures can be provided.

Formerly field mapping of soils was done upon topographic maps of the United States Geological Survey. If these or some other base maps were not available, base maps were constructed by plane table traverse.

Aerial photographs used for soil survey field base are most commonly on scales of 3.16 or 4 inches-to-the-mile. Plane-table mapping is usually done at a scale of 2 inches-to-the-mile. However, departures from these scales are made where special circumstances require it. Distinct soil areas of as little as one or two acres in size are shown on modern soil maps. In some areas where very small bodies of individual soil types occur in intimate association with each other, complexes, or associations of soil types, must be mapped at the map scales commonly used. Occasionally reconnaissance soil surveys have been made as a means of providing a general understanding of the soils of an area quickly and at small expense. Such surveys actually map associations of soil types frequently of sharply contrasted character, but which occur in intimate geographic association. In counties containing large sparsely settled areas, such as mountains or arid grazing land, as well as intensely used agricultural areas, reconnaissance methods are used in the mountainous or arid area, and detailed methods elsewhere.<sup>2</sup>

### Form of Results

The results of the soil survey are published in reports. In most cases a report covers the work done in one

county. In the West where agriculture is frequently localized in irrigated valleys, reports are commonly issued for "areas" covering less than a county.

Soil survey reports describe the internal characteristics and external features of each soil type mapped in the area covered; present for each soil type a description of the prevailing use, cropping systems, and soil-management practices; set forth in a table of productivity ratings the yield expectancy of important crops as estimated for each soil; and present the recommendations of the cooperating experiment station concerning the use and management of the soils as determined by its researches and studies. In each report there is also a statement describing important features of the county or area as a whole, including population characteristics and distribution, history of settlement, principal industries and occupations, markets, transportation and communication facilities, climate, and the principal characteristics of agriculture in the area.

The soil map accompanying the report is a lithographed colored map, in most instances on a scale of one inch equals one mile. A reprint of a small portion of a published soil map is bound into this report facing page 58.<sup>3</sup> Larger scales than this are sometimes used where special conditions require. A recent practice is to show all the soils falling in one major use group in one color on the map. The distinctions between soil types within the use group are then shown by the boundary lines and symbols in black.

The soil survey report constitutes the only comprehensive published source of information concerning the agricultural land resources in most of the counties where soil surveys have been made. It provides a large measure of guidance to settlers and to public agencies administering not merely land-use activities, but activities which require an understanding of the distribution of land-use capabilities. These activities include among others, highway planning, planning rural electric systems, rural school locations, tax assessment, and public relief. One of its principal uses, however, is to enable farmers to determine whether the results of researches and experience brought to them by their State experiment stations through their extension services, or through publications, apply to their own farms, and if so, to what parts.

Soil surveys have been completed for 978,000,000 acres, for which maps and reports have been published. Field work is complete in about 80,000,000 acres more (fig. 12).

<sup>2</sup> For a detailed description of the procedure used in making soil surveys see: Kellogg, Charles E., *Soil Survey Manual*, United States Department of Agriculture, Mis. Pub. 274, Washington, D. C.

<sup>3</sup> For an illustration of a soil survey report, see: Youngs, F. O., and Jennings, D. S., *Soil Survey of the Price Area, Utah*, Feb. 1939.

**Personnel**

Personnel employed in soil survey work are most commonly trained in soil science, geology, chemistry, and agronomy. Scientists of all degrees of experience in soil mapping are used of course, because new workers must be trained to fill vacancies and meet expanding needs. Inexperienced men always work under the immediate direction of an experienced man. Periodic

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inspections of the work are given by regional inspectors who have responsibility for seeing that the work follows nationally standardized procedure and is of high quality and accuracy. Since all of this research is conducted in cooperation with the appropriate State agencies, a very large part of the personnel actually performing the work are employees of these agencies.

# LEGEND

## EXPLANATION OF SYMBOL

37B18

37 - Moderate sheet erosion with occasional gullies  
 B - Slope, 3 - 8 percent 18 - Soil type, Bertrand silt loam

### EROSION

#### SHEET EROSION

- 2 - Less than 25 percent of topsoil removed
- 3 - 25 to 50 percent of topsoil removed
- 33 - 50 to 75 percent of topsoil removed
- 4 - 75 percent or more of topsoil removed, or all topsoil and some subsoil removed

#### GULLY EROSION

- 7 - Occasional gullies: More than 100 feet apart
- 8 - Frequent gullies: Occurring less than 100 feet apart but including less than 75 percent of area delineated
- 9 - Very frequent or large gullies
- ( ) - Indicates gullies too deep to be crossed with tillage implements, as 7, 8, or 9
- V - Indicates gullies, too deep to be crossed with tillage implements, in which a deep friable horizon is exposed, as 7V, 8V, or 9V

#### MISCELLANEOUS

- 1 - No apparent erosion
- + - Recent alluvial or colluvial deposits
- 0 - Undifferentiated erosion

#### GROUPING OF EROSION CLASSES

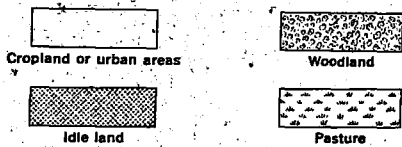
- No apparent erosion: 1
- Recent alluvial or colluvial deposits: +
- Slight erosion: 2, 27, 8
- Moderate erosion: 28, 3, 37
- Moderately severe erosion: 38, 33, 337
- Severe erosion: 338, 4, 47
- Very severe erosion: 48, 9

### SLOPE

	DOMINANT PERCENT
A - Nearly level; not subject to erosion	Less than 3
B - Subject to erosion if cultivated; control practicable	3 - 8
BB - Subject to erosion if cultivated; more intensive control measures necessary than on B slopes	8 - 15
C - Too steep for practical erosion control under clean cultivation; suitable for close-growing crops	15 - 25
D - Too steep for practical erosion control if cultivated; suitable only for permanent cover	25 - 35
DD - Too steep for erosion control if grazed; suitable only for permanent forest cover	35 or more

### LAND USE

Reproduced in gray



### SOILS

#### ALLUVIAL SOILS

- 1 - Alluvial soils, undifferentiated
- 2 - Cass sandy loam
- 3 - Cass silt loam
- 4 - Muck
- 5 - Ray silt loam
- 6 - Ray and Genesee soils, undifferentiated
- 7 - Sarpy fine sandy loam
- 8 - Sarpy loam
- 9 - Sarpy sand
- 10 - Sarpy silt loam
- 11 - Stony colluvium, Wabash soil material
- 12 - Wabash loam
- 13 - Wabash silt loam

#### TERRACE SOILS, SUBJECT TO GULLY EROSION

- 14 - O'Neill gravelly sandy loam
- 15 - O'Neill loam
- 16 - O'Neill sandy loam
- 17 - Plainfield sand

#### TERRACE SOILS, SUBJECT TO SHEET AND GULLY EROSION

- 18 - Bertrand silt loam
- 19 - Jackson silt loam
- 20 - Judson loam
- 21 - Wabash-Judson silt loam
- 22 - Waukesha loam
- 23 - Waukesha silt loam

#### UPLAND SOILS, SLIGHTLY ERODIBLE, DERIVED FROM SANDSTONE OR SANDY GLACIAL DRIFT

- 24 - Boone loamy sand
- 25 - Boone sandy loam, deep phase

#### UPLAND SOILS, MODERATELY OR HIGHLY ERODIBLE, DERIVED FROM LIMESTONE

- 26 - Dubuque silt loam
- 27 - Rough broken land
- 41 - Millsdale loam
- 42 - Millsdale silty clay loam

#### UPLAND SOILS, MODERATELY ERODIBLE, DERIVED FROM LOESS AND GLACIAL DRIFT

- 28 - Carrington loam
- 29 - Carrington silt loam
- 30 - Dodgeville loam
- 31 - Dodgeville silt loam
- 32 - Lindley loam
- 33 - Lindley sandy loam
- 34 - Lindley silt loam
- 35 - Tama silt loam

#### UPLAND SOILS, HIGHLY ERODIBLE, DERIVED FROM LOESS AND GLACIAL DRIFT

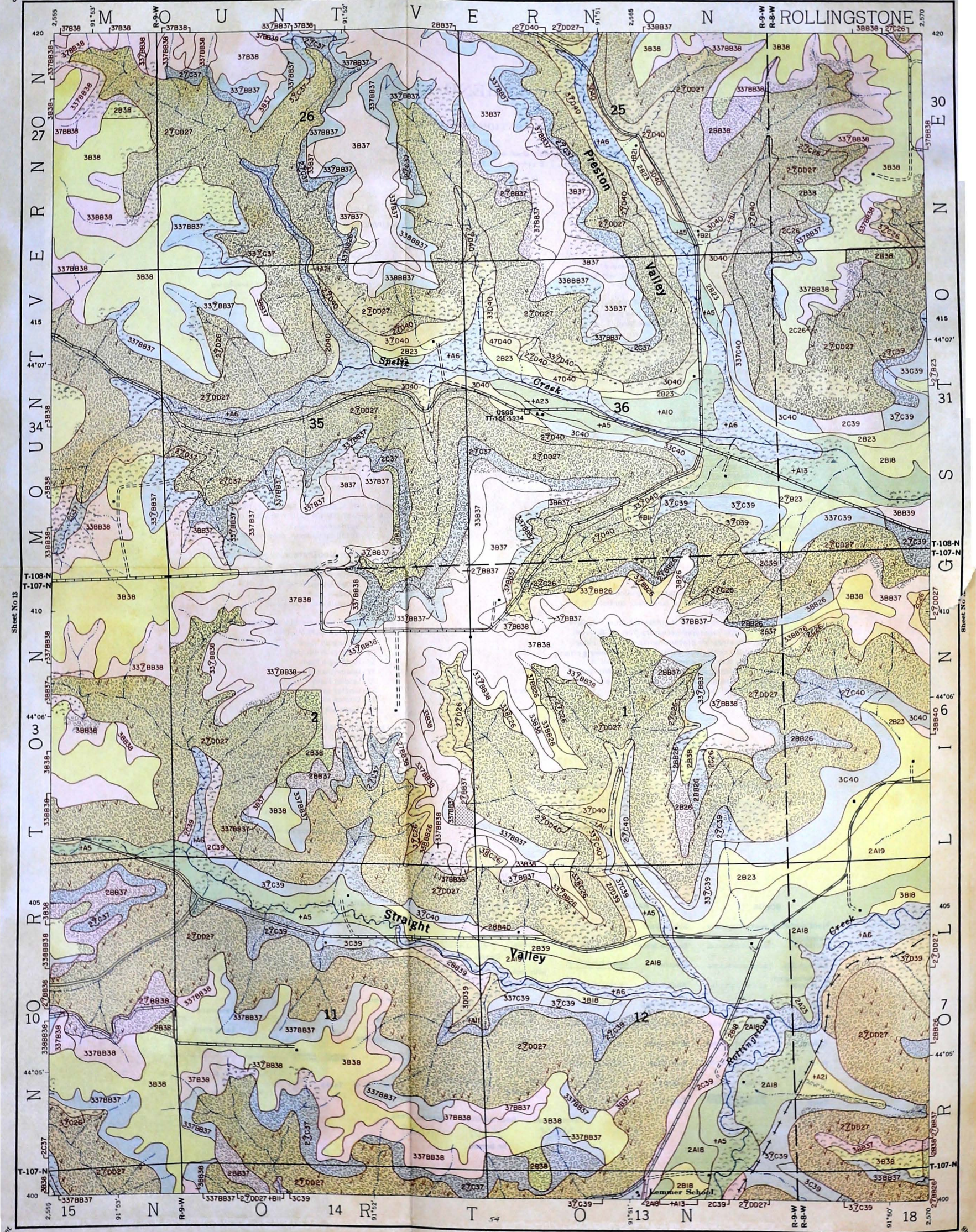
- 36 - Carrington loam, shallow phase
- 37 - Dubuque silt loam, deep phase
- 38 - Fayette silt loam
- 39 - Fayette silt loam, valley phase
- 40 - Fayette-Boone complex
- 43 - Tama-Boone loam

#### UPLAND SOILS, SLIGHTLY ERODIBLE, DERIVED FROM GLACIAL DRIFT

- 44 - Carrington sandy loam
- 45 - Dodgeville sandy loam

### TOPOGRAPHIC SYMBOLS

ROADS	RAILROADS	DRAINAGE (in blue)	BUILDINGS	BOUNDARIES
Hard-surfaced	Single track	Intermittent	Church	State
Semihard-surfaced	Double track	Perennial	School	County
Dirt-good motor	Electric	Canals	Creamery	Civil
Dirt-secondary or private	Abandoned	with lock	Cemetery	Township U. S.
Trail	R. R. Bridge	abandoned	R. R. Station	City Park
Bridge	Grade crossing	Lakes Intermittent	Power line	Reservation
Culvert	R. R. under	Marsh fresh salt	Pipe line	Land grant
Ford	R. R. over	Dams	Telephone line	Project (in brown)
Tunnel	Culvert	Spring	Levee	Triangulation station
Ferry	Tunnel	Sink	Mine Quarry	P. R. P.-P. T. S.
		Stony areas	Gravel pit	
		Rock outcrops (in brown)	Tanks	
		Gravelly areas		

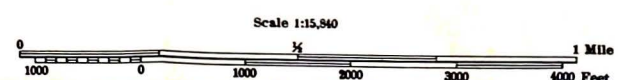


Base map compiled from aerial photographs by Soil Conservation Service.  
 Horizontal control by S.C.S., U.S.G.S., U.S.C.&G.S., and M.R.C.  
 Lambert projection, 5000 foot grid based upon  
 Minnesota system (South Zone) of plane coordinates with  
 last three digits of grid numbers omitted.  
 Sheet designated by state, county, and number.  
 Polyconic projection, North American 1927 datum,  
 indicated by marginal ticks.

**CLASSES OF LAND ACCORDING TO USE CAPABILITY**

- I-Suitable for cultivation without special practices
- II-Suitable for cultivation with simple practices
- III-Suitable for cultivation with complex or intensive practices
- IV-Not suitable for continuous cultivation
- V-Not suitable for cultivation

1"28'50".S.W. corner of map  
 upon  
 Magnetic North  
 5°  
 Approximate Mean Declination, 1937.  
 No Magnetic Change.



# CHAPTER XI. CONSERVATION SURVEYS OF THE SOIL CONSERVATION SERVICE

## Origin and Objectives

Land classification forms an important part of the technical service provided by the Soil Conservation Service to help farmers set up and follow plans for soil and water conservation. The work is known as conservation surveys. Its purpose is to provide a physical basis for drawing up farm conservation plans. A farm conservation plan is made for each farm which cooperates with the Soil Conservation Service in carrying on a soil conservation demonstration, and for each farm in a soil conservation district which enters into an agreement with the district to carry on soil conserving measures. The farm conservation plan is the basis of cooperation between the farmer and his soil conservation district. He agrees to follow the plan in return for which he receives certain types of help.

For the 4 years preceding 1940, the Soil Conservation Service has operated demonstration areas in representative agricultural regions to show ways of dealing with erosion problems. To these areas come farmers from the surrounding country to study the methods of soil and water conservation being carried on. More recently there have been organized numerous soil conservation districts, which it is hoped will help extend the assistance of the Federal Government in soil and water conservation work to a much larger group of farmers. The soil conservation district is a unit of local government authorized by State law. It provides a mechanism whereby farmers within a watershed or some other area may organize for community action and mutual protection in combatting soil erosion. Under the leadership of its supervisors a district may decide to follow a program similar to that now being carried forward in the demonstration areas of the Soil Conservation Service. One of the first steps will probably be a conservation survey of the district. The supervisors may enter into agreements with farmers, and on the basis of the conservation survey help them in developing soil conservation plans for the individual farms. The supervisors may provide farmers of the district with technical assistance, and make loans or grants of machinery, seeds, planting stocks, or other necessary supplies, in return for which the farmer agrees to follow the farm conservation plan worked out for his farm.

## Type of Work and Procedure <sup>1</sup>

The conservation survey typically involves the mapping of four items, namely soil type, percent of slope,

condition of erosion, and present land use. It involves also the classification of the land types mapped according to their capabilities for agricultural use.

## Field Mapping

Soil type is mapped according to the standard procedure and nomenclature used in the Soil Survey.<sup>2</sup> A joint inspection service is maintained by the Soil Survey and the Soil Conservation Service to insure consistency and conformity to standards in the soil mapping of both agencies.

For each soil type percent of slope is mapped in classes which have significance with respect to farming practices on that soil type. For example, if slopes of 6 percent or more on a given soil type are too steep to be cultivated safely, then 6 percent would be taken as the dividing line between two slope classes on that soil. As a rule at least five slope classes are recognized, in order to express adequately the slope factor for the determination of use capabilities. If the soils in an area vary in their erodibility (referring only to water erosion), a different set of slope classes is established for each group of soils on which the effect of slope on erosion and soil management is notably different. This is illustrated in the following tabulation:

<i>Soil group 1</i>		<i>Soil group 2</i>	
Slope class:	<i>Percent</i>	Slope class:	<i>Percent</i>
A-----	0-3	A-----	(1)
B-----	3-8	B-----	(1)
C-----	8-15	C-----	15-25
D-----	15-25	D-----	25-35
E-----	(1)	E-----	35

<sup>1</sup> Does not occur.

<sup>2</sup> And over.

Erosion conditions are mapped using symbols to express the kind (sheet, gully, wind) and the degree of erosion. The degree of erosion is ascertained by estimating the percentage of the original topsoil or subsoil that has been removed. The symbol "1," for example, indicates that less than 25 percent of the original topsoil has been lost, and "2" is used where the loss has been at least 25 percent, but less than 75 percent of the original topsoil. Areas that have received accumulations of material, as a result of either wind or water erosion, are also shown on the map.

<sup>1</sup> For a detailed description of procedure followed in making conservation surveys, and in classifying land according to use capability, see *Soil Conservation Service Handbook*, U. S. Department of Agriculture, Misc. Pub. 352, Washington, D. C., 1939.

<sup>2</sup> For soil mapping procedures see chapter X.

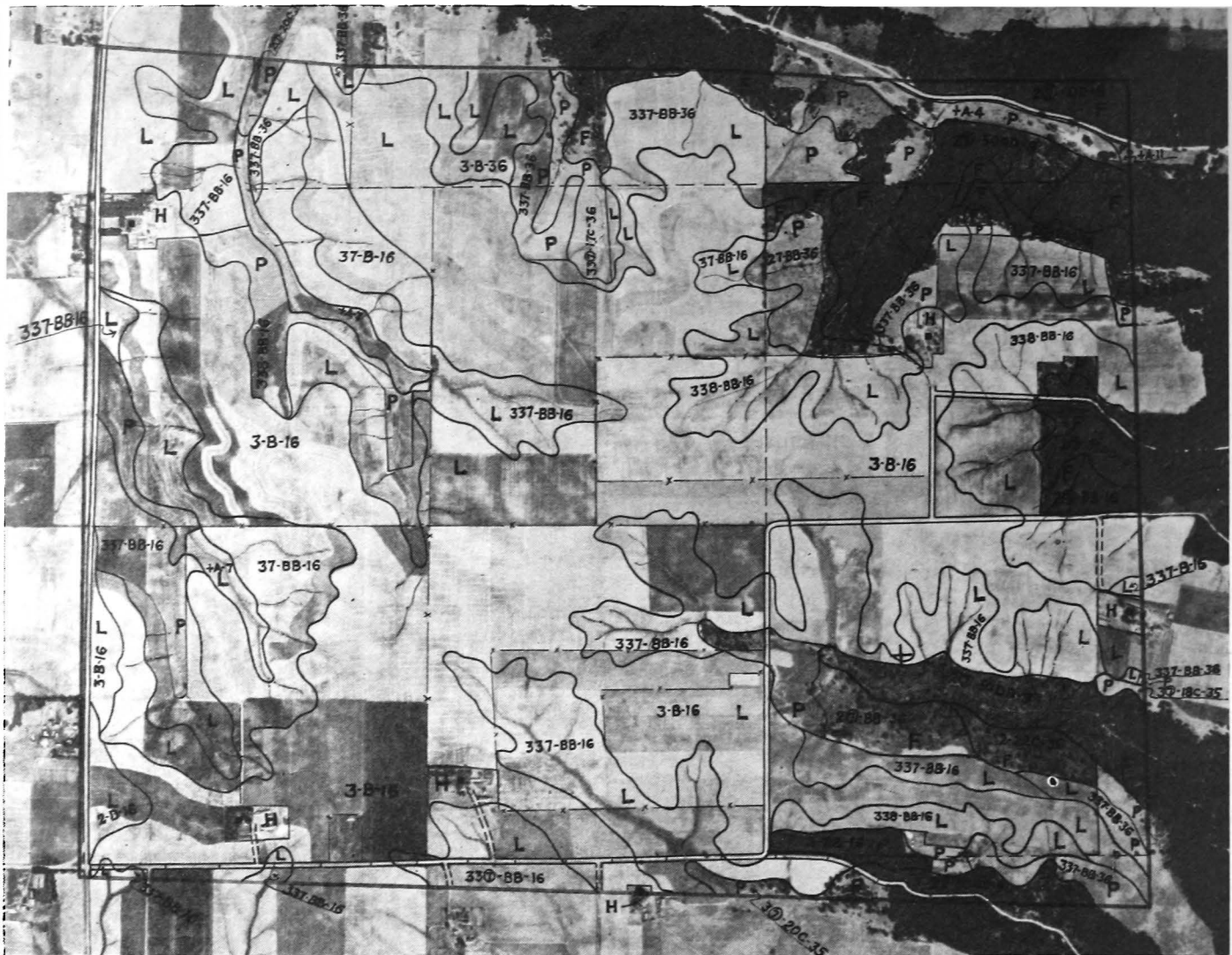


FIGURE 13. Part of a conservation survey field sheet. The same area is shown in the lower right corner of the multilithed map facing p. 65. The scale is approximately 4 inches equals one mile. Combined symbols show erosion-slope-soil type. Individual letters show present land use.

**EROSION LEGEND:**

- 2. Less than 25 percent of topsoil removed.
- 3. 25-50 percent of topsoil removed.
- 33. 50-75 percent of topsoil removed.
- 7. Occasional gullies, more than 100 feet apart.
- 8. Frequent gullies, less than 100 feet apart.
- ⊙ Indicates gullies too deep to be crossed with tillage implements.
- + Alluvial deposits.
- 7. is used with sheet erosion symbols, as 27, 337.

**SLOPE LEGEND:**

- A. Nearly level. Not subject to erosion.
- B. Subject to erosion if cultivated; control practical.
- BB. Subject to erosion if cultivated, control practical, but measures needed are more intense than on B slope.
- C. Too steep for clean cultivation. Suitable for close-growing crops.
- D. Too steep for cultivation. Suitable only for permanent cover.
- DD. Too steep for grazing. Suitable only for woodland.

**SOIL LEGEND:**

- 4. Stony colluvium, Wabash soil material.
- 7. Wabash-Judson silt loam.
- 9. Rough broken land.
- 11. Ray silt loam.
- 16. Fayette silt loam.
- 35. Dubuque silt loam.
- 36. Dubuque silt loam, deep phase.

Numbers such as 20C or 50DD show dominant percent of slope.

**LAND USE IS SHOWN BY LETTERS:**

- |     |               |   |           |
|-----|---------------|---|-----------|
| L   | Cropland      | P | Pasture   |
| H   | Farmsteads    | F | Woodland  |
| VVV | Rock outcrops | X | Idle land |

These three physical factors, soil type, slope, and erosion, are shown by three-part symbols enclosed by boundary lines. A boundary is drawn wherever any one factor changes. An example of the three-part symbol is "3-B-16." The symbol "3" denotes the erosion class; "B" is the slope, 3-8 percent; and "16" is the soil type, Fayette silt loam (fig. 13). These symbols are arranged in fractional form if space is limited.

Present land use is shown on the field sheets by a separate set of boundaries and symbols. The major categories, subdivided if additional detail is desired, in most cases are mapped as follows: L—Cropland; X—Idle land; P—Pasture; F—Woodland; H—Farmsteads.

The field mapping in detailed conservation surveys is done most commonly on aerial photographs on a scale of four inches to the mile. As a rule these are enlarged to 8 inches to the mile for use by the farm planning technicians in working out and portraying farm conservation plans. Such plans include field layouts, crop strips, terraces, and water disposal systems. In some areas with a very intricate or intensive pattern of agriculture, photographs on a scale of 8 inches to the mile may be used for field mapping. Reconnaissance conservation surveys are made at scales of 2 inches, 1 inch, or even a half inch to the mile. In some cases detailed mapping is done by plane table traverse, but this is avoided wherever possible and is done mainly where it is necessary to survey a few widely separated cooperating farms.

**Classification of Land According to Use Capabilities**

The nature of the soil, the slope, and the kind and degree of erosion all influence the nature and intensity of practices that are necessary for conservation and good

use of the land. After the three factors have been mapped they furnish a basis for classifying the land in order to indicate its use capability. This classification is a summation that directs attention specifically to two questions: (1) Is the land suitable for agricultural use? (2) What kind of practices (soil erosion control or other) are required, and how intensely must they be applied? Land is classified in the following categories:

- I. Suitable for cultivation without special practices;
- II. Suitable for cultivation with simple practices;
- III. Suitable for cultivation with complex or intensive practices;
- IV. Not suitable for continuous cultivation;
- V. Not suitable for cultivation.

Each of these classes may be subclassified according to the needs of particular regions or situations.

These definitions refer to practices of any kind: soil-erosion control, soil improvement, removal of stones or boulders, artificial drainage, or any other practices that may be required for permanent cultivation with preservation of the soil. Classes I, II, and III include all land that is suitable for regular and permanent use for crops that require tillage. Class IV may be used for crops part of the time or with extreme practices and measures. Class V is suitable only for permanent cover such as trees or grass.

The following example from the Burns-Homer-Pleasant Soil Conservation District, Winona County, Minn., illustrates what is meant by "special practices" and "complex or intensive practices." Land of class I in this district needs only the usual 3-year rotation of corn-small grains-legumes and an occasional application of barnyard manure to maintain the soil and produce at least moderate yields. Both of these are common practices in the locality, and are not regarded as special practices. Safe and permanent cultivation of lands of class II requires such special practices as a rotation of not less than 6 years, or contour cultivation

TABLE 2.—Classes of land according to use capability for 7 soils in Burns-Homer-Pleasant Soil Conservation District, Minnesota

	Erosion and slope <sup>1</sup> characterizing class—				
	I	II	III	IV	V
4. Stony colluvium, Wabash soil material.					+A, +B, +BB, +C, 2DD, 27BB, 47BB.
7. Wabash-Judson silt loam.		+A, +B, 1A, 1B, 2A, 2B, -A.	BB, 27BB.		3B, 3BB, 37D, 33D, 33DD, 337D, 4BB.
9. Rough broken land.					+A, +B, 1B, 1C, 2A, 2B, 2BB, 2C, 2D, 2DD, 27C, 27D, 27DD, 3B, 3BB, 3C, 3D, 3DD, 37D, 37DD, 337D.
11. Ray silt loam.	+A	+B.			
16. Fayette silt loam.		+B, 1A, 1B, 2A, 2B, 27B, 3A, 3B.	1BB, 2BB, 27BB, 3BB, 37B, 37BB, 38B, 38BB, 33B, 33BB, 337B, 337BB, 338B.	2C, 27C, 3C, 37C, 33C, 337C, 338BB, 4BB, 47BB, 48BB.	2D, 27D, 3D, 37D, 338C, 47C, 48C.
35. Dubuque silt loam.		2A.	2B, 3B.	1BB, 2BB, 27BB, 3BB, 37B, 33B, 337B.	2C, 2D, 27C, 27D, 27DD, -C, 3C, 3D, 37BB, 37C, 37D, 37DD, 38BB, 38C, 38D, 33BB, 33C, 33D, 337BB, 337C, 337D, 338B, 338BB, 338C, 338D, 4BB, 4C, 47C, 48BB, 48C, 48D.
36. Dubuque silt loam deep phase.		1B, 2A, 2B.	1BB, 2BB, 27BB, 3B, 3BB, 37BB, 33B, 38B, 337B, 37B.	1C, 2C, 27C, 28BB, 3C, 37C, 38BB, 33BB, 33C, 337BB, 337C, 338B, 338BB, 4B, 4BB, 47BB.	2D, 27D, 3D, 37D, 38C, 33D, 337D, 338C, 47C, 48BB.

<sup>1</sup> For explanation of the symbols in these columns see the legend for fig. 13, a conservation survey field sheet.

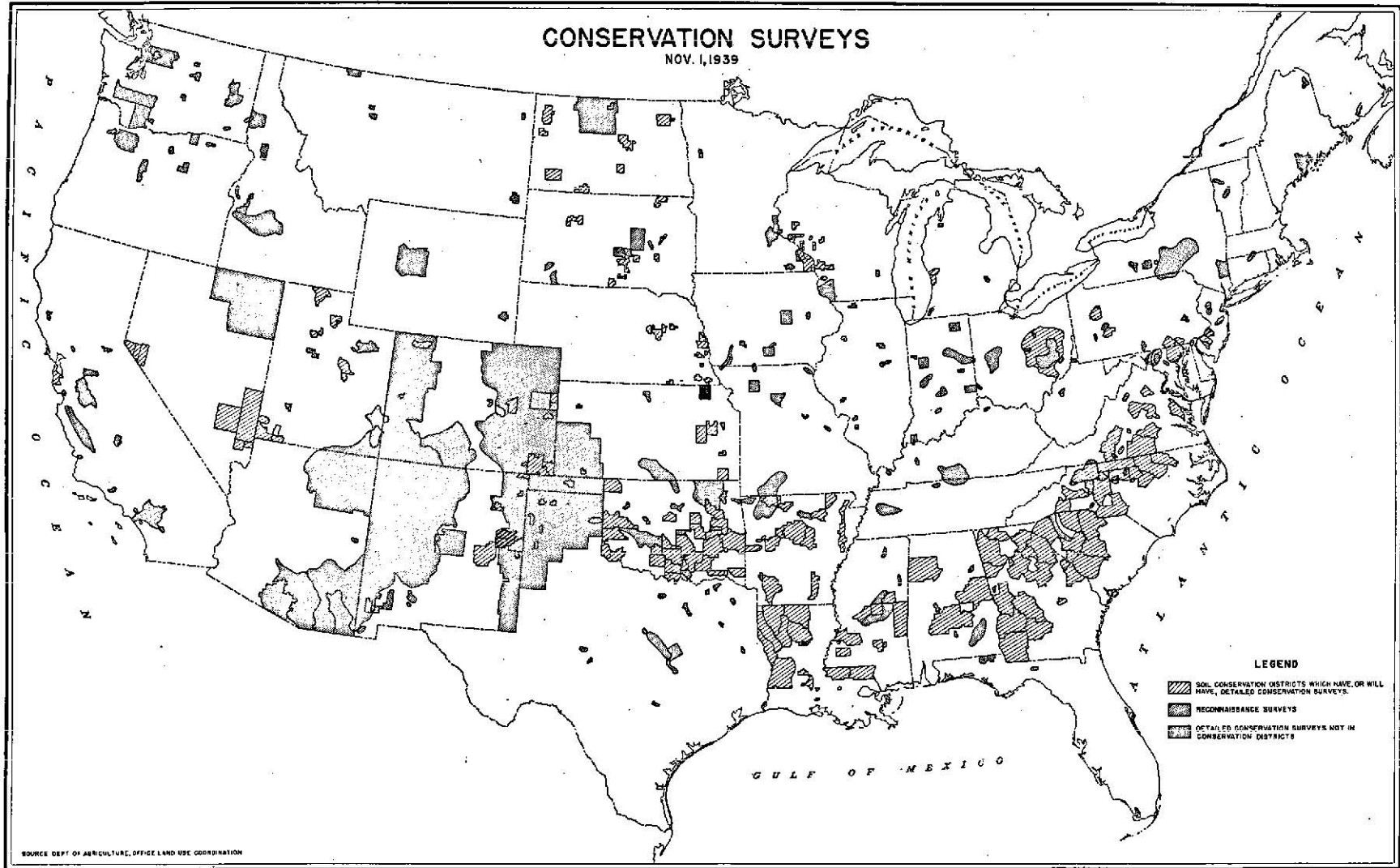


FIGURE 14.—Progress of Conservation Surveys, November 1939



and strip cropping if shorter rotations are used, or terraces. On class III land safe cultivation requires such complex or intensive practices as contour cultivation in combination with a 6-year rotation that includes 4 years of hay; or a combination of contour strips and terraces if the usual 3-year rotation is to be used. Land of class IV is best used for pasture. Over-grazing should be avoided. Many of the pastures need lime and fertilizer in order to produce and maintain effective cover. If any crops are grown on land of class IV the rotation must be a long one, and careful contour striping is necessary. Class V land is best used only for woodland and should not be grazed.

In grazing regions land not suitable for cropping but suitable for grazing is further classified according to its use capability, in the following three classes:

Slightly susceptible to deterioration and needing no practices other than those necessary to attain proper number and distribution of livestock;

Moderately susceptible to deterioration and needing special practices;

Highly susceptible to deterioration and needing special practices.

The classification of land according to its use capabilities is not made by any one person. A trained conservation surveyor ascertains the type of soil, slope, and kind and degree of erosion, and delineates these factors on the aerial photograph in their relation to the present land use; that is, he makes the conservation survey. Then the planning technicians, State and local technical specialists, leading farmers, and conservation surveyors jointly study the entire situation and agree upon the capability classification of each type of soil as it is influenced by slope and existing erosion. A table similar to table 2 is prepared. With the table at hand, anyone can determine readily the class of each delineated area.

Form and Use of Results

The most immediate use of the conservation survey material is made when the planning technicians take photographic enlargements of the survey field sheets to a farm as an aid in working out a farm conservation plan. It is then that the most immediate use is made of the use-capability classification. Recommendations are made as to the cropping systems and practices suited to each of the land classes. Farmers and research workers cooperate with the planning technicians in developing these recommendations. (Table 3.) To put these data into more nearly permanent form for future use, the conservation survey maps are reproduced on multilith quadrangles on a scale of 4 inches to the mile. These maps (facing p. 65) are accompanied by reports setting forth the results of the conservation survey and showing the relationships between soil characteristics, slope, land use practices, and erosion conditions. They are issued for each area covered. Recommendations are made in these reports concerning land use and erosion control measures for the different combinations of soil, slope, and erosion conditions. Descriptions of individual soil types are contained in an appendix. A general description of the area, including its topography, climate, native vegetation, economic and cultural development and agriculture, is included.<sup>3</sup>

Detailed conservation surveys have been made over an area of approximately 51,000,000 acres and are in progress in an area of about 181,000,000 acres. Reconnaissance conservation surveys have been completed on about 285,000 square miles in addition to the Nationwide reconnaissance survey made in 1934-35. Reconnaissance conservation surveys in progress cover approximately 37,000 square miles (fig. 14).

<sup>3</sup> For an illustration of this type of report see, *Erosion and Related Land Use Conditions on the Crooked Creek Project near Indiana, Pennsylvania, 1940.*

TABLE 3.—Table of recommendations <sup>1</sup>

Land use capability class	Land use	Cropping systems	Supporting conservation practices	Soil treatments <sup>2</sup>
I. (Green)	Cultivation	Row crop 2 years, small grain, hay	None	Manure.
	do	Row crop, small grain, hay	Contour strips, 75'-125', or terraces	Lime+manure.
II. (Yellow)	do	Row crop, small grain, hay 3 years	Contour cultivation	Do.
		Row crop, small grain, hay 4 years	None	Do.
		Pasture	None	Do.
III. (Red)	Cultivation	Row crop, small grain, hay	Contour strips and terraces	Do.
		Row crop, small grain, hay 2 years	Contour strips 60'-100'	Do.
	Pasture	Row crop, small grain, hay 4 years	Contour cultivation	Do.
		do	None	Do.
IV. (Blue)	Woodland	None	Controlled grazing. Contour furrowing for adapted soil, slope and vegetative cover.	Lime+phosphorus.
		In case it is necessary to cultivate class IV land, special intensive practices will be planned to meet the conservation needs.	Protection and management	None.

<sup>1</sup> This example of a table of recommendations was prepared to show the principles involved in applying land use, cropping systems, supporting conservation practices, and soil treatments to the respective land use capability classes.

<sup>2</sup> According to soil tests and needs.

NOTE.—Remaining classes for grazing lands, woodlands, and other lands are not included in this table.

A general reconnaissance conservation survey of the whole country was made in 1934 and 1935 in order to locate and identify on a fairly broad scale the erosion problem areas of the country. Results of this survey were published on a series of State maps, mostly on a scale of 1:500,000.

#### **Personnel**

Personnel employed in making conservation surveys most commonly consists of graduates of agricultural

colleges trained in soil science or agronomy. Applicants are taken from Civil Service registers. Inexperienced men are given intensive training in field mapping under the direction of experienced surveyors before undertaking regular work. As has been stated, the use-capability classification is developed jointly by the area technicians and the conservation surveyors, often with the advice of county agents and extension specialists, as well as staff members of the State Agricultural Experiment Station.

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## CHAPTER XII. LAND CLASSIFICATION IN THE BUREAU OF RECLAMATION

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### Origin of Function

Long before the time of Columbus the reclamation of arid lands was practiced by the Indians on the North American continent in what is now Western United States. Spanish missionaries in the West irrigated plots around their missions. The haciendas and ranchos of Spanish and Mexican settlers were not complete without their irrigated gardens. When settlers migrated westward from humid regions of the United States into the desert areas, they also quickly adopted irrigation in order to produce food crops necessary for their subsistence.

During the early years of western settlement, irrigation was comparatively simple, consisting of the diversion of small streams and the reclamation of lands bordering water courses. Increasing complexity carried the developments beyond the means of private capital and the need for public participation was recognized by the passage of the Carey Act in 1894. Under this act large areas of desert land were patented to several States on condition that the land would be reclaimed by irrigation and disposed of to actual settlers. Federal participation did not begin until the passage of the Reclamation Act of June 17, 1902 (32 Stat. 388).

Land classification as a vital element in the Federal program of reclamation began with the passage of that act. It was first carried on as part of the preliminary examinations and surveys made by the Geological Survey in the Department of the Interior. In 1906 an independent agency, the Reclamation Service, was established in the Department. In 1926 the Service was given bureau status. Throughout this period and to the present land classification has continued to increase in importance as developments continued to grow in size and complexity.

The organic act which authorized Federal construction of irrigation projects established a Reclamation Fund to be used in the examination and survey for and the construction and maintenance of irrigation works and the payment of all other expenditures authorized by that law. Into that fund went certain revenues from the disposal of public lands largely in the West, and later, from the utilization of publicly owned resources. Under the law, construction cost on reclamation projects must be repaid to the Reclamation Fund by the settlers on reclaimed land. This put an economic and a legal obligation on the Bureau of Reclamation. If projects are not carefully planned, efficiently carried out, and effectively used, there would not be full

compliance with the law. Of great concern, also, is the social obligation. The human damage caused by the failure of a project would be serious and perhaps irremediable. The place of land classification in this setting is clear.

### Objectives

The objectives of the Bureau's program are to provide new opportunities for people to make decent homes, to build new communities, to strengthen the arid and semi-arid sections of the country, to conserve and utilize land and water resources, and to enrich the economy of the Nation. To aid in achieving these objectives on a sound basis the land-classification work seeks to determine precisely where and in what quantities irrigable lands can be found for subdivision into tracts, not to exceed 160 acres each, sufficient in size for the support of a single family and for the repayment of irrigation costs.

### Procedure and Methods

The land-classification objective is a determination of the quality and quantity of arable land within a given project area and a determination of the feasibility of increasing the economic value of that area by irrigation. The quality of the land must be evaluated, not only upon its natural characteristics, but also upon the changes in its inherent producing capacity which can be induced by irrigation. This qualitative analysis of the land is determined on the basis of the soil, topography, drainage, and climate. The type of crops which can be produced is an important element in the qualitative analysis as well as the accessibility to markets, market requirements, and quantity and quality of irrigation water. To be of standard applicability, successful and desirable in its objective, a land classification must be based on an accurate determination of the fixed qualitative characteristics. Any revisions which may become necessary because of variable economic factors may readily be made.

The areas classified usually have never been cultivated and the quality of such land has been established only to the extent disclosed by drought-resistant native vegetation. A determination of the potential utility of the land under irrigation usually must be predicated upon a comparison with areas of similar characteristics which have been irrigated. The resultant effect of the artificial increase of soil moisture must

be studied, not only from the standpoint of crop production, but also from the standpoint of soluble mineral salts.

Thus, in addition to such usual soil characteristics as fertility, texture, and depth of soil mantle, a determination also must be made of the soluble salt content, permeability of underlying rock formation, and subsurface drainage characteristics. Topography or surface relief must be studied carefully, not only to determine the distribution and intensities of variations in the surface characteristics, but also the availability of drainage outlets for surplus irrigation water.

#### Scales of Operation in Land Classification

The scales of operation in land classification undertaken by the Bureau, differentiated primarily on the basis of the amount of detail and accuracy of the end results, are as follows: (1) reconnaissance; (2) semi-detailed; and (3) detailed.

1. *Reconnaissance.*—This scale of classification involves a general outline of land features of conspicuous importance in planning irrigation development in a particular region. It is applicable to three general conditions: (1) For use on large areas where only general information on the extent of the arable land is required; (2) to determine the general extent and location of arable areas with the object of obtaining sufficient information on which to base justification of a more detailed investigation; and (3) for use on areas under consideration for supplemental water supply where only an approximation of the total acreage of arable land is required. These surveys are accomplished on maps having a scale of 1:24,000.

2. *Semidetailed.*—The second scale of classification involves a careful examination of lands likely to be devoted to intensive agricultural use, while marginal use areas are only briefly studied. The arable and nonarable lands are mapped with considerable accuracy, but the boundaries between different classes of arable lands are not delineated in the same degree of accuracy as required in a detailed classification. The use of this scale of operation is concerned with secondary investigations where only a moderate degree of detail and accuracy are required. Conclusions drawn from results of such a classification are used: (1) in conjunction with engineering investigations to determine the feasibility of projects; and (2) to determine the extent and character of lands utilized within a certain drainage area and the ultimate amount of additional development which may be expected. This type of classification is delineated on maps having a scale of 1:12,000.

3. *Detailed.*—The third scale of classification involves examinations of the features in sufficient detail to provide information as to the character of the lands on each 40-acre tract which is required in planning con-

struction of a project. Basic data with respect to various soil and subsoil conditions, topography, and drainage are obtained in detail for the purpose of: (1) planning the project development; (2) laying out the canal distribution system; (3) outlining a drainage program for the irrigable lands; and (4) land appraisal. The delineation of such a classification is accomplished on maps having a scale of 1:4800.

In each of the three scales of land classification the criteria are substantially the same and fall in two principal categories, the physical features of the land and the economic features of its irrigation.

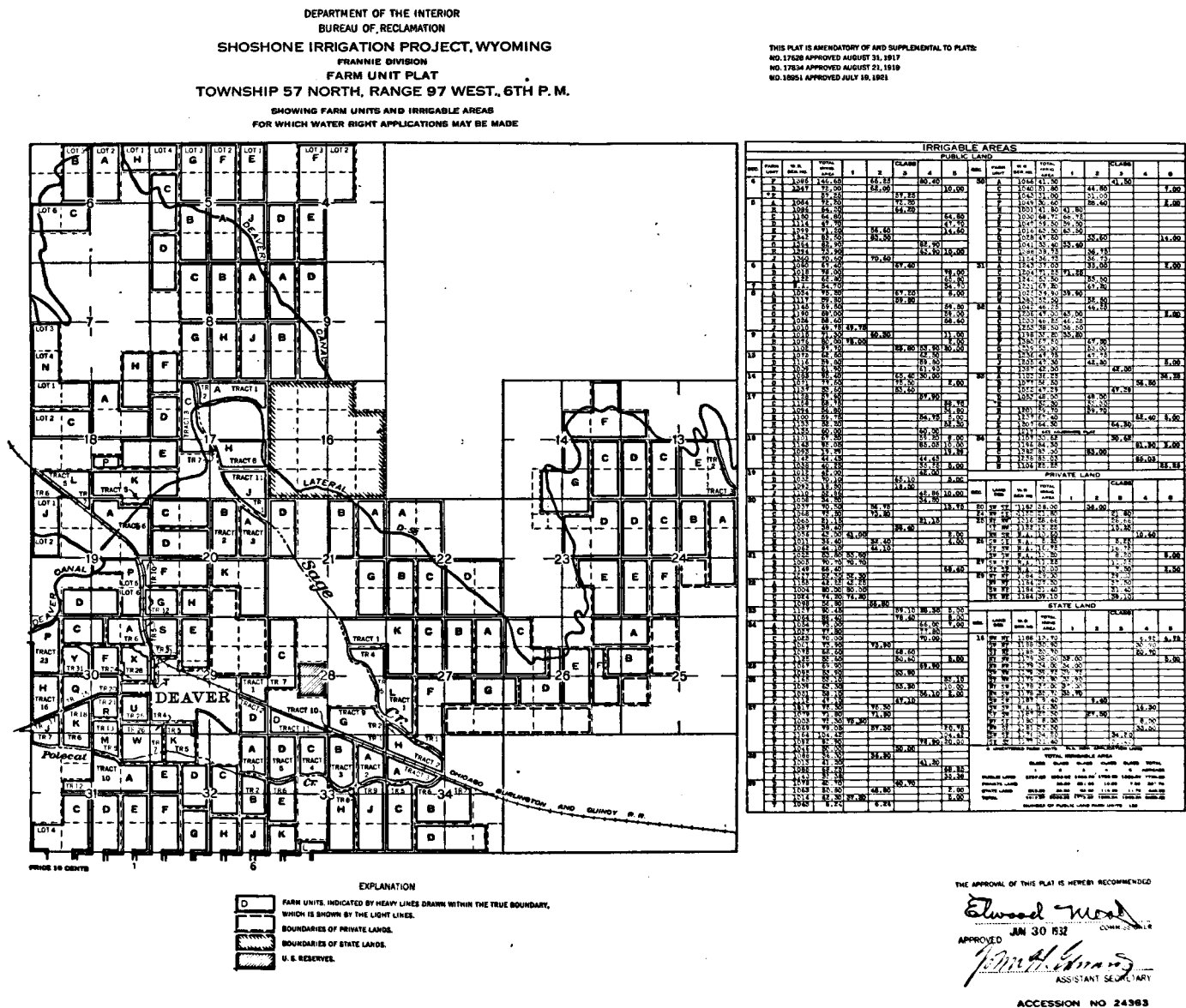
*Physical land features.*—The ideal physical features of an irrigation area are: (a) an entirely smooth land surface, (b) a gentle slope, but sufficient to facilitate irrigation and permit drainage of surplus water, and (c) deep, fertile loam soils. The first step in a classification program is to determine the location and area of land in the proposed project which approaches these ideal conditions sufficiently to warrant construction of the project. The second step is a tentative determination of project boundaries that will embrace the aggregate amount of arable land that can be irrigated by the available water supply, with due consideration of the engineering and economic feasibility of the irrigation works that will be required. The third step consists of a detailed topographic survey, scale 1:4800. The purpose of this survey is two-fold: (a) it provides a basis for planning the layout of the irrigation canals and the farm distribution system, and (b) it refines data on slope and surface features. The fourth step is a detailed soil survey. This survey provides data covering the adaptability of soils and the distribution of soils of different significant qualities for each 40-acre unit. These data together with data from preceding steps provide a basis for the next two steps.

*Economic features.*—The economic feasibility of a project is a function of its cost and the potential earning power of the project land. The cost determination is very largely an engineering problem. The potential earning power is the problem of land classification and is determined on the basis of the type and yield of crops which can be produced, accessibility to markets, and the market requirements. Resulting data are coordinated with the study of physical features of the land, to provide a basis for determining the economic feasibility of a project. These data also are required for the purpose of subdividing a proposed project area into optimum-sized operating units. The importance of establishing proper farm units and variable charges was not fully appreciated in some early projects. At that time charges for irrigation water were based solely on the average cost per acre of constructing the irrigation works (amount of water used and the cost of delivery thereof), without regard to the

quality of the irrigated land. As a result a given amount of water used on certain land within a project area produced excellent returns, while delivery of the same or a greater amount of water to other land did not result in the establishment of an economically independent unit. The early experience in project development showed that the security of the settlers on the project as a whole, as well as both private and government investments in project developments, demanded that each farm unit should be established on a comparable basis and that the quality of the land should be given consideration in fixing charges and establishing farm units. Accordingly, "paying classes" are established on the basis of relative ability to produce returns. These paying classes embrace land types which may be

subdivided into economic farm units, of substantially equal size, generally ranging from 40 to 80 acres but not exceeding 160 acres each. It is intended that each unit afford a substantially equal and adequate opportunity to support a family and to repay its allocated share of construction costs. These same economic data also provide a basis for developing a plan of recommended land uses which is a guide to the action program of the proposed project, as well as the settlement and development of the land.<sup>1</sup> Types of farm economy are determined as well as rate of development, location

<sup>1</sup> In connection with the Columbia Basin Project, because of its complexity, large area of irrigable lands (approximately 1,200,000 acres), and cost, the Bureau has undertaken in cooperation with 32 other agencies, Federal, State, and local, its most elaborate study for the determination of proper plans and programs for the settlement and development of a project area.



of villages, transportation and power facilities, manufacturing and recreation needs. Usually not more than three paying and three nonpaying classes are differentiated in the land classification work, defined as follows:

1. The *first class* lands are those constituting the highest type of arable lands, suitable in all respects for cultivation and production of crops under irrigation. They are smooth-lying, with slopes up to 5 percent; soils at least four feet in depth, medium or fairly fine in texture, mellow, open in structure, allowing easy penetration of roots, air, and water, having free drainage yet good water-holding capacity, and free from accumulation of soluble salts (0.2 percent or less).

2. The *second class* lands are of intermediate character, suited to the cultivation and production of quite a wide range of crops. They are not as desirable nor of such high general value as lands in *class 1*. They are more costly to prepare, owing to slightly unfavorable topography, and are more costly to farm, owing to the use of more irrigation water or to difficulty in the application of water. The soils may be comparatively shallow (12–18 inches of good plow soil, 36 inches of soil penetrable by roots and water). The drainage may be impeded. Soils may contain moderate concentrations of soluble salts (0.5 percent or less). Alkalinity may run pH 9.0 or less in the surface two feet. The texture of the soil may be too sandy or it may be a heavy clay. The topography may be of an uneven or rough slope of less than 5 percent or smooth slopes of from 5 to 10 percent.

3. The *third class* lands are of inferior quality and of low productivity. They have a restricted crop adaptation due to such soil deficiencies as shallow depths (6 to 12 inches over gravel or loose rock, 36 inches penetrable by roots and water); extremes of texture (sandy or heavy clay); or presence of sufficient loose rock on the surface and in the plow zone to interfere seriously with cultural operations. They are, in some instances, lands having impeded drainage and moderate concentrations of soluble salts. In still other areas, they are lands of uneven and rough topography where there would be danger of erosion if used for crops which require plowing and cultivation. The lands of the third class designation warrant utilization only under the best of economic conditions where they can be developed in conjunction with lands of better quality.

4. The *fourth class* lands are those which sometimes have a specific limited utility. They are made up of heavy compact soils with tough impervious layers in the subsoil. Sometimes they are considered as having a possibility of reclamation by artificial drainage, but due to inherently poor drainage qualities, such measures have met with a small degree of success. For the most part these lands are considered nonarable.

5. The *fifth class* consists of lands which are submarginal for a variety of reasons. They often include lands which are water-logged and have an accumulation of an injurious amount of soluble salts, or lands which are subject to periodic floods, a condition which is susceptible to correction only through construction of flood control or drainage works.

6. The *sixth class* lands are permanently nonarable, consisting largely of lands having a rough, broken, or eroded surface, rendering them unfit for cultivation. Other areas consist of "bad lands" or rough areas of raw shale, or shallow soils over shale or sandstone; others consist of gullied areas in deep alluvial soils; and still others consist of sandy or gravelly stream beds. In this class are also included areas which are too high for delivery of irrigation water or small isolated areas which, due to their position, are not considered feasible in the development of farm units. (See tabular statement on p. 75.)

*Land ownership and use.*—The preparation of an ownership map is required for projects involving lands which are not part of the public domain. A study also is made of present utility of the non-Federal land. Using the ownership map as a means of distinguishing property units and the land-use data showing the current productive value of the land, an appraisal is made of the dry land value of the privately owned properties without regard to possible increases in value as a result of irrigation. These appraisals are made so that fair values can be assigned to privately owned property units in excess of the maximum 160-acre single farm unit allowed by law. The excess acreage of each privately owned farm unit must be sold at the appraised value if the land owner desires to irrigate any of his land from the project canals. By this procedure speculation in project lands is obviated with the result that the ultimate settler on such private land can obtain his farm unit at a fair price and therefore have a better chance of success. These steps are not required as to lands which are part of the public domain, and which are opened to homestead entry under the public-land laws subject to a requirement for repayment of water-right charges.

*Field procedure.*—Land-classification data are plotted on base maps prepared in accordance with procedures which are identical to those described in chapter VIII, for topographic map work of the Geological Survey, and chapter VI, for use of areal photographs. Where adequate photographic or topographic base maps are not available, such maps are prepared by the Bureau, usually on field sheets 18 by 24 inches in size. The various classes of land are mapped by plane-table sketching or by traverse. The amount of care and accuracy exercised in delineating the boundaries between the different classes depends upon the detail of the survey. Where more than one man is responsible for the mapping of an area, comparison of the work is made, not only at a common border of the maps, but throughout the entire area in order that any differences in the interpretation of the land characteristics and classification standards may be reconciled. Uniformity of classification is essential.

Borings or pits are made for determining soil characteristics and generally are extended to a depth of 5 feet. In detailed classifications, the minimum number of such borings is one for each 40-acre tract; in semi-detailed classifications, one for each 160-acre tract, and in reconnaissance classifications a sufficient number to be reasonably representative of the areas classified. These are the minimum requirements applicable where conditions are uniform, but additional borings are made where the nature of the soil is variable, or where additional refinement is desirable. Quantitative determination of the approximate salt content of the soil is

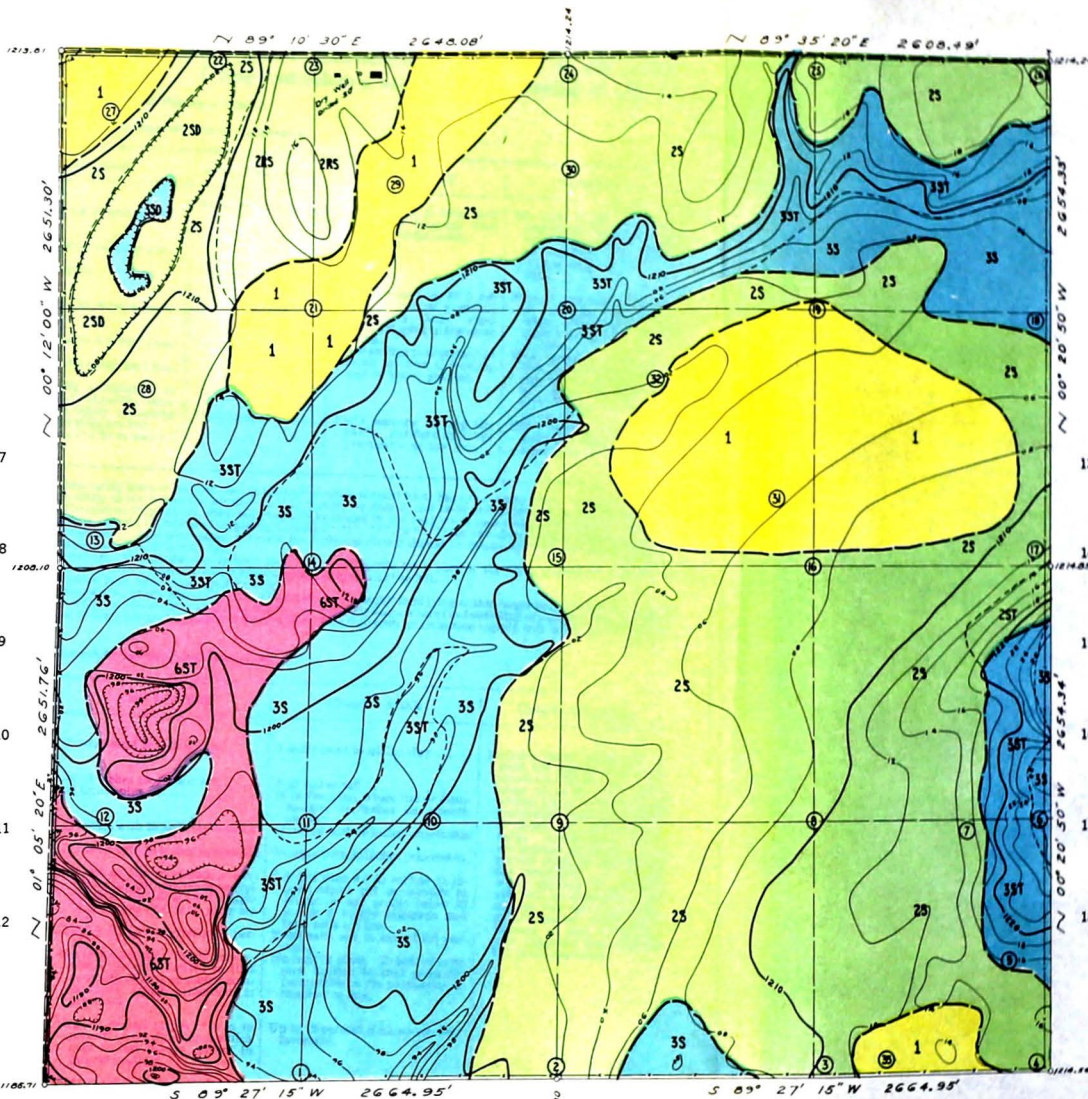
**SOIL PROFILES**

**SYMBOLS**

- Sand
- Loamy sand to sandy loam
- Fine sandy loam to silt loam
- Silt loam to clay loam
- Clay
- Gravel or loose rock
- Creviced rock
- Calcareous hard pan
- Caliche
- Solid rock
- 1.03% Total salts
- 8.6 = pH
- Profiles are 5 feet deep
- Location of pits or borings

**LEGEND**

- ARABLE LAND**
- Class 1 = Yellow
  - Class 2 = Green
  - Class 3 = Blue
  - Class 4 = Pink
- NON-ARABLE LAND**
- Class 6 = Red
- REASONS FOR LOWER CLASS THAN NO. 1**
- S = Inferior soil
  - T = Inferior topography
  - D = Inferior drainage conditions
  - R = Loose rock in plow zone
- Land under Irrigation



1	1/4 Cor. Sage, Bunch gr. & R. thistle.	450' W of 1/4 Cor. Sage & bunch gr.
2		
3	1/2 Cor. Sage & bunch gr.	1/2 Cor. Sage & bunch gr.
4		
5	1/4 Cor. Sage, bunch gr. & R. thistle.	1/4 Cor. Bunch gr. & sage.
6		
7		
8		
9		
10	S.E. Cor. Sage, bunch gr. & R. thistle.	650' W of 1/4 Cor. Bunch gr.
11		
12	3/4 Cor. Sage & bunch gr.	300' E of 1/4 Cor. Bunch gr. & R. thistle.

13	250' N.E. of W.1/4 Cor. Sage & bunch gr.	1/4 Cor. Sage & bunch gr.
14	1/4 Cor. Red sand weed, sage, & bunch gr.	1/4 Cor. Scrubby sage.
15	1/4 Cor. Bunch gr.	1/4 Cor. Sage & R. thistle Near cleared field.
16	1/4 Cor. Bunch gr. & sage.	800' E of N.W. Cor. Scrubby sage.
17	1/4 Cor. Bunch gr. & sage.	1/4 Cor. R. thistle, Cleared.
18	1/4 Cor. Small sage.	1/4 Cor. Sage & R. thistle.

**CLASSIFIED AREA IN ACRES**

	Class 1	Class 2	Class 3	Class 4	1-3	R/W	TOTAL
NE 4 NE 4	010	17.82	21.96		3588		3588
NW 4 NE 4	012	28.09	11.76		3597		3597
SW 4 NE 4	25.58	12.60	2.80		4018		4018
SE 4 NE 4	25.77	15.88	1.12		4009		4009
NE 4 NW 4	12.96	23.17	4.24		4037		4037
NW 4 NW 4	6.57	32.18	1.56		4026		4026
SW 4 NW 4	4.26	29.52	14.48	013	3994		4009
SE 4 NW 4	1.56	27.2	35.63	028	3991		4019
NE 4 SW 4		6.30	32.25	1.56	3855		4011
NW 4 SW 4			20.64	19.46	20.64		4010
SW 4 SW 4			10.10	29.69	10.10		4029
SE 4 SW 4			914	31.26	40.40		40.40
NE 4 SE 4			32.63	7.62	40.25		40.25
NW 4 SE 4			40.15	0.11	40.26		40.26
SW 4 SE 4			35.79	3.88	40.65		40.65
SE 4 SE 4			4.80	29.08	6.58		40.46
TOTAL	8177	304.97	205.57	5112	592.31		643.43

25	1/4 Cor. Sage & bunch gr.	400' S.E. of N.W. Cor. Cleared.	800' N.E. of 1/4 Cor. Sage & R. thistle.	400' N.W. of 1/4 Cor. Sage & bunch gr.
26		R. thistle & sage.		
27				
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**SEC. 35 T20 N. R25 E. W.M.**

Scale: 1 inch = 400 feet

DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
COLUMBIA BASIN PROJECT - WASHINGTON

**LAND CLASSIFICATION**

CLASSIFIED: J. R. Chase SUBMITTED: J. R. Chase  
DATE: Jan 17, 1938 APPROVED: J. R. Chase

EPHRA TA, WASHINGTON 202535

**LAND CLASSIFICATION**

TRACED: J. R. Chase  
CHECKED: J. R. Chase  
SUBMITTED: J. R. Chase  
202535 643.43 ACRES

FIGURE 16.—Sample Land Classification Map

made with an electrolytic bridge for each section of the soil profile, and the results are recorded on the field sheets opposite the section to which they pertain. Soil

reaction is expressed by pH measurements, which are determined colorimetrically or with a pH meter. Dilute hydrochloric acid is used in making an estima-

Standards of classification adopted for the most commonly used of these six categories are as follows:

Standards for semi-detailed land classification

Land characteristics	Class 1 land	Class 2 land	Land characteristics	Class 1 land	Class 2 land
<b>SOILS:</b>			<b>Rock and rocky soil</b>	No solid rock or loose rock that will interfere with ordinary cultivation.	No rock in place. Easily removable loose rock limited to that generally cleared in similar communities where irrigation is practiced.
Texture.....	Sandy loam to friable clay loam.	Loamy sand to friable clay.			
Depth: *			<b>TOPOGRAPHY:</b>		
To gravel, sand or cobble.....	24 inches good plow soil.....	12-18 inches good plow soil.	Slopes.....	Smooth slopes up to 5 percent in general gradient; reasonably large sized bodies sloping in the same plane.	Smooth general slopes of 5 to 10 percent or rougher slopes which may be less than 5 percent in general gradient.
To solid rock or impervious hardpan.....	48 inches plus.....	36 inches plus.	Surface.....	Even enough to require only small amount of leveling and no heavy grading.	May require considerable leveling and moderate grading, but in amounts generally found feasible in like areas where irrigation is practiced.
To caliche hardpan (slightly penetrable).....	30 inches with 48 inches penetrable.	24 inches with 36 inches penetrable.			
To penetrable lime zone.....	18 inches with 48 inches penetrable.	14 inches with 36 inches penetrable.	<b>DRAINAGE</b> .....	Early seepage of land unlikely. Artificial drainage practicable at low cost.	Early seepage may develop. Artificial drainage practicable at reasonable cost.
Alkalinity.....	pH less than 9.0 in surface 3 feet. pH 9.0 or higher in section of soil profile below 3 feet if highly calcareous and total salts are low.	pH 9.0 or less in surface 2 feet. Higher pH permissible in section of soil profile below 2 feet if highly calcareous and total salts are low.			
Salinity.....	Total salts not to exceed 0.2 percent.	Total salts not to exceed 0.5 percent.			

\* At the lower range of minimum depths the texture must be fine sandy loam or heavier, and at the higher range it must be as heavy as sandy loam. Loamy sands underlain by coarse sand or gravel should be 24-30 inches deep (depending on the percent of silt and clay) to qualify for class 2, and 18-24 inches deep to qualify for class 3. While areas may be placed in a lower class than "1" for any of the reasons listed above, they will generally be placed in the next lower class if decidedly inferior in two or more respects. The reasons for placing areas in a lower class than "1" should be indicated by placing the letters "S", "T", or "D" after the classification number, depending on whether the deficiency is in "soil," "topography," or "drainage". The boundaries between the different classes should be delineated with a solid line and the boundary between areas placed in the same class for different reasons should be a broken line.

Irrigated land.—All the land that is irrigated or has been irrigated even though the supply may have been inadequate for a part of the time, is classed as irrigated. Irrigated meadow or pasture is shown in contrast to other irrigated land by reverse crosshatching.

Class 6—Nonarable.—Includes lands which do not meet the minimum requirements for class 2. Also small areas of arable land lying within larger bodies of nonarable land when these would obviously not make usable fields. Arable areas which are isolated for irrigation by gravity (high), or those where the feasibility of making water delivery is questionable, will be classified in the regular way and the matter of eliminating arable land because of cost of serving with an irrigation supply will be left to the engineer in charge of the investigation.

Standards for Detailed Land Classification

Land characteristics	Class 1.—Arable	Class 2.—Arable	Class 3.—Arable	Class 6.—Nonarable
<b>SOILS:</b>				Includes lands which do not meet the minimum requirements for Class 3. Also small areas of arable land lying within larger bodies of nonarable land when these would obviously not make usable fields. Arable areas which are isolated for irrigation by gravity (high) or those where the feasibility of making water delivery is questionable will be classified in the regular way and the matter of eliminating arable land because of cost of serving with irrigation water will be left to the engineers.
Texture.....	Sandy loam to friable clay loam.	Loamy sand to friable clay.....	Loamy sand to friable clay.....	
Depth: *				
To gravel, sand or cobble.....	24 inches good plow soil.....	12-18 inches good plow soil.....	6-12 inches soil.....	
To solid rock or impervious hardpan.....	48 inches plus.....	36 inches plus.....	36 inches plus, where flat or hummocky; 24 inches on smooth slopes. 16 inches with 36 inches penetrable.	
To caliche hardpan (slightly penetrable).....	30 inches with 48 inches penetrable.	24 inches with 36 inches penetrable.	16 inches with 36 inches penetrable.	
To penetrable lime zone.....	18 inches with 48 inches penetrable.	14 inches with 36 inches penetrable.	8 inches with 36 inches penetrable.	
Alkalinity.....	pH less than 9.0 in surface 3 feet; pH 9.0 or higher in section of soil profile below 3 feet if highly calcareous and total salts are low.	pH 9.0 or less in surface 2 feet; higher pH permissible in section of soil profile below 2 feet if highly calcareous and total salts are low.	pH less than 9.0 in surface 12 inches; higher pH permissible in section of soil profile below 12 inches if highly calcareous and total salts are low.	
Salinity.....	Total salts not to exceed 0.2 percent.	Total salts not to exceed 0.5 percent.	Total salts not to exceed 0.6 percent.	
Rock and rocky soil.....	No solid rock or loose rock that will interfere with ordinary cultivation.	No rock in place. Easily removable loose rock limited to that generally cleared in similar communities where irrigation is practiced.	No rock in place. Extent of loose rock limited to that generally permissible in the production of meadow or hay.	
<b>TOPOGRAPHY:</b>				
Slopes.....	Smooth slopes up to 5 percent in general gradient; reasonably large-sized bodies sloping in the same plane.	Smooth general slopes of 5 to 10 percent or rougher slopes which may be less than 5 percent in general gradient.	Up to 12 percent if slopes are very favorable.	
Surface.....	Even enough to require only small amount of leveling and no heavy grading.	May require considerable leveling and moderate grading but in amounts generally found possible in like areas where irrigation is practiced.	May require heavy grading in spots but not more than has been generally found possible on similar developed projects.	
<b>DRAINAGE</b> .....	Soil and topographic condition: such that no specific drainage requirement is to be anticipated.	Soil and topographic conditions such that drainage will probably be required but with reclamation by artificial means appearing feasible at reasonable cost.	Narrow valleys, etc., where drainage will probably be required. Also areas requiring surface outlets provided these can be provided at reasonable cost.	

\* At the lower range of minimum depths the texture must be fine sandy loam or heavier, and at the higher range it must be as heavy as sandy loam. Loamy sands underlain by coarse sand or gravel should be 24-30 inches deep (depending on the percent of silt and clay) to qualify for Class 2, and 18-24 inches deep to qualify for Class 3. While areas may be placed in a lower class than "1" for any of the reasons listed above, they will generally be placed in the next lower class if decidedly inferior in two or more respects. The reasons for placing areas in a lower class than "1" should be indicated by placing the letters "S", "T", or "D" after the classification number, depending on whether the deficiency is in "soil," "topography," or "drainage." The boundary between areas placed in the same class for different reasons should be a broken line.



tion of the lime content. Where soil conditions encountered are not fully explained by these field examinations, or where the irrigation water to be used is high in soluble minerals, representative soil samples are sent to the chemical laboratory of the Bureau, to agricultural college laboratories, or to the Bureau of Plant Industry laboratory, for more detailed analyses and interpretation.

Classification is indicated on the field sheets by symbols. The numerals 1 to 6 are used on the map to designate the classification. Where the numerals 2 to 6 are used, the basis for such classification is indicated by the letters "S" for inferior soil conditions, "T" for inferior topography, "D" for inferior drainage, and "R" for loose rock in plow zone. For example, the symbol "2ST" indicates that the land belongs to the second class because of inferior soil and rough or steep topography. The boundary between the different classes is indicated by a solid line, while areas placed in the same class but for different reasons are separated

by broken lines. Lands that are now being irrigated are indicated by cross hatching.

**Form of Results**

The land-classification studies all lead up to the preparation of the farm-unit plat, showing farm-unit subdivisions of public lands and the areas, public and private, to be served with water. A typical farm-unit plat is illustrated in figure 15. Copies of the plat are filed in the General Land Office and the local land office. They form the official record to which homestead entries and water-right applications must be made to conform. When the farm-unit plat has been completed and filed, it is the basis of a public notice, which is a formal announcement concerning irrigable land and water charges against the land. It announces the date on which the farm units shown on the plat will become subject to entry, and when water will be available for private lands, if any, which are included in the area. It

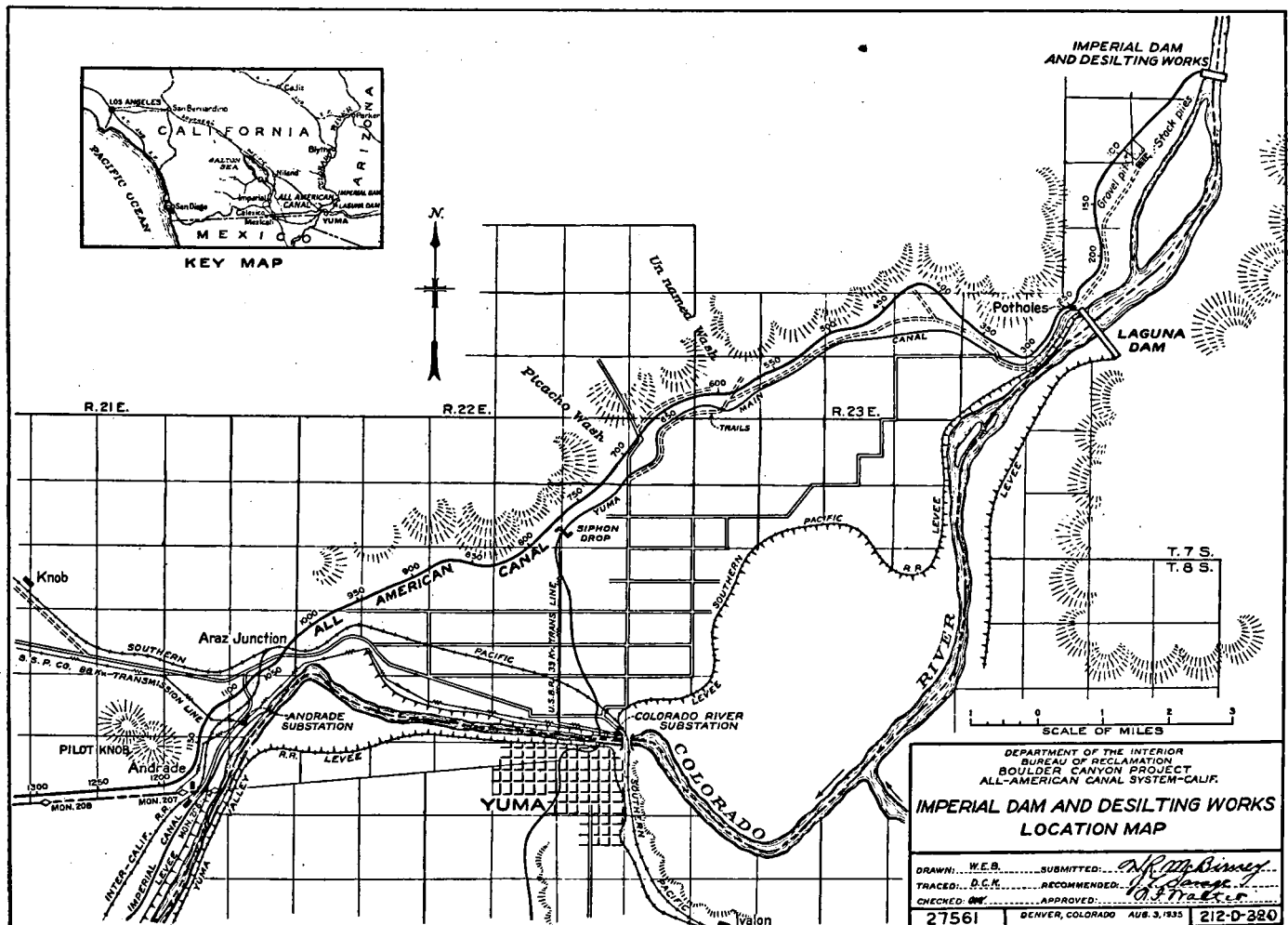


FIGURE 17.—Sample Location Map of Engineering Structure

also announces the charges against the land, and when they will become due.

The land-classification maps are retained in the project office, where they are available to the public. Prospective settlers, and those interested in the lands of the project area, consult these maps to ascertain characteristics of the soils and the potentialities of various tracts. Ordinarily, one map is made for each section of land and hand-colored in order that the public can readily discern the land classes in detail on any tract. A sample map, showing sec. 35, T. 20 N., R. 25 E., W. M., of the Columbia Basin project appears as figure 16. This map is not typical of the area since it was selected deliberately to illustrate the detailed nature of the classification work in progress.

The determination of the project boundaries is followed by issuance of a map of the project. These

maps are revised from time to time in order to illustrate the development of the project areas by inclusion of roads, railroads, new communities, and the like. They are made available to the public through sale at nominal prices.

Other results of the investigations, more indirectly, are reflected in such forms as design and construction of irrigation facilities. Canal capacities are determined directly from the results of the land classification, and they, of course, are reflected in the design and construction of the canals, the diversion works, and the storage facilities. A sample of the location maps made for such engineering structures is shown in figure 17, illustrative of the Imperial Dam and desilting works. Figure 18 is a photograph from the air of these same works and a completed section of the All-American Canal, which will carry water from the Colorado River to the Imperial and Coachella Valleys in California.



FIGURE 18.—Imperial Dam, Desilting Works, and All-American Canal



FIGURE 19.—Location of Federal Irrigation Projects in Western United States, December 1939

UNITED STATES  
 DEPARTMENT OF THE INTERIOR  
 BUREAU OF RECLAMATION  
 WESTERN PART OF THE UNITED STATES  
 SHOWING LOCATION OF  
**FEDERAL IRRIGATION PROJECTS**

Scale of Miles  
 0 60 100 150

Msp No. 29-5  
 December 1939

### **Progress to Date**

Several hundred reconnaissance surveys and investigations have been made by the Bureau of Reclamation. Of those conducted, 78 resulted in a determination that the proposed project would be infeasible, and no further investigations were undertaken. In 66 instances, in which the reconnaissance indicated further work was warranted, detailed investigations disclosed that the projects proposed were infeasible at the time. In certain cases, infeasibility was the result of a lack of economic necessity, a factor which has since been altered.

Sixty-three projects or divisions of projects have been investigated, found feasible, and constructed by the Bureau of Reclamation; 21 projects or divisions of projects have been investigated, found feasible, and are now under construction by the Bureau; 6 projects were investigated and authorized on which construction has not as yet begun; 26 projects were investigated, found feasible, and were constructed or are under construction by other agencies, private, cooperative, State, or Federal.

In the summer of 1939, 82 investigations were in progress by the Bureau, some nearing completion and others barely started. It is proposed that 37 other investigations be launched before the close of the 1940 fiscal year.

In its 38 years of operation, the Bureau of Reclamation has constructed water storage and irrigation works to serve more than 3,000,000 acres of land, on which more than 900,000 persons make their homes on more than 50,000 farms and in more than 250 villages, towns, and cities (fig. 19). Nearly 1,000 schools and more than 1,000 churches have been built in these new communities, and crops of a value of nearly 2½ billions of dollars have been harvested. The operating projects represent an investment by the Federal Government of approximately \$250,000,000, and of this sum \$50,000,000 has been repaid under the Reclamation Law.

In 1939 projects under construction were designed to make available eventually for settlement almost 2,500,000 acres of new land, and to provide supplemental water for about as many additional acres which were not adequately watered by systems already in existence.

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## CHAPTER XIII. LAND STUDIES IN THE OFFICE OF INDIAN AFFAIRS

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### Origin of Function

Almost immediately after the establishment of the Government of the United States, a definite purpose of establishing fixed exterior boundaries of the area to be occupied by each Indian tribe developed as a national policy. Tracts were at first described as the areas "allotted" to various tribes for occupancy and hunting purposes. A treaty of November 17, 1807 (7 Stat. 105), under which several tribes ceded to the United States certain lands which they had claimed within the Northwest Territory, provided for a number of reservations, varying from 2 square miles to 6 square miles each, for the future occupancy of the Indians. This, as well as many subsequent treaties, permitted the Indians to hunt and fish on the land ceded, although settlement, in some cases, made hunting and fishing rights substantially valueless. A treaty of July 8, 1817 (7 Stat. 156), with the Cherokee Indians clearly contemplated a definitely established reservation on the Arkansas and White rivers. Subsequent treaties for the removal of other Indian tribes were equally explicit in providing permanent reservations. Between 1825 and 1850 treaties for land cessions and the reservation of definite areas were made with numerous tribes both east and west of the Mississippi River.

During the administration of Franklin Pierce (1853-57), a determined policy of effecting treaties with the various tribes was instituted by George W. Manypenny, Commissioner of Indian Affairs. Most of these treaties provided for the cession of lands for permanent reservations, and for the allotment of lands within such reservations to individual Indians. The policy of reducing the area occupied by each Indian tribe to the amount of land it was thought to need for agricultural and grazing purposes became much more positive after the enactment of the General Allotment Law of February 8, 1887 (24 Stat. 388).

Indian reservations were created by Executive order as early as 1855. In line with Manypenny's vigorous policy of delimiting sharply the rights of Indian tribes, most of the Executive orders issued between 1855 and 1870 defined the boundaries of reservations that had been authorized by the terms of treaties, or covered relatively small area. After 1870 a revived interest in Indian affairs and growing opposition to further treaties resulted in numerous Executive orders setting aside extensive areas especially within that portion of the public domain that had been acquired from Mexico.

From the beginning the legal status of Indian reservations has been an anomalous one. The making of treaties with the Indians implied that they occupied a distinct political status similar to that of foreign nations; yet the Federal Government could not consistently recognize any sovereignty except its own within its territorial boundaries. Gradually, the theory was developed that the Indian tribes were dependent nations, whose natural rights to a degree of self-government and to the use of the soil and all its appurtenant advantages should be recognized by the United States, but that the fee title to the land held by Indian tribes belonged to the United States and was subject to such disposition as the sovereign Government should wish to make.<sup>1</sup>

The legal status of reservations created by Executive order has also been uncertain and subject to variable interpretations. These reservations had been established by unilateral Executive action in segregating the reserved lands from the general public domain. It was long maintained by some Government officials that the reservations created by Executive order could be diminished in size or abolished by the authority which had created them, and such action was taken in specific instances.<sup>2</sup> However, successive legislative acts and Executive and judicial interpretations have now given to the Indians occupying Executive order reservations practically the same rights as those enjoyed by Indians occupying reservations created by treaty.

The theory that the Indians had only the right of occupancy in the lands comprised within a reservation, and that this right might be terminated by the Federal Government at will, has practically been superseded by the legal theory that the Indians have a complete and indefeasible interest in the land and that they are subject only to the sovereign right of control which the Congress is morally obligated to exercise over the affairs of a class of citizens that has always been assumed to be incapable of self-protection. Upon this assumption the United States Government still maintains its authority to administer Indian affairs. The relationship of the Federal Government toward Indian property, both tribal and individual (so far as the restrictions with

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<sup>1</sup> Johnson & Graham, *Lessee v. McIntosh* (8 Wheaton 543); *Cherokee Nation v. Georgia* (6 Peters 1); *Samuel A. Worcester v. Georgia* (6 Peters 515); *U. S. v. Cook* (86 U. S. 591); *Lone Wolf v. U. S.* (187 U. S. 566).

<sup>2</sup> See *Executive Orders Relating to Indian Reservations*, Washington, D. C., Govt. Printing Office 1912 pp. 35-37, and Kinney, J. P., *A Continent Lost—A Civilization Won*, Johns Hopkins Press, Baltimore, Md., 1937, pp. 276-277, 298.

respect to the latter have not been removed by Congressional authority), is that of a trustee; and the Federal Government holds itself to the same fiduciary responsibility that would be imposed upon a trustee who had been clothed by a court with the duty of administering the property interests of a minor or other incompetent.

Under section 8 of article I of the Federal Constitution, the Congress was authorized: "To regulate commerce with foreign nations, and among the several States, and with the Indian tribes." As constitutional authority for the control over Indians and their property which has been exercised for a century and a half by the Federal Government, there remains only the sentence in section 8 of article I giving to the Congress the right to make all laws necessary for carrying into execution the powers vested by the Constitution in the Government of the United States.

By Act of August 7, 1789 (1 Stat. 49) Congress placed the administration of Indian Affairs under the Secretary of War. Affairs were administered by that Department until the Department of the Interior was created by the Act of March 3, 1849 (9 Stat. 395) when the administration of Indian Affairs was turned over to the Secretary of the Interior. The successive occupants of the position of Commissioner of Indian Affairs, an office created by the Act of July 9, 1832 (4 Stat. 564), were apparently desirous of advancing the interests of the Indians; but absorption in the details of regulating trade, of distributing goods and funds due the Indians under the terms of treaties, and of trying to keep the natives pacified, prevented the formulation of any effective plans for their economic or social advancement.

Subsequent to 1877 the agitation for the confinement of Indians within reservations and the assignment of small tracts to individual Indians became constantly more urgent. A general allotment act was passed by the Congress and approved by President Cleveland on February 8, 1887 (24 Stat. 388). This act contemplated the settling of each Indian family upon a tract that would correspond to the homesteads on which white families were accustomed to support themselves.

### **Objectives of Classification of Indian Lands**

The enactment of the General Allotment Act of February 8, 1887, made necessary the classification of lands into agricultural lands, grazing lands, and forest lands. These classifications were made in the field by men authorized to conduct the allotment of the lands to the Indians. Although no detailed surveys were made, other than cadastral surveys, an attempt was made to locate the Indians upon lands which were sus-

ceptible to individual development. In many of the western States the area of land within the Indian reservations suitable for agricultural use was extremely limited and in carrying out the terms of the General Allotment Act, and its amendments, or special authorizations as to the amount of land to be allotted to the individuals, the Indian Service found it necessary to allot hundreds of thousands of acres of grazing land and forest land. Much of the forest land which was allotted was unfit for agricultural use even after the timber was cut, and, as a consequence thereof, large areas in individual ownership were never placed under the plow.

The requirements with respect to classification prescribed by the General Allotment Act of 1887, and its amendments, were generally followed until the enactment of the Act of June 25, 1910 (36 Stat. 855). By this time the irrigation of Indian lands had reached such a state of development that it was deemed advisable to prescribe a new classification of lands which were to be allotted. Section 17 of the Act of June 25, 1910, limited the allotment of irrigable lands to an area of 40 acres for one individual and provided that:

such irrigable land shall be held to be equal in quantity to twice the number of acres of nonirrigable agricultural land and four times the number of acres of nonirrigable grazing land.

Since 1910 the allotment of Indian lands followed the classification procedure above referred to. The lands to be allotted were selected by special allotting agents in the field. Detailed reports covering these classifications were not required other than a record of the cadastral survey. However, the men who conducted the work were experienced in land use generally, and where suitable areas were available the selections made were based on sound principles.

Subsequent to the allotment of a large number of reservations, agreements were entered into with the Indian tribes under Congressional authority providing for the sale and disposition of parts of the original reservations which were not held in individual Indian ownership. In implementing these agreements the so-called "surplus" lands were classified and appraised. They were divided into various classes, such as irrigable land, agricultural land, grazing land, and forest land, and the value of each subdivision was appraised and made a matter of record. These classifications were conducted by commissions authorized by the Congress pursuant to legislation providing for the opening of designated reservations for homestead entry under the Homestead Laws of the United States. The appraisal commissions ordinarily consisted of three members and complete reports covering each subdivision of land were made a matter of record.

Concurrently with the development of more intensive methods covering land classification generally, the methods used on Indian reservations were markedly improved and the procedures now followed are based on sound principles of classification.

As heretofore stated, the Federal Government acts in the capacity of a trustee governing the management of Indian property, and in discharge of its obligations in that connection, the classification of Indian lands is undertaken for the primary purpose of protecting Indian property rights and securing sound land use. Such classification, therefore, must envision every utilitarian value inherent in Indian lands. Since 1933 a very definite policy of Indian-land acquisition rather than land disposition has been in effect and proper land use stands at the very apex of Indian administration. Consequently, intensive land classification in connection with the management of Indian property, the acquisition of new lands and placing of lands under intensive cultivation, has become highly important, and the methods of classification in use are similar to those generally applied on areas where a sound land-use policy is in effect.

#### Character and Extent of Indian Land, Forest and Range Resources

According to statistics compiled by the Office of Indian Affairs at the close of the year 1938, the land resources of the American Indian now aggregate approximately 55,000,000 acres (fig. 20). This extensive area consists of tracts varying from small homestead plots to large reservations of several million acres and is distributed in 27 States of the Union. The large bulk of the land, however, is in the larger reservation tracts and is concentrated very largely in a comparatively few of the western States. Of the total land area in Indian ownership, only a relatively small portion is suited to intensive agricultural cultivation and by far the larger portion is either forest or grazing land. Approximately 16,500,000 acres is forest land and over 42,000,000 acres, inclusive of forested range, is grazing land. The forest land supports a total stand of 35,000,000,000 board-feet conservatively valued at over \$87,000,000. The grazing land is capable of supporting more than 2,000,000 animal units (cattle, or equivalent) annually over a 6 months' period. It follows that the 240,000 or more Indians now enrolled at Federal agencies are vitally interested and dependent upon the land, forest, and range resources.

One of the more valuable of the remaining Indian assets is water. More intensive use by the Indians of their present and future irrigation facilities can be expected by reason of the many benefits and opportunities provided by the Indian Reorganization Act

(48 Stat. 984). This act is bringing about profound changes in Indian life and Indian land use.

According to the record, there are at present about 260 irrigation projects on the various reservations west of the Mississippi. These projects range in size from tracts of a few acre used for subsistence gardens to the larger projects such as those of the Gila River, Yakima, Uintah, Blackfeet, Crow, Fort Hall, and Wind River reservations. During the fiscal year 1938, the total irrigable area of all Indian irrigation projects was 1,230,492 acres, with 813,867 acres under constructed canals.

#### Type of Work

The studies of land-use problems by the Office of Indian Affairs consist of original land-classification surveys to obtain basic information concerning land, forest and forage resources, and the presentation of such information in the form of official reports as the basis of land management plans and programs. These surveys involve the examination of the areas under investigation to obtain data with respect to topography; soil; amount, condition, and types of vegetative cover; past and present use of the land; and such other factors as may be required in the classification of lands and the development of management plans and policies.

The classification program consists of the following types of work:

1. *Classification of lands proposed for purchase.*—Intensive classification surveys are made of lands proposed for purchase by the Federal Government for the use and benefit of Indians. These surveys consist of an examination of the soil, topography, vegetative types, present use, and other conditions which are essential in evaluating the property and determining its adaptability to use by Indians.

2. *Intensive range surveys.*—Intensive range surveys are conducted on Indian lands to obtain detailed data with respect to topography, soil, vegetative types, drainage and available water, grazing capacity, and the present and past use of the land. Based on these data, the range lands are classified into range types and management plans and policies are formulated for proper land use.

3. *Intensive forest surveys.*—Intensive forest surveys are made for the purpose of obtaining basic data relating to topography, soil, volume of timber by species, forest reproduction, and the condition of the forest as to distribution, growth, and damage by fires, insects, and diseases. Based on these data the lands are classified with respect to forest types, type maps are prepared, timber volumes are determined, and plans and policies are formulated for the use and conservation of the forest resources.

4. *Classification of lands proposed for irrigation.*—Intensive surveys and investigations are made of agricultural lands which have been proposed for irrigation. These surveys involve studies of topography, soil, types of vegetation, available water supply, climatic conditions, and other factors which affect the development and use of the lands.

5. *Extensive range surveys.*—Extensive range surveys are conducted when sufficient funds are not available for more intensive work. These surveys consist of a general examination of the topography, soil, vegetative types, distribution of available stock water, and present and past use of the land. Based on these data and such other data as may be available, the lands are classified into broad forage types and preliminary land-

use plans and policies developed for the conservation of the range resources.

6. *Extensive forest surveys.*—Extensive forest surveys are conducted to obtain general data with respect to topography, soil, volume of timber by species, forest reproduction, and the condition of the forest. These data are used in a general classification of the lands into broad forest types and in the formulation of temporary plans and policies for the proper use of the forest lands. These surveys are followed by intensive forest surveys when funds become available and where conditions warrant.

7. *Aerial surveys.*—Aerial surveys are made of Indian lands for various purposes. The data obtained from these surveys materially assist in land classifica-

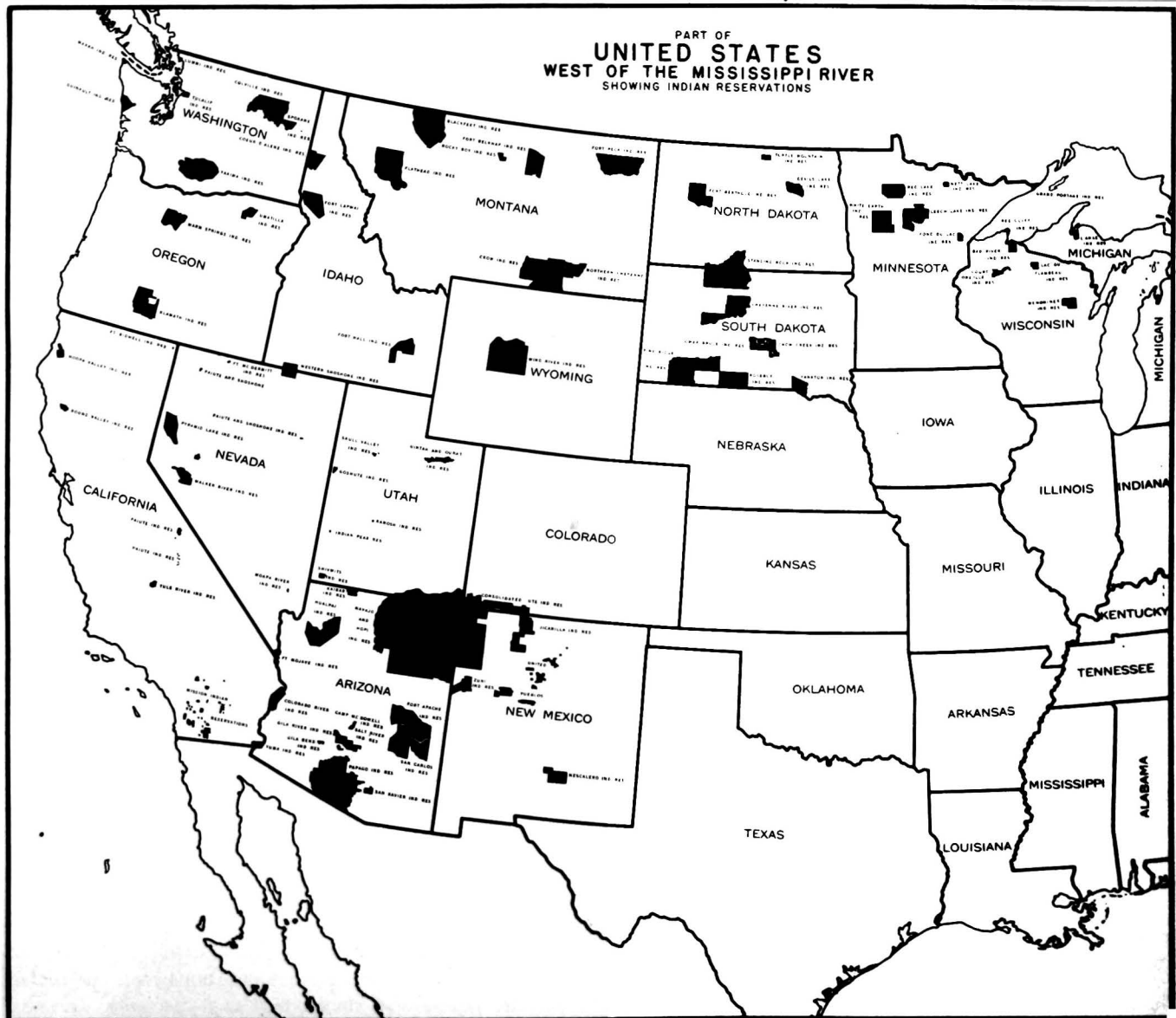


FIGURE 20.—Indian Reservations in Western United States



tion with respect to vegetative types and in the preparation of planimetric and other types of maps which are needed in field work.

8. *Special land-use investigations.*—Investigations are conducted for the purpose of classifying land for special uses such as power and reservoir sites, Indian community centers, industrial sites, roadless and wild areas, and recreational areas.

### Methods in Use

The procedures followed by the Office of Indian Affairs in the classification of lands vary according to the objectives sought. Generally the procedures for the various types of classification work conform to those used by other agencies of the Federal Government. The methods used in conducting range surveys conform to the standards formulated by the Inter-Agency Survey Committee.<sup>3</sup> The methods followed in making forest surveys conform to the standards generally used by other bureaus of the Federal Government responsible for the management of forest lands. Detailed data are obtained with respect to volume, diameter classes, and height of the timber by species; soil types, topography, and drainage; forest reproduction; condition of the timber as to distribution, growth, and damage by fire, insects, and diseases; cultural improvements; and other conditions which affect the management of the land.

Surveys and investigations of areas in proposed irrigation projects conform with the standards of the Bureau of Reclamation.<sup>4</sup> Topographic surveys, physical and chemical analysis of the soils and other land-classification factors also are determined pursuant to methods used by other bureaus of the Federal Government engaged in the same type of land classification.

### Progress of the Work

Land-classification surveys on Indian lands are made partly by the regular staff employed by the Office of Indian Affairs and partly through cooperative arrangements with other Governmental agencies qualified in the various fields of land-investigation work.

1. *Cadastral surveys.*—Cadastral surveys are made by the General Land Office and have been substantially completed on practically all of the Indian Reservations of the United States. In some cases only boundary surveys have been made. These cadastral surveys furnish the base upon which other land-classification surveys are made.

2. *Aerial surveys.*—Aerial surveys have been made of approximately 37,036,000 acres of Indian lands. These surveys have been conducted largely in coopera-

tion with other bureaus of the Federal Government, including the Soil Conservation Service, the Agricultural Adjustment Administration, and the Forest Service. Mosaics have been prepared for approximately 34,629,000 acres of the area aerially surveyed.

3. *Topographic surveys.*—Topographic surveys have been conducted on Indian lands by the United States Geological Survey, the Office of Indian Affairs, the General Land Office, and the Bureau of Reclamation. These surveys cover approximately 11,059,500 acres.

4. *Forest surveys.*—Forest surveys have been completed on approximately 5,001,000 acres of Indian forest lands. Preliminary plans are under consideration looking to the conducting of intensive surveys on all reservations of major importance from a forestry standpoint which have not been completed to date. It is expected that this work will be carried forward as soon as funds for that purpose are provided.

5. *Range surveys.*—Range surveys have been made on approximately 26,151,000 acres of Indian lands by the Office of Indian Affairs in cooperation with the Soil Conservation Service, Department of Agriculture. It is planned to conduct such range surveys on an additional area of 16,000,000 acres of range lands in Indian ownership when funds are made available for this purpose.

6. *Irrigation surveys.*—Most of the agricultural lands on Indian reservations have been extensively surveyed by the Office of Indian Affairs for the purpose of classifying them into irrigable and nonirrigable areas. Intensive surveys have been conducted on approximately 1,218,880 acres of Indian lands located within irrigation projects which have been developed or are proposed for development. It is proposed to continue this work when funds are made available and further development is essential to the social and economic welfare of the Indians.

7. *Land-purchase surveys.*—Considerable progress has been made in the purchase of lands for the use and benefit of Indians. Surveys for evaluation purposes of purchased areas, comprising approximately 430,220 acres, were completed prior to such purchase. Many of the areas which have been proposed for purchase have been similarly classified. Based on funds available, it is planned to continue the classification and appraisal of lands proposed for purchase. The progress which will be made in this connection depends on appropriations by the Congress and the need of additional lands by the Indians.

### Personnel

The Land Division of the Office of Indian Affairs has supervision over all land examination work conducted for the purpose of classifying lands proposed for purchase. The field personnel of this Division consists

<sup>3</sup> See ch. XV.

<sup>4</sup> See ch. XII.

of men trained in land classification and land valuation.

The Division of Forestry and Grazing conducts range and forest surveys and cooperates with other Government agencies in carrying out this work. The field personnel of this Division includes men who have received their professional training in forest and range management in the various State universities and

colleges. By reason of their training and experience they are well equipped to conduct intensive range and forest surveys in accordance with the accepted standards for that work.

All intensive surveys of irrigable lands are directed by the Irrigation Division whose personnel consists of irrigation engineers and other professional men qualified in the field of reclamation.

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## CHAPTER XIV. SCENIC, HISTORIC SITES AND RECREATIONAL LAND CLASSIFICATION OF THE NATIONAL PARK SERVICE

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### Origin of Function

One of the unique and most complicated land-classification activities performed by any agency is that used in selecting areas for inclusion in what is now generally known as the national park system. The origin of the principles involved in such classification is generally credited to an expedition which in 1869 explored the region subsequently included in the Yellowstone National Park. In 1870 a second exploration of the region was undertaken jointly by the General Land Office and the United States Army. The first scientific studies of the region were undertaken in 1871 under the joint auspices of the Geological Survey and the Army Engineer Corps. The reports of these exploratory surveys aroused wide public interest and resulted in the creation of the Yellowstone National Park by act of Congress approved March 1, 1872 (17 Stat. 32).

Almost 40 years prior to the foregoing action the Congress, by the act of April 29, 1832 (4 Stat. 505), reserved for the use of the United States the Hot Springs, Territory of Arkansas. The purpose of this reservation was to preserve permanently for public use certain medicinal springs, and to prevent private exploitation of an area which was becoming nationally known because of the curative properties of its springs. This reservation therefore was not, like Yellowstone, created primarily for recreation but was created in pursuance of a policy of preventing private exploitation of essential natural resources.

The Act of June 30, 1864 (13 Stat. 325) granted certain lands, now within Yosemite National Park, to the State of California with the stipulation that the area should be held for "public use, resort and recreation." The land was ceded back to the Federal Government in 1905 and added to the lands dedicated to park purposes in 1890.

Following the enactment of the foregoing laws, the Congress from time to time created other public use reservations of various types more or less as public demand therefor arose. The reservations thus created were under the respective jurisdiction of the Departments of the Interior, War, or Agriculture.

In addition to the special reservation enactments which preceded the present national parks activities, the Act of June 8, 1906 (34 Stat. 225), entitled "An Act for the Preservation of American Antiquities," authorizes the President to declare, "by public proclamation,

historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest—to be national monuments." The administration of any such national monument was again placed under the respective jurisdiction of the Departments of Interior, War, or Agriculture, depending on which Department exercised jurisdiction over the land containing the monument.

### Establishment of the National Park Service

The National Park Service was established by the act approved August 25, 1916 (39 Stat. 535). The portion of that act under which its land-classification work is performed is as follows:

The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means, and measures as conform to the fundamental purpose of the said parks, monuments, and reservations which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.

In 1933 the administration of all national monuments was consolidated in the National Park Service. Since then the Secretary of the Interior has served as the President's advisor concerning the establishment of additional national monuments.

The functions of the National Park Service were further enlarged in 1935 when the Congress passed an act to provide for the preservation of historic sites, buildings, objects, and antiquities of national significance (48 Stat. 666). This declared a national policy, authorized acquisition, and did not restrict establishment to objects located on public lands, as does the Antiquities Act of 1906. The land classification principles contained in this enactment are:

\* \* \* That it is hereby declared that it is a national policy to preserve for public use historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the United States.

The act authorized the Secretary of the Interior, through the National Park Service, to make a survey of historic and archeologic sites and materials to determine which ones possess exceptional value; to acquire and administer such sites and objects; to enter into agreements with states, corporations, associations, or individuals for the protection and management of

historic sites, whether they are owned by the Federal Government or not; and to develop an educational, or informational, service to make available the facts about such sites. The act also authorizes the Secretary to appoint a general advisory board known as the "Advisory Board on National Parks, Historic Sites, Buildings, and Monuments" to advise him on general park policies and to appraise the value of historic sites from the national point of view.

In 1936, the Park, Parkway, and Recreational Study Act (49 Stat. 1894) was passed by the Congress, authorizing the National Park Service to cooperate with other Federal agencies and with the States in making a recreation study of the United States for the purpose of recommending a plan of coordinated and adequate public park, parkway, and recreational-area facilities. This act authorizes classification of lands for recreational purposes.

### Objectives

The primary objectives of the National Park Service land-classification program are to locate, appraise, and secure for public inspiration and benefit:

1. Areas nationally of more value for recreation than for any other use;
2. Outstanding stretches of the ocean beaches (fig. 26);
3. Nationally important prehistoric and historic sites, objects, and buildings (figs. 23, 24).
4. The finest representative examples of native plant and animal life (fig. 22);
5. The most instructive geological exhibits, such as the Grand Canyon (fig. 21); and
6. A system of nationally important scenic and historic parkways (fig. 25).<sup>1</sup>

These objectives are attained by locating and preserving in a public reservation areas and objects which exemplify major themes of nature and history. Thus the geological formations of the continent are a theme of major educational and recreational importance. A rock outcrop, a major fault, a group of fossils, or other geological formations, even though unspectacular in appearance, may be selected for reservation to exemplify the history of the geologic ages. The units selected for reservation are not necessarily

spectacular, though in most cases the most instructive geological manifestations are also of outstandingly scenic value, and a coincidence of educational and recreational values is achieved.

The objectives also include the preservation of the finest representations of the different plant and animal associations, which are characteristic of the various ecological types. The desirability of preserving outstanding examples of the natural flora and fauna is becoming increasingly important from an educational standpoint, as the native character of the country is increasingly modified by the impact of civilization.

Archeological material, because of its irreplaceable nature and limited quantity, is regarded as a resource of national value. The preservation of all such material is impractical, but as much as possible is reserved for present and future study so that the themes of human relationship and cultural developments may be understood.

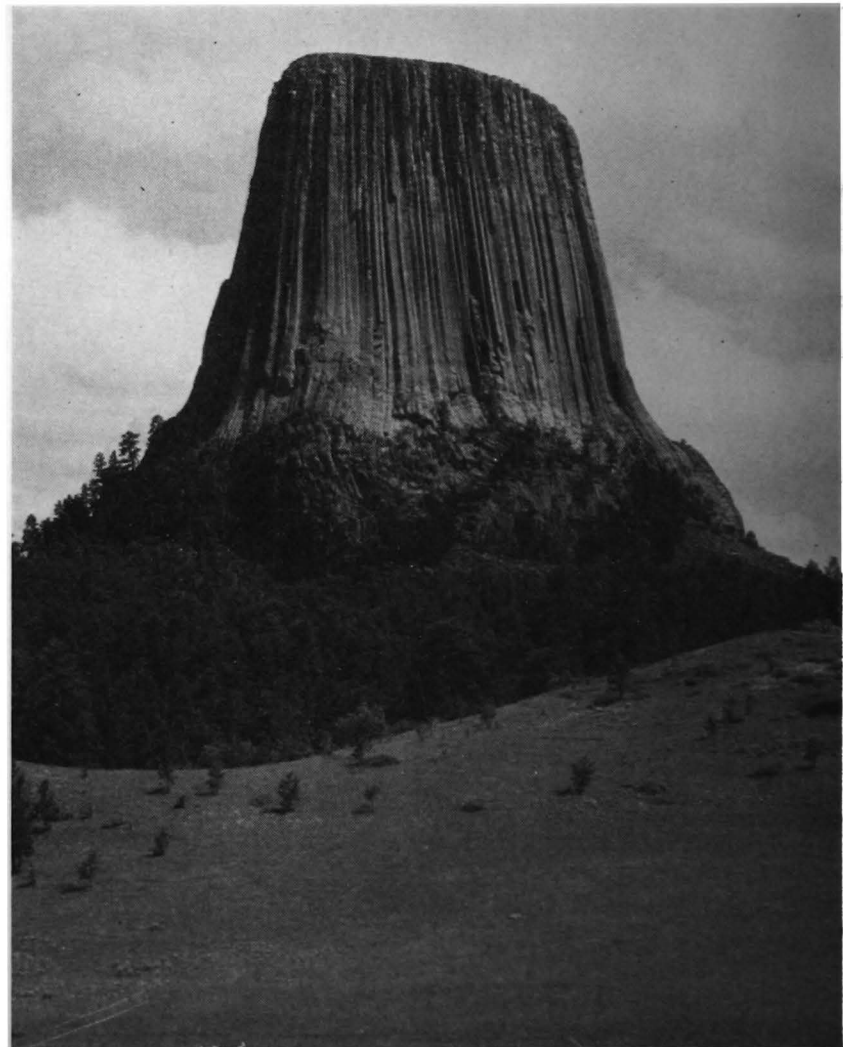


FIGURE 21.—Geologic Exhibits, Devil's Tower National Monument, Wyoming

<sup>1</sup> *Portfolio on the National Park and Monument System*, American Planning and Civic Association, 1938. For further amplification of the national park idea, the following publications of the American Planning and Civic Association are recommended: (1) 20th Anniversary National Park Supplement to *Planning and Civic Comment*, Vol. 2, No. 4, and (2) *American Planning and Civic Annuals*, for the years 1936, 1937, 1938, and 1939.

History is current as well as ancient. It is the objective of the National Park Service to preserve historic sites, battlefields, and areas that portray the domestic, cultural, and industrial phases of American development.

These different types of areas are being assembled into a coherent system. In the West, the problem has been simplified because areas desired for preservation are in most cases already in public ownership. In the East, however, the areas which are regarded as desirable units in the program are almost entirely in private ownership. They must be purchased and, sometimes, restored. The program will grow as additional land-classification information is obtained. Surveys for the purpose of proper appraisal of different areas are in continual process.

#### Land-Classification Categories

The national park system, as of April 1, 1940, was composed of 11 categories of reservations, with a total

area of 21,453,871.64 acres. The 11 categories are as follows:

Type of area	No.	Area
		<i>Acres</i>
National parks.....	25	10,165,878.79
National historical parks.....	4	7,642.27
National monuments.....	80	9,519,998.78
National military parks.....	11	20,977.31
National battlefield sites.....	7	2,147.60
National historic sites.....	4	223.59
National recreational area.....	1	1,699,573.00
National memorials.....	8	317.11
National cemeteries.....	11	355.03
National capital parks.....	1	6,008.63
National parkways.....	3	
Total.....	155	21,453,871.64

A twelfth category, National Seashore, has been authorized by the Congress (50 Stat. 669).

The large number of categories applicable to areas in the national park system is due to the fact that prior to 1933 several departments of the Federal Government were responsible for reservation and administration of areas now in the national park system. Some of the categories involving reservations of similar types are established under different legislative authorizations. The same type of reservation, for example, may be set up as a national historic park by act of Congress, a national monument by proclamation of the President, or a national historic site by designation of the Secretary of the Interior.

For the purpose of land classification, however, the 12 categories, with exception of Boulder Dam National Recreational Area, are generally similar: they are public reservations set apart for recreational use. Boulder Dam National Recreational Area is primarily for water storage, with recreation subordinated to the primary use.

#### Procedure

In most cases studies of proposed park areas are initiated by public interest in particular localities. The study which led to the creation of Yellowstone National Park is a striking example of this procedure. People had heard of the unusual character of the region. Public interest was aroused, and the first official party, led by Gen. Henry D. Washburn, Surveyor General of Montana and by Lt. G. C. Doane of the United States Army, explored the Yellowstone region in 1870. As a

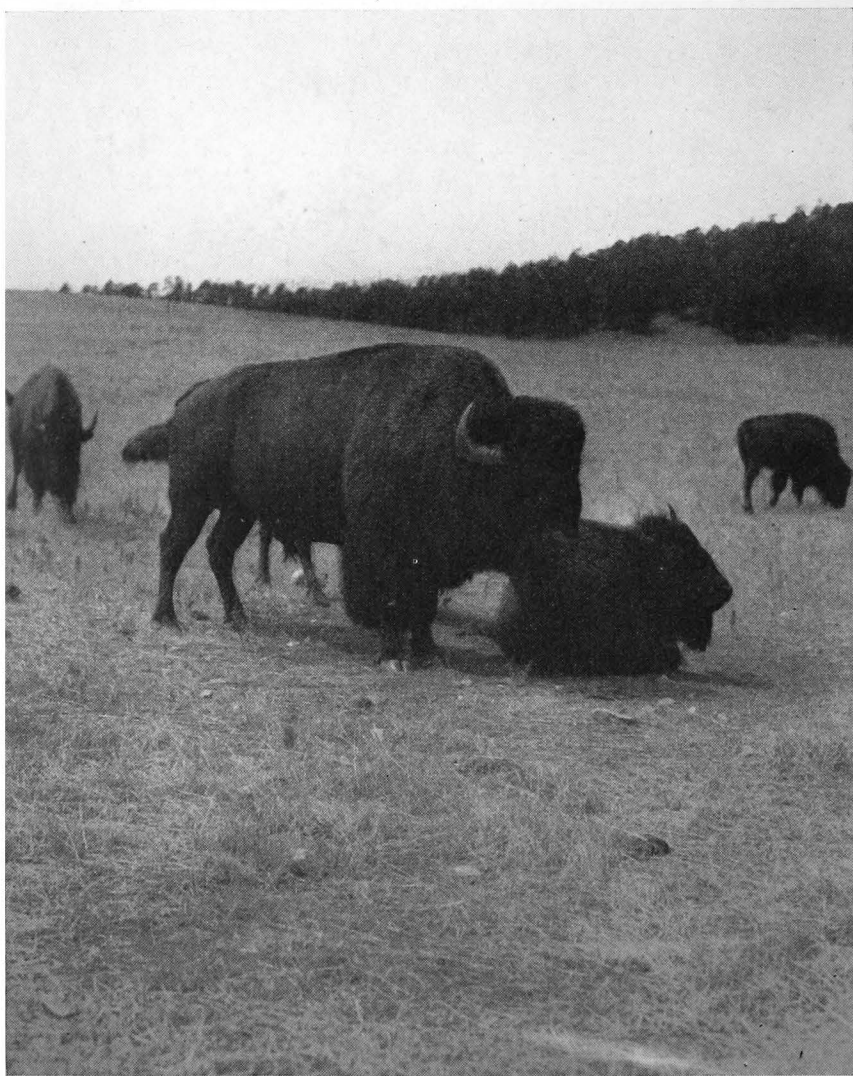


FIGURE 22.—Native Animal Life, Wind Cave National Park, South Dakota

result of the party's published report, Congress authorized and directed a further study of the area. In 1871 the Army and the Department of the Interior collaborated in what is known as the Hayden Survey of the Yellowstone region. This expedition collected scientific data and made a large number of photographs. The boundaries of the proposed park were drawn as a result of this expedition.

Today the National Park Service conducts three correlated studies as a basis for land classification. They are: (1) Studies of proposed national parks, monuments, and seashores, etc.; (2) park, parkway, and recreational area studies conducted in cooperation with other Federal agencies and with the States; and (3) historic sites and structures survey.

A proposed area, during the period of investigation and study will be examined by a geologist to ascertain whether it contains any unique geologic features, whether it will fill a missing chapter in the national geological story, and whether it is among the best exhibits of its kind. A biologist will examine the area to ascertain whether it possesses important remnants of rare species, whether it is an unusual ecologic type, or one of the best remaining examples of some ecologic type not adequately protected elsewhere. An historian or archeologist will examine the area to determine whether it is a site of significant historic or prehistoric structures or relics that are of importance to the theme of cultural, regional, or national development. An architect will examine the historic structures to determine whether they are significant in the development of architecture in this country. Each of these technicians will recommend the area he considers essential to comprise an effective geologic, biologic, or historic unit. A landscape architect will calculate the probable developments for public use and will recommend a suitable area. A study also is made of the economic potentialities of the area to determine its importance for mining, logging, grazing, water storage, the development of water power, or other commercial purposes. Subsequently, these facts and recommendations are studied and correlated with land ownership and acquisition, public sentiment, probable or ascertainable public use, the over-all scenic or recreational value, and with the relationship of the proposed area

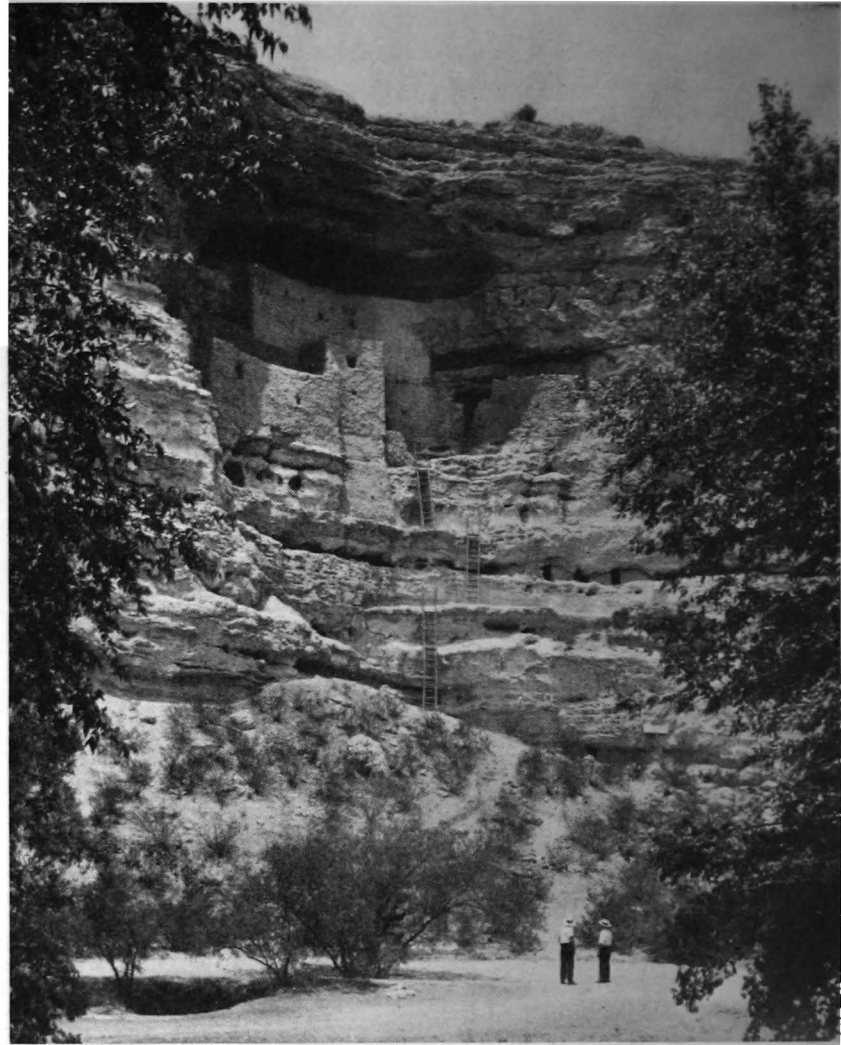


FIGURE 23.—Prehistoric Sites, Montezuma Castle National Monument, Arizona

to the national park system, to the broad objectives of the system, and to general policies of land use.

All facts and reports thus obtained are carefully reviewed, and when a park project is deemed meritorious, recommendation for its establishment is submitted to the Congress where final determination is made and appropriate legislative action is taken. Preliminary procedure for creating national monuments is similar, except that final determination in such matters rests with the President.

State studies conducted under the Park, Parkway, and Recreation Study Act are primarily a responsibility of the several States. The National Park Service acts as advisor and correlator only. The main features of the study are: (1) an inventory of existing recreational facilities and their uses; (2) an analysis of recreational needs and the factors affecting these needs; (3) an inventory and analysis of potential recreational areas;

recommendations for their classification and best use; and (4) recommendations for adequate legislative authority, administering and advisory agencies, and methods of financing programs — all to the end that a national plan for recreation involving city, county, metropolitan, State, and National components can be built upon the basis of local needs, studies and recommendations.

As of April 1, 1940, 27 States had completed their first study reports; the reports from 10 additional States are expected by January 1, 1941; 8 other States and the Territory of Hawaii have participated in the study; and only 3 States have been unable to assume any part of the study. These plans and reports are being used as a guide by the States in the further development of local park, parkway, and recreational area systems and as a

basis for continued cooperation with the National Park Service.<sup>2</sup>

The States are authorized “to negotiate and enter into compacts or agreements with one another with reference to planning, establishing, developing, improving, and maintaining any park, parkway, or recreational area.” The study, accordingly, has included several interstate parkway proposals and it is hoped that a national plan for parkways will be formulated for correlation with a national plan of highways. The several bills, now before Congress, to authorize parkway studies, including the Mississippi River Parkway proposal, are major ventures in land classification for recreational use.

<sup>2</sup> Methods employed in the investigations are treated in detail in *Procedure for Park, Parkway, and Recreational-Area Study*. National Park Service, Department of the Interior, Washington, D. C.



FIGURE 24.—Historic Sites, Morristown National Park, New Jersey

The general nature of the Historic Sites Survey is described in the following quotation from instructions of the Secretary of the Interior, February 28, 1936, which have been published by the National Park Service:

1. The National Park Service, through its branch of historic sites and buildings, shall perform the duties prescribed in the Act, and in so doing it shall study and investigate historic and archeologic sites and buildings throughout the United States, and list, describe, tabulate, classify and evaluate such plan for their acquisition, preservation and use. It shall submit annually to the Secretary of the Interior a report on the areas studied during the preceding year.

2. The Director of the National Park Service, after consultation with the Advisory Board or the appropriate subcommittee thereof, shall recommend to the Secretary the designation as national historic sites of any such historic sites and buildings as appear to possess the necessary attributes, including national historical or archeological significance, availability, possession

of suitable physical characteristics, capability of development and control, and the possibility of administration as a national historic site.

The procedure in designating a national historic site is stated as follows:

Study of the site by the National Park Service and a determination of its national importance within the scope of the Act.

Preparation by the National Park Service of a memorandum for the Secretary's approval, including a map of the recommended boundaries and descriptive material of the site to be designated. The memorandum shall include recommendations as to the official name of the site and the method of administering it if and when accepted. The justification must show that the recommended site is of national significance.

The Advisory Board on National Parks, Historic Sites, Buildings, and Monuments meets several times each year to consider, among other subjects, the merits of proposed historic areas. The plan of classification



FIGURE 25.—Scenic and Historic Parkways, Virginia



rests upon the significance and relationship of each proposed area to the historical theme it is desired to preserve and portray. The sites are not selected, therefore, at random, but as related units in a philosophy of history that has definite chapter themes such as: (1) Spanish Exploration and Settlement, (2) the Establishment of the French Colonies, (3) the Dutch and Swedish Settlements, and (4) English Exploration and Colonization.

A map has been drafted, showing a total of about 500 historic and prehistoric sites being considered by the Board. These sites are designated as: (1) "Acquired"; (2) "previously approved by the Board"; (3) "eligible for immediate consideration"; and (4) "eligible for later consideration". This map has not been published and is not for publication. The Board is considering the sites chronologically.

In 1934, the National Park Service sent questionnaires to a number of outstanding American archeologists asking them to classify, in order of scientific importance, the sites with which they were acquainted. These questionnaires are filed with the National Park Service.

The growth of the national-park system is guided by the land-classification studies herein described. The State and local park systems are growing on the same basis, but within their respective levels of responsibility. The national program of recreational areas is evolving as a combination of all levels of responsibility.

#### **Master Plan Studies**

The lands within an established area must be classified to accomplish their preservation and most profitable use. To attain this objective, area studies and the



FIGURE 26.—Ocean Beaches, Example of a Seashore Proposed for Acquisition

resultant plans of development are correlated and recorded through the medium of the master plan.<sup>3</sup> Briefly described, the master plan consists of:

1. A base map which shows topography and all existing features and is compiled and drawn from best available sources;
2. A road-system plan which shows existing and proposed roads with indications of progress being made in construction;
3. A trail-system plan showing existing and proposed trails;
4. A general-development, or zoning plan which indicates the locations of developed areas existing or proposed, wilderness areas, sacred areas, private property, historic areas, research areas;
5. A fire-control map upon which is shown facilities for fire control, lookout locations, fire caches, communication lines, fire trails, water channels;
6. A forest-type map indicating all different existing types of flora within a park;
7. Plans for developed areas which comprise the larger number of sheets within the master plan, and show on large scale the present and future development proposed at each individual area where people must live. Locations of all buildings, roads, bridges, or other developments are established, including even parking areas, hitch racks or flagpoles;
8. A development outline which consists of typed sheets which are bound with their corresponding graphic plans, and which state as briefly as possible the facts, figures, decisions, programs, and methods of treating the various problems of that particular portion of the park being considered.

The master plan for a park shows all developments, existing and proposed. It is prepared by professional men to meet the requirements of the public in using the park. A road-and-trail system, for example, is carefully planned in its entirety. It may take many years to complete, but each unit of construction that is executed is a portion of this complete plan and a step towards its achievement.

The master plan is more than the work of one man; it is a product of the Service as a whole. Each feature of it has been studied and passed upon by the various technical branches of the Service before administrative approval is given. No trails, roads, buildings, campgrounds, or other developments are permitted within a

<sup>3</sup> The national park master plans, revised annually, are on file in the National Park Service and are available for inspection.

park unless they have been previously approved and included in the plan. The plan is a conservative device, purposely adopted to avoid hasty or ill-conceived projects.<sup>4</sup>

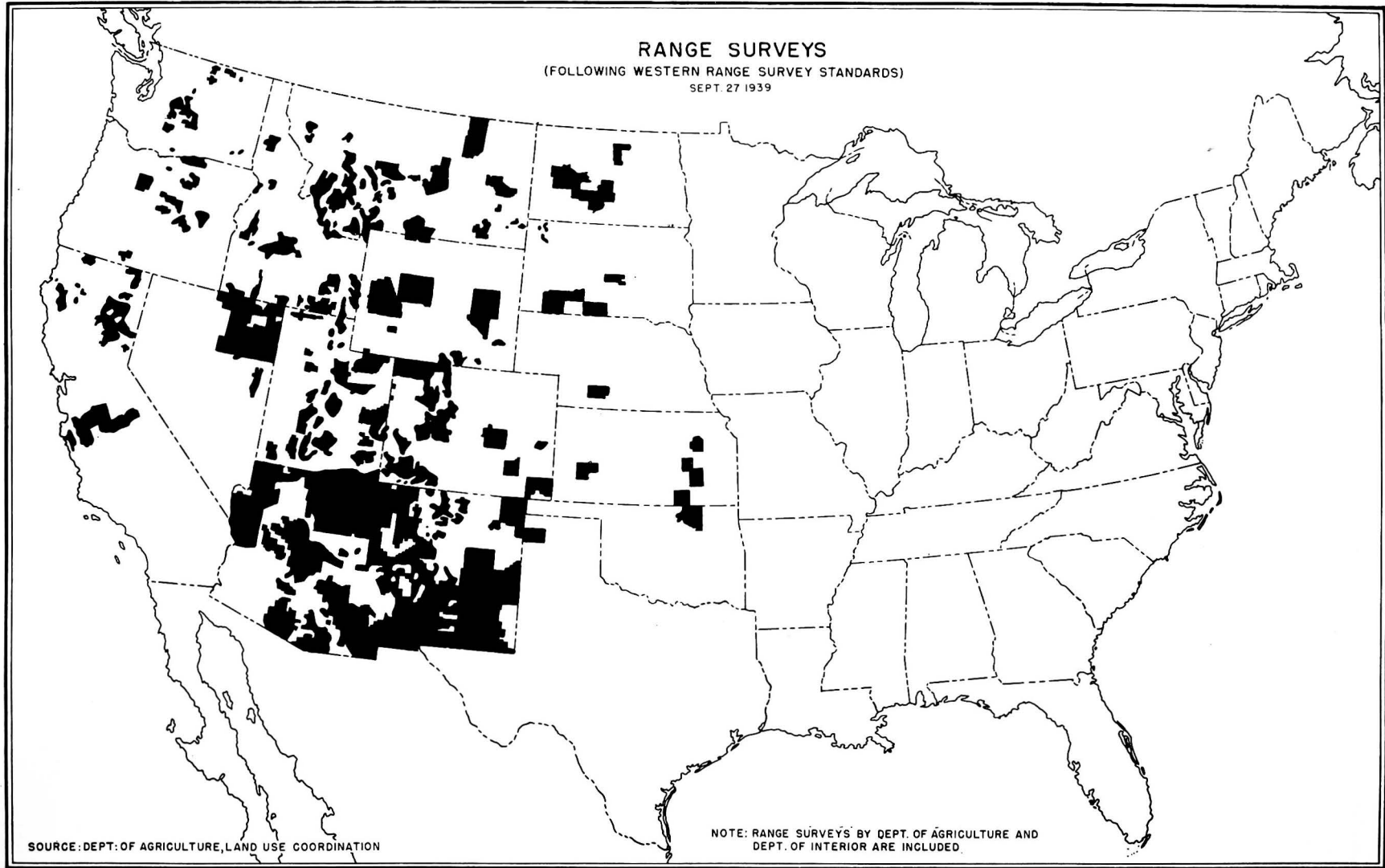
The objectives and studies that provide the data for the master plan are of importance to the subject of land classification. These studies are similar to, and, in effect, a continuation of, the studies that led to establishment of the area as a park. Each technician examines the area to ascertain the facts pertaining to his subject. Each reviews proposed plans of development to assure the proper protection and the optimum use of the resources for which he is responsible. The administrator correlates the different points of view on the basis of the evidence submitted and the final product is the approved master plan.

There is no type plan applicable to all parks, monuments, and other reservations in the System. Each area presents different problems requiring individual solution. Perhaps the only general rule that can be applied is that the development of each area shall be consistent with the preservation and best use of the resources for which it was established. Thus, park developments vary all the way from the roadless, wilderness park, such as Isle Royale, to the landscaped highway which is the central feature of the Mount Vernon Memorial Highway.

### Personnel

Technical specialists in the fields of history, archeology, geology, biology, architecture, and landscape architecture, as well as specialists in related fields, are required in the National Park Service to perform the land-classification function. The contributions of these technicians are correlated by park planners who must have an acquaintance with the respective technical fields and who must maintain an over-all perspective, synthesizing the technical recommendations in a coherent, practicable plan.

<sup>4</sup> From portfolio on the National Park and Monument System, American Planning and Civic Association, 1938.



PREPARED IN OFFICE OF THE NATIONAL RESOURCES PLANNING BOARD

FIGURE 27.—Range Surveys in Western United States, September 1939

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## CHAPTER XV. RANGE SURVEY PROCEDURE<sup>1</sup>

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### Objectives and Origin of Function

Range surveys are carried on for the purpose of providing basic data necessary for the development of management plans for range areas. These surveys show the location and physical condition of forage resources, their relation to other land resources, and their potentialities for livestock grazing on a stable basis consistent with the maintenance of a vegetative soil cover. They are particularly important in the western United States on the public and private range land, much of which is badly in need of improvement. Federal<sup>2</sup> and other agencies have used range surveys for a number of years, in one form or another, as a basis for range management. (Fig. 27.)

### Types of Work

In the conduct of a range survey, range examiners combine (1) the technique of observing the character, composition, and density of vegetative cover with (2) an evaluation of the effects of natural influences and livestock grazing upon the depletion, maintenance, or development of the vegetative cover. A forage inventory is thus secured, with supplementary data regarding seasons of grazing use and the disposition of livestock, together with information concerning the quantitative disposition of forage, the grazing systems involved, and the presence and condition of range improvements.

Range surveys differ from many other surveys. They not only assemble and compile factual material regarding the range resources, but also require the interpretation of these facts and the eventual assembly of all of this information into simple and workable unit range management plans.

### Methods and Technique

Range surveys involve integration of factual material, with an understanding of the manner in which various kinds of livestock utilize range forage resources. Broad, general-range observations are ordinarily of sufficient value for the formulation of plans for halting and reversing forage depletion on a specific area, or for checking accelerating erosion. More detailed information is essential to the restoration of depleted ranges and for

the long-time and sound planning for the proper utilization of the forage and other natural resources.

A comprehensive and complete range survey project will provide the following information:

1. *Delineation of range forage types.*—The delineation of range forage types consists of recognizing and mapping ecologic type associations on the basis of growth habit and environmental conditions. Eighteen such type associations have been adopted as standard for range surveys throughout western United States. Mapping includes, in addition, special range types that are peculiar to certain regions. In connection with both the standard and special types, a classification is made of significant subtypes, and type combinations.

2. *Composition of the vegetation type.*—Data on the composition of the vegetation are provided by a primary classification which distinguishes grasses, herbs, and shrubs. Each group has a special significance with respect to the season of use, range readiness, system of grazing, and kinds of livestock. This classification is followed by a determination, in percentages, of the proportionate representation of individual species.

3. *Density of total vegetation.*—One of two methods of surveying density of total vegetation is used. The original method, the one most widely employed, consists of an ocular examination over the entire mapped area of each vegetative type. The second method consists of actual measurements of a large number of 100-square-foot plots which, in the aggregate, are assumed to be representative of the entire mapped area. Both methods have their special adaptabilities and, when properly employed, are believed to provide equally reliable estimates. In both cases allowances are made for superstories of shrubs and tall vegetation which forms a canopy over surface vegetation.

4. *Forage utilization factor.*—The intensity of grazing to which various species can be subjected and still maintain themselves as a forage crop and, in addition, maintain sufficient foliage and roots to hold soil in place, is carefully studied prior to survey activities and checked during field survey operations. Upon this forage utilization factor, sometimes termed palatability rating or value index, depends the soundness of the determinations of carrying capacity and of the recommendations for improvement in range management.

5. *Forage-acre factors.*—On the basis of the field observations the examiner calculates a forage-acre factor for each type area mapped. This factor is a combination of the density and volume of forage cover and the degree to which the cover can be grazed. The range potentialities of a given area are expressed in forage acres,

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<sup>1</sup> Under agreement as outlined in *Instructions for Range Surveys*, Interagency Range Survey Committee, U. S. Department of Agriculture and U. S. Department of the Interior, Apr. 24, 1937.

<sup>2</sup> Forest Service, Grazing Service, Office of Indian Affairs, Soil Conservation Service, Agricultural Adjustment Administration.

a forage acre being the equivalent of a surface acre with 100 percent forage density and 100 percent palatability. To determine the number of forage acres, the forage-acre factor is multiplied by the number of surface acres.

6. *Forage-acre requirement.*—Of outstanding importance in developing range management plans are the number of forage acres normally used by various kinds of livestock on properly managed ranges, the establishment of proper use norms, and the determination of the forage-acre requirement base by means of which the forage-acre data are converted to terms of grazing capacity. Upon them depend the accuracy and the reliability of the carrying capacity estimates.

The forage-acre requirement is the number of forage acres required to carry one animal unit for a specified time period. It fluctuates, even in the same locality, primarily according to the efficiency of management practices, conditions of vegetation, rate of stocking, growth habits of principal forage species, precipitation, length of growing season and other climatic factors, and methods of making estimates. All of these factors have to be properly evaluated, not only individually, but as they are related to each other. Their proper evaluation requires the collection of accurate information covering each of these items.

7. *Topography and drainage.*—Where aerial or topographic maps are not available, topographic features are mapped in the course of the survey, especially where these features affect the accessibility of the range. Such things as impassable barriers and roughness of terrain have an important bearing on the suitability of range for various kinds of livestock, the proper frequency of stock-water developments, the system of grazing, and other features of livestock handling and range management.

8. *Culture.*—All culture, including buildings, fences, corrals, stock-water developments, roads, trails, and other features bearing on the use and management of the range, not already shown on base maps, are mapped in the field. Standard symbols for these features have been developed and correlated, insofar as possible, with the requirements of the Federal Board of Surveys and Maps.

9. *Character of watering places.*—The importance of livestock watering places in the development of range management plans is obvious. The many types of watering places include streams, lakes, springs, seepages, wells, and reservoirs. Each is studied from the standpoint of the quantity and dependability of the water supply for the period during which the surrounding range will be used, the condition of development, the need for improvement or maintenance, the distance to other water supplies, the character of adjacent terrain and accessibility of watering places to livestock,

and the relation of stock-water supplies to conservation of soil and surface moisture and control of run-off.

10. *Current livestock use.*—The kind and number of stock of various kinds on the range is ascertained.

11. *Range condition.*—The condition of the range and forage including the location of over-grazed or under-grazed ranges, and the defects in utilization or management responsible for conditions, are observed and noted.

12. *Seasonal use.*—The present date when stock enter or reach each portion of the range is ascertained. The limits of practicability of seasonal use, as conditioned by vegetative readiness, availability of water, and other related factors are estimated.

13. *Distribution of stock.*—The relationship of the distribution of livestock in various portions of the range unit to the availability and distribution of forage is observed.

14. *Handling of stock.*—The manner in which stock is being handled, including herding of cattle and sheep, bedding of sheep, condition of bedgrounds, excessive trailing, methods of salting, and other phases of stock handling which have a detrimental effect on the maintenance and development of the vegetative cover, is ascertained.

15. *Rodent damage.*—The location and kind of rodent damage, and the casual factors are ascertained.

16. *Poisonous plants.*—The species, abundance, and location of poisonous plants are ascertained, and the extent of losses and the possibilities of avoiding future loss are estimated.

17. *Insect pests.*—Damage by grasshoppers, crickets, and other insect pests is noted.

18. *Game.*—Indications of game are observed and factors meriting further study on the part of a biologist are noted.

19. *Predatory animals.*—Important species of predatory animals, their approximate ranges, and their depredations are observed, and the need for further study on the part of a biologist noted.

20. *Effect of grazing on soil and timber.*—The effect of range use on other resources, including soil and timber is ascertained.

21. *Areas needing special measures.*—The presence of areas needing reseeding, deferred grazing, exclusion of livestock, and other range management and special mechanical control measures to assure range recovery, is noted.

## Procedure

The procedures followed in the range surveys are described in Instructions for Range Surveys, formulated at the Western Range Survey Conference, April 24, 1937. Minor deviations from these instructions are

made only to meet special conditions that require particular treatment. The sequence in operations consists of eight steps.

1. *Preparation of base map.*—In order to map vegetative types, a base map is required. In some instances it has been necessary to construct this map in the field as the work progresses. In the majority of instances, however, topographic maps prepared by the Geological Survey are available, and if possible, aerial maps, on a scale of either 1 inch or 2 inches to the mile, are secured in advance of field survey operations. When the latter are used, preliminary accentuation of drainages and other outstanding topographic and cultural features materially aid the field surveys.

2. *Mapping vegetative type.*—Vegetative type areas are outlined on the map. They are distinguished from one another by differences in density and composition. Ordinarily, the distinctions in vegetative types are reflected in the degree and kind of erosion and correspond closely to erosional type delineations. When the plant density varies by one-tenth or more of the total surface, or where the relative abundance of given species in the composition definitely changes, a new type is designated. Except on most intensive surveys, areas smaller in size than 20 acres are rarely shown as separate types. The standard requirement is that all portions of the range area shall be examined in sufficient intensity that no important forage producing area shall be overlooked.

3. *Preparation of type description sheet.*—A type description sheet is prepared for each type delineated on the map, although a given type which recurs in several places will not require separate description, appropriate reference being made on the map to the applicable serial number of the type description.

4. *Compilation of forage acre factors in the field.*

5. *Determining forage acre requirement.*

6. *Compilation of carrying capacity estimates, by types, legal subdivisions, management units, and ranch ownerships.*

7. *Preparation of final maps.*

8. *Incorporation of range survey material into the management plan for the area.*

### Form of Results

The data obtained in range surveys are most commonly used in setting up range management plans. Two types of maps are usually made in connection with range surveys: (1) A forage type map, which shows the location and extent of forage types, the surface acreages of each type, and the surface acreage of each type in terms of animal-month units, and (2) a management map showing in detail the features that pertain to range management on the area, including the location of all watering places; salt grounds, both existing and proposed; recommended range units, together with numbers and kinds of livestock that will be assigned to each; length of time grazing should be permitted on each grazing unit; location of stock driveways; areas of poisonous plants and rodent infestation, and areas requiring reseeding or special treatment measures for rehabilitating the vegetative cover and facilitating control of erosion.

These maps usually constitute a part of the written management plan for the area, which outlines in detail the existing conditions of the forage resources, its current management, and the measures necessary to control erosion, establish and maintain desirable forage species, and provide the greatest possible stability of the livestock industry. These maps are not usually published, nor is the management plan. In some instances range survey reports have been mimeographed.<sup>3</sup>

<sup>3</sup> See "An Inventory of the Range Resources in Petroleum County, Mont., with an Analysis of the Range Problems and Recommendations for their Solution," the Cooperative Western Range Survey, Washington, D. C., July 21, 1938.

DEPARTMENT OF THE INTERIOR  
GRAZING SERVICE  
GRAZING DISTRICTS UNDER TAYLOR GRAZING ACT

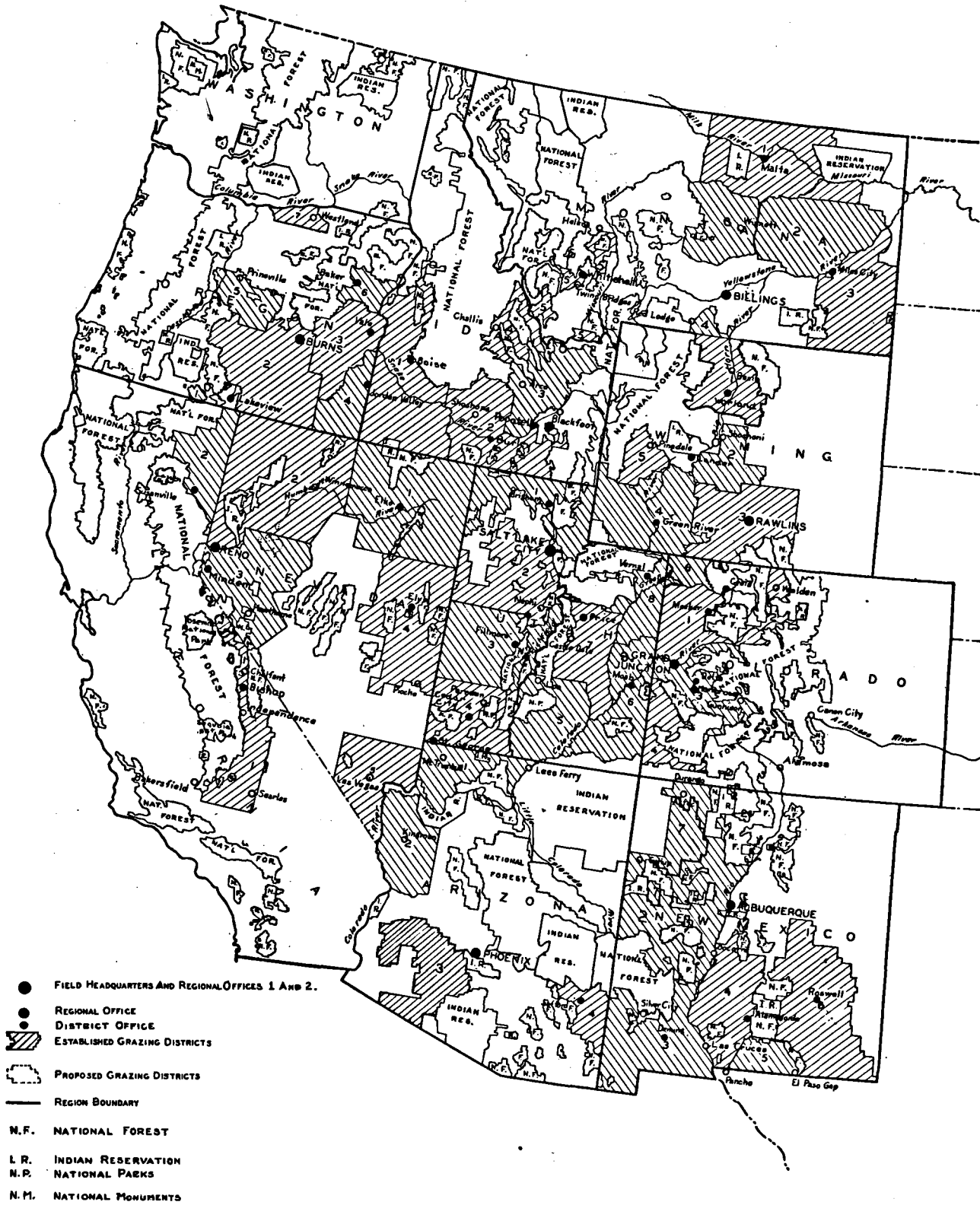


FIGURE 28.—Grazing Districts Established Under the Taylor Grazing Act

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## CHAPTER XVI. RANGE LAND CLASSIFICATION OF THE GRAZING SERVICE

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### Origin of Functions

The earliest concise expression of principles of range-land classification in the Department of the Interior is contained in the report, "Report on the Lands of the Arid Region of the United States," which was written in 1878 by John Wesley Powell, in charge of the United States Geographical and Geological Survey of the Rocky Mountain Region. In that report, Major Powell suggested a system of public land administration based on a general classification of the arid region in the United States. This classification recognized four classes: Mineral land, coal land, timber land, and pasturage land. Major Powell further suggested that a general law be enacted to provide for the organization of pasturage districts in which the residents should have the right to make their own regulations for the division of the land, the use of water for irrigation and for watering of stock, and the pasturage of land in common or in severalty. His proposed grazing law provided that no one person should be entitled to more than 2,560 acres of land in one continuous body or in two parcels, one for irrigation not to exceed 20 acres, the other for pasturage purposes. This proposal and subsequent plans to authorize regulation by the Federal Government of grazing on the public domain were before Congress for a period of more than 50 years before a general grazing law was enacted.

As the western States developed under the existing public land laws, the need for Federal control and management of the public range became urgent. The range land became overstocked, the natural highly palatable forage species were reduced or entirely eliminated, and competition for range privileges not infrequently caused bitter and even fatal controversies. Public sentiment in favor of planned and supervised use of range land was expressed in the form of petitions from various localities, advocating the establishment of grazing reserves or districts. The first such district to be established in the public land States was the Mizpah Pumpkin Creek Grazing District in Montana, embracing an area of 180,000 acres of Federal, State, railroad, and some private land. This district was established pursuant to an act of Congress approved March 29, 1928 (45 Stat. 380), which was a special law providing for the Federal regulation of grazing through a cooperative grazing association known as the Mizpah Pumpkin Creek Grazing Association. The act authorizes the leasing of public land to stockmen owning land within or adjacent to the area for grazing

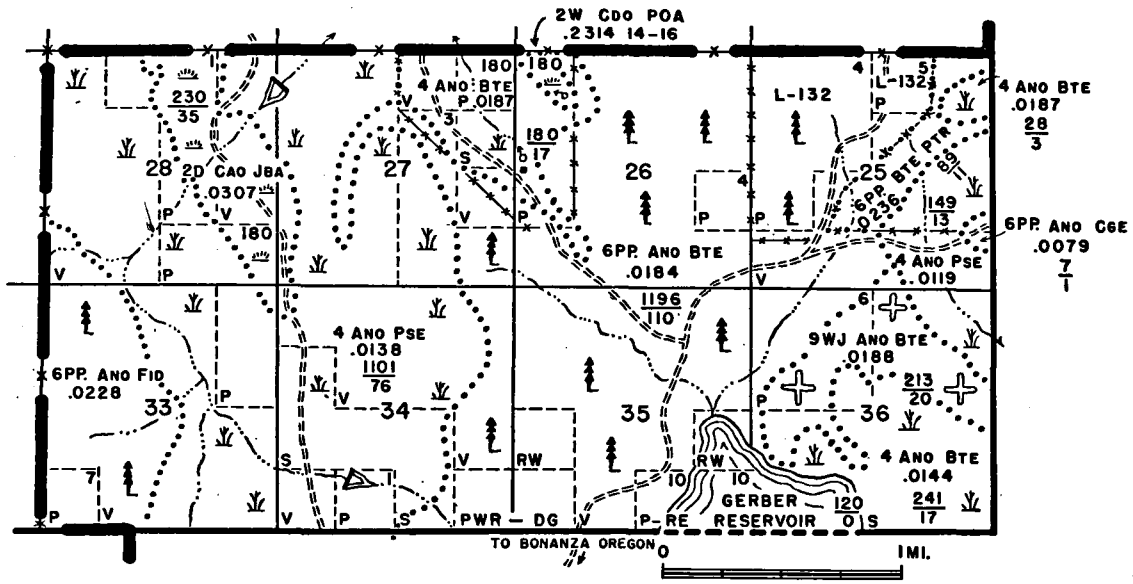
and range development purposes under such rules and regulations as may be prescribed by the Secretary for the purpose of protecting the range.

Under the act of March 4, 1931 (46 Stat. 1530), 500,000 acres of public land in the Owens River Valley and Mono Lake Basin in eastern California were reserved for the protection of the watershed supplying water to the city of Los Angeles and other cities and towns in the State of California. This law contains a proviso under which occupation of the reserved land for grazing purposes is specially authorized, subject to such rules and regulations as the Secretary of the Interior may deem necessary to conserve the natural forage resources of the area. The land was classified under the direction of the Geological Survey for its forage and watershed resources, and permits to use the range were issued by the Division of Investigations.

Concurrently with the activities of the Department of the Interior, the Department of Agriculture, through its experiment stations and, since 1905, through its administration of national forests, developed principles of range management. Methods were devised for determining the amount of feed that would be available in a given range unit and the amount thereof that could be harvested with a reasonable assurance of gradual restoration of the range to maximum economic use. On the basis of these determinations the number of livestock that should be permitted on the range could be stated. The application of the results of these studies has demonstrated to western livestock interests the almost incalculable benefits of regulation of the range land. Bitter opposition from the stockmen during the early stages of this regulatory procedure today has been displaced by active cooperation because the stockmen have found that their profits from a smaller number of properly nourished stock far exceed the profits from a larger number of underfed stock.

The enlarged homestead law of 1909, commonly known as the Dry-farm Homestead Act, required a specific type of classification in the western range country. Primarily, this classification was made for the purpose of limiting entries to nonirrigable semiarid land which could be successfully cropped only once in 2 years, the land being left fallow 1 year and the rainfall conserved for use during the following year. It was the theory of the Congress when that law was enacted that where 2 years' rainfall was required to produce one crop, the size of the homestead unit should be doubled and made 320 acres. Later a new element of classi-





- MAP SYMBOLS**
- GRAZING DISTRICT BOUNDARY
  - DRY WATER COURSE
  - EARTHEN TANK (RESERVOIR)
  - UNIMPROVED ROAD
  - SPRING
  - FENCE
  - GRAZING TYPE LINE
  - HOUSE

- PLANT SYMBOLS**
- GRASSES
    - PSE POA SECUNDA
    - FID FESTUCA IDAHOENSIS
    - BTE BROMUS TECTORUM
    - POA POA SPP.
  - SANDBERG BLUEGRASS
  - IDAHO FESCUE
  - DOWNY CHESS
  - MIXED BLUEGRASS
  - GRASSLIKE PLANTS
    - CDO CAREX DOUGLASII
    - JBA JUNCUS BALTICUS
    - CGE CAREX GEOPHILA
  - DOUGLAS SEDGE
  - WIRE RUSH
  - DRYLAND SEDGE
  - BROWSE
    - ANO ARTEMISIA NOVA
    - PTR PURSHIA TRIDENTATA
  - BLACK SAGE
  - BITTERBRUSH

- TYPE DESIGNATIONS SYMBOL**
- NOS. 2 MEADOW W-WET, D-DRY
  - 4 SAGEBRUSH TYPE (ARTEMISIA SP.)
  - 6 PINE TYPE (PINUS PONDEROSA)
  - 9 WOODLAND TYPE (JUNIPERUS OCCIDENTALIS)

**CARRYING CAPACITY DATA**  
FOR EACH TYPE AND PLACED UNDER DESIGNATION:

FORAGE FACTOR	ACRES FED. RANGE	FORAGE REQUIREMENT	CARRYING CAPACITY
.0138	X 1101	÷ .2	= 76
.0228	X 293	÷ .2	= 33
.0184	X 1196	÷ .2	= 100
ETC.	ETC.	ETC.	ETC.

- LAND STATUS (SYMBOL IN LOWER, LEFT CORNER OF TRACT)**
- FEDERAL RANGE V
  - PATENTED LAND P
  - STATE LAND S
  - PUBLIC WATER RESERVE PWR
  - RECLAMATION WITHDRAWAL RW
  - RECLAMATION EASEMENT ON PRIVATE PROPERTY RE

	PRIVATE, STATE & APPROPRIATED ACRES	FEDERAL RANGE	CARRYING CAPACITY IN AUMS
SEC. 25	240	400	40
SEC. 26	160	480	44
SEC. 27	240	400	31
SEC. 28	240	400	34
SEC. 33	120	520	50
SEC. 34	240	400	32
SEC. 35	160	480	44
SEC. 36	640	---	---
TOTALS	2040	3080	275 AUMS

- LAND TENURE (NO. IN UPPER, RIGHT CORNER OF TRACT)**
- | LAND INDEX NO. | OWNER AND LESSEE (L)      |
|----------------|---------------------------|
| 1              | U.S. NATIONAL CORPORATION |
| 3              | TAYLOR, ANDREW            |
| 4              | HILIUS, EMMANUEL V. L-132 |
| 5              | PRAIN, JOHN G. L-132      |
| 6              | HANSON, PETER             |
| 7              | WALKER & HOVEY            |
| 10             | DEVAUL, WILLIAM           |
| 132            | GERBER, HENRY             |
| 180            | HOLBROOK, G. L.           |

FIGURE 29.—Land-Use Map (in part)—Oregon Grazing District No. 1. Part of Township 38 S. Range 13 E., Wm. Base Tracing With Grazing, Status and Land Tenure Overlays

fication was introduced into this law by permitting nonresident entries in certain States. Such entries were permitted on land where a domestic water supply could not be developed at a reasonable cost.

The stock-raising homestead law of December 29, 1916 (39 Stat. 862), increased the size of the homestead unit to 640 acres of land classified by the Secretary of the Interior as nontimbered, nonirrigable land, chiefly valuable for grazing and raising forage crops, and of such a character that 640 acres were reasonably required for the support of a family.

The classification of land required under these acts was begun by the Geological Survey and continued as a function of that bureau until after the passage of the Taylor Grazing Act of June 28, 1934 (48 Stat. 1269).

### Establishment of the Grazing Service

The Taylor Grazing Act of June 28, 1934 (48 Stat. 1269), authorizes the inclusion in grazing districts of vacant, unappropriated, and unreserved land of the United States which in the opinion of the Secretary of the Interior is chiefly valuable for grazing and for raising forage crops. The law requires that provision be made for the protection, administration, regulation, and improvement of such grazing districts. It authorizes a study of erosion and flood control in the grazing districts. It also authorizes examination and classification of land to determine which is more suitable for agricultural crops than for native grasses and forage plants. In order to fulfill the purposes of this act, the Division of Grazing was established by the Secretary of the Interior July 17, 1934. The name was changed to the Grazing Service by order of the Secretary dated August 26, 1939.

### Type of Work

The land-classification program of the Grazing Service is divided into two main categories: Advisory technical classifications and grazing district surveys. The first category involves classifications as to surface utility of land. This classification is used for administrative action in the Department of the Interior on various applications under the public land laws that require a determination of the surface utility of land. Extraordinary care is required in this classification work to prevent improvident homestead entries, to forestall ill-advised efforts to cultivate land which has no permanent value for farming purposes, and to promote a sound national policy of conservation of natural resources.

A special type of work is required where grazing-district land must be used to satisfy outstanding land grants to States and educational institutions. It obviously would be contrary to the public interest to permit selection of land to satisfy such grants at key points in

a grazing district where the administrative program for the district would be disrupted. Likewise, the grant must be given equitable consideration. Usually the determination of the areas to be selected in satisfaction of the grant is a matter for negotiation.

Grazing-district surveys involve an inventory of all land resources in a district, a report of how the grazing resources have been handled, and a determination of a program of integrated use of the public range to obtain maximum benefits therefrom.<sup>1</sup>

The grazing-district examination also includes a determination of the available range facilities such as water, fences, corrals, dipping vats, and emergency storage of supplemental feed supplies, with indications as to whether or not these facilities are publicly or privately owned. For areas where lack of range facilities prevents full use of natural feed supplies, the classification includes a determination of the number and kind of range facilities which should be developed to permit proper use. As a result of such classifications, stock-watering reservoirs are developed by the Grazing Service.

The Federal range in general is used in connection with privately owned ranches and farms of the livestock operators. A classification of the properties in private ownership to determine their production of feed for livestock and the present and former use of these ranches in connection with the Federal range is required in order to adjudicate preference rights granted under the Taylor Grazing Act.

### Methods Employed

The established grazing districts have a gross area of 257,000,000 acres, of which 134,000,000 acres are Federal range, extending throughout the greater part of 10 western States (fig. 28). Within this vast region are grazing areas on national forest and Indian lands which have been classified by the agencies having supervision of such land. In addition, the Soil Conservation Service, the Farm Security Administration, and the Agricultural Adjustment Administration have made range examinations of extensive privately owned land in the same area. A considerable area also has been classified by the Geological Survey. The work of these agencies is examined and utilized where adaptable to the problems involved in the administration of the Taylor Grazing Act.

The methods of classification used by the Grazing Service in general follow the procedure adopted by cooperative agreement with the Forest Service, Grazing Service, Office of Indian Affairs, Soil Conservation Service, and Agricultural Adjustment Administration, outlined in Chapter XV, "Range Survey Procedure."

<sup>1</sup> See Range Survey Procedure, Chapter XV.

### Form of Results and Résumé of Accomplishment

A total of 54 grazing districts has been established in the 10 western States of Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, and Wyoming, embracing 16,199 townships and parts of townships which require examination. Maps, upon which data are compiled, are prepared on a scale of 1 inch to 1 mile, on sheets containing 32 townships. For each map there are various tracings showing the material here listed:

1. Base Tracing: Topography and culture;
2. Grazing Overlay: Grazing types, carrying-capacity data, range facilities, and management data;
  - 2a. Soils Overlay: Data on soils, surface gradients, and erosion;
3. Land Status Overlay: The control of land in grazing districts as established by law and proclamation;
  - 3a. Land Tenure and Use Overlay: Status information and land tenure. Ownership and leases of the land which has passed to State, county, corporate, and private ownership.

Range-survey reports of June 30, 1940, from the various regions show that—

- 590 base maps are required.
- 465 base tracings have been prepared, about  $\frac{1}{2}$  showing topography and culture by Grazing Service range surveys.
- 142 Grazing overlays are now available. Field work has been done which will allow preparation of another fifty sheets.
- 266 status overlays have been prepared and are in use. Status plats, an office record on 2 inches equal 1 mile scale, have been prepared of the 16,199 required townships.

The detailed land-classification work summarized is as follows:

	<i>Acres</i>	<i>Acres</i>
To be examined (gross area grazing districts).....		257, 000, 000
Survey by the Grazing Service .....	86, 000, 000	
Cooperative surveys (Division of Grazing and other agencies—State and Federal).....	7, 000, 000	
Surveys by other agencies used by the Grazing Service.....	10, 000, 000	
To be examined.....	154, 000, 000	
	257, 000, 000	

The program of detailed land classification is roughly one-fourth completed.

The range surveys of private properties which claim privileges on the Federal range are of two kinds: Properties consisting of water (and land) in Arizona

and New Mexico, and properties which are land (and water) in the more northerly States. All the water properties have been examined by the preliminary survey and are being checked in a review of properties and range carrying capacities, now in progress. This work involves 20,000 land (and water) properties, approximately half of which have been examined and reported on, in part, by detailed reports. The constant change of property ownership and change in requirements of examination will require revised or new reports in a large percentage of these cases.

An illustration of a detailed range survey is shown as figure 29, with an appropriate interpretation of symbols. This was a cooperative survey made by the Soil Conservation Service and the Grazing Service. Land classification of similar but less detailed nature, obtained by the Geological Survey, has been published for certain areas in a series of maps and explanatory text as follows:

- Central Great Plains in 5 sheets for western Kansas and Nebraska, southeastern Wyoming, and eastern Colorado;
- Northern Great Plains in 8 sheets for western North Dakota, northwestern South Dakota, the plains area of Montana, and northeastern Wyoming;
- Utah in 1 sheet;
- Western Colorado in 2 sheets;
- Western Wyoming in 2 sheets

### Personnel

All the supervising personnel are civil service employees who have had technical training in range subjects and considerable in-service training in their respective lines. Range surveys personnel in the regions are largely range examiners, Civilian Conservation Corps, who are specially qualified appointees with proper educational background and experience in range matters. Recent appointments have been made from graduates of range-survey courses and with civil service ratings as junior range examiners.

Personnel for the temporary crews who make up range-survey parties are usually chosen from graduates and students of range-management courses who are seeking training in actual field examinations.

The various drafting offices are now manned by 150 picked enrollees from Civilian Conservation Corps camps who are given training and experience in drafting and photographic reproduction of maps and charts. .

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## CHAPTER XVII. LAND CLASSIFICATION WORK IN MICHIGAN

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### Section 1. Land Economic Survey

#### Origin of Functions

With the passing of pine lumbering in northern Michigan in the early 1900's, a period of some 20 years of effort toward agricultural utilization of the land ensued. At the end of this period several land problems were coming into evidence. Agriculture had occupied certain areas successfully, but in general the rate of expansion seemed to be slowing down; in certain areas agriculture had failed; in many cases methods and agencies of agricultural promotion and colonization were subject to severe criticism; the bulk of the area remained idle and unused so far as agriculture was concerned; forest fires ran unchecked, and the forest was not returning; and liabilities were accumulating rapidly and the more prosperous sections of the State were being called upon to supply increasing subsidies to the northern sections.

During this period there had been a generally increasing interest and study of the northern land problems. A legislative committee had reported in 1908 on forestry, tax delinquency, and allied problems. As a result a Public Domain Commission had been established in 1909 whose duties were: (1) to administer the rapidly growing tax delinquent public domain, (2) to establish forest reserves, and (3) to attack the fire problem. In 1919-20 the Bureau of Agricultural Economics carried out investigations as to colonization methods. Academic groups in the State educational institutions became interested in the northern land problems. In 1917 an act was passed by the legislature authorizing a land and economic survey of the north country but no action was taken under this authorization because of the World War.

#### Establishment of Activity

In 1919 and 1920 much discussion of the northern land problems was carried on at the meetings of the Michigan Academy of Science. From these discussions certain definite conclusions were reached. These were:

(1) That the land-use situation in the north was becoming increasingly serious, and that the problems would have to be tackled constructively and promptly;

(2) That differences in opinion as to the land and its problems which existed among the best-informed individuals and groups to date had prevented the development of a constructive land policy;

(3) That a constructive policy could only be established on the basis of scientific land inventory which would discover the physical characteristics of the land, the history of its use, the

prevailing economic conditions, and such other data as might be pertinent.

As a result of these deliberations and the backgrounds of interest which had been developing in the State for a decade or more, arrangements were made between the University, the State Agricultural College, the State Department of Agriculture, and the State Department of Conservation (then just established) to undertake an experimental land inventory of a single county in the north.

This experimental survey, applied in Charlevoix County, was completed in the summer of 1922. Results were promising. The next year the work was taken over by the State Department of Conservation of which the Land Economic Survey, as it was named, became a division with regular legislative appropriations to support it.

#### Objectives

From the start as an official agency, the Survey was definitely fact-finding in nature. It specifically refused to undertake land classification defined as a determination of land-use recommendations for definite areas. Three major forms of land use of importance in the north were recognized. These were agriculture, forestry, and recreation. Effort was centered upon searching out and presenting factual data pertinent to the understanding of problems relating to these land uses. It was assumed that such data would be utilized by the appropriate action agencies in the development of policies, plans, and programs.<sup>1</sup>

#### Type of Work

The largest part of the work involved a systematic inventory of land features.<sup>2</sup> This may be outlined briefly as:

- (1) Standard Soil Survey (U. S. Bureau of Chemistry and Soils, cooperating);
- (2) Lay-of-the-land Survey, showing five slope categories;
- (3) Base Map, showing standard base data;
- (4) Cover Map, showing:
  - (a) Natural cover associations; for forested lands; the density and stocking of stands.
  - (b) Open cover types.
  - (c) Cleared farm lands, showing crop lands and pastures.
  - (d) Abandoned farm lands.
- (5) Lake Maps.

<sup>1</sup> Lovejoy, P. S., "Theory and Practice in Land Classification," *The Journal of Land and Public Utility Economics*, Vol. 1, No. 2, April 1925, pp. 160-175.

<sup>2</sup> Barnes, Carleton P., "Land Resources Inventory in Michigan," *Economic Geography*, Vol. 5, No. 1, January 1929, pp. 22-35.

Coincident with, but separate from the physical inventory, a study was made of economic conditions. Under this head data were collected on:

- (1) Population distributions and changes;
- (2) Political organization and changes;
- (3) Assessed valuations and tax rates;
- (4) Tax delinquency;
- (5) Land ownership and intent in ownership;
- (6) Economic activities, trade and trade areas;
- (7) Miscellaneous data.

#### Technique

In northern Michigan, with the exception of a few mining areas in which topographic mapping had been done earlier, the General Land Office Survey maps formed the basis for survey operations. Based then upon the General Land Office maps, the Land Economic Survey necessarily constructed its own base maps. This necessitated road traverses, the location of section corners, and the laying out of control lines for the later soil and cover mapping. Soil and cover mapping were carried out on the general plan of running traverses through each section at intervals of one-half mile, with

such offsetting as might be required to bring accuracy within the standard practices of the United States Division of Soil Survey.<sup>3</sup> The lay-of-the-land and cover classification was carried out in similar degree of refinement.

The economic inventory was carried out with progressive improvement which grew out of experience in range and accuracy of procedure and constant experimentation. The personnel used was distinct from that employed in the land inventory. The economic inventory involved the following:

- (1) the use of census data, and other official statistics;
- (2) the analysis of data on ownership, assessed valuation, tax rates, tax delinquency, etc., from county courthouse records;
- (3) consultation with township supervisors, bankers, business operators and others concerning intent in ownership, economic activities, etc.;
- (4) analysis of shipping data from railroads and other transportation agencies; and
- (5) interviews with farmers, business men, recreational facility operators and the like, with respect to trade areas, economic activities, etc.

#### Form of Results

The areas covered by the Survey between 1922 and 1933 consist of five counties in the Upper Peninsula and ten counties in the northern part of the Lower Peninsula (fig. 30). Several county soil and cover maps were published; all others are available in blueprint form. On the backs of the published soil and cover maps are printed summaries of physical and economic data, with maps of generalized physical and economic divisions, and general conclusions. In the case of each county covered, comprehensive soil and economic reports were prepared, but only summaries of these appear on the maps. In addition, in most counties, special maps and reports were prepared on geology, and water resources. These studies and reports were by specialists in these fields, working in conjunction with, but independent of, the regular survey parties.<sup>4</sup>

#### Personnel

The permanent staff of the Land Economic Survey was composed of a

<sup>3</sup> It should be noted that the cooperation of this Federal agency necessitated a degree of detail which might not otherwise have been required in many areas.

<sup>4</sup> For reference to reports, maps, etc., of the Land Economic Survey, consult *Biennial Report, Michigan State Department of Conservation, 1937-38, Lansing, Mich.*

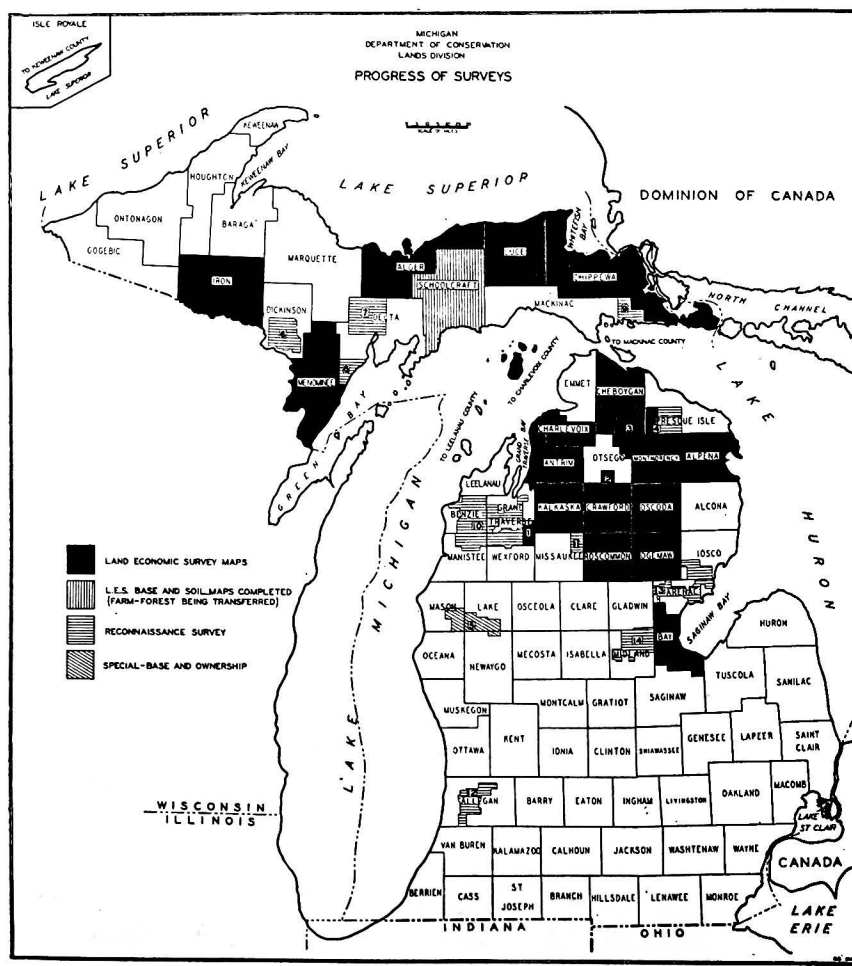


FIGURE 30.—Areal Coverage of Land Classification Maps in Michigan, July 1939

small group including thoroughly trained soil men, foresters, and economists. The field personnel other than that furnished by the United States Bureau of Chemistry and Soils was made up of the few regular staff members, plus a large proportion of students drawn from the soil, forestry, geography, and other departments of the college, university, and other institutions. Generally such students worked from two to three summer seasons, some going on into permanent positions with the Survey.

#### Significance of Survey

Throughout the history of the Land Economic Survey the principle was strictly adhered to that the agency was purely fact-finding; that no recommendations as to land classification for use were to be made; that the data were merely to be made available to all who might wish to use them.

In actual practice the survey work carried out county by county was scheduled, in large degree, to those counties in which official and private agencies or groups indicated interest in having the work done. In such cases, on completion of the work, meetings with interested groups were held, the data were explained, and the potential utilities discussed. No doubt such procedure did much for the education of local people and groups, but the direct effects are difficult to determine. Reports on techniques and findings were made at meetings such as those of the Michigan Academy of Science, and several such were published.<sup>5</sup> There is no doubt that this survey, directly and indirectly, has had much influence on the development of understanding the northern land problems in the State, and in the conditioning of public sentiment to the various control and adjustment problems that have been brought about.

At the time of the initiation of the Survey, the State public domain, derived mostly through the processes of tax delinquency, approximated 400,000 acres. Since that time and the official demise of the Survey in 1933, this public property has increased to some 2,500,000 acres. At present (1939) the immediately potential acreage approximates 5,000,000.<sup>6</sup>

During the period, 1922 to 1939, the functions and responsibilities of the Department of Conservation, both in relation to the public domain and the north country in general, have increased very greatly. The data of the Land Economic Survey have been used increasingly, in connection with the establishment of State forests and other State units, in the determination of acquisition policies, both by purchase and in trading opera-

tions with the U. S. Forest Service and with private parties. The Land Economic Survey data have been valuable in connection with various Federal agencies, such as the Forest Service, National Park Service, Resettlement Administration, Farm Security Administration, and Bureau of Biological Survey, both in providing fundamental factual data of value in the promotion of various projects, and in relation to the marshaling of data which have prevented several dubious proposals from being attempted.

The experience of the Land Economic Survey and the procedures which have been continued under the various divisions since the official ending of the Survey in 1933, have been utilized increasingly in relation to numerous administrative problems. The Game Division has continued its inventories, with numerous refinements; the Institute for Fisheries Research has taken over and improved upon the inventory of lakes and streams, and the results are used in stream improvement programs, fish planting practices, acquisition programs, etc. The data have been of value in connection with the rapidly rising interest in rural zoning, and the newer techniques which are developing in this and other connections stem back very directly to the Land Economic Survey experience.

## Section 2. Land Type Inventory and Classification

### Origin of Functions

In Michigan, as elsewhere during the past several years, there has been increasing interest in planning activities in relation to land use. The systematic work of the Land Economic Survey has been very useful in connection with such work, as, for example, in proposals for rural zoning. According to Michigan law, county zoning ordinances must be approved by the State Planning Board, and the Land Committee of this board has felt that the land use designations of such ordinances, however simple they might be, should be based upon reasonably complete and adequate inventory data. Unfortunately in several counties where interest in rural zoning has crystallized into action, no systematic inventory has been done. Neither time nor money have been available for systematic work such as the standard soil survey or the more complete Land Economic Survey procedure. As an outgrowth of this situation, much interest and study has centered about methods of quicker and less expensive inventory and land classification, reasonably applicable to this problem.

### Establishment of Activity

For many years experimental work has been under way at the Michigan State College of Agriculture and Applied Science in methodology and techniques of land

<sup>5</sup> Schoenmann, L. R., "Land Inventory for Rural Planning in Alger County, Michigan." *Michigan Papers in Geography*, Vol. 2, 1932, pp. 329-61.

<sup>6</sup> From 1933 to 1938 the depression caused tax moratoriums, prevented the normal tax delinquency procedure from operating, and the present great potential area is the result of the accumulation during this period.

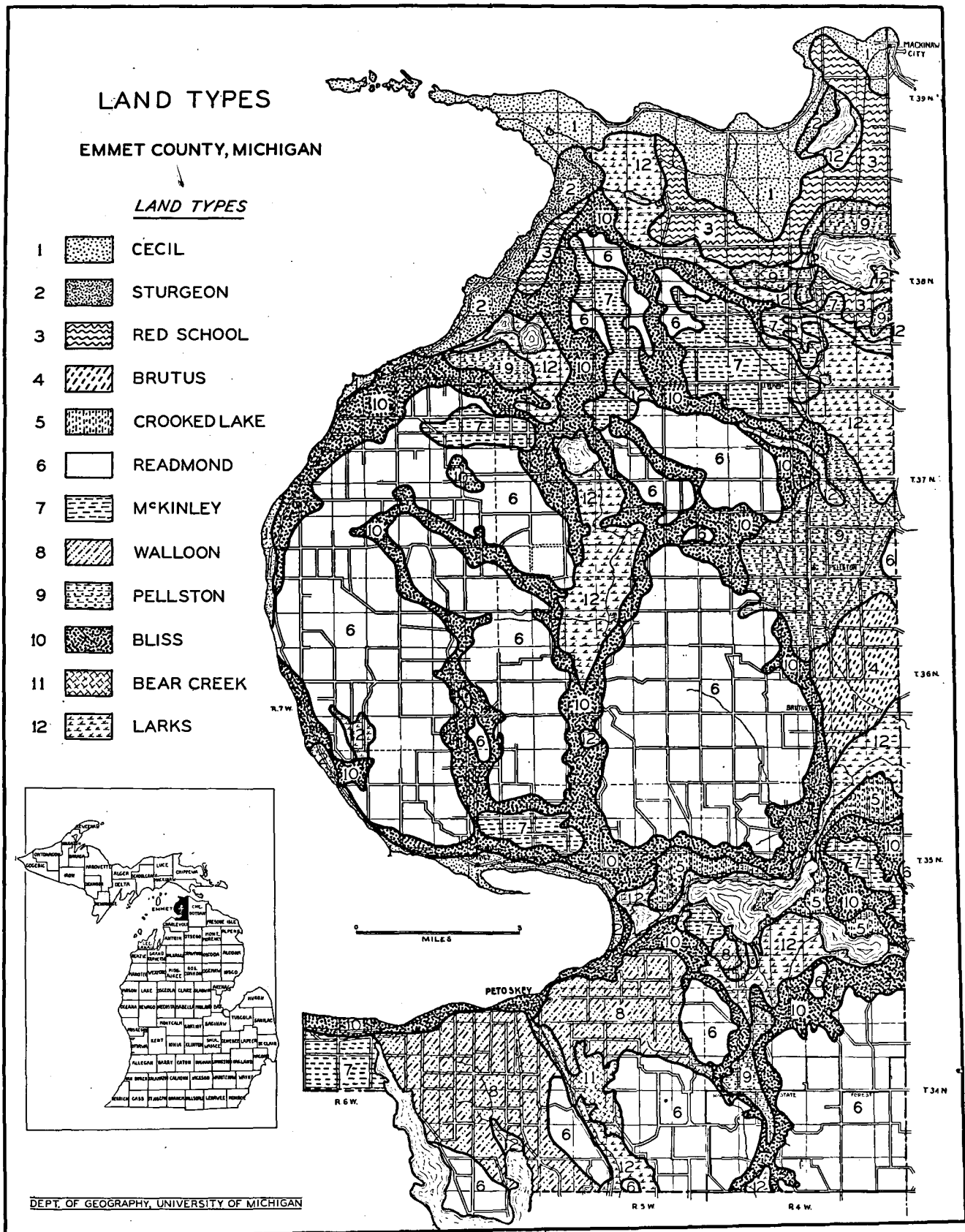


FIGURE 31.—Land Types in Emmet County, Michigan

LAND-TYPE LEGEND OF EMMET COUNTY  
FIGURE 31

1. *Cecil Bay*.—Vegetation, (Major) cedar, balsam, spruce, aspen, white pine, Norway pine, maple. (Minor) ash, elm, white birch, yellow birch, hemlock. Surface, successive beach ridges with occasional flat areas. Soil, (Major) Alpena loam, Eastport sand (Minor) Newton, Rife, Greenwood, Wallace, Saugatuck. Drainage, rapid and slow.

2. *Sturgeon*.—Vegetation, (Major) Norway pine, white pine, jack pine, oak, aspen (Minor) fire cherry, sugar plum, maple. Surface, dune topography with some fresh blows. Soil, (Major) Wallace (Minor) Bridgeman, Houghton, Grayling. Drainage, good, locally poor between the dunes.

3. *Red School*.—Vegetation, cedar, spruce, balsam, aspen, elm, ash, maple, white pine, hemlock. Surface, gently sloping toward the lake, surface broken occasionally by old sandy beach ridges. Soils, (Major) Ogemaw, Munuscong (Minor) Saugatuck, Newton, Rife.

4. *Brutus*.—Vegetation, (Major) maple, elm, aspen, ash, hemlock (Minor) cedar, spruce, balsam. Surface, level and gently rolling. Soils, (Major) Selkirk, Brimley, Ogemaw (Minor) Saugatuck, Newton, Rubicon. Drainage, slow to poor.

5. *Crooked Lake*.—Vegetation, cedar, spruce, tamarack, elm, ash, maple. Surface, level, gently sloping. Soil, (Major) Bergland (Minor) Saugatuck, Newton, Rife. Drainage, slow.

6. *Readmond*.—Vegetation, (Major) maple, beech, elm (Minor) aspen, hemlock. Surface, dissected, sandy morain, steep marginal slopes, gentler interior slopes, entire surface characteristically broken by a maze of "fossil" valleys. Soil, (Major) Emmet loamy sand (Minor) Emmet sandy loam, Onaway sandy loam, Kalkaska loamy sand. Drainage, rapid, few streams, few, if any, swamp areas, some seepage on slopes.

7. *McKinley*.—Vegetation, (Major) maple, beech, elm (Minor) basswood, aspen, yellow birch, cherry. Surface, Morainic surface with drumlin like appearance, ridges have a NW-SE trend, considerable local relief and steep slopes. Soil, (Major) Emmet sandy loam (Minor) Onaway sandy loam, Emmet loamy sand, Newton, Granby, Rife. Drainage, poor between many of the ridges.

8. *Walloon*.—Vegetation, (Major) maple, beech, elm, basswood, yellow birch (Minor) aspen, cherry. Surface, pronounced drumlin like topography with a NW-SE, steep marginal slopes. Soil, (Major) Onaway sandy loam (Minor) Onaway loam, Emmet sandy loam, Granby (Newton), Lupton (Rife). Drainage, poor in depressions.

9. *Pellston*.—Vegetation, (Major) aspen, fire cherry (Minor) residual pine and maple. Surface, practically level, occasionally broken by beach ridges. Soil, (Major) Rubicon sand (Minor) Kalkaska loamy sand, Saugatuck, Newton, Rife. Drainage, good, locally small areas where poor.

10. *Bliss*.—Vegetation, (Major) maple, beech, elm (Minor) cherry, hemlock, aspen, basswood, yellow birch, white birch. Surface, gently sloping, may be sharply broken at intervals where terraces develop. Soil, (Major) Kalkaska loamy sand (Minor) Rubicon, Saugatuck, Newton, Rife, Porcupine. Drainage, good, with local areas where poor.

11. *Bear Creek*.—Vegetation, aspen, elm, ash, maple, cedar, spruce, balsam. Surface, level to gently sloping with occasional sandy ridges. Soil, (Major) Antrim (loamy sand?) (Minor) Kalkaska loamy sand, Newton, Rife. Drainage, slow to poor.

12. *Larks*.—Vegetation, cedar, spruce, balsam, ash, elm, maple, alder, willow, aspen. Surface, flat. Soil, (Major) Rife, Newton, Saugatuck, (Minor) Granby, Houghton, Lupton, Greenwood. Drainage, poor.

inventory and classification.<sup>7</sup> The concept of the land type as a unit of inventory and classification has been developed as a basis for new field operations, and as a means of making the standard soil maps more intelligible and useful in relation to land-use planning. With the emergence of the county zoning and other problems, and with no other agency in a position to do the necessary work, the College and the Agricultural Experiment Station have undertaken the application of the land-type classification to these problems in Delta and Dickinson Counties. Further work is under way or planned in other counties where the need is pressing.

#### Objectives

The land-type concept, as at present applied to systematic inventory and classification, derives principally from the work of J. O. Veatch. It is essentially an effort to distinguish land units of an order larger and more complex than the soil type so as to provide:

- (1) a simpler and quicker method of field inventory;
- (2) a more readily intelligible and simpler presentation of soil data by grouping into units applicable to planning purposes natural associations of soils and their related physical characteristics; and
- (3) a rational physical basis for correlation with economic, social, and allied data.

In Dickinson County, the study was made definitely to aid in the development of a rural zoning program. This was also true of the work in Delta County.

#### Type of Work

The land type is a summation of the physical elements of surface, soil, and drainage, together with the natural vegetation related to these conditions, into natural units of classification. In each of these units the association of these physical characteristics is definitely unique. As applied in Michigan, such land types may vary in size from a few acres up to many square miles in extent. Thus, in a real extent, the land type is a logical next step in order of division above the soil type. (Figs. 31 and 32.)

Each land type normally embraces several soil types; in some cases a single soil type may occur as a component in several land types, but only if it is associated with other distinguishing features. From the land type of this magnitude, combinations may be made by grouping several closely related land types to form divisions of greater magnitude. The Emmet County map illustrates such a combination. (Fig. 31.) This concept is applicable to mapping in new areas. Similarly, after

<sup>7</sup> Veatch, J. O., *Agricultural Land Classification and Land Types of Michigan*; Agricultural Experiment Station, Michigan State College, SP. Bull. No. 231, 1933; "Classification of Land on a Geographic Basis," *Papers of the Michigan Academy of Science, Arts, and Letters*, Vol. XIX, 1933, pp. 359-365; "Graphic and Quantitative Comparisons of Land Types," *Journal of the American Society of Agronomy*, Vol. 27, No. 7, July, 1935, pp. 505-510; "The Idea of the Natural Land Type," *Proceedings, Soils Science Society of America*, Vol. 2, 1937, pp. 499-503.



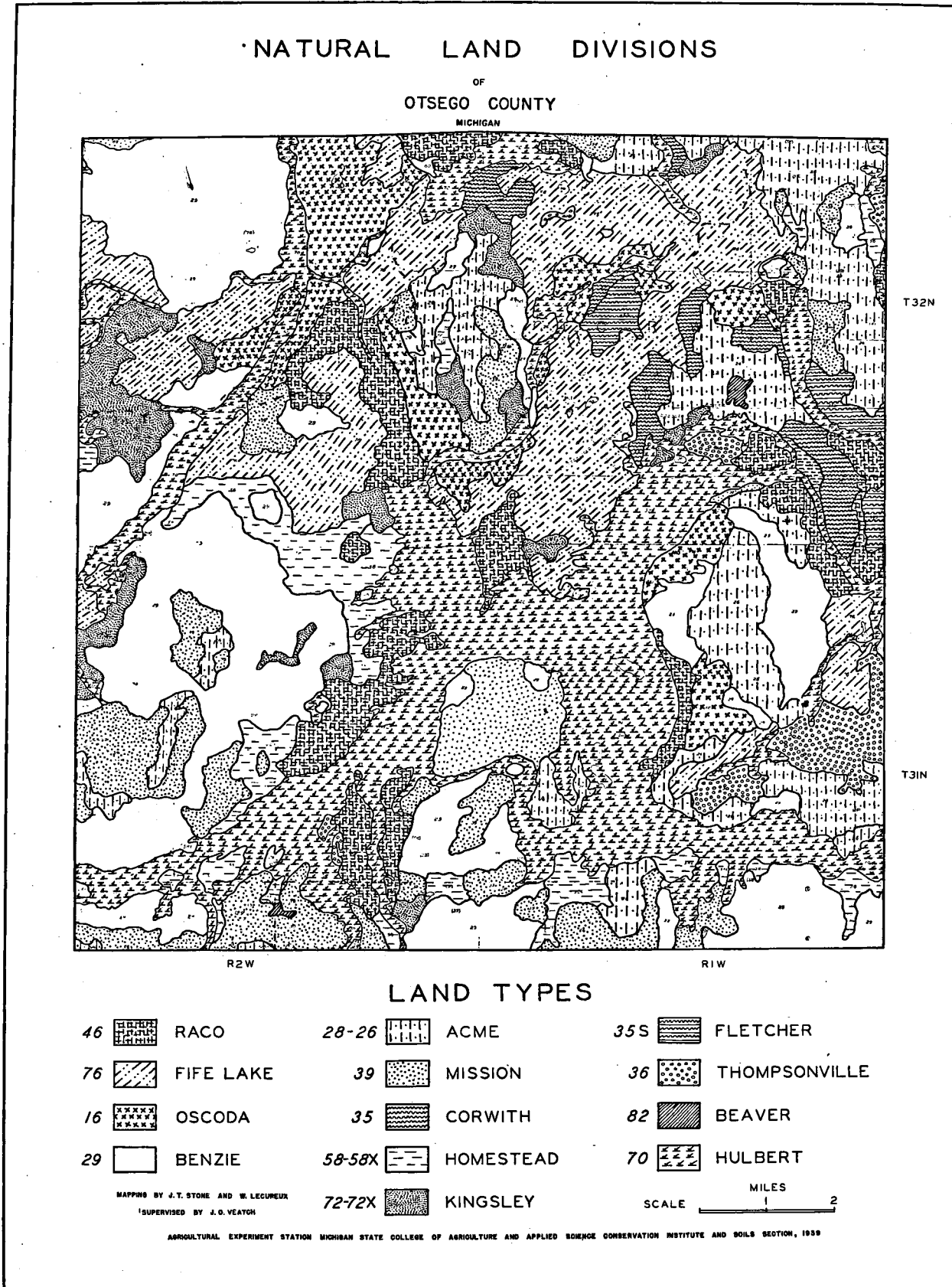


FIGURE 32.—Land Types in Otsego County, Michigan

## LAND-TYPE LEGEND OF OTSEGO COUNTY

## FIGURE 32

46. *Raco Land Type*.—Dry plains; Rubicon sand and Grayling sand dominant; includes Saugatuck sand, Newton sand, Rifle peat, and Greenwood peat. A slopes dominant; relief 10–20 feet. Pine land.

76. *Fife Lake Land Type*.—Pitted plains; Rubicon sand and Roselawn sand dominant; includes Greenwood peat, Rifle peat, Saugatuck sand, and Newton sand. A and B slopes characteristic with some C slopes; relief 20 to 50 feet. Pine land.

16. *Oscoda Land Type*.—Roselawn sand dominant; includes Roselawn sandy loam, Rubicon sand, and Rifle peat. Characterized by C, D, and E slopes and less than 25 per cent A slopes; relief 75 to 100 feet. Pine land.

29–18. *Benzie Land Type*.—Emmet loamy sand dominant; Hartwick loamy sand, Emmet sandy loam, Kalkaska loamy sand, Echo sand, Greenwood peat, and Rifle peat included. C, D, and E slopes characteristic. Less than 50 percent of A and B; relief 100 to 200 feet. Hardwood land.

28–26. *Acme Land Type*.—Nester loam, Emmet sandy loam dominant; Emmet loamy sand, Bergland loam, Rifle peat and Greenwood peat included. A and B slopes characteristic with some C; relief 20 to 50 feet. Hardwood land.

39. *Mission Land Type*.—Emmet sandy loam dominant; Emmet loamy sand, Nester loam, Onaway loam, Bergland loam, Echo sandy loam, Greenwood and Rifle peat included. C, D, and E slopes characteristic; A and B slopes included relief 100 to 200 feet. Hardwood land.

35. *Corwith Land Type*.—Roselawn sandy loam dominant; Roselawn sand, Rubicon sand, and Rifle peat included. C, D, and E slopes characteristic, some A and B; relief 100 to 150 feet. Pine land.

58–58X. *Homestead Land Type*.—Dry plains; Kalkaska loamy sand and Kalkaska loamy sand, gravelly phase, dominant; Saugatuck sand, Newton sand, Greenwood sand, and Rifle peat included. A slopes dominant; relief 10–20 feet. Hardwood land.

72–72X. *Kingsley Land Type*.—Kalkaska loamy sand, Emmet loamy sand, and gravelly phases of the same types dominant; Emmet sandy loam, Saugatuck sand, Newton sand, Rifle peat and Greenwood peat included. B slopes characteristic and greater in area than A; C slopes less than 25 per cent of area; relief 20 to 50 feet. Hardwood land.

358. *Fletcher Land Type*.—Roselawn sandy loam dominant; Roselawn loamy sand, Rubicon loamy sand, and Rifle peat included. A and B slopes characteristic; few C slopes; relief 20 to 50 feet. Pine land.

36. *Thompsonville Land Type*.—Low mixed wet and dry plains. Saugatuck sand dominant; Newton sand, Munuscong sandy loam, Rubicon sand, and Rifle peat included. Dominantly A slopes; relief 5 to 10 feet. Mixed hardwood and conifers.

82. *Beaver Land Type*.—Low wet clay plains. Bergland loam dominant; Nester loam, Munuscong sandy loam, Saugatuck sand, Newton sand, Greenwood peat, and Rifle peat. Dominantly A slopes, relief 5 to 10 feet. Mixed hardwoods and conifers.

70. *Hulbert Land Type*.—Timbered swamps, open bogs, and marshes. Rifle peat dominant; Greenwood peat, Carbondale muck, Newton sand, Saugatuck sand, and Bergland loam included. A slopes dominant; little or no relief. Spruce, cedar, tamarack, leatherleaf, and sedges dominant cover.

land types have been determined by field work, it is possible to recognize and delineate them from standard soil maps. In some cases distribution of land-use patterns, ownership patterns, and other economic data have been plotted and correlated with the land type maps with seemingly successful results. Experimental work done in Delta, Dickinson, and Emmet<sup>8</sup> Counties, areas not previously covered by any systematic inventory, and in several counties in which soil maps are available, indicate that the number of individual and distinct land types varies from approximately 15 to 25 within a county. It is possible to correlate many types over considerable distances with as high degree of accuracy as in the case of soil types.

## Technique

The first step in mapping land types is a reconnaissance of the area, and the tentative determination of land types to be mapped. Systematic type mapping of units then proceeds with no attempt to differentiate individual soil types within such units, or to determine similar details of other physical factors. In other words, the land types are recognized and the component factors synthesized in the field, and the unit mapped accordingly.

Work has been done where individual air photographs, scale 1:20,000, and township air mosaics, scale 1:31,680, were available and where neither were available. Best success at least cost has been achieved in use of the mosaics, with direct plotting of boundaries in the field. The scheme, however, has been used successfully in counties where no better base has been available than the inch-to-the-mile county road map; although, of course, there was less accuracy in definition of boundaries and location than where the mosaics or individual photographs were used.

In some counties rather complete plotting of land use, and economic and fiscal data has been carried on, and experimental work on designation of land-use classes and categories for planning purposes has been attempted.

## Form of Results

The complete work has been carried out in Emmet County, for which an illustrative land-type map is presented. Since the work to date has been experimental, and no agency has been designated to undertake such surveys systematically, only fragmental reports have been published.

## Personnel

The land-type work has been carried on to date directly by or under the immediate supervision of men,

<sup>8</sup> Stirling, M. C., "Land Types in Emmet County, Michigan," *Papers of Michigan Academy of Science*. Vol. XXIV, pt. 3, 1933, pp. 55–59.

not only well trained in soil mapping, but thoroughly familiar with the areas involved in terms of other physical factors, and land-use practices. Similarly, the economic studies and inventories have involved especially well-trained people. The recognition of the land types, and the determination of the whole classification requires much more than average competence in the general field of physical inventory. Since much generalization is made in the field, the mapper must be able to determine the individual soil types accurately, and must be prepared to recognize the various contributing evidences of surface features, drainage, vegetation, etc., which are used as criteria in a rapid survey of this nature. It appears to take considerably more experience and ability to make a land-type map than is required for ordinary soil mapping, in order that the accuracy and dependability of the work may be at an equal level. Land-type survey is a natural outgrowth of the years of experience in detailed inventory in Land

Economic Survey, and the experimental search for quicker and cheaper methods and techniques applicable to the land and land problems of northern Michigan.

#### Use of Materials

In Delta and Dickinson Counties the land-type mapping was done specifically to aid in the drawing up of zoning ordinances and has been used for that purpose. It should prove especially valuable in this connection in the readjustments in the zoning ordinances which obviously will need to be made in the future. There is much evidence that the results obtained by this method will be of great use to government agencies, such as the State Conservation Department, the Farm Security Administration, the Forest Service, and others involved with the problems of these areas. Such work may produce utilities comparable to those derived from the earlier Land Economic Survey.

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## CHAPTER XVIII. LAND CLASSIFICATION IN THE TENNESSEE VALLEY AUTHORITY

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### Origin of Functions

The Act of Congress of May 18, 1933, creating the Tennessee Valley Authority, gave it two broad responsibilities, namely, (1) carrying out a specified program for the control and development of the Tennessee River system, and (2) integrating this program with the welfare of the people of the Tennessee Valley (fig. 33).<sup>1</sup>

To carry out these responsibilities one of the Authority's first requirements was sound factual information concerning the land. What kinds of land would be flooded by proposed reservoir projects? Where must erosion-control measures be applied to protect proposed reservoirs from damage by siltation? What rural areas represented the better potential markets for electricity? Where and to what extent were lands not performing their water-holding function? Where were land resources depleted, and, looking toward their rehabilitation, to what uses could they best be put? Some of these questions could be answered only by highly detailed surveys, others by the rapid coverage of large areas in relatively brief intervals. Some questions could be answered only by directing the studies to one or, at most, a few elements in the land and land-use patterns. Other questions required an inventory and appraisal of composite conditions. As the program of studies developed, land-classification investigations fell into seven major categories: Topographic mapping, soil surveys, inventories of forest, mineral, and recreational resources, a classification of rural lands, and the integration of the studies of reservoir properties into action programs. Each line of investigation performed its distinct function in the total program of the Authority.

### Topographic Mapping

One of the Authority's immediate needs was topographic maps of the Tennessee Basin. Since major divergences from the river development plan prepared by United States Army Engineers were contemplated, even the excellent and detailed topographic maps of their Tennessee River Survey were not adequate.<sup>2</sup>

<sup>1</sup> *Annual Report of the Tennessee Valley Authority*, for fiscal year ended June 30 1939. 76th Congress, 3d Session, H. D. 534. 1940.

<sup>2</sup> In the Spring of 1933 standard U. S. Geological Survey maps, scale 1 inch equals 2 miles, were available for 46 thirty-minute quadrangles that lie wholly or in part within the Tennessee Valley. In addition, maps for 32 fifteen-minute quadrangles were available at a scale of 1 inch equals 1 mile, and some special maps at a scale of 1 inch equals 2,000 feet were available for the Smoky Mountain area. This left approximately 40 percent of the Valley with no topographic maps except the detailed maps of the Tennessee River survey which covered a narrow margin of land immediately adjoining the Tennessee River. All of the thirty-minute quadrangle maps were compiled from reconnaissance surveys made fifty or more years ago. For land-planning purposes, these maps were inadequate, except for the most generalized

The program of topographic mapping, carried on cooperatively by the Tennessee Valley Authority Department of Water Control Planning and the United States Geological Survey, was the first survey work to get under way. A long-term project, preliminary maps are available only for areas adjoining the main river channel and major tributaries and a number of quadrangles scattered through the Valley. The methods and standards were those under which the United States Geological Survey is now operating.<sup>3</sup> These topographic maps were and will continue to be of major significance to many elements in the Tennessee Valley Authority program, as well as adding to the national wealth of topographic information. Two byproducts of the topographic mapping program have had such a profound bearing on land classification by the Authority that they must be given special attention. These two byproducts are aerial mosaics and planimetric maps.

*Aerial mosaics.*—The compilation of aerial mosaics was a preliminary step in topographic mapping. The first, made from five-lens photographs, were available in September 1934. Complete sets for the whole Valley were available by July 1935. Because of distortion inherent in this rapid type of photography, these mosaics proved to be of limited value in the making of topographic maps<sup>4</sup> and thus single-lens mosaics were made, first for the reservoir and other critical areas, and later for other parts of the Valley.

In spite of distortion the multiple-lens mosaics were of inestimable value for land-classification work because they show ground detail. In the hands of technicians these alone provided a basis for dividing the land into major classes of forested areas and cleared areas, and some highly experienced technicians could carry their classifications into differentiations of forest cover and of other types of land use. But with adequate base maps nonexistent, the greater function of these mosaics was providing essential base materials for use in plotting observations in the field. The problems of distortion presented by multiple-lens mosaics were entirely eliminated in the reservoir areas where single-lens mosaics were used, and where the necessity for detailed work made the inaccuracies of the five-lens mosaics of real significance.

use. To July 1, 1939, new topographic surveys had been completed and published in 35 seven-and-one-half-minute quadrangles at a scale of 1 inch equals 2,000 feet. Other quadrangles are being completed and published at an estimated rate of 50 quadrangles per year.

<sup>3</sup> See ch. VIII.

<sup>4</sup> See ch. VI.

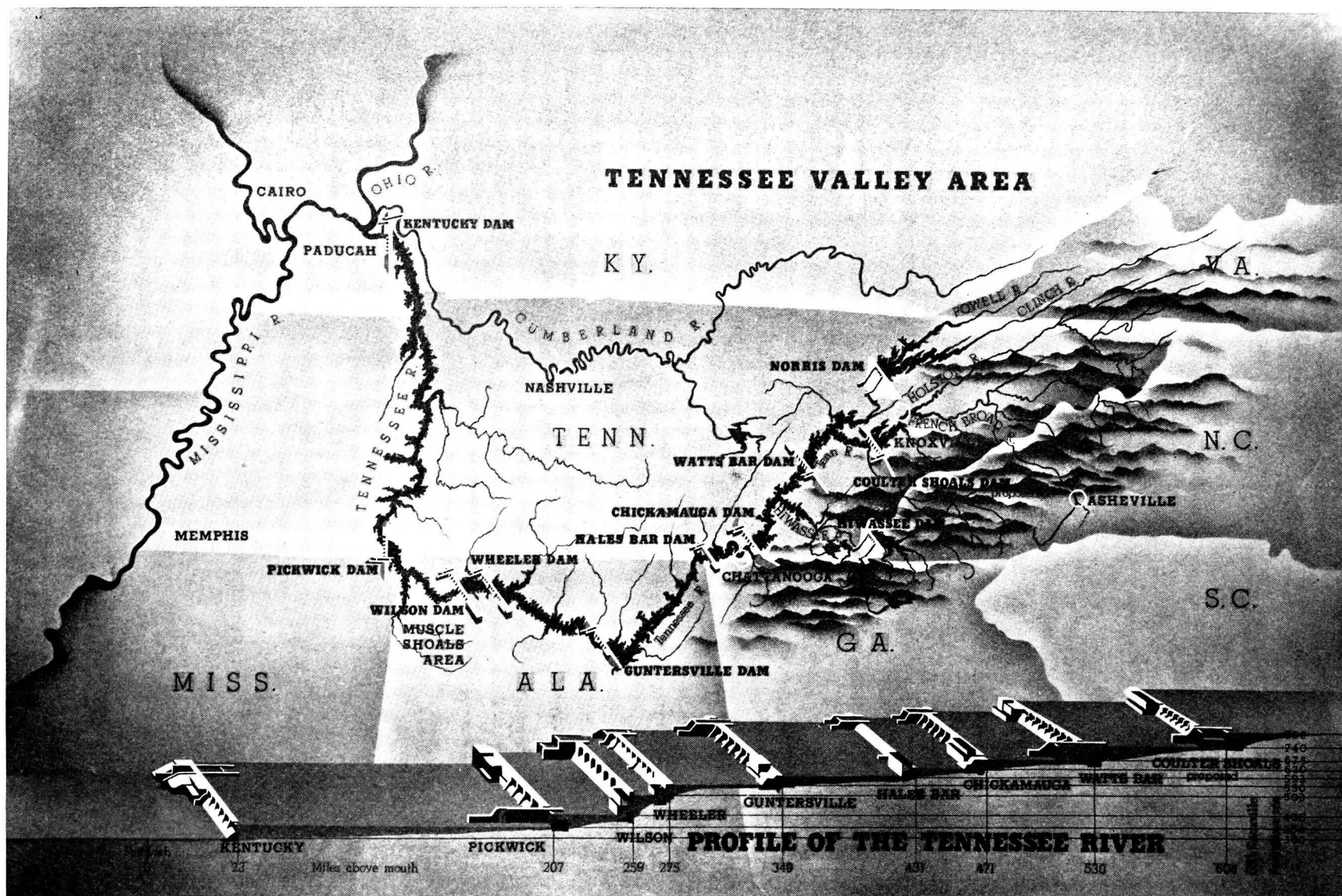


FIGURE 33.—Tennessee Valley Area

*Planimetric maps.*—A second preliminary step in the making of topographic maps was the production of planimetric maps. These maps, scale 1:24,000, showed all the cultural data standard for topographic maps: place names, buildings, roads, civil boundaries, etc., and stream patterns, forest cover, and such physiographic features as ridge crests. The maps corrected distortion inevitable in the multiple-lens mosaics and made clearer some features presented photographically on the mosaics. In addition, they made possible certain significant land differentiations. But more important, by far, they provided a means of correlating land and cultural data and were an essential tool in field work.

The first planimetric maps were available in selected areas by September 1934. Maps for the entire Valley were available by July 1937.

### Soil Mapping

The mapping of soils in the Tennessee Valley is carried on under a memorandum of agreement between the United States Department of Agriculture, the land grant colleges in the Valley States, and the Tennessee Valley Authority<sup>5</sup> (Fig. 34). The surveys are made according to standard specifications of the Department of

Agriculture.<sup>6</sup> In addition to the stated objectives of these standard surveys, the work in the Tennessee Valley was keyed to the requirements of the Authority's experimental production of phosphate fertilizers. Given data on the behavior of specific soils under the application of fertilizers, it is particularly important that the extent of these soils in the Tennessee Valley be known so that the best procedures in the use of the fertilizers on these soils can be recommended.<sup>7</sup>

Also related to the Authority's fertilizer program is the mapping of soils on fertilizer demonstration farms. These farms, 23,000 in number with a combined total of nearly 4,000,000 acres,<sup>8</sup> were selected to represent a

<sup>5</sup> Represented by the Department of Agricultural Relations.

<sup>6</sup> Chapter X carries a full statement of the soil survey work of the Department of Agriculture, including a discussion of the value of soil surveys to land classification and the methods of soil mapping developed in the Tennessee Valley.

<sup>7</sup> To 1934 soil surveys had been published for 35 counties wholly or partially within the Tennessee Valley. Like the earlier topographic surveys, these did not measure up to modern standards or needs and in most respects were quite inadequate. To July 1, 1939, new soil surveys were completed in 26 counties though none of these surveys had been published. Three preliminary hand-colored copies of each county map have been made, one on file each with the U. S. Department of Agriculture, the T. V. A., and local county agricultural agent. Disregarding 6 counties of which only minute portions lie within the Tennessee Valley, the number of counties that lie wholly or partially in the Valley is 118. Fifty-seven lie wholly in the Valley. Sixteen of these 57 counties are among the thirty-five that were covered by earlier soil surveys. Twelve are among the twenty-six for which new surveys have been completed.

<sup>8</sup> *Annual Report of the Tennessee Valley Authority, for the fiscal year ended June 30, 1939.* 76th Cong., 3d sess., H. Doc. 534. 1940.

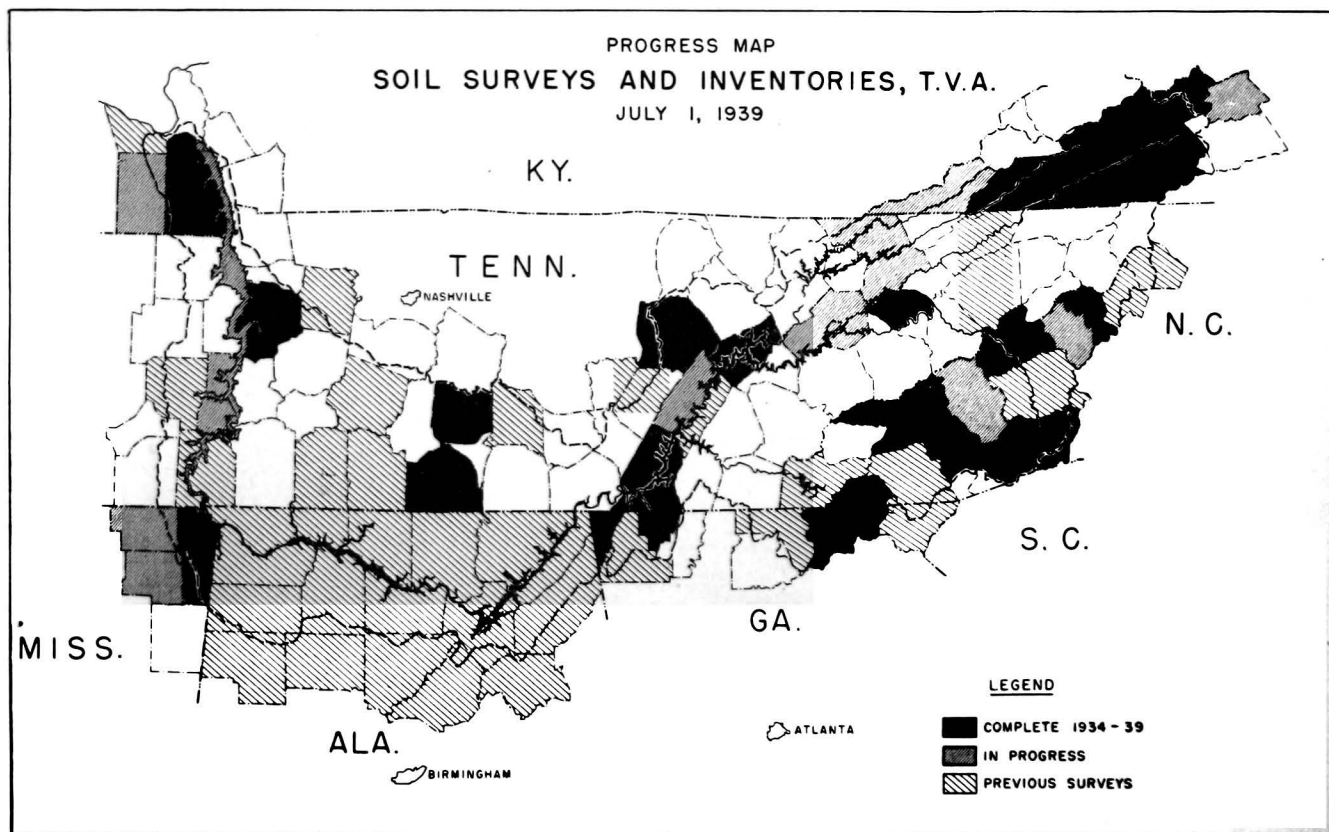


FIGURE 34.—Coverage of Soil Surveys in the Tennessee Valley, July 1939

wide variety of soils and a wide variety of uses. Most of them are located in the Tennessee Basin but some are scattered throughout other portions of the United States. In order to obtain accurate information concerning the behavior of soils under the application of phosphate fertilizer, each farm is to be mapped in a detail even greater than that of the standard soil survey. So far, only a start has been made on this program, mainly in the Tennessee Valley. From the standpoint of land classification these surveys are of particular significance because they will provide detailed sample data, up-to-date and according to the best standards, for areas scattered over a considerable portion of the United States for which no adequate soil data are available.

In addition to these two lines of work related to the Authority's fertilizer program, standard soil surveys are made for lands bordering the reservoirs. These lands are purchased as part of the Authority's river development program and are entirely owned and controlled by the Authority. The classification of soils on these reservoir properties according to their use capabilities, a new element in soil survey work, is of unique value to the Authority because land-use plans for the properties must be developed. Use-capability classifications provide a sound basis for these plans by indicating the potentialities of the soils for agriculture. These measures of potentiality then become the basis for

determining to what uses the agricultural land in the properties can best be put.

**Forest Resources Inventory<sup>9</sup>**

The inventory of the forest resources of the Tennessee Valley is the first step in a long-term program of forest development looking toward the use of forests as a means of watershed protection and as a source of income for the Valley (fig. 35). The 1939-40 program calls for the completion of the inventory. Currently, data are being assembled, tabulated, and analyzed. Later stages will consist of the presentation and interpretation of facts and the formulation of programs and policies of development.

The methods employed in the inventory are of particular interest in the field of forest and classification since they represent a departure from standard methods. Former methods involved (1) detailed analyses of sample plots or of traverses, with a minimum of mapping on foot, and (2) considerable use of interpolation to project the data on an areal basis. The method applied in the inventory in the Tennessee Valley consists of (1) mapping two major items: forest types and forest volume classes, with complete aerial coverage by minimum plots of 100 acres, and (2) mapping sample plots in detail for four items: forest specie distribution,

<sup>9</sup> Under the jurisdiction of the Department of Forestry Relations.

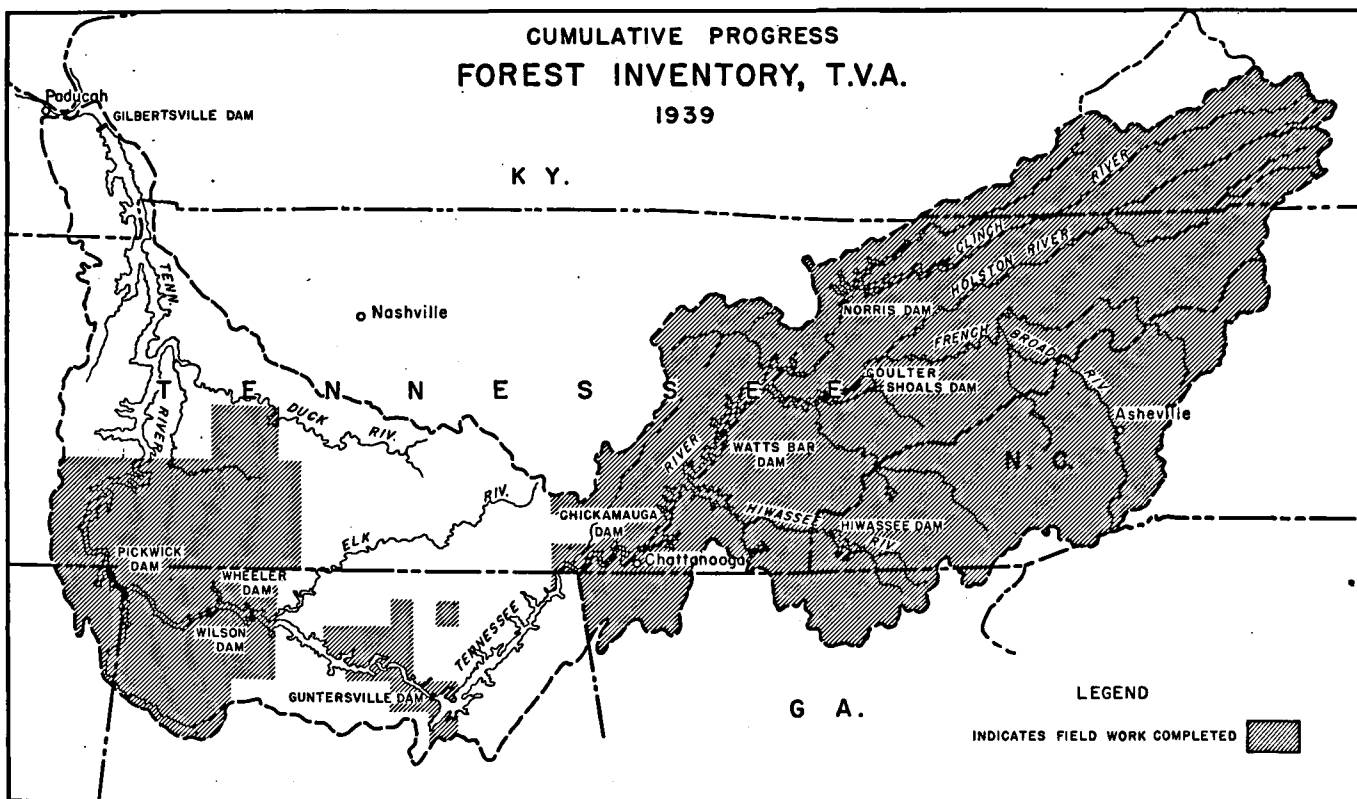


FIGURE 35.—Coverage of Forest Inventory of the Tennessee Valley Authority, July 1939

growth rate, mortality, and merchant-ability. The first is done by car, two men to the car, using planimetric maps and aerial mosaics, scale 1:24,000, as base maps.<sup>10</sup> Similar base maps are used in the mapping of sample plots which is done on foot at the rate of two to four plots per man-day. From both types of mapping are drawn data covering the botanical and commercial range of the tree species.

Preceding the organization of the inventory, valley-wide reconnaissance surveys were made and all pertinent data were brought together and studied. On the basis of this information and a variety of experimental work, the criteria were set up in final form, the procedures were agreed upon, and the work was organized.

Speed in coverage and costs varies with the complexity of the area being mapped, the amount of footwork required, and with the weather and the highway conditions. About 60 square miles are covered per car-day. The cost seldom exceeds \$1 per square mile.

Office work consists of thorough tabulations, using the Hollerith punch-card system, so that data can be drawn off by political units, watersheds, quadrangles, or in totals. Reports are being prepared, containing tables and maps by counties, for use in the Authority. Later, analyses will be made on other bases, including the regional, so that the results can be used in developing policies and programs appropriate to any unit.

Preliminary to the development of land-use plans for reservoir properties, forestry studies are made to ascertain the nature and extent of existing forest cover and the nature and extent of lands suited to forest production, experimental forest uses, and wildlife uses. Data are plotted in the field on single-lens aerial mosaics. These data covering timbered areas are analyzed, tabulated, and summarized in map form. Where necessary, unforested lands, shown by maps of land uses and land conditions to be potentially best suited to forestry, are surveyed in more detail where necessary. Results of these studies are combined with those covering forested areas to serve as a basis for forest land-use recommendations. These recommendations become a part of the reservoir land-use plans.

Following the completion of the land-use plans, areas on reservoir properties designated for forestry and related uses are studied in more technical detail for the purpose of developing specific use programs and management plans for individual parcels of land. The existing timber stands are covered by an intensive forest survey which results in a detailed inventory of present volume classes by forest types, condition classes, species, and administrative and operating units; the rate and volume of timber growth is determined along with defects and rate of mortality; and local woods

and mill practices are surveyed and appraised. From the analysis of this information allowable cuts are calculated and cutting areas designated. Unforested areas, designated for forest and related uses, are also studied in more detail as necessary to prepare similar management plans for their development.

### Recreational Surveys<sup>11</sup>

That some maladjustments in land use in the Tennessee Valley are due to population pressure was a fact recognized before the inauguration of the Authority's program. With the ultimate objective of ascertaining the extent to which recreational resources could be developed to relieve this pressure and at the same time to provide an expanded economic base, the Authority made an inventory of scenic resources and the extent to which they were utilized. Resources not fully utilized were classified according to their potentialities for development for recreational uses.

A systematic search was first made of local newspapers and literature concerning the Valley. All references to sites of possible scenic or recreational interest were noted and then checked through interviews with local residents. This proved to be a very effective and economical method of determining in advance of actual field work where observations should be directed. As a result, the field survey was made with a minimum expenditure of both time and effort.

The results of the inventory constitutes a vast file of data, photographs, maps, and descriptive material which has proved of great interest to Federal, State and local agencies considering plans for recreational developments and conservation and to private citizens traveling in the Valley.<sup>12</sup>

The scenic inventory made available a wealth of data concerning recreational resources. In addition, it injected a new element into recreational land classification. Heretofore, the classification of recreational areas has been almost solely on the basis of jurisdictional and administrative criteria. Classifications based on these criteria were rarely made unless some local group interested in the development of an area organized to give their desires group backing. As a result, areas of recreational potentialities were not brought to the attention of the touring public and many areas in need of expanded economic opportunities were not benefiting from recreational resources there to be developed.

The methods employed in the scenic inventory uncovered areas of great recreational potentialities, developed an economical method of analyzing and recording their recreational assets, and then classified

<sup>10</sup> The method is an adaptation of the unit-area method of land classification treated later in this chapter.

<sup>11</sup> Under the jurisdiction of the Department of Regional Planning Studies.

<sup>12</sup> *The Scenic Resources of the Tennessee Valley*, Tennessee Valley Authority.



their potentialities on functional rather than on jurisdictional and administrative grounds.

In addition to its approach to recreational planning through the scenic inventory, the Authority has developed recreational facilities and plans in connection with the management of its reservoir properties. When the Authority's present construction program has been completed, the Tennessee River from Knoxville, Tenn., to Paducah, Ky., will appear not as a river but as a chain of eight lakes, each lake in the chain separated from adjoining lakes only by a dam. In addition, two lakes will lie on major tributaries of the Tennessee River. To a great region naturally lakeless, each reservoir will constitute a recreational asset of special significance. The cumulative recreational value of all the reservoirs is immeasurable. Special significance is thus given to the studies of reservoir properties that relate to their recreational development. These studies consist of appraisals of (1) the recreational potentialities of each reservoir area as a whole, (2) the potential role of each reservoir in the development of the whole chain of lakes, and (3) within each reservoir area, each unit and site of possible recreational interest.

Data, maps, and reports from preliminary reservoir studies are analyzed in order to discover areas of special recreational interest. Subsequently, each area is studied

from the standpoint of its scenic, aesthetic, and site characteristics. In addition, local and regional travel routes are studied to ascertain the nature of traffic by volume, flow, source, and destination, and population distribution is analyzed to determine local needs for recreational developments and local facilities for serving recreational trade and traffic.

The distinct elements of land classification in these recreational studies come largely in the later stages of the work, namely, when the consideration of all the various factors culminates in recommendations covering specific recreational areas. At this stage lands are specifically classified. Some are designated for park developments, some as sites for cottage colonies, others for boat docks and swimming facilities, and so forth. Some areas are designated for immediate development. Other areas are designated for future development so that interim uses will not adversely effect their recreational potentialities. These designations, appearing in report form with maps, charts, tables and photographs, share in the development of land-use plans for the properties. After the completion of the land-use plans further studies may be applied to areas finally designated for recreational use for the purpose of developing use programs and management plans for individual parcels of land.

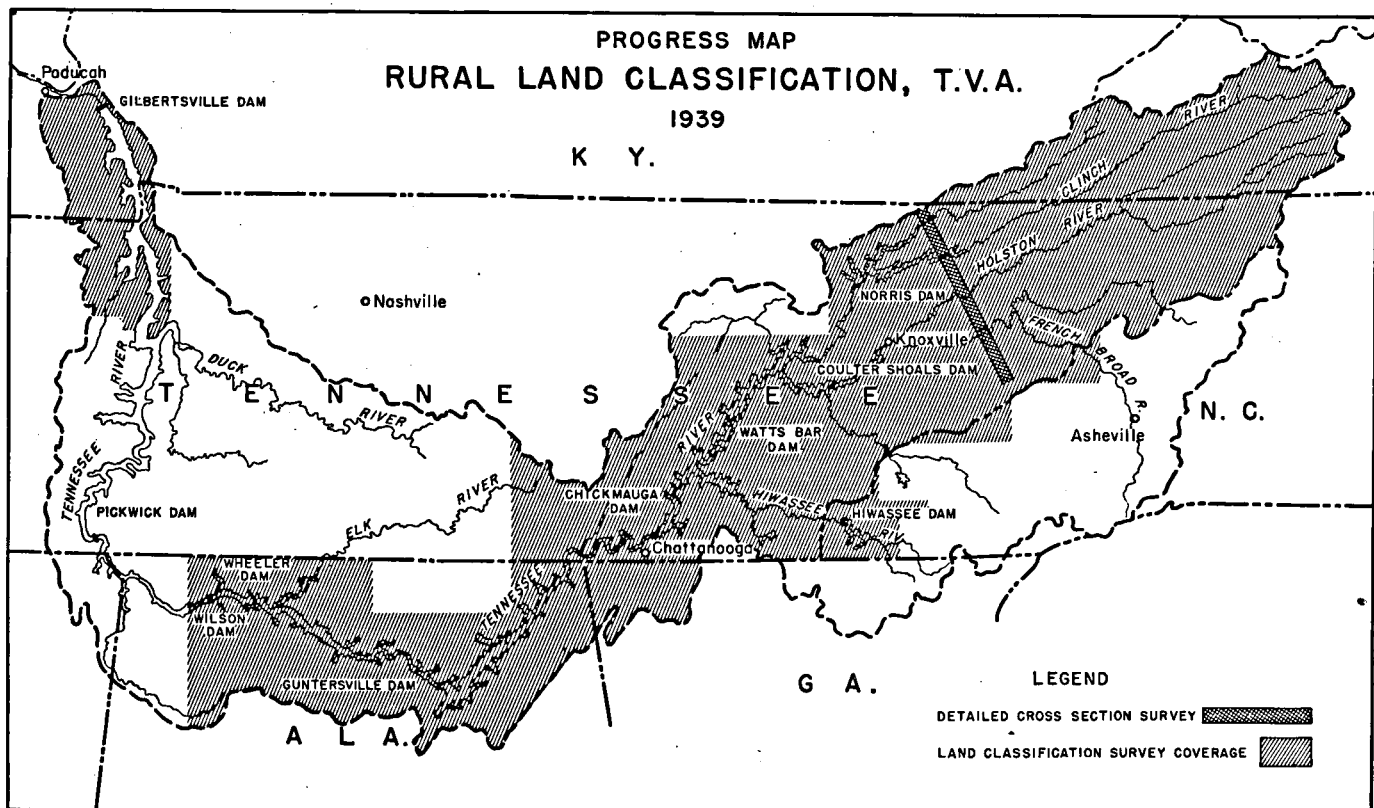


FIGURE 36.—Coverage of Rural Land Classification Survey of the Tennessee Valley Authority, July 1939

Rural Land-Classification Surveys<sup>13</sup>

The rural land-classification surveys are aimed at an understanding of the composite economy of the Valley. They deal with composite conditions of the land and land uses. Three such surveys were made: one applied to the Upper Tennessee Valley, a distinct division of the Tennessee basin lying upstream roughly from Chattanooga, Tenn.; another basin-wide in scope; a third applied to reservoir areas.

*The Cross-Section Survey of the Upper Tennessee Valley.*—The initial rural land-classification survey covered a cross section of the Upper Tennessee Valley, an area of closely knit parallel ridges and valleys, trending in a NE-SW direction. The cross section formed a 4-mile-wide strip lying across the middle of the upper valley, transverse to its axis. This cross section thus caught a 4-mile-wide sample of each valley and each ridge from the Unakas, northward to the Cumberland Plateau, a distance of roughly 60 miles. (Fig. 4.)

Field mapping was done on foot at the rate of 300 to 400 acres per man-day. Observations were recorded on aerial mosaics, scale 1:12,000, in the form of fractional codes.<sup>14</sup> Each of four digits in the numerator referred to a separate land-use item, whereas each of the three digits in the denominator referred to a land feature. The particular number recorded in the place of each digit designated the particular nature of the item observed. For example, in fig. 37, "1x5" in the numerator designated: "1," cropped land; "a," corn; "x," no second crop; and "5," no erosion control practices. "2111" designated: pasture, plowable, permanent open, terracing. "232" in the denominator designated: "2," slopes of 10 to 20 percent grade; "3," thorough drainage; and "2," sheet erosion. "333" designated: slopes of 20 to 40 percent grade, thorough drainage, gullying.

The four land-use items, each subdivided for detail, covered cropped land, pasture land, idle and fallow land, and woodland (not pastured).<sup>15</sup> The three land items, also subdivided, covered slope, drainage, and erosion conditions. Only one fraction was recorded on the mosaics for each body of land delimited. A "new" body of land was delimited when a change occurred in one or more of the items being mapped. The size of the bodies of land delimited ranged upward from a minimum of 2 to 3 acres, depending upon the amount

of land surface to which the conditions recorded in the fraction applied. Direction of slope was added by drawing directional arrows regardless of unit-area boundaries. Notes concerning the quality of farmsteads, types of transportation facilities, nature of community centers, and similar items were plotted on the mosaics in code or keyed to the mosaics by number and symbol.

As the field work was completed, field recordings were transferred to master mosaics in ink. Bodies of land were measured (by planimeter) and the location, acreage and field data for each unit were punched on a Hollerith card. Data from the survey could thus be analyzed in either map or statistical form. The method of mapping and handling data made it possible to study separate items or combinations of items. For example, by disregarding all notations except those denoting erosion conditions (the last of the denominator digits), and by recognizing lines of demarcation applying only to that digit, a map could be made displaying the distribution of erosion conditions and nothing else. This procedure permitted the analysis of erosion conditions in terms of any items or combination of items. Applying the same procedure, several items could be studied in combination in terms of single items or other combinations of items. Map and statistical materials drawn from this survey formed the basis of several confidential reports and memoranda as well as two published articles.<sup>16</sup>

The Upper Tennessee Valley Survey provided data on land uses and land conditions for use in program planning in that part of the Tennessee Basin. In addition, it served land-classification work in the Authority: (1) by furnishing a quantitative basis for ascertaining the relative significance of features of land use and land condition that should be emphasized in further land-classification work; (2) by demonstrating the advantages of aerial mosaics in land-classification work, particularly with respect to accuracy and economy of operations; (3) by revealing that the methods employed produced data more detailed than necessary to meet initial requirements of Valley-wide planning and moved too slowly to serve these requirements; (4) by providing detailed data for use in verifying the accuracy of less detailed data, and (5) by developing methods of detailed unit-area classification for later use on reservoir properties. In these terms, the Upper Tennessee Valley Survey laid the basis for the unit-area basin-wide classification of rural lands.

<sup>13</sup> Under the jurisdiction of the Department of Regional Planning studies.

<sup>14</sup> The evolution of the fractional code method of field mapping is covered in the following references:

Jones, Wellington D., Finch, Vernor C., "Detailed Field Mapping of an Agricultural Area," *Annals, Assoc. Am. Geographers*, Vol. 15 (1925);

Whittlesey, Derwent, "Devices for Accumulating Geographic Data in the Field," *Annals, Assoc. Am. Geographers*, Vol. 17 (1927);

Finch, Vernor C., *Montfort—A Study in Landscape Types in Southwestern Wisconsin*, The Geog. Society of Chicago, Bulletin No. 9, University of Chicago Press, 1933.

<sup>15</sup> A timber survey, coordinated with the survey described here and employing an adaptation of the fractional code, was made by the Dept. of Forestry Relations in part of the sample cross section.

<sup>16</sup> Glendinning, Robert M., and Torbert, E. N., "Agricultural Problems in Grainger County, Tenn.," *Economic Geography*, Vol. 14, No. 2, April 1938.

Hudson, G. Donald, "Three Major Physical Divisions of the Upper Tennessee Basin," *Economic Geography*, Vol. 13, No. 1, January 1937.



FIGURE 37.—Sample Section of Field Mosaic, Cross-Section Survey of the Upper Tennessee Valley

*Basin-wide unit-area survey.*—The unit-area survey, which is Basin-wide in scope, was developed in response to an immediate and growing need for knowledge of land uses and land resources over the entire Tennessee Basin. In March 1935 the Department of Regional Planning Studies addressed itself to the problem of meeting this need. The literature was searched for leads as to methods of land-resource inventories and classification. The best reconnaissance methods were too general to yield adequate data. Other methods were too slow and too expensive. Nothing seemed to bridge the gap between the two extremes. From March to July 1935, a series of field mapping experiments were made, using every available type of base map and a variety of schemes of mapping. The objective was to devise a method that would give complete areal coverage; would provide quantitative data; would be sufficiently detailed and accurate to meet current planning requirements; and would be available when needed and at a cost commensurate with utility. By July 1935 such a method had been developed and tested in the field sufficiently to warrant the inauguration of a Basin-wide program of this type of land classification (fig. 36).

Although the techniques employed in the unit-area survey were similar to those employed in the cross-section survey in that they covered composite conditions and used the fractional code recorded on aerial mosaics, there were some outstanding differences. Complete and balanced coverage was achieved in the unit-area survey by omitting no areas and by treating all areas with the same degree of detail. Rapidity of coverage was assured by making 200 acres the minimum-sized body of land, delimited by "reading" some landscape features directly from the aerial mosaics, and by providing for the use of cars. In order to provide a system by which significant conclusions could be read from the survey data easily and quickly, three summary appraisals were added to the individual items heretofore mapped in farming areas. One related to land-use conditions, the bodies of land being classified into five categories, from "very poor" to "excellent." The second classified the bodies of land in the same fashion according to the composite qualities of the land. The third indicated the degree to which agricultural problems, if any, were critical. These three summary appraisals were made in the field and were recorded on the mosaics as part of the fractional code set down for each unit area used for agricultural purposes. (Fig. 38.)

Several specific phases of the Authority's program had given rise to the question of the economic status of urban centers and to the question of rural-urban relationships. The cross-section survey and other land studies provided data on rural land uses and land

conditions, but there were no immediate means of relating findings from these studies to findings from urban studies. To provide this connecting link, field techniques of the unit-area survey included the delimitation of the retail trade area of each retail trade center. For the purpose of this survey, a trade area was defined as the area from which fifty percent or more of the retail trade flowed to a common center.

In the unit-area survey, field equipment consists of aerial mosaics, scale 1:24,000, on which all field observations are recorded; planimetric maps, scale 1:12,000, on which are plotted boundaries for retail trade boundaries; soil maps, if they are available, which serve to orient the field men to local soils; and legends, soil augur, clinometer, and similar standard items.

Mapping is done by cars, the mappers leaving the cars in most cases only to verify some detail or to interview local residents concerning local retail trade. Each crew consists of two equally trained men who alternate in mapping and driving. Each day's mapping begins with careful orientation. The landscape and mosaic are then studied to determine the character and extent of the first unit area to be mapped. A tentative characterization of the unit is made and recorded in a long fraction. (Fig. 38.) Tentative boundaries are then drawn in yellow pencil, the limits of the unit depending upon the spread of relatively homogeneous conditions. Next the boundaries are checked and corrected at every point to which access is possible by roads, either immediately or when adjacent areas are being covered. During this process the landscape and the tentative fraction are scrutinized. When the final boundaries are redrawn in black pencil, the final fraction is recorded and the three summary appraisals are made and noted. Each succeeding unit area is similarly treated, a new unit being characterized and delimited if a change is noted in *one* or more of the items mapped. By this process, the pattern of enclosed unit areas and fractions is gradually completed.

Field mosaics are sent into the central office as they are completed. Here all penciled notations, boundaries and fractions, are transcribed in black ink. Field data are then transferred to planimetric maps, primarily to correlate field data with data shown on planimetric maps, but also to increase precision by eliminating the distortion inherent in multiple-lens mosaics and to simplify the making of photographic reproductions. When this work is completed the acreage of each unit area is measured with a roller planimeter and the acreages entered on the planimetric map. The planimetric maps with all data plotted, including field data, acreages, and trade-area boundaries are then reproduced photographically at a scale of one inch equals one mile. Thus are provided two complete records for file and reference purposes (the inked mosaics and planimetric



FIGURE 38.—Sample Section of Field Mosaic, Unit-Area Survey of Basin-wide Scope, Tennessee Valley

**LEGEND**

**ROMAN NUMERALS**

**TYPES OF AGRICULTURAL AREAS**

- I. Areas in which no significant agricultural problems are apparent.
- II. Areas in which agricultural problems are not critical.
- III. Areas in which agricultural problems are moderately critical.
- IV. Areas in which agricultural problems are very critical.
- V. Areas in which agricultural problems are so critical that a radical change in land use appears desirable even to the extent of retiring lands from agriculture.

**SHORT FRACTION**

**SUMMARY APPRAISAL OF UNIT AREAS**

**NUMERATOR**

- Areas classified on the basis of the quality of agricultural use of the land.
- Class 1. EXCELLENT—Medium to large fields; little or no idle land; complete agricultural utilization of the land under a regime especially well suited to the land.
  - Class 2. GOOD—Medium to large fields; little or no idle land; efficient agricultural use under a regime well suited to the land.
  - Class 3. MEDIUM—Small to medium fields; limited idle land; moderately efficient agricultural use under a regime moderately well suited to the land.
  - Class 4. POOR—Small to medium fields, in many cases interrupted; considerable idle land; low-grade, inefficient, or destructive agricultural use under a regime ill-suited to the land.
  - Class 5. VERY POOR—Very small, interrupted fields; excessive idle land; very low-grade, inefficient, or destructive agricultural use under a regime in most cases entirely unsuited to the land.

**DENOMINATOR**

- Areas classified on the basis of the present quality of the land for arable farming.
- Class 1. EXCELLENT—Lands exceptionally well suited to intensive arable farming.
  - Class 2. GOOD—Lands well suited to arable farming and moderately suited to intensive forms of arable farming under proper land management.
  - Class 3. MEDIUM—Lands suited to less intensive forms of arable farming or to general farming under proper land management.
  - Class 4. POOR—Lands for the most part poorly suited to all forms of arable farming even under proper land management; in many cases best suited to grazing.
  - Class 5. VERY POOR—Lands not suited to either arable farming or grazing; in most cases suited to forest production, recreation, etc.; in some cases, waste land.

**LONG FRACTION**

**DETAILED LAND-USE AND LAND CONDITIONS BY UNIT AREAS**

**NUMERATOR**

**LAND-USE CONDITIONS**

- FIRST DIGIT**  
Agricultural Land Use
- 1. General farming
  - 2. Animal industry
  - 3. Cash-crop farming
  - 4. Part-time farming
  - 5. Subsistence farming
- SECOND DIGIT**  
Agricultural Emphasis
- A. Corn
  - B. Beef cattle
  - C. Cotton
  - D. Dairying
  - F. Forage crops
  - G. Small grain
  - H. Hogs
  - M. Mules or horses
  - N. No emphasis
  - O. Orchards
  - P. Poultry
  - S. Sheep
  - T. Tobacco
  - W. Truck

**THIRD DIGIT**

**Field Size**

- 1. Large —more than 15 acres
- 2. Medium —6 to 15 acres
- 3. Small —2 to 6 acres
- 4. Very small —less than 2 acres

**FOURTH DIGIT**

**Idle Land\***

- 1. Little or none—less than 5 per cent
- 2. Limited — 5 to 10 per cent
- 3. Considerable—10 to 30 per cent
- 4A. Excessive —30 to 60 per cent
- 4B. Dominant —more than 60 per cent

\*Includes fallow, idle, and abandoned land and pastures so weedy and brushy as to be virtually non-productive.

**FIFTH DIGIT**

**Quality of Farmsteads and Equipment**

- 1. Excellent
- 2. Good
- 3. Medium
- 4. Poor
- 5. Very poor

**OTHER TYPES OF AREAS**

- 6. Forested land †
- 7. Recreation area †
- 8. Rural village †
- 9. Urban area †
- Q. Manufacturing, mining, or both ‡
- RR. Rural non-farm, residential §
- X. Rural non-farm, non-residential
- Y. Major water bodies

\*Stands alone over long denominator.  
 †Stands alone—no denominator.  
 ‡Stands alone—no denominator. When qualified:  
 01—Manufacturing alone.  
 02—Large mining enterprise with power machines.  
 03—Small scattered mining operations (may appear as a qualification of agricultural area).  
 §RR stands alone over long denominator—more than 75 per cent of all dwellings rural non-farm.  
 (RR1) Preceded by other digits—50 to 75 per cent of all dwellings rural non-farm.  
 (RR2) Preceded by other digits—25 to 50 per cent of all dwellings rural non-farm.

**DENOMINATOR**

**LAND CONDITIONS**

**FIRST DIGIT**

**Slope**

- 1. Relatively level — 0 to 5 per cent
- 2. Relatively level to undulating — 5 to 10 per cent
- 3. Undulating to moderately hilly —10 to 20 per cent
- 4A. Moderately hilly —20 to 30 per cent
- 4B. Hilly —30 to 40 per cent
- 5. Steep —more than 40 per cent

**SECOND DIGIT**

**Drainage**

- 1. Thorough—no problems.
- 2. Adequate—normally no problems, but heavy rain may limit or curtail field operations.
- 3. Poor—serious problems of cultivation under normal rainfall conditions, but in most cases no interference with pasture uses.
- 4. Very poor—land cannot be cultivated; largely marsh and swamp; some land may provide forage.
- 5. Excessive—insufficient moisture retained for agricultural production; associated with rocky, steep, and eroded land or shallow soils.

**THIRD DIGIT**

**Erosion**

- 1. Little or no observable erosion—no breaks in cover.
- 2. Little denudation—mild sheet erosion with or without finger gullies; widely spaced gullies.\*
- 3. Gullying or sheet erosion or both to a degree detrimental to agricultural use—excessive sheet erosion; closely spaced gullies less than 6 inches in depth; gullies of larger size widely spaced (more than 10 feet).\*
- 4. Sheet erosion so excessive that either upper soil horizon has been depleted or gullies are so numerous and deep that cultivation is rendered difficult.\*
- 5. Erosion so severe that upper soil horizon or more has been removed by sheet or gully erosion\*; cultivation rendered futile or impossible.

\*For refinement, a sub-digit may be added.  
 Examples: 2a. dominantly sheet wash.  
 2b. dominant gullying.

**FOURTH DIGIT**

**Soil Stoniness**

- 1. Free from stones.
- 2. Moderately stony—stones present but no obstacle to cultivation.
- 3. Stony—stones numerous enough to render cultivation difficult.
- 4. Very stony—more stones than soil on surface, practically precluding cultivation.

**FIFTH DIGIT**

**Rock exposure**

- 1. Little or none—less than 1 percent of the surface of the area is exposed rock.
- 2. Limited — 1 to 10 per cent
- 3. Considerable—10 to 30 per cent
- 4. Excessive —30 to 50 per cent
- 5. Dominant —more than 50 per cent

**SIXTH DIGIT**

**Soil depth**

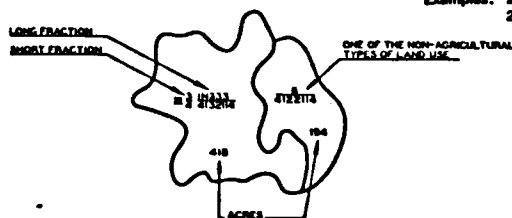
- 1. Deep —more than 6 feet
- 2. Moderately deep —3 to 6 feet
- 3. Shallow —1 to 3 feet
- 4. Very shallow —less than 1 foot

**SEVENTH DIGIT**

**Soil Productivity\***

- 1. Exceptionally productive—  
Example: Chocolate-colored limestone or marble soils and rich alluvial deposits.
- 2. Productive—  
Example: Dark-red dolomite and limestone soils.
- 3. Moderately productive—  
Example: Yellow-red dolomite and limestone soils.
- 4. Low in productivity—  
Example: Yellow to gray cherty dolomite, very low grade limestones, limey shales, and tillable sandy soils.
- 5. Very low in productivity—  
Example: Poor shales, rough stony land, and such lands originally low in productivity, now ruined by erosion.

\*Including factor of inherent fertility.



maps), and one complete set of records for study use (the reproduced planimetric maps).

The next office procedure is a classification of each unit area according to the intensity of use to which the land is adapted. Each unit area is thrown into one of three classes, namely: (1) land suited to intensive uses (with emphasis on cropping); (2) land suited to extensive uses (with emphasis on pasture); and (3) land suited to nonagricultural uses. This classification reveals in broad outline the potentialities of the land. It is based on data from the unit-area survey, soil maps, land-use studies made by other agencies, and all other pertinent data that can be obtained. Optimum classes are recorded in color on reduced reproductions of planimetric maps previously noted and become part of the permanent record file.

Lastly, all land-classification data are put in form for ready tabulation and statistical analysis through the use of the Hollerith card system. The acreage (measured by planimeter), land use, land conditions, and optimum classification for each unit area are punched by code on a Hollerith card. Each card is keyed to the State, county, trade area, and planimetric quadrangle in which the unit area falls. As in the case of data from the Upper Tennessee Valley Survey, analyses can be made of single items and combinations of items in a wide variety of ways and, in this case, according to a wide variety of economic and political, divisions.

The feature of the unit-area survey most significant in the general field of land classification is that it bridges the gap between detailed methods on the one hand, and reconnaissance methods on the other. Detailed information is indispensable to study, planning, and management when the problems involve individual parcels of land. For use in the administrative development of programs and policies, experience has shown that such information must be generalized before the broad lines that programs and policies should follow become evident. Reconnaissance methods produce results invaluable for preliminary understandings, but as a basis for program development and policy making, their broad generalizations come under the category of "better-than-nothing" knowledge.

Examples of the types of programs and administrative decisions to which results of the unit-area survey contributed are:

1. The planning of the extension of rural electrification lines: in what specific areas is the extension of lines economically feasible?
2. The planning of dam construction: what were the relative benefits and adverse effects of single versus multiple dam construction?
3. The planning of highway construction: would it be more economical to purchase lands isolated by reservoir construction or to build highways to the lands, replacing dislodged facilities?

4. The erosion-control program on nonagricultural land: what is the volume and distribution of the erosion-control load in the Tennessee Basin?

5. The planning of reservoir construction: what are the relative adverse and beneficial effects of alternative reservoir purchase boundaries on local economic units of retail trade?

*Surveys of reservoir properties.*—In addition to the two surveys just described, rural land-classification surveys were made of reservoir properties. Most of the varied problems concerned with lands in reservoir areas stem from these two questions: (1) how much land must be purchased, and (2) what land-use plans must be developed for the lands purchased? Originally, these two questions were treated separately. In each proposed reservoir area detailed rural land-classification surveys were made between the contour established as the lower level of the proposed pool and the contour that tentatively set the outer limits of purchase. In most respects the detail and the technic employed were identical to those developed in the Upper Tennessee Valley survey. The reservoir work had the advantage of single-lens mosaics, scale 1:15,000; individual crops were not mapped but, similar to the unit-area survey, cleared land was classified according to its quality. No statistical data were drawn from the survey. Inked master mosaics, legends, and field notes were made available to other departments for use in the prosecution of their own special studies.

It became evident, however, that the problems of purchase boundaries and land-use plans were inseparable. They both involve an intimate knowledge of land resources, present land uses, and potential land uses with particular reference to three major uses of reservoir properties: Agriculture, forestry, and recreation. It became evident, too, that both problems required the consideration of engineering factors, malarial control, highway relocations, movements of population, adjustments in tax base, and the like. It was apparent that the consideration of these factors and the appraisal of potential land uses required a common fund of land classification data. The purpose of the present rural land classification surveys of reservoir properties is to provide this common fund of information.

Two lines of work are carried on concurrently. One provides detailed data for specific problem areas within the tentative outer purchase contour. The other covers the land to be flooded and sufficient land beyond to include the local highways and the local market and service centers. Methods employed in the detailed work are similar to those used in the Upper Tennessee Valley Survey and earlier reservoir studies, whereas those employed in the second line of work are similar to those used in the unit-area survey. In both surveys, however, cooperating units in the Authority stated in

advance the types of data which their work required, and, in the case of specialized technical data, the criteria to be used in their collection. The legends developed for these surveys took account only of these specified needs.

Examples of the expressed needs of each of these cooperating units illustrate the nature and broad scope of the surveys:

1. The Department of Forestry Relations requested the data noted above and, in addition, areas suited according to specified criteria, to fish hatcheries and wildfowl refuges;

2. The Health and Safety Departments requested the delimitation of mosquito-control-problem areas, the criteria being specified;

3. The Commerce Department requested that sites for commercial docks be noted according to a set of definite criteria;

4. Roads and railroads to be inundated were noted and classified at the request of the Highway and Railway Division;

5. The Department of Agricultural Relations requested data pertaining to the use and condition of cleared land. By means of a fractional code, units of not less than ten acres were classified according to their suitability for agricultural, mixed agricultural and non-agricultural, and non-agricultural uses. Important crops, degree of slope, idle land and drainage and erosion conditions were recorded for each unit;

6. The Department of Regional Planning Studies requested the mapping of areas outstanding because of specified scenic features and recreational potentialities;

7. The Department of Power Planning requested the mapping of transmission lines, and industrial and domestic consumers of electricity adversely affected by the reservoir project and notes on the nature and extent of damages.

For the detailed work within the tentative purchase contour, mapping was done on foot only where access by car was impossible. Single-lens aerial mosaics, scale 1:15,000, served as base maps. Interviews were held with residents, operators of stores, industries, and ferries, and persons connected with schools and churches in order to obtain an understanding of the functional structure of the area and to answer series of specific questions raised by the cooperating units.

In depicting the regional setting of the proposed reservoir project variation from the methods employed in the Basin-wide Survey is in emphasis rather than in items covered, methods of recording, field equipment, or degree of detail. Physiographic divisions of the area are recognized and delimited in the field on aerial mosaics, scale 1:63,360. The survey of the reservoir region is keyed to these physiographic divisions. In each are mapped dominant land and land-use conditions, major crops, quality of farmsteads, etc. Information is obtained for each division concerning local trade and market habits, routes of travel, manufacturing and commercial activities, transportation facilities, raw and finished products that might move by water, and the existing and potential uses of electricity.

All field data, originally plotted in the field on aerial mosaics, are put in ink form and transferred in ink to

planimetric maps for coordination with planimetric map data and to facilitate reproduction. Duplicate copies of these planimetric maps are forwarded to cooperating departments. With them goes a report containing answers to specific questions that all departments raised and a report containing maps, charts, pictures, and tables which presents the functional structure of the proposed reservoir area and its regional setting.

After each department has analyzed these materials in terms of its own needs, the reservoir studies enter the second stage, namely, the supplementary study of areas of special concern by each department on the basis of which recommendations relating to purchase boundaries and land-use plans are made.

## Integration

### The Rural Land-Classification Surveys

The rural land-classification surveys of reservoir areas are primarily inventories and appraisals of present land conditions and present land uses. Under present techniques these precede and are basic to specialized investigations dealing with problems of an engineering nature, such as highway relocation; and land utilization, such as farming or recreation. The inventory phase of the rural land-classification surveys lies in the observing and recording of present land conditions and uses. The appraisal phase lies in the focusing of these data in terms of areas where problems and conditions require the attention of technical specialists. Judgments with respect to the potentialities of the land are limited to those areas where these matters are relatively obvious, or where technical specialists have been able to set down concrete, observable criteria of relatively obvious application.

### The Specialized Investigations

It is not the purpose of the rural land-classification surveys of reservoir areas to furnish land-use recommendations. Ascertaining the use potentialities of the land and recommending the specific uses to which it should be put are the primary responsibilities of the technical specialists in farming, forestry, public health, school administration, wildlife, and the like. The specialists analyze the results of the land-classification studies and then direct their investigations to those portions of the reservoir area where occur problems and conditions which require their particular skills. Three of these special investigations have been mentioned, namely, Soil Mapping, Forest Resources Inventory, and Recreational Surveys. Others deal with malaria control; the location of commercial boat docks and terminals; the distribution of public services, such as schools; road, highway, and ferryboat connections; wildlife preserves;



erosion control; and the like. The purpose of these specialized investigations is to recommend areas for purchase along the margins of the proposed reservoir and to recommend the uses to which these lands should be put, both from the special point of view of the men conducting the individual investigations.

#### **The Integration of Recommendations**

All recommendations for purchase and land use are submitted to a central unit for integration.<sup>17</sup> Recommendations with respect to purchases are plotted on a base map of the reservoir area; purchase boundaries are adjusted where necessary to bring recommended purchases into accord with each other; the result is submitted to an interdepartmental committee for approval and channeled through to the engineering department in charge of dam and reservoir construction.<sup>18</sup>

Recommendations dealing with land uses are plotted on a separate set of base maps. Since the specialized investigations and the land-use recommendations are made independently, divergent recommendations are sometimes offered for the same area. Such instances are minimized, because, in most cases, the particular technical needs of most areas are relatively obvious; specialists, by working in close harmony with each other, have learned to recognize in other cases what skills other than their own are required; and all technical

<sup>17</sup> Dept. of Regional Planning Studies. The personnel in this department that makes the rural land-classification surveys of reservoir areas also serves as the agent of integration.

<sup>18</sup> Dept. of Water Control Planning.

studies have the same basic land-classification materials. Decisions regarding the priority of some divergent recommendations can be made by the central unit. Others are submitted to an interdepartmental committee for decision. When all recommended land uses have been reviewed and adopted, they are set down on base maps, area by area, so that all parcels of land have been accounted for. This constitutes the land-use plan.

#### **Management**

When the land-use plan has been officially approved by the Board of Directors of the Authority, it is transferred to the Department of Reservoir Property Management for execution. On the basis of the land-use plan, a program or plan of management is developed and put into effect by that department.

Participation of the departments that made the original recommendations does not end with the land-use plan. The same or other units of these departments may be called upon to take up some of the developmental activities. The management plans for entire sections of the land use may be turned over to other departments or units for development. In some instances management difficulties may arise necessitating a revision of the original land-use plans by the makers of the original recommendations. This calls for integration by the central unit. All such cases, however, maintain the feature of management. Jurisdiction and initiative remain in the management agency.

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## CHAPTER XIX. ECONOMIC LAND-CLASSIFICATION STUDIES IN NEW YORK

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Within the boundaries of New York State many different grades of land are found. For all this land, even the least productive, there is an economic use. Some land, for example, can be profitably used for growing vegetables and other intensively cultivated crops. Some land is suited to less intensive farming, whereas other land is best fitted only for such very extensive uses as forestry and hunting and fishing. The land utilization and classification studies made by the New York State College of Agriculture are meant to provide maps which will show the location and area of the different kinds of land and to present other information which will be useful in furthering the best development of every land class.

### Origin of Functions

Soil surveys and studies of farm management laid the foundation for current land-classification work in New York State. The first soil survey was made in the Westfield area in 1901. In 1902 soil surveys were made of the Lyons area, mostly in Wayne County, and of the Big Flats area, in Chemung and adjoining counties. Types of soil as mapped and defined in the soil surveys soon began to be studied from the economic point of view. A study of apple orchards in Wayne County, published in 1905, brought out the relationship between soil types and apple yields.<sup>1</sup> Results from the orchard surveys led to statistical analyses of the operations of whole farms. The first of these analyses, relating to farms in several towns in Tompkins County in the year 1908, was published in 1911.<sup>2</sup> It indicated the relative profitableness of farming on different types of soil, and showed that considerable areas of idle farm land in the county were on soil that should never have been cleared, and should be reforested. In later years, the methods first employed in these early studies in Tompkins County were used in collecting and analyzing thousands of farm business survey records in all parts of the State. Without the knowledge of farm management principles thus gained, it would not be possible to classify land from the economic point of view.

Although the earlier studies made land classification possible and shaped the methods which would be employed, pressing need for the work first became appar-

<sup>1</sup> Warren, G. F., *An Apple Orchard Survey of Wayne County, New York. Part I—The Apple Industry*, Cornell Univ. Agr. Exp. Sta. Bul. 226, 1905.

<sup>2</sup> Warren, G. F., and Livermore, K. C., *An Agricultural Survey. Townships of Ithaca, Dryden, Danby, and Lansing, Tompkins County, New York*, Cornell Univ. Agr. Exp. Sta. Bul. 295, pp. 386-387, 1911.

ent in connection with the problem of farm abandonment. During the 45-year period from 1880 to 1925, more than 4,500,000 acres of land went out of agricultural use in New York. Some areas came to be known as abandoned farm areas, because so few farms remain occupied. The intensive study of the reasons for abandonment began in 1923, when the Chenango County Farm Bureau called on the College for a survey of the situation in that county. After several preliminary studies, a comprehensive economic survey of all the farms and other parcels of land in 40 abandoned farm areas was published in 1929.<sup>3</sup> The results of the study were available, however, before publication, and together with other data, resulted in the passage of a series of laws for the purchase and reforestation of abandoned farm land by the State and the counties. The State Reforestation Law of 1929, which became a part of the State Constitution in 1931, authorized the State Conservation Department to acquire, by gift or purchase, reforestation areas of not less than 500 acres of contiguous land, and to plant and manage forests for the production of timber.

A land-classification survey was needed to determine the location and extent of the abandoned farm areas adapted to reforestation. But there were also other needs to be filled by such a survey. Economic studies of the relation of roads, electric service, education, and farm-mortgage credit to agriculture in New York had indicated that these services are essential to the most productive use of agricultural land, and that only land that can support these facilities is likely to remain in farms. A land-classification survey was thus needed to determine the areas which were adapted to reforestation and also to indicate the areas where the agricultural productivity of the land could be increased by improving the facilities for production, marketing, and farm living.

### Personnel

The work of Dr. George F. Warren was of leading importance in the historical development of the land utilization work. He made the apple orchard surveys and was principal author of the 1908 farm management survey of Tompkins County. Serving as head of the Department of Agricultural Economic and Farm Management, he had the wisdom and foresight to initiate and direct the studies of farm abandonment,

<sup>3</sup> Vaughn, L. M., *Abandoned Farm Areas in New York*, Cornell Univ. Agr. Exp. Sta. Bul. 490, 1929.

rural roads, rural electrification, and agricultural credit on which the later work was to be based. The first land-classification study was made under his direction.

The research in land utilization and classification is at present in charge of a senior member of the departmental staff. Graduate students in agricultural economics have immediate charge of the work in specific counties, and prepare the reports, sometimes as theses in partial fulfillment of the requirements for the M. S. or Ph. D. degrees. Field work is done by graduate students. The clerical staff, which varies in number with the amount of work that is under way, consists of young women who are university graduates chosen for their ability. They do the exacting work of summarizing in statistical form the data shown on the maps, and prepare all of the maps for publication in bulletins.

### Establishment of Activity

The economic studies of land utilization and classification are a part of a broader program adopted in 1930. In 1929, Governor Roosevelt's Agricultural Advisory Commission recommended that a general study be made of the agricultural resources of the State. The legislature accepted this recommendation and began to appropriate money for this purpose in 1930. Funds were provided for work on (1) the soil survey, (2) the assembling of climatological data, (3) the land utilization and classification survey, (4) the orchard-soil survey, (5) the vegetable-soil survey, (6) the pasture survey, (7) the publication of crop bulletins, and (8) studies of the cost of producing milk. The land utilization and classification survey was begun in Tompkins County. The methods of study that were developed by the Department of Agricultural Economics and Farm Management of the New York State College of Agriculture in the course of the work in that county have been applied in later studies without any substantial changes.

### Objectives

The purpose of the economic studies of land utilization and classification is to determine the location and extent of the areas of land in each county that are adapted to different degrees of intensity of use, and to suggest plans for the development of the resources of each land class. A further purpose is to study factors which are related to the intensity of use of the various classes. Some of these factors are fundamental conditions which determine the intensity of use to which the land is adapted; others merely measure present intensity of use; and others register the effect of variations in the intensity of land use on the economic welfare of farmers. A knowledge of such factors is necessary to the success of any land-planning program.

The purposes of the land utilization and classification studies have not been changed since the work began.

### Definition of Land Classes

On the basis of the intensity of use to which the land is adapted, areas have been classified into seven principal classes:

Land class I comprises areas which are better adapted to forest and recreational uses than to farming. Most of the land is idle or in woods and is suitable for immediate purchase by the State for reforestation and recreational purposes. Very little farming is being done.

Land class II is also better adapted to forest and recreational uses than to farming, but considerable farming is still going on in these areas. The land is suitable for purchase and reforestation by the State as fast as it becomes available at a reforestation price.

Land classes III to VII are adapted to continued agricultural use. The higher the land class number, the higher the degree of intensity of use to which the land is adapted, and the better the opportunity for farmers to earn incomes and accumulate capital.

Areas which are predominantly rural in character, but in which residential and other suburban uses are very important, have been classified as IIR, IIIR, IVR, and so on. The numeral indicates the relative intensity of agricultural use to which the land is adapted, and the "R" indicates that non-agricultural uses are important.

Cities and villages have been designated as residential areas. No attempt has been made to subclassify them.

The individual land class areas are irregular in shape. All of them are large enough to contain at least one farm, and most of them cover several square miles. In most cases, a township of 36 square miles includes three or four land classes.

### Methods and Techniques

The land class area boundaries are drawn on the basis of lay-of-the-land, soil, land use, and the apparent amount and condition of agricultural capital.<sup>4</sup> These factors are related as causes, measures, or effects, to the intensity of use to which the land is adapted. Lay-of-the-land and soil, together with local variations in all of the features of climate and in nearness to market, are fundamental factors determining the intensity of the economic use to which land is adapted. All of these fundamental factors influence the kind of crops that are raised and the uses to which the surface of the land is put. Land use is thus a secondary

<sup>4</sup> The methods used are fully described in Cornell University Experiment Station Memoir 160, entitled "Methods Used in an Economic Study of Land Utilization in Tompkins County, New York, and in Other Similar Studies in New York."

factor which is a partial measure of economic intensity. The kind of crops grown, together with the type of livestock products produced and other factors, determine comparative farming returns in different areas within a county. Over a period of years comparative farming returns in different areas are the principle influences governing the amount and condition of the capital which farmers can accumulate. There are other factors, also related to intensity as causes, measures, or effects, which could be used in classifying land. In obtaining information on lay-of-the-land, soil, land use, and the amount and condition of agricultural capital, and in classifying the land by means of these data, the following steps are followed:

*Property classification map.*—The first operation is the classification of property holdings. Enumerators, traveling two in a car, drive over all the roads in the county; classify the farms and other properties; and record the classifications, by the use of colored symbols, on United States Geological Survey topographic maps. Farms are classified as poor, fair, good, very good, or excellent, based on the apparent amount and condition of the farm capital. The principal, but not the only, evidences observed are the size and condition of the farm buildings. Vacant farmsteads are indicated. Rural residences not on farms are classified as to condition and whether they are occupied or vacant. Churches, schools, camps, and commercial properties are classified as used or unused. Whether properties are or are not connected to electric distribution lines and telephone lines, and sometimes whether they have or do not have lightning rods, is indicated. Roads are classified according to type of construction and apparent amount of use. Electric distribution lines and telephone lines are sketched on the maps.

Practiced enumerators make such a map from observation, seldom stopping the car, and can cover about one township in a 10-hour day. The field map is copied in black india ink at the close of each day's work.

The resulting property map indicates the general character of the land use, that is, whether the land is being used exclusively for farms, for rural residential purposes, or for a combination of these and other uses.

The subclassification of farms indicates the degree of success with which agricultural areas are being utilized. Farmers are continually struggling to adjust their farming operations to the character of the land in such a way as to earn as much as they can and to accumulate the largest possible amount of capital. Variations in the amount and condition of the capital which experienced farmers have been able to accumulate and maintain on the land, therefore, measure the combined economic effect of lay-of-the-land, climate, soil, and markets, and are one of the most reliable indications of the intensity of use to which the land is adapted.

*Land-use map.*—The second operation is a classification of land according to use. If aerial photographs are available, they are used as base maps. The enumerators walk over the land in such a way that all portions of the area are observed. The land use in each field, whether wheat, oats, hay, pasture, idle land, or any other is recorded on the photographs in detail. Meadows are subclassified according to condition and type of grass. Other important major uses, such as corn, have been subclassified in some studies.

If aerial photographs are not available, United States Geological Survey topographic maps are used as base maps. Each map is marked off in squares of about one-eighth inch on a side, each square representing 10 acres. The enumerators record in each square the predominating land use, and make supplementary field notes of the nature and estimated area of minor uses.

Farmers in the more productive areas in a county use their land more intensively than do farmers in the less productive areas. The completed land-use map presents a picture of the relative intensity of use of different areas. Since this represents the accumulated experience of the farmers it throws light on the productivity of the land. Areas where farmers are raising such crops as potatoes, cabbage, alfalfa, silage corn, and fruit are almost certainly more productive than areas where there is a considerable amount of woods and idle land and where much of the cropland is in weedy meadows, oats, buckwheat, and similar crops that usually are unprofitable in New York. The land-use map and the property map, taken together, give a clear picture of the relative productivity of areas within a county.

*Topographic maps.*—United States Geological Survey topographic maps to the scale of about an inch to the mile have already been made for all parts of New York State.<sup>5</sup> Besides being useful as base maps in making the property classification and land-use maps, they furnish information on the lay-of-the-land. This is one of the primary factors influencing the intensity of agricultural land use.

*Soil maps.*—Another primary factor influencing the intensity of use of the land is the physical and chemical nature of the soil. This factor is responsible for most of the variation in the productivity of areas within counties. Soil maps, made by the College of Agriculture in cooperation with the United States Department of Agriculture<sup>6</sup> are available for all of the counties that have been classified. These maps indicate some of the physical and chemical differences in soil that are important in determining the economic use of the land.

*Land class boundaries.*—The third operation in classifying the land is to draw the land class boundaries on

<sup>5</sup> The work of the Geological Survey is described in ch. VIII.

<sup>6</sup> The work of the Soil Survey is described in ch. X.

the combined basis of the property classification map, the topographic map, the land-use map, and the soil map, used in that order. (Fig. 39.)

Preliminary boundaries based on the property map are first drawn. Areas where most of the farms are not occupied and most of the farmsteads are now vacant or have fallen down are classed as I. Areas where most of the farms are occupied but poor are classed as II. Areas where fair, good, and very good farms predominate are classed as III, IV, and V, respectively. The topographic map is useful in drawing the preliminary boundaries between land-class areas, because a differ-

ence in productivity, such as may be expressed by a predominance of fair farms in one area and of good farms in an adjoining area, is often related to a difference in lay-of-the-land which is shown on the topographic map.

The preliminary boundaries, which have usually been drawn on transparent paper, are next superimposed on a land-use map. Since this map shows the intensity of use of each field, its use results in more nearly exact land-class boundaries than could be drawn on the basis of the property map alone.

The modified map is last superimposed on a soil map. Such a map is of considerable value in discovering the

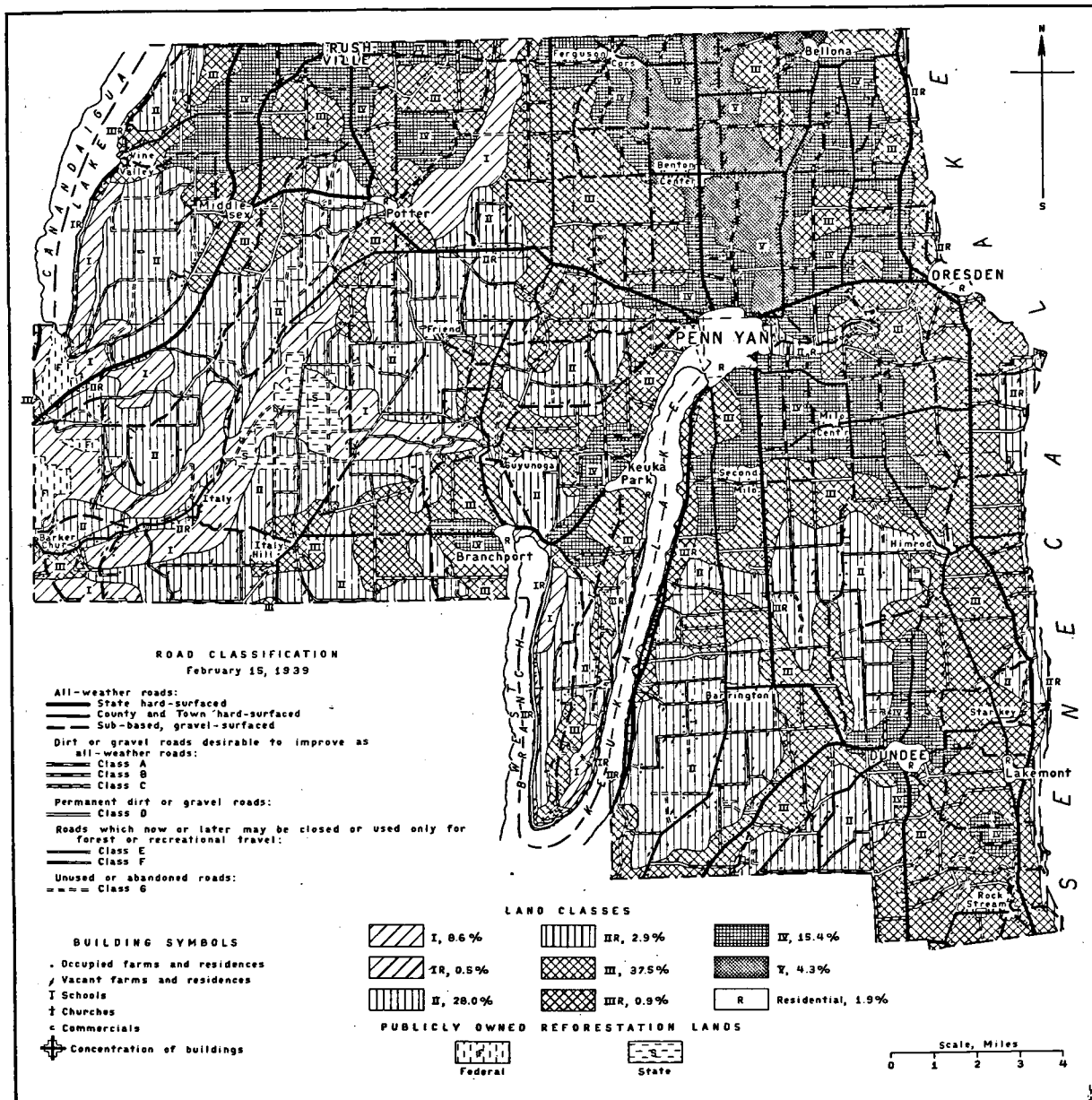


FIGURE 39.—Land Classification Map of Yates County, New York. (This map was prepared for, *An Economic Study of Land Utilization in Yates County, New York*, by W. D. Woodin of the Department of Agricultural Economics and Farm Management, New York State College of Agriculture.)

basis for differences in productivity that have been noted. Taken together with the apparent experience of the farmers as indicated by the land-use and property classification maps, the soil map also forms the basis for some modification of the preliminary land-class boundaries.

Since all the factors used in the land classification are linked to each other in a cause and effect relationship, they usually combine to indicate, without essential conflict, the land class in which an area belongs and the location of the area boundaries.

The final operation consists of taking the land-class map into the field for checking. The persons making the study drive over the roads in the county and continually observe the apparent intensity of use of the land in reference to the land-class map. If the land-class map has been correctly drawn, they will be able readily to recognize the various land classes by means of differences in the kind and condition of crops, size and condition of buildings, the lay-of-the-land, and many other features of the landscape. These differences are usually apparent immediately upon crossing from one land class into another. The nature and extent of these differences is usually not realized by persons who have not made use of land-class maps in the field.

Some modifications of the land-class boundaries may result from the field inspection trip. These may be necessitated by minor errors in the original property class, land use, topographic, and soil maps. They also may be necessitated by failure properly to interpret the basic evidence which was given by these maps. The final land-class map bears a reasonable relation to all of the factors which were measured in the course of the study. When used in the field, it also appears reasonable to farmers and others who are familiar with agriculture.

*Land classes described statistically.*—After the final land-class map is made, the property-classification map is summarized statistically so as to show the differences between land classes in respect to the types of properties which they contain. The land-use map is also summarized, furnishing a detailed description of the use of land in each class. The areas of each soil type in each land class are also determined. In some studies statistical comparisons between land classes have been made on the basis of slope and elevation as measured by the topographic map. These statistical summaries of the factors on the basis of which the land classes were distinguished give a clear picture of some of their important physical and economic differences.

The land classes are further compared statistically in terms of data on assessed valuations, tax delinquency, the character of farm businesses, farm credit, farm fire insurance, consumption of electric current,

rural poor relief, rural school costs, farm wages, tenancy and other relevant subjects. Information on assessed valuations and tax delinquency is obtained from public records and by interviewing tax assessors and other local government officials. Farm credit and farm fire-insurance data are obtained from the records of credit agencies and fire insurance companies. Information on poor relief and school costs is obtained by interviewing local officials and by referring to governmental records.

The most important comparisons between land classes are those which are made on the basis of farm business data. These data have been collected in the course of farm management surveys, in which, through personal interviews of farmers, complete information on receipts and expenses has been obtained for thousands of farms. By means of the survey data and maps showing the location of the farms that were studied, it has been possible to compare land classes on the basis of all of the details of farm organization and farming returns. Although all the classifications have been made since 1930, such comparisons show that the gross and net incomes of farmers in the higher classes have been greater than in the lower land classes over the period beginning in 1908, for which farm management data are available.

Making and presenting such comparisons is the only effective way to discover and teach the practical significance of the economic land-classification maps. By this means, farmers and other interested persons and organizations are enabled to understand how variations in the productivity of land affect their operations. The ability of the land classes to benefit from and pay for applications of capital from public and private sources has been found to vary directly with the intensity of use to which the land in each class is adapted. Farmers have been enabled to adjust their programs to fit these variations in land classes.

The statistical studies of the character of the land classes are also gradually accumulating a body of data on which a new and usable theory of land economics is being built. A practical theory of land economics results in teaching, recommendations, and Government regulations for the use of land that are consistent with the nature of agriculture and of people.

*Plans for rural roads and electric lines.*—Economic studies of land utilization and classification are immediately applicable to the problem of providing farmers with adequate public services. Suggested plans for the improvement of rural roads and the extension of rural electric distribution lines are made by the College on the basis of the final land class map and the property classification map. Part of the dirt roads are grouped in the order of the desirability of surfacing them in order to serve farm-to-market needs. Others are classified as useful for forest and recreational purposes only,

if land classes I and II were reforested. Some are recommended to be closed. Three grades of suggested rural electric distribution line extensions are mapped, according to the amount of use they probably would have if constructed. The probable amount of use is measured on the basis of studies of the actual consumption of electricity by different classes of farms and other rural properties. The road and electric improvement maps are based on the assumption that practically every farm in areas adapted to agricultural use should eventually have an all-weather road and an electric distribution line.

### Form of Results

Economic studies of land utilization and classification have been completed or are partially completed in

the eighteen counties of Tompkins, Montgomery, Chemung, Broome, Tioga, Chenango, Genesee, Steuben, Rensselaer, Monroe, Cortland, Clinton, Wyoming, Chautauqua, Otsego, Yates, Schuyler, and Cattaraugus. (Fig. 40.) In 1934, a preliminary survey was made of all the counties not already studied in detail (except those near New York City), for the purpose of distinguishing the areas of land classes I and II.

For each of the first 14 counties listed, an experiment station bulletin has been published presenting the results of the detailed land-classification study.<sup>7</sup> Each bulletin includes a detached, folded map of the county showing the land-class areas in different shades of gray stippling, the present road system and suggested improvements, rural dwellings, and cities and villages.

<sup>7</sup> See reference listed at the end of this chapter.

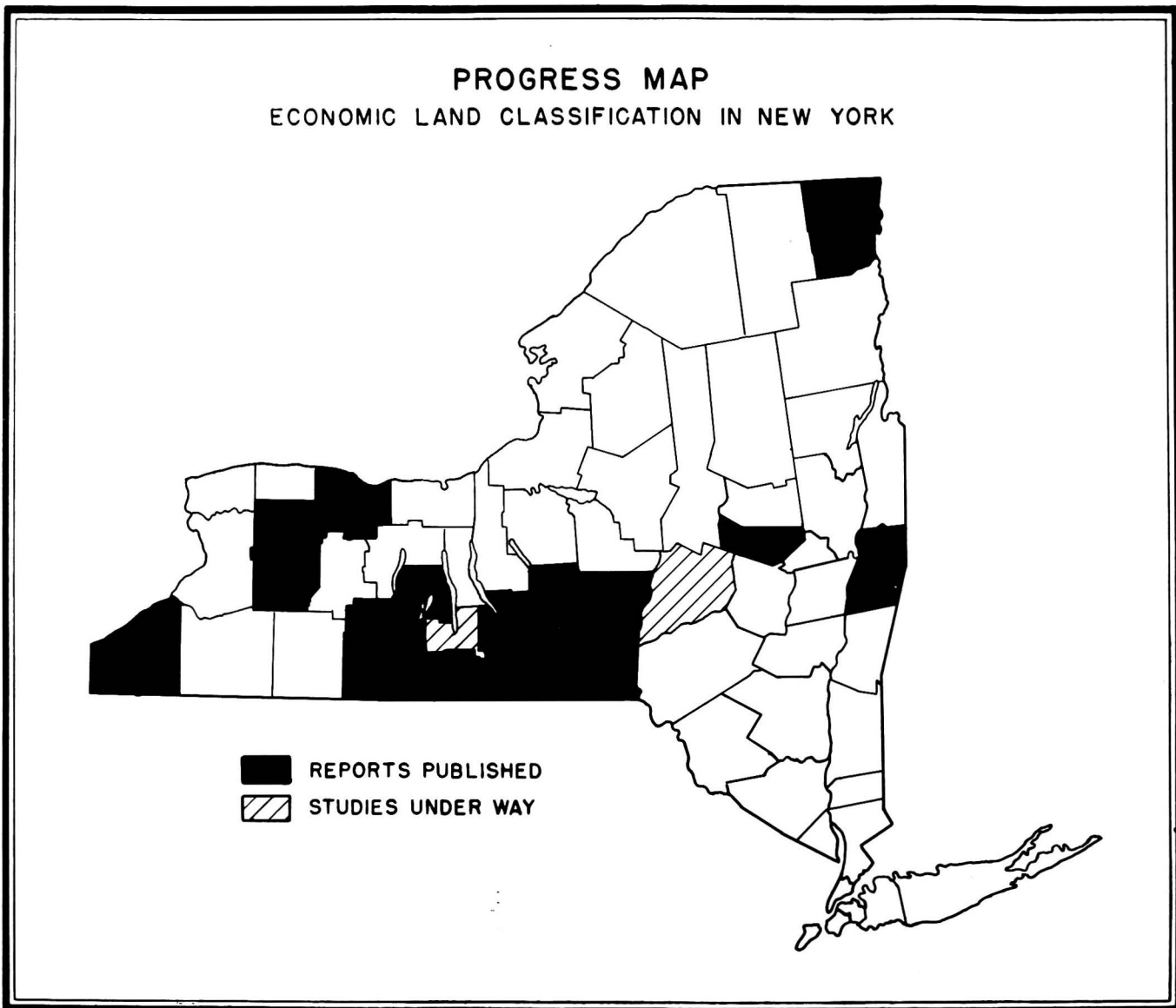


FIGURE 40.—Coverage of the New York Economic Land-Classification Surveys, July 1939

The scale is approximately an inch to a mile. Each bulletin includes a one-page illustration of the land classes with present and suggested rural electric distribution lines. The results of statistical studies of the economic significance of the land classes are presented in considerable detail, together with pictures to illustrate the character of the land and the farms in different land classes. Based on the available data, recommendations are made for the highest development of the economic resources of each class of land.

The results of the land-classification studies are being used by the Agricultural Extension Service in its educational program, by the Experiment Station as the basis for research in Farm Management and Land Economics, by the State Conservation Department and the Federal Government in purchasing submarginal land, by the State Highway Commission in planning rural road improvements, by electric utility companies in extending their lines, by credit agencies in studying their loan experience and shaping loan policies, by fire insurance companies in studying their experience and planning for the future, by tax assessors in valuing land, by persons buying farm real estate, and even by agencies selling commodities to farmers. The use of the maps gradually increases as they become more widely known. They are of value to farmers and to all other persons and agencies which contribute to agriculture in the hope of a return.

## References

The methods and results of the economic studies of land utilization and classification are presented in the following series of bulletins and memoirs, which may be obtained from the New York State College of Agriculture at Cornell University, Ithaca, N. Y. The

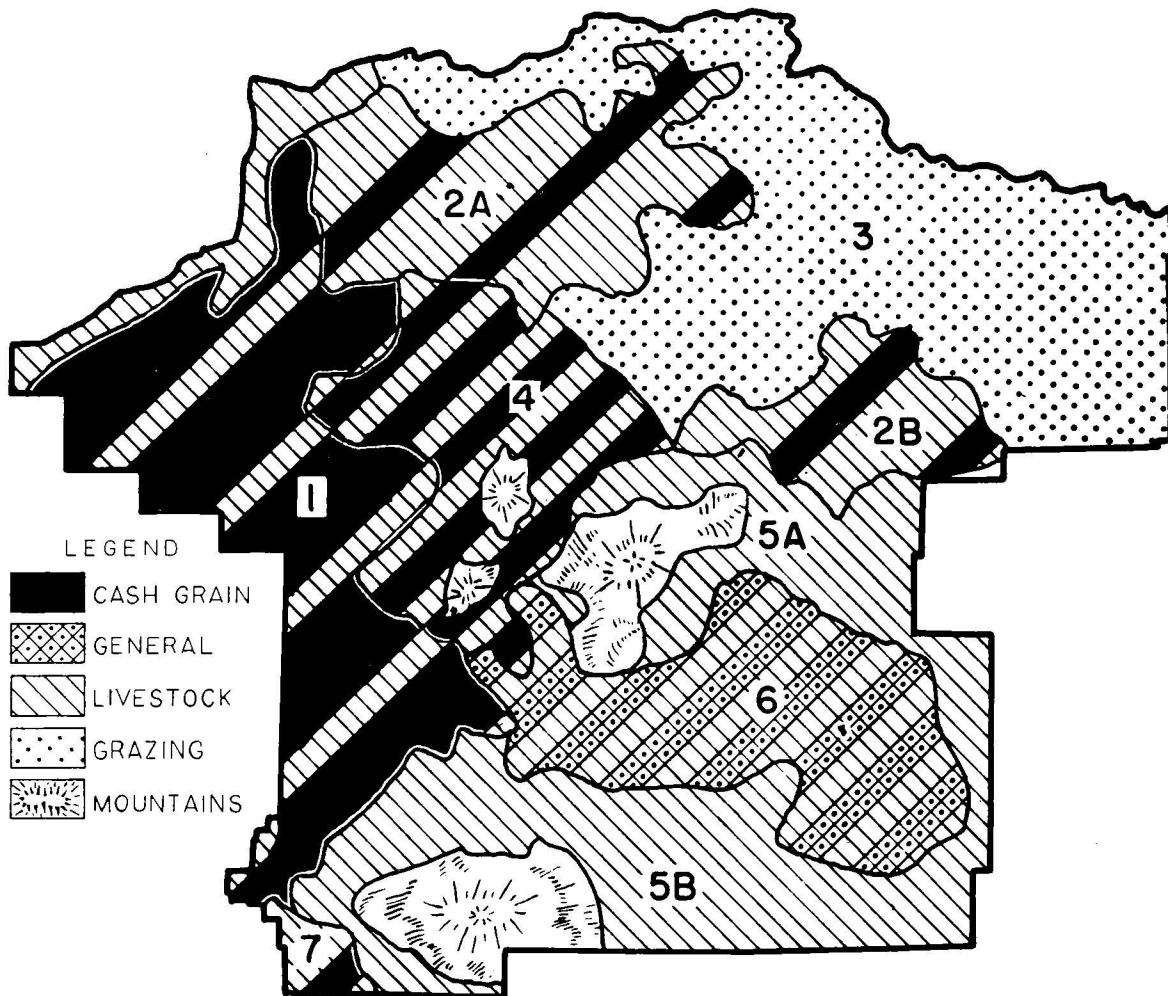
bulletins for individual counties differ in respect to the subjects which were correlated with the land class map.

- (1) Lewis, A. B., *Methods Used in an Economic Study of Land Utilization of Tompkins County and in Other Similar Studies*, Cornell Agricultural Experiment Station Memoir 160, 1934.
- (2) La Mont, T. E., *Land Utilization and Classification in New York*, Cornell Agricultural Extension Bulletin 372, 1937.

The following are Cornell University Agricultural Experiment Station Bulletins which have dealt with land classification:

- (3) Lewis, A. B., *An Economic Study of Land Utilization in Tompkins County*, Bull. 590, New York, 1934.
- (4) Hill, F. F., and Blanch, G. T., *An Economic Study of Land Utilization in Montgomery County*, Bull. 613, New York, 1934.
- (5) La Mont, T. E., *An Economic Study of Land Utilization in Chemung County*, Bull. 640, New York, 1936.
- (6) La Mont, T. E., *An Economic Study of Land Utilization in Broome County*, Bull. 642, New York, 1936.
- (7) Jones, P. B., *An Economic Study of Land Utilization in Tioga County*, Bull. 648, New York, 1936.
- (8) Tyler, H. S., *An Economic Study of Land Utilization in Chenango County*, Bull. 654, New York, 1936.
- (9) Efferson, J. N., *An Economic Study of Land Utilization in Genesee County*, Bull. 668, New York, 1937.
- (10) Keeper, W. E., *An Economic Study of Land Utilization in Steuben County*, Bull. 674, New York, 1937.
- (11) Beck, R. S., *An Economic Study of Land Utilization in Rensselaer County*, Bull. 675, New York, 1937.
- (12) Wilson, W. T., and Efferson, J. N., *An Economic Study of Land Utilization in Monroe County*, Bull. 683, New York, 1937.
- (13) Matzen, E. H., *An Economic Study of Land Utilization in Cortland County*, Bull. 685, New York, 1938.
- (14) White, O. H., *An Economic Study of Land Utilization in Clinton County*, Bull. 689, New York, 1938.
- (15) Kling, H. R., *An Economic Study of Land Utilization in Wyoming County*, Bull. 707, New York, 1938.
- (16) Joss, A., *An Economic Study of Land Utilization in Chautauqua County*, Bull. 720, New York, 1938.





SUGGESTED MAJOR LAND USE OF AREAS

- 1 SUITABLE FOR FARM UNITS ENGAGED PRIMARILY IN CASH GRAIN PRODUCTION, WITH SUPPLEMENTAL LIVESTOCK ENTERPRISE.
- 2A-2B LIVESTOCK FARMS AND RANCHES, WITH SECONDARY CASH GRAIN PRODUCTION.
- 3 SUITABLE FOR EXTENSIVE GRAZING USE IN GRAZING DISTRICTS, SERVING THE ADJACENT AREAS.
- 4 CASH GRAIN FARMS WITH VARYING DEGREES OF COMBINATION OF A SUPPLEMENTAL LIVESTOCK ENTERPRISE, AND LIVESTOCK RANCHES.
- 5A-5B LIVESTOCK RANCHES ASSOCIATED WITH LOCAL GRAZING DISTRICTS.
- 6 FARMS OF A GENERAL TYPE, WITH LIVESTOCK, CASH GRAIN, AND SPECIALTY CROPS.

PREPARED BY THE OFFICE OF THE MONTANA LAND USE PLANNING SPECIALIST, LAND UTILIZATION DIVISION, RESETTLEMENT ADMINISTRATION REGION X, IN COOPERATION WITH THE DEPARTMENT OF AGRICULTURAL ECONOMICS, MONTANA AGRICULTURAL EXPERIMENT STATION.

FIGURE 41.—A Forecast of Probable Best Major Land Uses by Areas for Fergus County, Montana

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## CHAPTER XX. LAND CLASSIFICATION AS A PART OF AREA LAND-USE PLANNING IN MONTANA

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### Origin and Objectives

Land-use planning work was undertaken in Montana by the State College in cooperation with the United States Department of Agriculture and the Resettlement Administration. The work was in response to the need for guidance of readjustment programs in the Great Plains portion of the State. Its purpose was to divide the State into land-use adjustment areas, and secure agreement on the major land uses and the types of adjustment needed in each area. It thus included, among other things, a classification of areas according to their best probable major uses.

### Type of Work

The areas classified are large, most of them covering several hundred square miles (fig. 41). The probable best major use to which these areas are suited is expressed in terms of the kinds of operating units which will provide adequate family living and support community services. The classification is broad, the areas being distinguished from one another according to major differences in the types of operating units thought desirable. Such land classification is, of course, of a different order than that in which all bodies of land of more than a few acres in extent are classified according to their suitability for particular cropping systems or other uses.

In addition to having classified the areas according to probable best major land use, recommendations were made concerning the adjustments needed in each area.

### Methods and Techniques

The areas classified were first identified and delineated on the basis of homogeneity of the pattern of soils and physical productivity, the pattern of present land use, and the presence of major problems of adjustment. The boundaries of these homogeneous "land-use adjustment areas" were determined principally by studying a series of maps showing the distribution of physical and land-use features. Study of these maps disclosed much correspondence between these features. Thus, an area having deep productive soils with a yield expectancy of over 22 bushels to the acre on summer fallow was likely to appear on the present land-use map as an area having a high percentage of the land in crops, on the map of operating units as an area with many medium-sized operating units nearly all of which are producing wheat, and on the map of gross

income probability per farm as an area in which a large percentage of the farms have a gross annual income expectancy of \$2,000 or more (fig. 42).

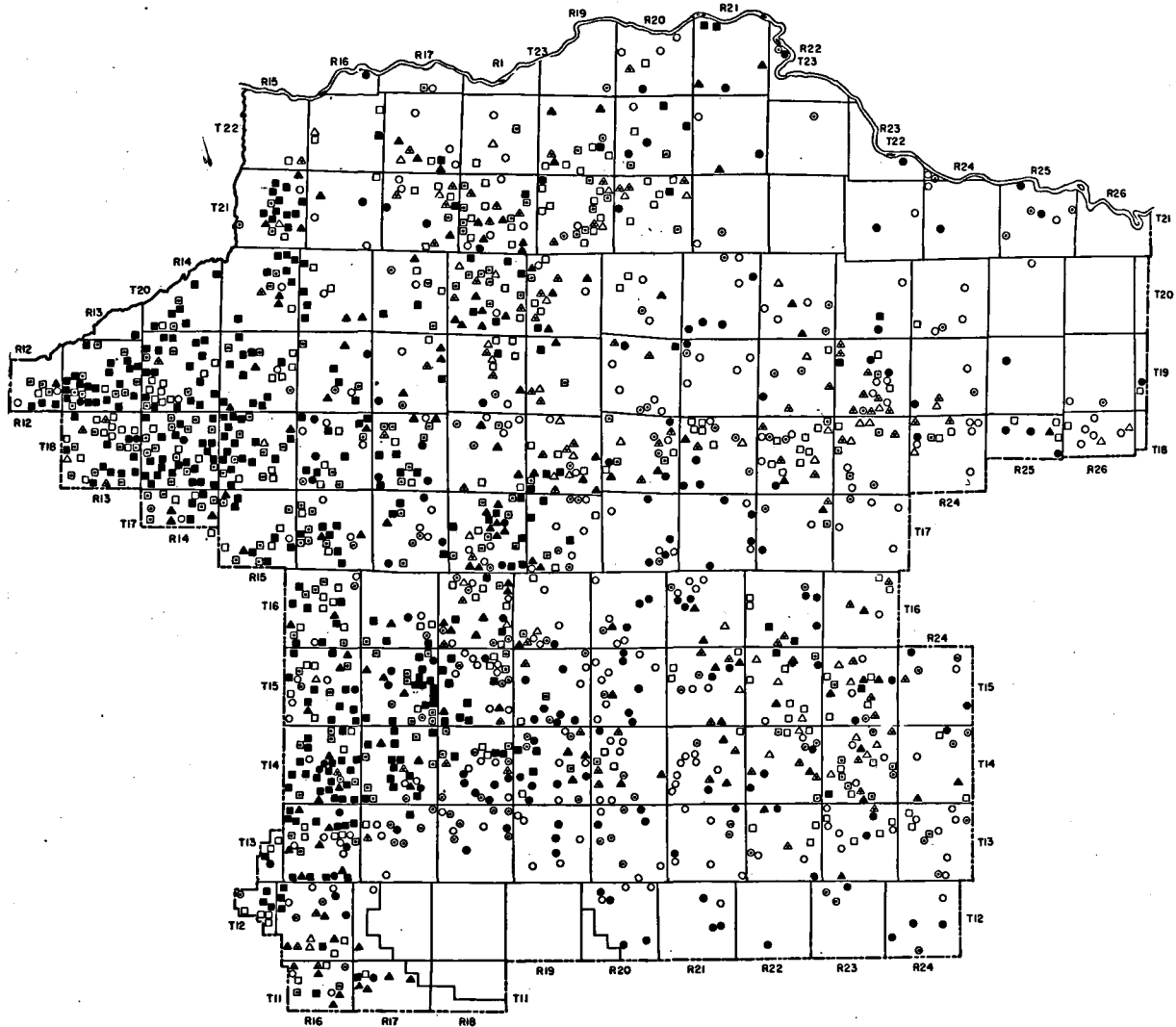
Much of the task of delineating the areas that were classified consisted of plotting on maps the features, the distribution of which determined the area boundaries. As far as possible, maps already in existence were utilized. For example, a reconnaissance soil survey map already available was used to depict the distribution of physical conditions, and in some counties to help make a classification of land according to wheat yields and grazing capacity in some counties (fig. 42). The use of land in wheat farms was taken from Agricultural Adjustment Administration contract records, and plotted on maps. The data on operating units were obtained from records of the Agricultural Adjustment Administration, the Regional Agricultural Credit Corporation, the Forest Service, from records of Federal drought purchases of livestock, and from county assessors' records. Much of the plotting and transfer of map material was done by FERA and WPA workers, without whose help many of the maps used in the project could not have been prepared.

Having outlined the areas to be classified, there followed the task of analyzing the conditions and problems in each. Naturally, much of the map information used to delimit the areas was also used in the analysis of conditions and problems. The data on individual operating units assumed particular importance in the analysis of the problems of the areas, since it gave information indicative of the ability of each operating unit to return an income sufficient to support a family. Furthermore, the data concerning every operating unit were plotted in place on the map, (1) to ascertain the distribution of units with given income expectancies in each area, and (2) to determine the relationship between size, organization, and income expectancy, and physical land conditions (figs. 43 and 44).

For each operating unit the size (in acres), the number of cattle and the number of sheep normally carried, and the expectable production of wheat, was ascertained or estimated. Knowing these factors, the gross income probability of each farm could be estimated (fig. 41).

Farm management information on the organization and income of different types and sizes of farms on land of different grades of productivity was utilized in the area analysis.

Information on public facilities, indebtedness, tax status, and various other things bearing upon the

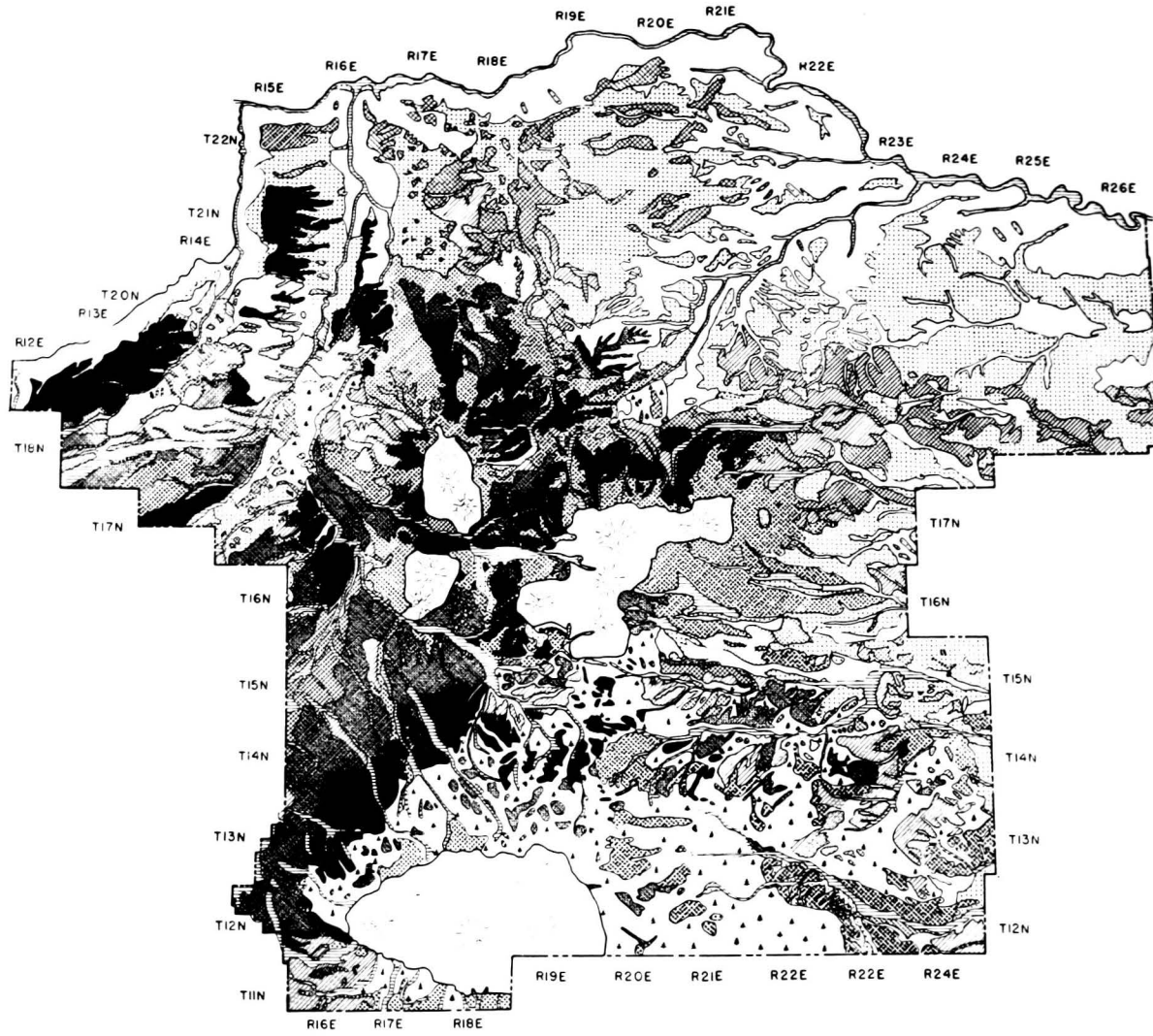


TYPE OF FARM	INCOME GROUPS		
	\$1,000 AND LESS	\$1,001 - \$2,000	OVER \$ 2,000
WHEAT	□	◻	■
COMBINATION	△	◡	▲
LIVESTOCK	○	⊙	●

THE GROSS INCOME PROBABILITY PER FARM ILLUSTRATED ON THE ABOVE MAP WAS DERIVED BY CONSIDERING THAT THE AVERAGE INCOME FROM ONE DAIRY COW, THREE BEEF CATTLE, 15 SHEEP, AND 75 BUSHELS OF WHEAT WERE EACH EQUAL TO \$60. THE BASIS FOR THESE VALUES IS FOUND IN FARM MANAGEMENT DATA OF THE AREA, AND REPRESENTS APPROXIMATELY A NORMAL OR LONG-TIME AVERAGE

COMPILED BY THE DEPARTMENT OF AGRICULTURAL ECONOMICS, MONTANA AGRICULTURAL EXPERIMENT STATION, IN COOPERATION WITH THE OFFICE OF THE MONTANA LAND USE PLANNING SPECIALIST, LAND UTILIZATION DIVISION, RESETTLEMENT ADMINISTRATION, REGION X, AND THE WORKS PROGRESS ADMINISTRATION, FROM RECORDS OF THE AGRICULTURAL ADJUSTMENT ADMINISTRATION, U.S.D.A., REGIONAL AGRICULTURAL CREDIT CORPORATION, FOREST SERVICE, U.S.D.A., RECORDS OF FEDERAL DROUGHT PURCHASE OF LIVESTOCK, AND COUNTY ASSESSORS RECORDS.

FIGURE 42.—Gross Income Probability Per Farm, Fergus County, Montana

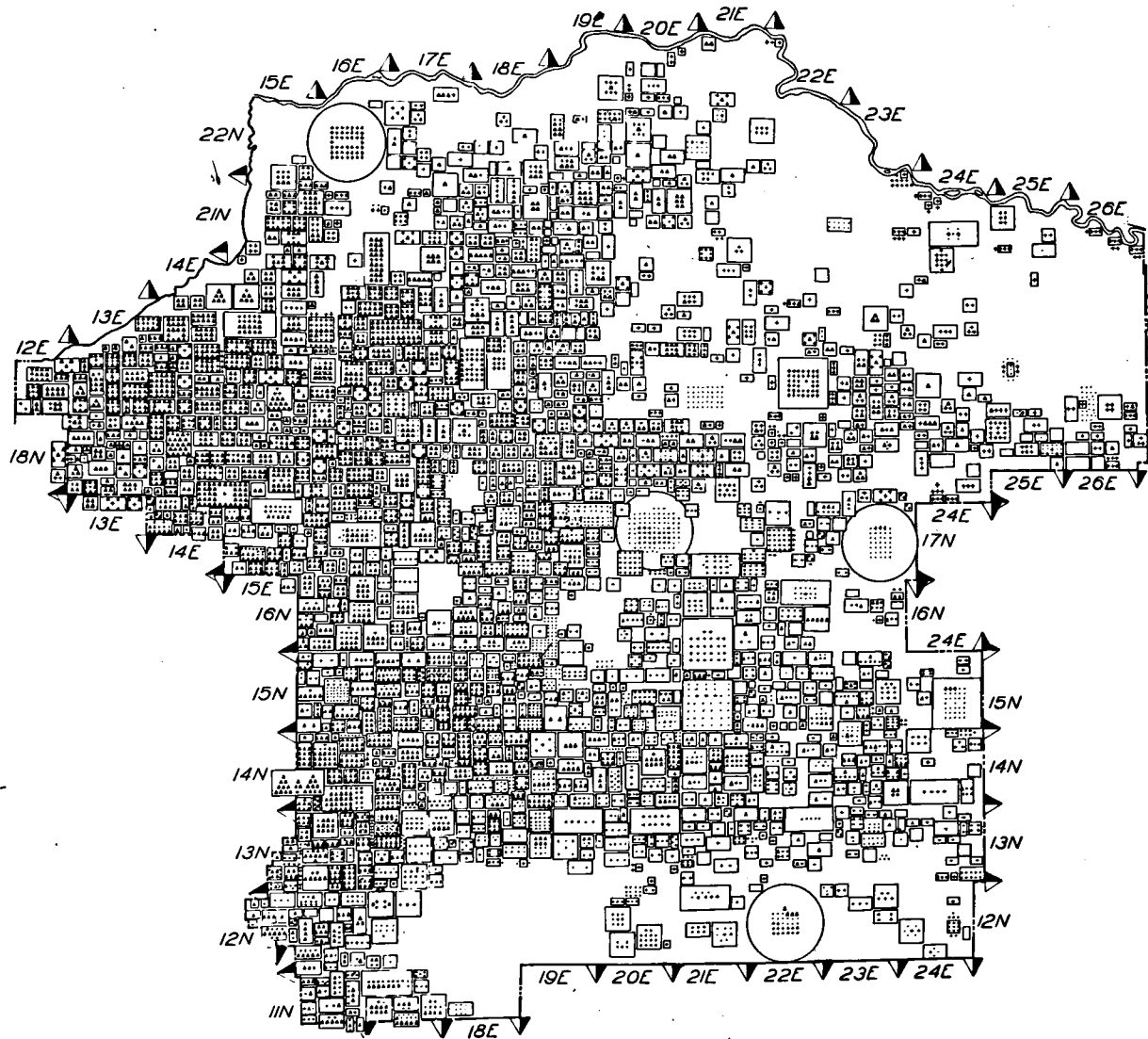


L E G E N D

FARMING LAND	MISCELLANEOUS LAND	GRAZING LAND
GRADED AS TO YIELD OF SPRING WHEAT ON SUMMERFALLOW GRADE		GRADED AS TO ACRES PER 1000 LB. STEER FOR 10 MONTHS GRADE
<ul style="list-style-type: none"> <li> 1 ST-22 BUSHELS OR OVER</li> <li> 2 ND-16 TO 21 BUSHELS</li> <li> 3 RD-12 TO 15 BUSHELS</li> <li> 4 TH- 8 TO 11 BUSHELS</li> </ul>	<ul style="list-style-type: none"> <li> LAKES AND STREAM BOTTOMS</li> <li> MOUNTAINS</li> <li> TIMBERED GRAZING</li> </ul>	<ul style="list-style-type: none"> <li> 1 ST AND 2 ND- 27 ACRES OR LESS</li> <li> 3 RD AND 4 TH-27 TO 55 A.</li> <li> 5 TH-56 ACRES OR MORE</li> </ul>

PREPARED BY THE AGRONOMY DEPARTMENT, MONTANA AGRICULTURAL EXPERIMENT STATION, BASED ON SOIL RECONNAISSANCE CONDUCTED COOPERATIVELY WITH THE BUREAU OF CHEMISTRY AND SOILS, U.S.D.A.

FIGURE 43.—Land Classification Based on Soils and Production, Fergus County, Montana



L E G E N D

- |                    |               |                   |            |                |
|--------------------|---------------|-------------------|------------|----------------|
| +25 BEEF CATTLE    | □ 0-160 ACRES | ▨ 640 1,280 ACRES | □ 5,000 TO | ○ 10,000 ACRES |
| ● 125 SHEEP        | ▨ 160-320 A   | ▨ 1,280 2,560 A   | □ 10,000   | ○ AND          |
| ▲ 500 BU. OF WHEAT | ▨ 320-640 A   | ▨ 2,560-5,000 A   | □ ACRES    | ○ OVER         |

THIS IS A DIAGRAMMATIC MAP WHICH SHOWS THE SIZE AND APPROXIMATE LOCATION OF OPERATING UNITS IN FERGUS COUNTY. THE PRINCIPAL SOURCES OF INCOME FROM THESE OPERATING UNITS ARE BEEF CATTLE, SHEEP AND WHEAT. TWENTY-FIVE BEEF CATTLE, 125 SHEEP, AND 500 BUSHELS OF WHEAT ARE CONSIDERED EQUIVALENT TO EACH OTHER FROM THE STANDPOINT OF GROSS INCOME. THE AMOUNT OF THIS INCOME IS \$400 FOR EACH GROUP. TO GET AN UNDERSTANDING OF THIS MAP IT SHOULD BE CONSIDERED IN RELATION TO FIGURE 10A.

FOR THE PURPOSE OF ASSEMBLING ALL PERTINENT DATA RELATING TO EACH OPERATING UNIT, A CARD 8½ x 11 INCHES IN DIMENSION WAS DEVELOPED WHICH PROVIDED SPACE FOR NAME AND LOCATION OF OPERATOR, CROP AND LIVESTOCK DATA, ETC., AS WELL AS A TOWNSHIP PLAT ON WHICH COULD BE LOCATED EVERY PARCEL OF LAND IN EACH OPERATING UNIT. COPIES OF THESE CARDS MAY BE SECURED UPON REQUEST TO THE MONTANA LAND USE PLANNING SPECIALIST.

COMPILED BY THE OFFICE OF THE MONTANA LAND USE PLANNING SPECIALIST, LAND UTILIZATION DIVISION, RESETTLEMENT ADMINISTRATION, REGION X, IN COOPERATION WITH THE DEPARTMENT OF AGRICULTURAL ECONOMICS, MONTANA AGRICULTURAL EXPERIMENT STATION.

FIGURE 44.—Location, Size, and Income Factors of Farms and Ranch Operating Units, 1928-32, Fergus County, Montana

desirability of particular types of operating units, was studied.

Having analyzed the kind of operating units now using each of the delimited areas, and having gotten a measure of their success in returning income, as well as the public costs associated with them, conclusions were reached as to the kind of operating units believed to be desirable in each area. Classification of the areas according to the probable best major use of land (kind of operating units) sets forth these conclusions (fig. 41).

In addition to classifying the areas according to the probable best major land use, the analysis of each area undertakes to ascertain what changes in the present pattern of operating units, in cropping systems or soil management practices, and in public facilities, are needed in order to bring about or facilitate the major land use considered desirable.

Participation of local people in decisions as to the best major land use and the kind of adjustments needed, was sought and obtained. Increased responsibility of local people for these decisions has followed the merging and integration of this activity with the county agricultural land-use planning process.<sup>1</sup>

The gathering and presentation of factual material on maps and otherwise, continues to be the function of the technicians cooperating in this enterprise. The material is presented to community and county agricultural land-use planning committees as an aid in

<sup>1</sup> See chapter XXII.

making better decisions, and as an aid to keeping the decisions consistent between counties.

### Form of Results

The factual material development in connection with this activity is presented to county and community committees, either in rough draft or in data handbooks for individual counties, issued by the Montana Extension Service.<sup>2</sup>

Much of the factual data collected in this activity is summarized in a bulletin of the Montana Agricultural Experiment Station.<sup>3</sup>

An analysis of present types of farming and trends in farm organization and production, together with recommendations for farm adjustments growing out of this activity, will be presented in a series of bulletins of the Montana Agricultural Experiment Station, each covering a group of counties having similar conditions.<sup>4</sup>

It should be noted that the Montana Agricultural Experiment Station does not refer to the activity described here as land classification, but uses that term to describe the process of rating or grading soil types or soil areas according to the expected yield of wheat or grazing capacity (Fig. 42).

<sup>2</sup> *Planning an Agricultural Program for Fallon County*, Montana Extension Service, Bozeman, October 1936.

<sup>3</sup> *Physical Environment and Economic Factors Affecting Montana Agriculture*, Johnson, Neil W., and Saunderson, M. H., Montana Agri. Expt. Sta. bull. 328.

<sup>4</sup> *Farm Adjustment in Montana; Study of Area VII; Its Past, Present and Future*, Johnson, Neil W., Montana Agri. Expt. Sta. bull. 367, March 1939.

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## CHAPTER XXI. LAND CLASSIFICATION IN THE SIERRA NEVADA FOOTHILLS OF CALIFORNIA<sup>1</sup>

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### Objectives

The classification of land according to the uses or combination of uses likely to give the greatest social return was undertaken as part of comprehensive land-use planning studies in the Sierra Nevada foothills. Greatest social return was intended to imply: (1) increased per capita net real income, (2) reduced dispersion of incomes, and (3) permanence of income.<sup>2</sup>

The foothill areas in which these studies were made are characterized by pressing and complicated land-use problems, including conflicting as well as competing uses of land, declining bases of income, declining population, and inadequate financial support for local governmental units. The areas have been much in need of the coordination or planning of major land uses based on the uses to which the land is best suited.

In these studies distinction was made between the research basic to planning, on the one hand, and actual planning on the other hand. The point of view was taken that planning with respect to land use involves setting up goals in the form of uses or combinations of uses for particular areas and reaching decisions as to the desirable course of action necessary to attain these goals. The responsibility of the research worker ended when he had set forth the advantages and disadvantages of a number of alternative uses or combination of uses for particular areas. It was the responsibility of the planning agency (local land utilization committee, State planning board, etc.) to determine which of the alternative uses were "best" and to forward the program that would see these uses put into effect.<sup>3</sup>

The land classification discussed here falls within the first stage of the planning process, namely, that of basic research.

### Procedure

The first part of the procedure consisted of ascertaining the physical characteristics of the land and

distinguishing between areas possessing distinctive patterns of physical characteristics. Two different procedures were employed, one in the areas covered early in the course of the study where soil surveys were available, and another in the areas covered later where soil surveys were not everywhere available.

Drawing data from standard soil survey work, the first step grouped soil types into three major classes on the basis of soil features known to have an important bearing on crop production. Class A consisted of deep residual soil types having considerable range in texture. Class B consisted of the moderately deep soil types. Class C consisted of the very shallow or very stony soil types.

The second step involved a study of elevations and surface features. Elevations were divided into three classes, the dividing altitude between the classes being one of known agricultural significance. All lands with elevations up to 2,000 feet above sea level were put into one class, and all lands between 2,000 feet and 3,500 feet above sea level were put into a second class. All elevations above the 3,500-foot contour were put into a third group. Elevations of 2,000 feet and 3,500 feet were thus taken as the critical altitudes for the area.

On the basis of surface features the lands were divided into two categories, rolling land and gently rolling land.

The lands were then grouped into classes on the basis of their combined features of soil, surface, and altitude. Five such classes were distinguished as follows:

Class 1. All lands having class A soils, gently rolling surface, and elevations up to 3,500 feet and all lands having class A soils, rolling surface, and elevations up to 2,000 feet.

Class 2. All lands having class A soils, rolling surface, and elevations between 2,000 feet and 3,500 feet.

Class 3. All lands having class B soils, gently rolling surface, and elevations below 2,000 feet.

Class 4. All lands having class B soils, gently rolling surface, and elevations above 2,000 feet, and all lands, having class B soils, rolling surface, and elevations up to 3,500 feet.

Class 5. All lands above elevations of 3,500 feet regardless of soil class and all lands having class C soils below elevations of 3,500 feet regardless of surface features.

The distribution of these different classes of land, and their relative proportions in combination were studied in order to identify and distinguish on the map areas which are homogeneous in the pattern of their physical

<sup>1</sup> Carried on cooperatively by the California Agricultural Experiment Station and the California Forest and Range Experiment Station.

<sup>2</sup> Weeks, David, and Josephson, H. R., "Economic Criteria for Classifying Non-Urban Land According to Probable Best Uses," *Journal of Farm Economics*, Vol. 21, No. 2, May 1939.

Weeks, David, Wieslander, A. E., and Hill, C. L., *The Utilization of Eldorado County Land*, Calif. Exp. Sta. bull. No. 572; May 1934.

<sup>3</sup> In the areas covered earliest in this activity, the research workers themselves undertook to make the decisions as to what use or combination of uses was "best."

characteristics. Seven types of areas were recognized. They were characterized as follows:

Type 1. Areas having a predominating proportion of deep soil of both light and heavy texture, gently rolling surface, and elevations of 1,500 to 3,500 feet.

Type 2. Areas having deep, light-textured soils, gently rolling surface, and elevations ranging from 200 to 1,500 feet in combination with an approximately equal amount of land with similar soils and elevations but with rolling to mountainous surface.

Type 3. Areas having a predominating proportion of shallow soils, rolling surface, and elevations of 500 feet to 2,000 feet in combination with minor areas having deep soils, gently rolling surface, and elevations of 1,000 feet to 1,500 feet.

Type 4. Areas having a large percentage of shallow soils, gently rolling surface, and elevations below 1,000 feet in combination with minor areas of similar soils and surface with elevations ranging from 500 feet to 2,000 feet.

Type 5. Areas predominated by shallow soils, rolling to mountainous surface, and elevations of 500 feet to 1,500 feet.

Type 6. Areas having equal proportions of deep and shallow soils, rolling to mountainous surface, and elevations of 1,500 feet to 2,000 feet combined with minor areas having similar soils and elevations with rough, rocky surface.

Type 7. Areas of rough, mountainous, rocky nature, and a wide range of elevations combined with high plains.

In the areas covered later in the study, soil surveys were not everywhere available. In these areas a map

was prepared showing land-character-type areas. In the preparation of this map data covering climate, soils, surface features, and geologic structure were plotted on separate maps all on the same scale. Each map was analyzed to determine the details of the distributions it showed. Then they were superimposed over each other to bring out the coincidence in their patterns. Areas having distinctive combinations of physical characteristics were delimited on a summary map. Another map was prepared on which was delineated areas having distinctive combinations of vegetative types. The procedure thus far resulted in two summary maps. One showed land areas delimited on the basis of land features alone, soil, surface, and elevations, and the other showed land areas delimited on the basis of natural vegetation alone. Areas on the first were denoted by Roman numerals and on the second by colors. On the basis of these two summary maps, the map of land-character-type areas was prepared and drawn in final form. It is to these land-character-type areas, each fairly homogeneous with respect to physical characteristics and natural vegetation, that the economic interpretations were made.

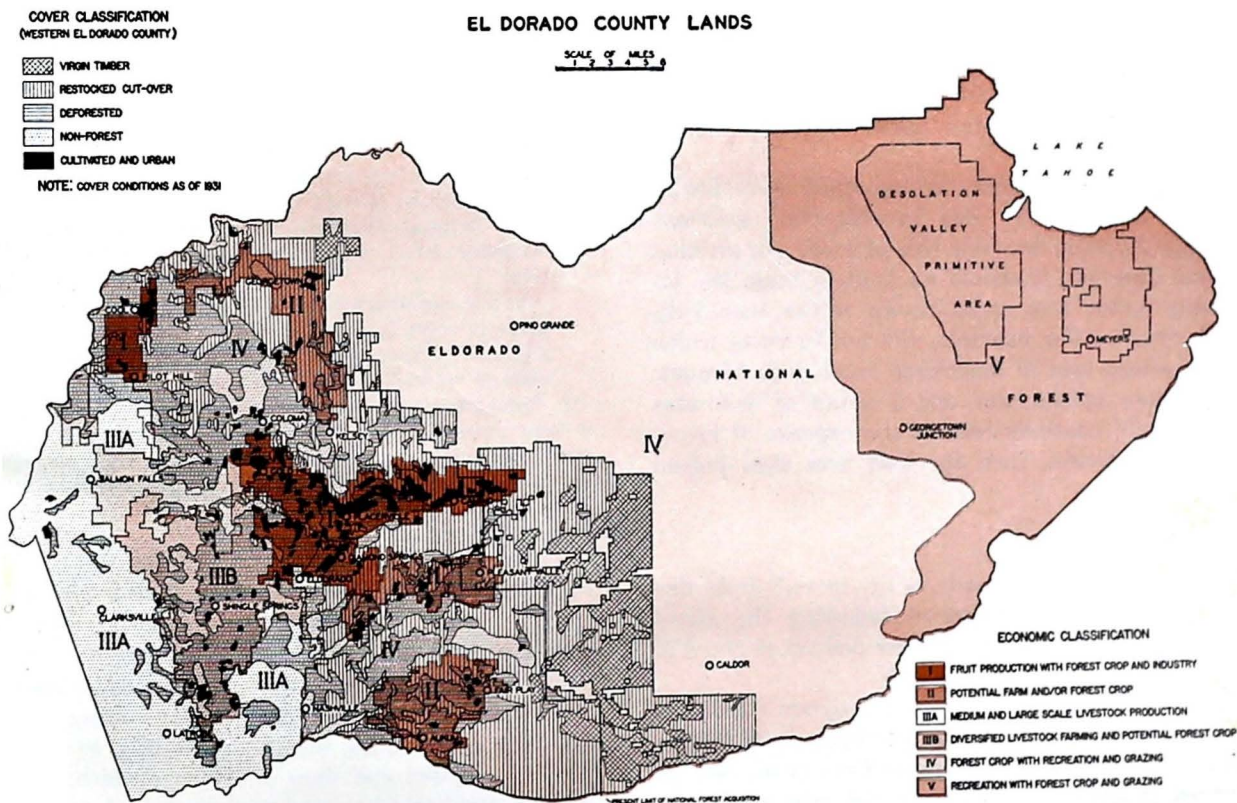


FIGURE 45.—Cover and Economic Land Classification, El Dorado County, California



### Use of Land Classification in Economic Interpretations

In the areas covered early in the course of this study, judgment concerning the use capabilities of the different land-character types was based upon analyses of costs and returns for each of the more important enterprises which actually compete for the use of each area. In addition, consideration was given to government expenditures and benefits in arriving at this judgment; to the bearing of prospective or present hydroelectric power, mining, and manufacturing upon the use capabilities of the several areas; and to the prospect of recreational development.

Attempts were made to produce quantitative summaries of the total net productivity of an area under given combinations of uses. Invariably, however, qualitative determinations had to be resorted to before it was possible to reach a final judgment. Certain areas, of course, were so obviously unsuited to some uses that no careful analyses of costs and returns of different enterprises were necessary to demonstrate the undesirability of such uses.

In the areas covered later in the study, although costs and returns, both public and private, have been the main basis of economic interpretation, the problem has become one of considering qualitatively the various possible uses and selecting the more promising ones for detailed analyses in order to ascertain the advantages of one over the other. In addition, data have been compiled with the idea of estimating the probable shift in the frequency distribution of net real incomes of the population affected by any marked change in land use.<sup>4</sup>

The areas covered early in the study were finally classified according to the investigators' decisions regarding the most desirable uses of each. In arriving at these decisions, it should be kept in mind the influencing factor was social return rather than individual return. For example, the public costs which attend certain uses of land were taken into account. If these were unduly large, and if certain of these uses of land could continue only at the expense of heavy public expenditures, then the land uses were judged undesirable.

### Form of Results

In the earlier studies made in the foothill areas five classes of land were delimited following the above procedure. These five classes were defined as noted in the legend accompanying figure 45.

For each of these five classes a program of utilization was recommended. For example, it is recommended that area V. in El Dorado County be used for livestock production. The suggested program in this area is:

1. In subdivision III.a, which is the medium to large scale livestock farming portion of this general classification, further consolidation of holdings together with the relocation of certain farmsteads would introduce economics in the management of the livestock industry and in the administration of county government.

2. Subdivision III.b of this general classification includes mainly shallow soils which are interspersed with about 15 to 20 percent of the deeper, more fertile soils. The objective on this land should be a farm economy which will utilize the shallow soils for grazing, the deeper soils for irrigated or dry-farmed supplementary crops, the rougher lands for timber production.

3. The deforested and nonforest lands in III.b that are now covered by woods and chaparral should be used for any forage value they possess but their capacity for profitable future timber production should be safeguarded by protecting them from broadcast burning or other damage by fire.

4. Plans for the conversion from natural vegetation in all parts of III.b where it still stands to grass should be postponed until more effective and cheaper methods have been developed experimentally.

5. The value of irrigation in area III.b is recognized, but any irrigation projects installed should, in the interest of economy, be designed to irrigate only a small proportion of the total area.

6. The problem of seasonal fluctuation of feed supply should be met in area III by one or more of the following means:

- a. The growing of supplementary crops by dry farming. These crops may include grain, hay, vetch, field peas, Egyptian corn, or other forage crops produced on the tillable portions of the farm.
- b. The production of alfalfa, clover, pasture, or other intensive crops by irrigation.
- c. The cooperative use of mountain range land.
- d. The purchase and sale of stock each year, pasturing them only during the grazing season.
- e. The renting of grazing land for the duration of the grazing season to livestock producers who graze their livestock elsewhere during the winter and late summer.
- f. Specialized farming with division of labor among different farming enterprises, for the production of the feeds necessary for a unified community livestock specialization.
- g. The consolidation of land holdings and livestock enterprises in order to obtain more economical producing units and more flexible systems of operation including the economical use of distant pasture lands.

7. Local planning in the interest of economy should be applied in those portions of III.b where the growing of supplementary crops will result in small scale enterprises, a relative dense population, and an increased need for such public services as roads and schools.

These same earlier studies, in addition to producing the above classification and suggested programs for land utilization, undertook to recommend ways and means of carrying the programs into effect. Public policy measures designed to bring about good land use were considered and their usefulness appraised.

In the later studies, the policy has been to set forth the basic factors and lines of evidence which planners need in deciding what land uses are best for each area

<sup>4</sup> *Op. cit.*, pp. 427.

but not to undertake to set forth planning decisions. These will be left to the planning groups or agencies.

**Personnel**

The work in the Sierra Nevada Foothills Area has been carried out by Dr. David Weeks of the California

Agricultural Experiment Station and A. E. Wieslander, C. L. Hill, H. R. Josephson, and Wade DeVries of the California Forest and Range Experiment Station. Other technicians in the fields of forestry, soils, agronomy, and plant ecology, and local farmers contributed to the investigation.

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## CHAPTER XXII. RURAL LAND CLASSIFICATION FOR TAX ASSESSMENT<sup>1</sup>

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### Origin and Objectives

Studies in many parts of the country have shown that the appraisal of farm land for purposes of tax assessment is often quite out of harmony with the production capability of the land. In many cases land of low-producing power is greatly over-appraised in comparison with land of high-producing power and vice versa. Although many European countries have developed scientific and orderly methods for appraising farm land in accordance with its production capacity, only recently has the problem been attacked in a systematic way in the United States.

A method of rural-land classification that would provide a basis for equitable tax assessment was developed in North Dakota and has been applied in three of the western counties of the State, namely, McKenzie, Billings, and Morton.<sup>2</sup> The proposal for the work originated with the county commissioners in McKenzie County who were faced with a critical problem of tax assessment of the rural lands in their county. They had had difficulties because of a lack of standardization of assessments, and it seemed to them that the most equitable system would be the one based on the producing power of the land. In 1921 the North Dakota Legislature had passed a law permitting counties to sponsor such a land classification, the expense of which would be borne by the county.<sup>3</sup> Since it was obvious that the fundamental basis of such a classification would be the physical characteristics of the land, the county commissioners approached the State agricultural experiment station with the thought that a soil survey should be basic to the work. The station undertook to develop a suitable method and carry it out. Cooperation was solicited of the United States Department of Agriculture with the result that the Soil Survey Division assisted by carrying out the necessary field studies and mapping. Approximately half of the cost of the mapping work was borne by the station which was reimbursed from county funds.

### Procedure

The procedure for developing this type of land classification may be summarized under four general points:

<sup>1</sup> Conducted by the North Dakota Agricultural College in cooperation with the Division of Soil Survey, U. S. Department of Agriculture.

<sup>2</sup> Kellogg, Charles E. and Ableiter, J. H., 1935. *A Method of Rural Land Classification*. U. S. Department of Agriculture, Tech. Bull. 469.

<sup>3</sup> See North Dakota Session Laws, 1921.

1. The physical features of the land, including internal and external soil characteristics as recognized in the modern detailed soil survey, were accurately mapped.<sup>4</sup> In addition, full cognizance was taken of significant differences in relief and stoniness, any other physical features of local importance in land use, and the native vegetation. Combinations of these features give physically defined natural land types. In order that the natural land types might be interpreted in accurate terms, individual land types of a size sufficient to influence significantly the capabilities of separate units of operation were separated

2. A productivity rating for each of these physically defined natural land types was determined in each of the two use-groups, namely, cropping and grazing, under current systems of management. These ratings represented the generalization of all information available, including that obtained inductively from a consideration of physical characteristics of the land, as well as that acquired deductively, from analyses of farmers' experience and experimentation. For convenience, the ratings of each land type were expressed in terms of a standard, taken as the best land from a physical point of view, in each of the use-groups.

3. The next step in the procedure was the determination of the use-group for each tract of land on the basis of existing ownership pattern, physical characteristics of the land, accessibility to markets, availability of water on grazing land, and size of contiguous areas of other land types.

4. Finally, each tract of land was rated within the use-group (or use-groups) to which it belonged. The ratings of the natural land types in the use-group are basic, but these ratings needed adjustments according to certain considerations that influence production on particular tracts or operating units. Such considerations include accessibility to markets, availability of water, nature of the existing vegetation on forest and grasslands, and accessibility of the various parts of the tract to the farmstead. By an analysis on the standard or ideal land of the marketing cost at various distances on the different classes of roads, a schedule was prepared showing the percentage reduction in the basic ratings of land for the various locations. Similar schedules were calculated with respect to the other factors.

<sup>4</sup> For detailed discussion of these methods see Kellogg, Charles E., *Soil Survey Manual*. U. S. Department of Agriculture, Misc. Pub. 274, 1938.

**Form of Results**

As a final result of the classification each piece of land, as it appeared on the tax roll, was given a rating in terms of the percentage of the standard for the county. The proper county officials need only to place an appraisal value on the standard land. Every other piece of land then has its appraisal value computed strictly in accordance with its productive capacity by applying the percentage factor assigned to it. In the development of the system the physical data were kept distinctly separate from those of economic origin so that with any changes in economic conditions, the necessary adjustments of the land classification could easily be made without additional field mapping.

**Utility**

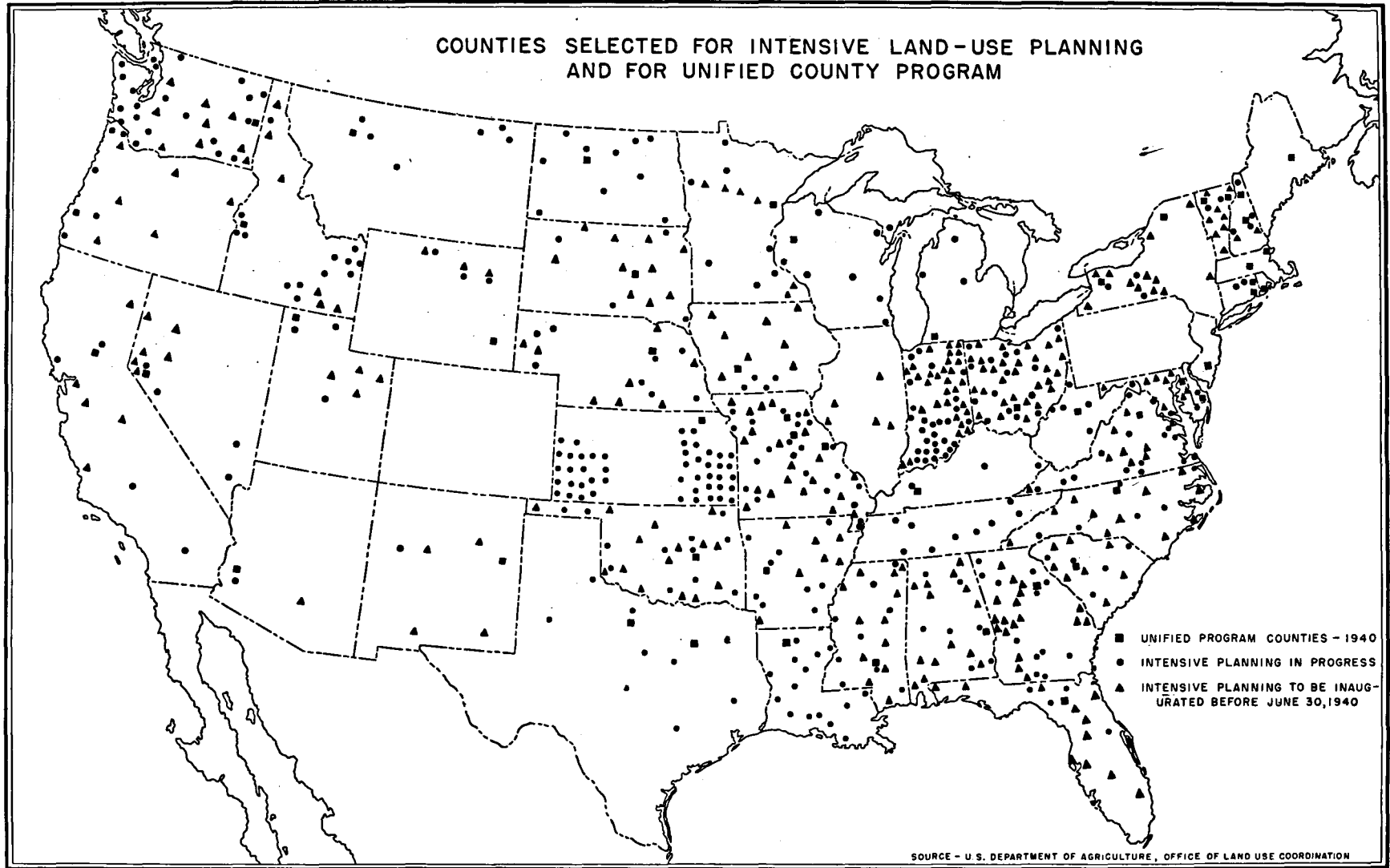
The purpose of the land-classification data thus obtained was to serve as a basis for the assessment of taxes on rural lands. The results have been found to be suitable for that purpose. After the assessments for each piece of land, as it appears on the tax roll, have been calculated and announced, opportunity is given for hearings on complaints in order that any errors that were made can be corrected. Although in a good many cases the assessments made by this method are quite different from previous assessments, the new results have been generally accepted. The reason for this is partly because the whole scheme was worked out in close cooperation with the county commissioners, and nearly every farm operator in the county knew the object of the work and had some contact with it as it progressed. Particular care was taken with the type of personnel employed in this work such that the local people were confident of their professional skill and earnestness.

Maps sufficiently detailed for purposes of tax assessment would, of course, serve many other purposes in-

*Final Ratings of a Sample Section in Percentage of Ideal*

Description	Distance to market (in terms of mileage of graded road)	Agricultural land			Grazing land				Final rating
		Area	Land rating	Rating after deduction for distance	Area	Land rating	Rating after deduction for distance	Rating after deduction for water supply	
	Miles	Acres	Percent	Percent	Acres	Percent	Percent	Percent	Percent
NENE	4	1	64	61	39	3	3	-----	4
NWNE	2	64	61	38	4	4	-----	-----	5
SWNE	10	66	63	30	9	8.8	-----	-----	22
SENE	13	93	89	27	2	2	-----	-----	30
NENW	5	78	74	35	3	2.9	-----	-----	12
NWNW	30	54	51	10	13	13	-----	-----	42
SWNW	13	57	54	27	20	20	-----	-----	31
SENW	27	78	74	13	21	21	-----	-----	57
NESW	40	77	73	-----	-----	-----	-----	-----	73
NWSW	35	76	72	5	4	3.9	-----	-----	64
SWSW	17	71	67	23	10	10	-----	-----	34
SESW	38	72	68	2	1	1	-----	-----	65
NESE	40	90	86	-----	-----	-----	-----	-----	86
NWSE	15	93	89	25	16	16	-----	-----	43
SWSE	8	93	89	32	16	16	-----	-----	31
SESE	40	93	89	-----	-----	-----	-----	-----	89

cluding the development of grazing districts, formulation of farm plans, the planning of water facilities, and the like. For example, after much of the land-classification work had been completed, the Federal submarginal land purchase program was initiated in this area. Results of the land-classification survey were used as a basis for determining what lands should be purchased and for appraising them. It might be added that since every factor that had a significant bearing upon agricultural production had to be taken into account in developing the mapping legends, the categories had to be developed in great detail. The results of this experience had the effect of increasing the accuracy and completeness of the system of classification for the soils of this region. Also, since economic conditions change more rapidly than physical conditions this work has definitely shown the necessity of keeping the two types of data separate so that the final classification may be revised in accordance with changing economic conditions without the necessity of revising all of the fundamental maps.



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FIGURE 46.—Coverage of the County Agricultural Land-Use Planning Program, June 1940

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## CHAPTER XXIII. LAND CLASSIFICATION AS A PART OF THE COUNTY AGRICULTURAL LAND-USE PLANNING PROGRAM

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### Origin and Objectives

Land classification is an important part of the County Agricultural Land-Use Planning Program. It is that phase of the program wherein local areas are mapped, analyzed, and classified according to the use or uses to which they appear suited. This phase is known technically as the Area Mapping and Classification Project. (Fig. 46.)

The County Agricultural Land-Use Planning Program is carried on cooperatively by the Department of Agriculture, the State land grant colleges, and farmers. It arose out of the need for harmonizing and coordinating the many land-use measures and programs being carried on. Since 1933, the number of public measures that have been undertaken to influence land use has increased enormously. Public agencies formerly relied largely upon research and education as the forces to shape and maintain good land-use practices. Now these agencies realize the need for public and cooperative measures to accomplish work that the individual farmer working alone could not accomplish, no matter how well he might be informed. These agencies, to mention some of the current public measures which affect land use, now induce shifts in cropping systems and practices through direct governmental payments; they take submarginal farm land off the land market through public purchase; they make new land available for settlement through expanded flood control, drainage, and irrigation operations; they give public aid to the relocation of settlers; through credit they try to rehabilitate farmers on a sound farm management basis; they extend public credit to aid the establishment of rural electric lines; they encourage the enactment of rural zoning ordinances to control land settlement.

Each one of these measures has been undertaken more or less independently and irrespective of the others. Under these circumstances it has been inevitable that in certain areas one measure operated to foster a situation which another measure was attempting to abate. For example, continual expenditure of Federal drought relief funds in parts of the Great Plains has tended to perpetuate a type of farming which cannot support itself without continual relief. Other Federal funds are being expended in the same area to replace this type of farming with one more suited to the land. The two Federal programs thus tend to work against each other.

The question has become, then, how to get all the different programs working harmoniously together when they reached the farm or local area. The test of whether these programs do work together is to see whether they work in the direction of a common desirable goal. But how could this test be applied? How could it be determined whether or not all programs were working toward a desirable goal in each area, if that desirable goal had never been agreed upon? In most parts of the country no such agreement had been reached. It had never been decided for instance, which areas were suited to farming and which were not. Individuals, of course, had their own opinions, but there had never been agreement, such as could be used in guiding public action.

It is one of the first tasks of the County Agricultural Land-Use Planning Program to decide what land-use goals or situations are desirable in each local area. In the course of the work in a given county, areas which have similar characteristics and are suited to the same uses are associated in a class, marked with the same designating symbol on a county map, and described individually in an accompanying report. Whether the land-classification element in this work consists merely in sorting the areas into classes according to desirable land uses, or in the whole job of reaching decisions about what use is best, depends upon how broadly one defines the scope of land classification.

The work is carried on under memoranda of understanding between the Department and the cooperating State agencies. The type of work contemplated is the outgrowth of experience accumulated during several years of land-use planning. The present work plan, "Work Outline No. 1,"<sup>1</sup> was developed from procedures used by the Department in several parts of the country. Every land-use agency in the Department participated in working out the procedure. Work along the lines indicated in "Land-Use Planning Work, Outline No. 1" was begun in the fall of 1938. It is now under way in about 750 counties. Between 50 and 75 more counties will initiate work before June 30, 1940. In about 50 counties the work has been carried to a point where it is acceptable as a guide to Department land-use programs.

<sup>1</sup> A description of the method employed is contained in "Land-Use Planning Work, Outline No. 1." U. S. Department of Agriculture, February 1938.

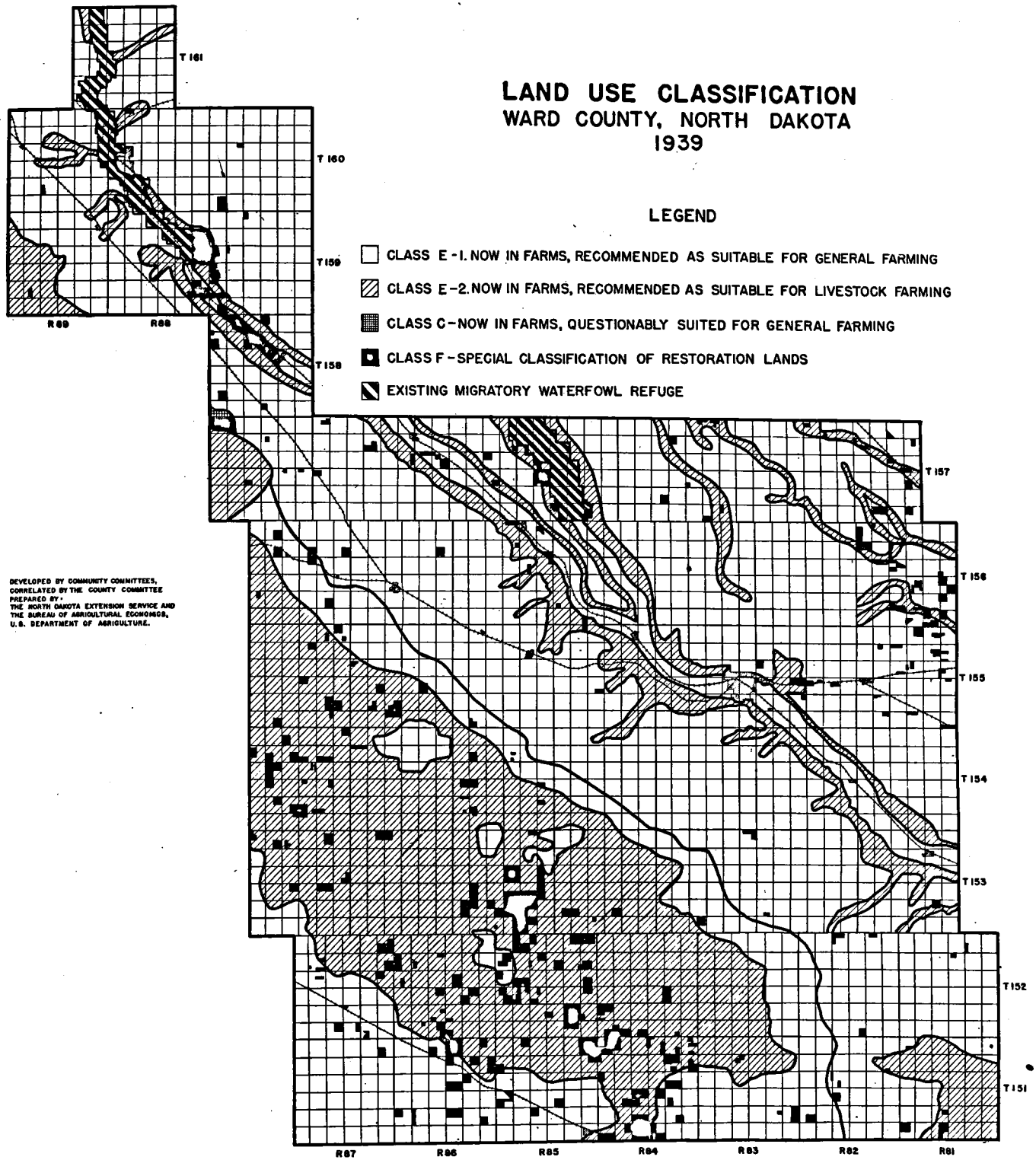


FIGURE 47.—Land-Use Classification in Ward County, North Dakota, 1939

## Organization

The county agricultural land-use planning program is conducted in the States through a State land-use planning committee. This committee consists of State administrative officials in charge of the action programs of the Department of Agriculture, such officials of State agencies as have responsibility for the administration or management of land-use programs being conducted under State laws, and a number of farmers representing each major type of farming area in the State. The State director of extension is chairman of the State land-use planning committee and an employee of the Bureau of Agricultural Economics, known as the State BAE representative, functions as committee secretary. These State committees are expected to serve as the central planning and coordinating group for all public agricultural programs operating in the State. Among other things they examine and approve various types of action programs to be initiated; appraise the plans, programs, conclusions, and suggestions made by county and community planning committees; develop recommendations designed to integrate the several action programs in the State, and perform such other functions as are necessary to formulate well-rounded, comprehensive, agricultural plans and programs. An employee of the State extension service functions as project leader, exercising general supervision over the project in his State.

Another important feature of the planning organization in each State is the so-called joint land-grant college BAE committee. This committee is composed of the State BAE representative and representatives of the State Agricultural extension service and agricultural station. The joint committee performs the important function of developing recommendations concerning the nature and scope of the planning work to be carried on in the State, acts as service committees for the State land-use planning committee on the technical and procedural aspects of the planning program, and in other ways assists in the more efficient and effective conduct of the work. For example, this joint committee assists in developing outlines, schedules, and procedures to be used in assembling, analyzing, and transmitting to the county planning committees such available information as is pertinent to the agricultural and land-use problems of each community. Likewise, this joint committee gives consideration to the research, investigational, and survey work necessary in the State to provide county and State land-use planning committees with information needed to formulate recommendations concerning the solution of agricultural land-use problems and on agricultural policies applicable to conditions within the State. When appropriate, the joint committee stimulates the organization of pertinent planning survey and research projects.

In the counties, the planning activities are carried on by a county land-use planning committee composed of at least 10 farm men and women, together with a few forest owners in counties where forestry is a problem, the county agent, at least one member of the AAA administrative committee, the county or district farm security supervisor, and other State and Department officials in the county who have responsibility for the administration of agricultural land-use programs. The farmer membership constitutes a substantial majority and a farmer is chairman of each community committee. The county agent generally functions as the executive officer or as secretary of the county committee.

## Types and Methods of Work

Much of the initial work is carried on at the community level. Counties are divided into subareas called communities. Community committees, which function informally as subcommittees of the county planning committee, meet, mark out the local land-use areas within their community, describe them, classify them, and make recommendations regarding their future use. They are assisted in this by being supplied whatever factual information, including maps and statistics, that has a bearing on their work. Technicians assist local committees by explaining the significance of the different lines of evidence. Community maps and reports are coordinated and assembled into a county map and report by a county committee. The county committee includes at least one member, usually the chairman, of each community committee as well as local representatives of Department of Agriculture programs and State agencies. Completed county planning reports and maps are transmitted to the State land-use planning committee, which if it finds them a suitable guide for land-use programs, recommends appropriate action by State agencies and transmits them to the Department of Agriculture for appropriate action on its part.

The land-classification aspect of this work consists of delimiting the homogeneous land-use areas and classifying them as follows:

- A. Areas now in farms but not suited to arable farming.
- B. Areas not now in farms, and which should not be used for arable farming.
- C. Areas now in farms, and which are questionably suited for arable farming.
- D. Areas not now in farms, but which are suitable for development into farms.
- E. Areas which are now in farms and which should remain in arable farming.

Subclassification of these classes will be undertaken according to the varying needs and conditions of particular regions.

Following the area mapping and classification phases of the County Agricultural Land-Use Planning Program, there is being developed what is known as the



unified county program. This represents a first step in the process of translating agricultural land-use plans into action and in bringing about the coordination of various types of action programs in the field. It gives special attention to the particular measures, devices, and lines of public, group, and individual action needed to accomplish the land-use, land-conservation, and rural rehabilitation goals or plans formulated under the area mapping and classification work. Likewise, it encourages farmer participation in building agricultural programs, in revising and coordinating the several National, State, and local programs where desirable, and in formulating such new programs for agriculture as are necessary to best achieve the desired adjustments in the area.

The planning recommendations and the land classification made in this project are based upon two principal classes of evidence; namely, the experience of farmers, and various data and information available from surveys and studies. This project is not a product of field work in the usual sense, although committees may, and often do, make field trips to help in reaching or confirming their decisions. The field work involved in supplying data used by the committees is most commonly not done solely to serve this project. It consists of aerial photographs; conservation surveys; soil surveys; farm income data; data on crop acreage, crop yields, and operating units, mapped in place from A. A. A. county records; and material from county records, such as data on ownership and data on public service costs.

Various types of base maps are being used, the most common being highway inventory maps, prepared by State highway departments in cooperation with the Bureau of Public Roads, scale 1 inch equals 1 mile. Planimetric, topographic, and other base maps are used in some cases, according to which is the best available. Aerial photographs are frequently studied by the local committees as a help in ascertaining the boundaries of areas, in becoming better acquainted with the characteristics of the areas, and as a base for recording certain data which are used in making some of the land-use recommendations. The scale of these photographs is either 4 inches equals 1 mile, or 8 inches

equals 1 mile, depending on which can be obtained more easily.

It is difficult to estimate an average rate of progress as the work is still in its initial stages. The meetings at which the work is largely done have to be scheduled at the convenience of the farmer members, so as not to interfere with farming operations. It is likely that several months will elapse between the time work is begun in a county, and the completion of the county report.

Formal publication of the land-classification maps and reports developed in the County Agricultural Land-Use Planning Program has not been decided upon. However, in a number of cases the county reports have been mimeographed and the maps reproduced by multilith process for distribution to those agencies and individuals having a definite concern with land-use adjustments and operations in the county. Fig. 47 is a reproduction of a map of this sort.

#### Personnel

County agricultural agents, trained in one or more branches of agriculture, are in most immediate direction of the work. The State project leaders, who have administrative direction of the work are most commonly trained in agricultural economics. This holds true also for the State BAE representatives who are jointly responsible with the State project leaders, for the technical soundness of the work. Both the State project leaders and the State BAE representatives are men of wide experience in either agricultural program planning or land-use planning work.

#### Importance of Local Participation

It is believed that the general land-use planning work of the Department (as distinguished from planning the administrative details of an operating program), including its land-classification phase, will henceforth involve participation by local producers, as is provided for in this activity. It is believed that plans, if they are effectively to be translated into action, must be understood by the bulk of people affected by such action, and that such understanding is best created by participation in the making of the plans, as is provided in this undertaking.

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