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# SOIL CONSERVATION SURVEY HANDBOOK

By

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Principal Soil Scientist
and staff
Physical Surveys Division
Soil Conservation Service


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CONTENTS



## INTRODUCTION

Soil conservation in its broadest sense implies permanent maintenance of the productive capacity of the land. The achievement of soil conservation not only requires that the land be used for the purpose for which it is best suited, but also necessitates the adoption of such soil conservation practices as are required for each kind of land.

[1] Mention should be made of the work of Glenn L. Fuller, under whose direction previous handbooks were prepared, and of A. E. Kocher, A. H. Paschall, and J. G. Steele. Many others have made contributions.

Land use and soil conservation measures, to be successful, must be adapted to the physical condition of the land. The land use and soil conservation measures that are put into practice may be modified or controlled by other factors, such as economic and social conditions, but the foundation plans must be developed in accordance with a physical inventory, particularly of soil conditions, percent of slope, character and degree of erosion, and present land use.[2]

This handbook sets forth a procedure for making a soil conservation survey and includes instructions for mapping the major physical land features essential to the development of a coordinated soil conservation program and for interpreting those features in terms of land use capability. The procedure given is designed to be broad in scope. Variations and supplements to fit local conditions are to be established by the field inspector at the time a survey is initiated.

## DEPARTMENT COMMITTEE ON SOIL AND EROSION SURVEYS

The Secretary of Agriculture established in 1937 a Committee on Soil and Erosion Surveys to assist the Office of Land Use Coordination in coordinating soil, erosion, and related land use surveys, primarily those conducted by the Soil Survey Division of the Bureau of Plant Industry and by the Soil Conservation Service. One representative from each of these two Bureaus and one from the Office of Land Use Coordination make up this committee. The committee reviews all requests for conservation and soil surveys to be conducted by or in cooperation with either Bureau. This is to prevent duplication of field effort and to insure that the information to be obtained meets all the requirements for basic information needed in the development of plans and programs in the Department as a whole. It designates an inspector for each area and approves plans for the survey. The inspector makes a preliminary examination of the area in cooperation with any interested agencies and prepares the preliminary work plan and the first inspection report. This report, after being approved by the Department committee, serves as a basis for development of the survey. Upon completion of the survey the inspector prepares a final inspection report for presentation to the committee, including recommendations for correlation of the soils.

## KINDS OF SURVEYS

Two major kinds of conservation surveys are recognized. They are differentiated on the basis of intensity of observation and detail of delineation.

**Detailed surveys.**—Detailed surveys are those in which the features studied are examined at close intervals and delineated in detail. They are intended primarily to furnish necessary information for intensive planning on individual farms or other small units.

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[2] Both percent of slope and degree of erosion have long been recognized in the classification of soil types and phases. However, since a soil profile may be materially altered and the native productivity of the soil almost wholly destroyed by only a few years of accelerated erosion, separate classification of erosion is desirable. Classification of slopes in detail is also necessary for detailed planning of land use.

**Reconnaissance surveys.**—Reconnaissance surveys are those in which the features studied are examined at wide intervals and are not delineated in detail. They are intended primarily to furnish information for extensive planning or over-all planning in large areas, such as county, State, or large watershed units.

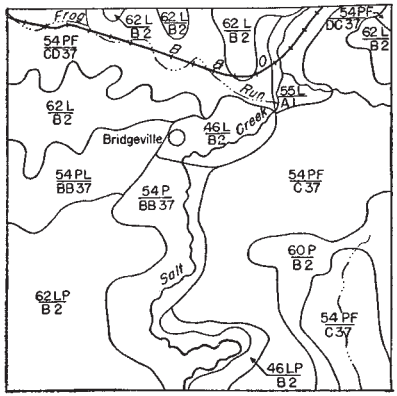


FIGURE 1.—Reconnaissance conservation survey of sections 12, 13, 18, and 19, Perry Township, Muskingum County, Ohio. Scale, 1:62,500. Original field sheet was a topographic map.

In some localities, where extreme detail is not necessary, semidetailed surveys may be made in order to record more information than is possible on a general reconnaissance. In other localities, combined detailed-reconnaissance surveys may be desirable. Such a survey might be made in a range and irrigated area in western United States—the irrigated valley would be mapped in detail, but a reconnaissance survey would supply all information needed on adjacent range land.

The purpose of each survey will determine the detail with which the physical variations are to be recorded. Wherever land conditions are relatively uniform a detailed survey may show no more separations than a reconnaissance. If detail does not exist it cannot be mapped.

Mapping should be carried on with no more detail than is necessary for land use planning. In some range or forest areas semidetailed surveys, a little more intensive than reconnaissance surveys, may furnish all the information that is required. On most farm lands detailed surveys will be necessary.

An example of a reconnaissance survey is shown in figure 1. Examples of detailed surveys are shown in plates 7 and 8.

## BASE MAPS FOR FIELD SURVEYS

### KINDS OF MAPS

**Aerial photographs.**—Aerial photographs will be used as field sheets for detailed soil conservation surveys if they are available and suitable.

**Available maps.**—Topographic sheets of the United States Geological Survey or other types of base maps will be used for most reconnaissance surveys. Very few such maps are available on the scale desired for detailed surveys.

**Plane-table maps.**—Whenever adequate aerial photographs or other base maps are not available, plane-table surveys will be made. Instructions on plane-tabling are given in the Soil Survey Manual.[3]

[3] KELLOGG, CHARLES E. SOIL SURVEY MANUAL. U. S. Dept. Agr. Misc. Pub. 274, 136 pp., illus. 1937. See pp. 37–45.

### SCALE

**Detailed surveys.**—On most detailed surveys the scale will be 4 inches equals 1 mile. Larger scales of 8 or 12 inches to the mile will be approved if a 4-inch scale is inadequate.

**Reconnaissance surveys.**—Mapping on general reconnaissance surveys will be on a scale of 1 inch or less equals 1 mile unless other scales are needed and suitable maps of another scale are available.

Mapping on semidetailed surveys will be made on a scale of 1 or 2 inches to the mile unless other scales are needed, suitable base maps of another scale are available, and their use is approved by the Department Committee on Soil and Erosion Surveys.

On combined detailed-reconnaissance surveys the parts of the area that require detailed information will be mapped on the scale of 4 inches equals 1 mile, and the parts for which detailed information is not required will be mapped on the scale of 1 inch or less to the mile. Field maps of scales other than those prescribed may be used if available, but they must be approved by the Department Committee on Soil and Erosion Surveys.

### DETAIL TO BE SHOWN ON BASE MAPS

The base maps used for reconnaissance surveys should be corrected and brought up to date insofar as this can be done in the time available.

When detailed surveys are made using aerial photographs as field sheets, all details necessary for compilation of the base map should be shown. Standard symbols are given in plates 1 to 4. Names of all important features should be given. The boundary of the survey should be shown accurately.

Aerial photographs should be corrected where cultural and other changes have occurred since the photographs were made.

## MAPPING PHYSICAL FEATURES OF THE LAND

### SOILS

Soils, which are recognized as natural bodies with definite morphological features, are classified and mapped by series and types. Soil types are differentiated on the basis of their characteristics. Soil properties, such as fertility, permeability, water-holding capacity, erodibility, and ease of cultivation, help to determine productivity. Soil types vary greatly, and proper utilization of the land is governed, within limits of sound practice, by the inherent capacity of the soil to produce.

It is important to recognize that soil profiles may be destroyed by erosion and that the completion of an erosion stage obliterates established soil types, creating conditions under which new types are developed. When soils are mapped, they should be classified as they exist in the field; that is, if removal of the topsoil has exposed material of an entirely different character, or if the texture of the surface soil has been altered by the deposition of material, a new soil type should be established. If the profile still retains its dominant characteristics, the type name is changed but not the series. However, if

the profile has lost its dominant characteristics, so that the soil properties that are characteristic of the series are changed, a new series should be recognized.

For example, if the surface layers of the profile have been changed by the accumulation of deposits, or if the surface layers have been removed by erosion, exposing material of a different character, and the features by which the soils are classified are so altered that the characteristics of the soil are no longer those of the normal profile of that series, the old soil series is destroyed and a new one should be recognized. Cecil sandy loam is changed to Cecil clay loam when the sandy loam surface is removed by erosion and the clay loam subsoil is exposed. Imperial silt loam is changed to Imperial sandy loam when the texture of the surface becomes changed by the addition of sands. The Houston soil loses its former identity as a series when the black topsoil is removed by erosion and the lighter-colored marly parent material is exposed. The Imperial or Holtville soils become members of the Gila series when they are deeply covered by recent deposits of lighter-colored material.

Instructions for the preparation of a soil-mapping legend and for the examination and description of soils, as well as a discussion of the units of soil classification and mapping, are given in the Soil Survey Manual (see footnote 3), pages 65–100. On soil conservation surveys where slope and erosion are mapped in detail, the recognition of soil phases to express variations in these two factors is not necessary except where important differences are not sufficiently well defined within separate types or series.

In many areas an expression of the present depth of topsoil is useful in planning land use and erosion-control practices. The term "topsoil," as used in this handbook, means the surface layer of soil, that is, the surface soil to average plow depth or the A horizon if this is deeper than plow depth. It cannot be defined precisely as to depth or productivity except in reference to a particular soil type. The existing range in depth of the topsoil will be mapped in addition to the designation of the soil type if this is requested by regional technicians and approved by the inspector.

### GROUPING OF SOILS

It is frequently useful, for purposes of land utilization and erosion control, to group soils on the basis of their texture, structure, relief, permeability, productivity, or other characteristics or properties in order to express significant differences in erodibility or land use capability. Suggestions for the grouping of soils are given in the Appendix.

## SLOPE

The most desirable method of mapping slope would be to make a detailed topographic map having a contour interval of 1 foot or less. Since it is impracticable to obtain such maps at the time they are needed, it is necessary to develop and map slope groups.

It is recognized that under natural cover a definite relation exists between slope and profile development in mature soils, other things being equal, and that every soil has a characteristic range of slope.

This range is often broad enough to include several recognizable degrees of behavior with respect to erosional processes. Fairly definite limits can be established (1) under which there is little or no danger of water erosion where cultivation is practiced or where for any reason vegetation affords little protective cover; (2) within which erosion can be controlled on cultivated land or other land where the cover affords only partial protection if adequate precautions are taken; and (3) above which permanent cover is required for protection because of susceptibility to erosion. At least two slope groups should usually be recognized under (2), and two or more groups may be necessary under (3). These limits may vary greatly for different soils or may be the same for a group of soils. In addition to erosion, other factors, such as amount of run-off, ease of cultivation, and fundamental differences in the character of the soils, must be considered in the development of slope groups. A suitable set of slope groups for each important soil or group of soils should be determined before beginning the survey, recognizing all these natural relationships.

Significant physiographic units or land forms may be used as a basis for the separation of major sets of slope groups. For example, one set of slope groups may be applicable to alluvial flats and terraces, another to undulating and rolling plains, and still another to foothills and mountains. Each physiographic unit or land form should be adequately described to identify it as a unit insofar as land use recommendations are concerned.

If significant variations exist in the characteristics and properties of soil types, two or more sets of slope groups will be necessary within the same physiographic unit. For example, those soils having a dense claypan will require a different set of slope groups from those soils having open, porous subsoils. The slope groups established for those lands with claypan soils might be less than 1 percent, 1 to 4 percent, 4 to 7 percent, 7 to 12 percent, and 12 percent and over; whereas the slope groups established on lands where the soils have open, porous subsoils might be less than 5 percent, 5 to 9 percent, 9 to 15 percent, 15 to 20 percent, and 20 percent and over.

For convenience, these ranges will constitute the slope groups that will be used in mapping. The dominant or controlling percent of slope, the slope group, or both will be shown on the map for each area delineated. The dominant percent of slope is the land gradient that must be given primary consideration, in combination with soil type and degree of erosion, in the making of land use and erosion-control recommendations. It is not necessarily the average percent. If the range of slopes in a group is narrow or if the survey is of a reconnaissance type, so that dominant percent cannot be designated, it is permissible to use the letter symbol alone. On detailed surveys, if the range in the group exceeds 4 or 5 percent, the dominant percent should be shown.

In actual practice it will be found that the same slope groups will apply to a number, possibly all, of the soil types within a survey. However, there may be certain soils that must stand alone, either to permit very wide slope limits or because they require very narrow ones.

Slope groups are to be designated by capital letters, beginning with A to represent the nearly level areas, following with B, C, D, E, and additional letters if needed. The slope-group symbols need not appear on the map if the dominating slope is shown, but they should be given in the legend.

A typical arrangement of slope groups, used on one survey, is given in table 1.

TABLE 1.—*Typical arrangement of slope groups*

| Kind of soil | Range of slope group— | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| Well-drained and imperfectly drained soils derived from till and outwash, and all bottom land. | Less than 5 | 5–15 | 15–25 | 25–35 | 35 and over. |
| Imperfectly drained soils derived from till. | Less than 3 | 3–8 | 8–15 | 15–25 | 25 and over. |
| Soils derived from lacustrine materials | Less than 2 | 2–5 | 5–10 | 10–15 | 15 and over. |

## MAPPING OF SLOPE GROUPS

It should be emphasized that slope groups are to be used as the unit for mapping slopes. If the survey plan calls for the mapping of dominant percent of slope, the surveyor should determine the slope group to which a delineated area belongs. He should then indicate on the map the dominant or controlling percent of slope. Percents of slope within any group should not be delineated separately. For example, when mapping the slope groups as outlined in the preceding paragraph, no attempt should be made to delineate separately any areas of imperfectly drained soil on till with slopes between 3 and 8 percent; a 4-percent slope in this group of soils should not be separated from a slope of 5, 6, or 7 percent unless there is also a difference in soil type or degree of erosion. Instead, it should be determined whether 3, 4, 5, 6, or 7 percent is the dominating slope within the single delineated area. A slope of 9 percent, however, would be delineated separately from one of 7 percent, because it is in a different group. The numeral placed on the map as a slope symbol therefore denotes two things: The slope group in which the delineated area has been placed and the dominating or controlling slope of the land delineated. The dominating percent will be used for detailed land use planning on farms and fields, but the slope group is more useful in tabulation and interpretation of survey data and in general land planning.

Although steepness of slope is of paramount importance in a slope classification, other slope characteristics, particularly length, uniformity, direction, and pattern of slope must be considered in formulating a program of erosion control and land use. Examples of distinctive land forms that contrast sharply with the stream-formed surfaces prevailing over wide areas and that affect soil conservation practices are the long southwesterly slopes of the Washington-Oregon-Idaho wheat belt, the short variable slopes characterizing the kame type of relief in the glaciated Northeast, the mounds of eastern Kansas and of the Arkansas-Louisiana Coastal Plain, the sinkholes of the limestone sec-

tions of southern Kentucky and elsewhere, and the hog wallows of the great interior valley of California. Such features, if significant, may be recognized in the survey work plan and indicated by symbols. The direction of slope, if deemed necessary by the regional technicians and inspectors, may be indicated by the use of small black arrows.

## EROSION

Erosion is a geologic process that removes or wears away soils and geologic materials from the land surface through the action of natural agencies, primarily wind, water, and gravitational creep. Both normal and accelerated erosion are recognized.

**Normal erosion.**—Normal erosion is the erosion characteristic of the land surface in its natural environment, undisturbed by human activity—as under the protective cover of the native vegetation. This type of erosion is sometimes referred to as geologic erosion. It includes: (1) Normal soil erosion, or the erosion characteristic of the soil type in its natural environment under the native vegetation undisturbed by human activity; and (2) rock erosion, or erosion of rocks, consolidated or unconsolidated (including soil material), on which there is little or no true soil—as in stream channels, high mountains, or badlands.

**Accelerated erosion.**—Accelerated erosion is erosion of soil or soil material over and above normal erosion, brought about by changes in the natural cover or ground conditions. It includes the changes resulting from human activity and those caused by lightning or rodent invasion. Classes are established to indicate both the kind and the degree of accelerated erosion. Water erosion is designated by numerical symbols and wind erosion by letters. On any survey there may be areas with no apparent erosion and others with various stages or degrees of sheet, gully, and wind erosion. The degree of erosion is determined by estimating the percent of the original topsoil, subsoil, and parent material or substratum that has been lost from the land surface that existed prior to the initiation of accelerated erosion. Such an estimate can usually be made by comparing the profile of the soil on which erosion is to be mapped with a virgin soil profile which occurs under similar topographic conditions. Wherever the virgin topsoil is shallower than the average plow depth, the position and depth of the lower part of the solum may be used in estimating the degree of erosion. Other evidence, such as plant succession, erosion history, and visible evidence of active erosion, may serve as indicators.

It should be emphasized that the degree of erosion is to be estimated in relation to the original land surface. A soil truncated by accelerated erosion may be recognized as a series or type different from the uneroded soil. In such cases the erosion symbol should indicate the total accelerated erosion that has occurred since the native vegetation was disturbed. For example, an eroded Cecil soil might be mapped as Cecil clay loam. If the original surface soil was Cecil sandy loam, and if approximately 85 percent of the original topsoil has been removed, erosion of class 3 (p. 9) would be mapped. In such an instance this Cecil clay loam, produced through truncation, should be distinguished in the soil legend from Cecil clay loam that has not been truncated.

## NORMAL (GEOLOGIC) EROSION

0. No apparent erosion.
W. Normal erosion (active):
  Ws. Normal sheet erosion.
  Wg. Normal sheet and gully erosion.
  Ww. Normal wind erosion.

No apparent erosion will be indicated by the symbol 0. This will be mapped on nearly level cultivated land, and on land that is protected by vegetation and shows no evidence of erosion. Active normal erosion—that is, erosion that has not resulted from activities of man or natural destruction of plant cover—will be indicated by the symbol W. If it is desired to show the type of normal erosion, which should be done only where it is significant in planning, normal sheet erosion may be designated by Ws, normal sheet and gully erosion by Wg, and normal wind erosion by Ww. If it is desired to indicate both type and degree of normal erosion, W may be used with an appropriate symbol given under accelerated erosion, as, for example, W2, W37, or WN.

## ACCELERATED EROSION

### WATER EROSION

Two results of erosion by water will be designated: (1) Removals, or erosion proper; and (2) accumulations resulting from removals on some other area. Removals include both sheet and gully erosion. To estimate erosion, the present thickness of topsoil and its range must be compared with the original thickness of topsoil and its range, as determined from examinations of undisturbed soils in comparable locations or from other evidence.

#### Removals

Classes of removals and the symbols used to designate them are as follows:

#### SHEET EROSION

1. Less than 25 percent of the topsoil removed. Erosion of class 1 is mapped if the effects of erosion can be identified but the average removal has been less than 25 percent of the thickness of the original topsoil.
2. 25 to 75 percent of the topsoil removed. If the thickness of original topsoil was about 16 inches and the present topsoil is between 4 and 12 inches, sheet erosion of class 2 would be mapped.
3. 75 percent or more of the topsoil removed, or all the topsoil and less than 25 percent of the subsoil[4] removed.
4. All the topsoil and 25 to 75 percent of the subsoil removed.
5. All the topsoil and 75 percent or more of the subsoil removed; parent material may be eroded.
6. The symbol 6 is reserved for conditions of local significance, such as slips or catsteps. Slips too small to be outlined on a map may be indicated by a crescent-shaped symbol, as shown on plate 5.

[4] "Subsoil," as used in this handbook, means the B horizon or that part of it not included in the topsoil as defined on p. 5.

### GULLY EROSION

Gully erosion is that type of accelerated erosion by water that produces definite channels too deep to be obliterated by normal tillage. Three classes of gully erosion are recognized:

7. Occasional gullies: More than 100 feet apart.
8. Frequent gullies: Occurring less than 100 feet apart but including less than 75 percent of the delineated area.
9. Very frequent or large gullies. This symbol will be used to designate an intricate network of gullies or an individual gully large enough to be outlined or any mappable area of which more than 75 percent is gullied.

Symbols 7 and 8 should be shown in conjunction with sheet-erosion symbols; that is, they should never be used alone. Symbol 9 should be used without a sheet-erosion symbol. On land affected by erosion of class 9 some difficulty may be experienced in identifying the soil type and slope. In such cases the slope of the original land surface should be shown, and a soil separation such as rough gullied land may be mapped if approved by the inspector.

**Depth of gullies.**—Three classes of gullies with respect to depth are recognized and should be indicated wherever they occur.

7, 8, or 9 (without other designation). Shallow gullies: Can be crossed with tillage implements but would not be obliterated by normal tillage; on range lands, can be easily crossed by stock.

⑦, ⑧, or ⑨. Deep gullies (not crossable with tillage implements) that have penetrated into compact subsoil or through it into compact parent material.

7V, 8V, or 9V. Deep gullies (not crossable with tillage implements) that have penetrated into friable parent material.

**Individual gully delineation.**—In regions where gullies are infrequent, line symbols may be used in red ink to indicate the location and depth of each gully. An individual shallow gully may be indicated by a solid red line and three dots, as shown in plate 5. An individual deep gully may be indicated by a solid red line and two dots (pl. 5). An individual deep gully, rapidly erodible, or one that has penetrated into a friable parent material, may be designated by a wavy red line (pl. 5).

### ACCUMULATIONS

+. Recent accumulations. Recent accumulations resulting from erosion are frequently significant from the standpoint of effects on agricultural lands and urban property and from other points of view. The term "recent accumulations" as here used refers primarily to accumulations resulting from accelerated erosion and not to young water-laid materials that have not yet formed well-developed soil profiles. On flood plains where there is no evidence of either erosion or deposition, normal (0) erosion should be mapped.

Accumulations will be indicated by the symbol + if less than 12 inches in depth or if differentiation according to depth is not desired. Deposits deeper than 12 inches may be indicated by numerical symbols followed by +.

Detrimental deposits should be indicated by the symbol + within a triangle (pl. 5).

### WIND EROSION

Two types of wind erosion will be designated, removals and accumulations.

#### Removals

P. Less than 25 percent of the topsoil removed.
R. 25 to 75 percent of the topsoil removed.
S. 75 percent or more of the topsoil removed, or all of the topsoil and less than 25 percent of the subsoil removed.
T. All the topsoil and 25 to 75 percent of the subsoil removed.
U. All the topsoil and 75 percent or more of the subsoil removed; parent material may be eroded.

Areas on which wind erosion has penetrated into a deep friable parent material should be distinguished from those areas which are eroding only in the topsoil or subsoil or in a compact parent material. Areas eroding in deep friable material should be indicated by UV or by placing the removal symbol U within the V. On surveys where this condition is mapped, the symbol U, used alone, would indicate deep wind erosion in compact or nonfriable material.

#### Accumulations

F. Shallow accumulations, less than 6 inches, either level or in hummocks.
H. Moderate accumulations, level, 6 to 12 inches.
K. Moderate accumulations, hummocky, 6 to 12 inches.
L. Severe accumulations, 12 to 36 inches.
M. Small dunes, 36 to 72 inches high.
N. Large dunes, 72 inches or more high.

The proportion of the area covered by accumulations may be indicated by following the class letter with the numeral 1 to indicate less than one-third of the area affected, 2 to indicate one- to two-thirds of the area affected, or 3 to indicate more than two-thirds of the area affected. Mapping units thus defined are erosion complexes (p. 13).

To indicate accumulations that have occurred on areas from which the topsoil has previously been removed, the numeral indicating the proportion covered may be placed in a prime position. If deposition has taken place on the surface soil, the numeral indicating proportion covered will be placed on a line with the letter. Examples: $F^2$ equals less than 6 inches accumulation covering one- to two-thirds of the area delineated, from which the surface soil has previously been removed. F2 equals less than 6 inches accumulation covering one- to two-thirds of the area delineated, the deposition occurring upon the original surface soil.

Subdivisions of any wind-erosion class may be indicated, if they are necessary, by double letters. FF might be used, for example, to indicate accumulations 3 to 6 inches in depth. Any such subdivisions should refer to depth and not to any other characteristic.

Drifted fences may be indicated as shown in plate 5. Sometimes it is desirable to indicate line drifts where they may never have been a fence or the fence no longer exists. Such drifts sometimes have an important bearing on land use, although too narrow to be included within boundary lines. They may be indicated as shown in plate 5.

Wind-erosion symbols for removal and for deposition will be used together or individually, as the conditions warrant. They will also be used in combination with water-erosion symbols if conditions warrant.

### STREAM EROSION

Streams in flood cause a type of erosion that often requires special treatment to effect control. The area responsible may be far removed from the one affected. Removals caused by floods may be designated by the use of the minus sign (−) following numerical symbols that may be established to indicate the range in depth of the removals. Removals of less than 6 inches, for example, may be indicated by 1− and those of 6 to 12 inches by 2−.

It should be borne in mind that bottom lands subject to overflow that show no measurable recent deposits or removals should be mapped with the 0 erosion symbol.

If it is necessary to show stream-bank cutting, it can be indicated by the use of hachures in red placed along the banks, as shown in plate 5.

### EROSION UNDIFFERENTIATED AS TO CHARACTER OR DEGREE

The symbol Θ will be used to designate erosion undifferentiated as to character or degree. This symbol may be used on urban areas, farmyards, and similar areas, but it should not be used if erosion conditions are important and should be mapped.

### STABILIZED EROSION

Stabilized erosion may be indicated by overscoring the appropriate symbol, as $\overline{7}$ or $\overline{\text{R}}$, if it is clearly evident that plant cover has recently reestablished normal erosion. Stabilization should not be confused with a degree of partial protection afforded by vegetation or by consolidated surface deposits such as desert pavement or rocky talus slopes.

### EROSION CLASSES AND GROUPS

The foregoing symbols, except those denoting gully erosion, are to be used singly or in combination, as required to express the type and degree of erosion. Each erosion symbol or group of symbols used on the map designates an erosion class. Examples are 1, 2, 27, PF, and 27PF. The erosion classes to be mapped on each survey should be listed in the survey plan. If additions to the list become necessary as the survey progresses, they should be approved by the inspector.

The number of erosion classes may vary from 12 or 15 on surveys of water erosion to 80 or more if wind erosion also has been mapped. These occur on different soil types and slopes. Obviously, each separation cannot have different treatment for erosion control and land use. Groups of erosion classes should therefore be established to express slight, moderate, severe, and very severe erosion, as well as no apparent erosion and recent alluvial or colluvial deposits. The groups should not be shown on the map, but they are necessary for interpretation and use of the survey. A grouping used for a survey in the Piedmont of Georgia is as follows:

Recent alluvial or colluvial deposits: +.
No apparent erosion: 0.
Slight erosion: 1, 17, Θ.
Moderate erosion: 2, 27.
Severe erosion: 28, 3, 37.
Very severe erosion: 38, 5, 9.

Erosion classes as defined on pages 9–12 have definite limits, based on the present thickness of topsoil and subsoil. At any point the sheet erosion class can be determined accurately provided the range in depth of the virgin topsoil of that soil type is known. In actual mapping, however, exact measurement and delineation of all the erosion classes in a field or in any mappable area is, of course, impossible, just as an accurate determination of all the variations in soil profiles is impossible. In practical mapping of erosion classes, therefore, it is neecssary to express the average or in some cases the dominant condition, keeping in mind that no delineation should be shown that is too small to be of significance in land use.

If two or more erosion classes occur so associated that individual erosion classes are not mappable as such, the mapping units must be established as complexes, defined in terms of the relative percentages of two or more erosion classes. For example, an erosion mapping unit might indicate approximately 25 percent of class 1 sheet erosion, 50 percent of class 2 sheet erosion, and 25 percent of class 3 sheet erosion. Other mapping units would be similarly defined in accordance with the nature of the landscape, the complexity of the erosion, and the significance of the various erosion conditions in land use.

In forested or mountainous areas or in reconnaissance mapping these mapping units will usually need to be defined in terms of a larger number of the fundamental classes than in detailed mapping, although in many agricultural regions the pattern of physical land types is very intricate and in some of them the erosion may need to be indicated by defined complexes.

Before erosion complexes are mapped on any survey, they are to be established by the inspector as part of the survey plan, together with the symbols by which they are to be indicated.

## MAPPING PRESENT LAND USE

Four major land use classes and a miscellaneous class will be recognized. Divisions of the major classes may be mapped if established and approved as part of the survey plan. All divisions must be described definitely in the legend.

Land use boundaries should be drawn independently of those used to delineate soil, slope, and erosion, as illustrated in plates 7 and 8. Red ink may be used for land use boundaries if desired.

The following land use classes will be recognized.

**L. Cropland.**—Cropland will include all land planted to crops and, in addition, fallow land, orchards, and land seeded down several years to grass, alfalfa, or other forage crops grown in rotation for hay. Meadows cut for hay and then grazed in a later part of the season should be included in this class. Specific crops may be indicated by divisions, such as L1 or L2, carefully defined in the legend.

**X. Idle land.**—Land either void of vegetation or maintaining plant growth of little economic or agricultural value will be mapped as idle land. (The plant cover on idle land may have considerable value as a food source for wildlife.)

Class X should be subdivided into X1, X2, or other divisions to express additional information, as land formerly cultivated, available for future agricultural use; land formerly cultivated, unavailable for

future agricultural use; or land never cultivated and unsuited to agricultural use, such as riverwash, rock outcrop, mines, or dumps.

**P. Pasture or range.**—Pasture includes grazing land or range other than pastured woodland, and land in grasses or legumes that is devoted primarily to grazing. Since this class includes a wide variety of conditions, the following subdivisions should be recognized if they occur: Wild grassland used solely for hay, land used for pasture in rotation, and land with small woody vegetation that normally does not grow beyond the browse or shrub stage. Additional subdivisions may be established to express the kind and condition of cover.

**F. Woodland.**—Woodland includes land with 40 percent of the ground covered by the spread of woodland or forest species of any age and land devoted to forest plantations. Pastured woodlands and virgin woodlands should be divisions of this class. To indicate type and condition or any additional desired information, F may be subdivided.

**H. Miscellaneous.**—Urban areas, large farmyards, golf courses, and areas not otherwise classified will be included in class H.

## CLASSES OF LAND ACCORDING TO USE CAPABILITY

Use of soil conservation surveys in the development of soil and moisture conservation operations has demonstrated the need for interpretation, by means of a simple grouping, of the complex factors surveyed. Such a grouping can be readily used as a physical basis for planning broad programs of land use adjustment. Classes of land according to use capability are to be developed for each surveyed area to meet these needs.

These classes indicate the most intensive tillage that can be practiced safely with permanent maintenance of the soil or, in regions where cultivation is not practiced, the most intensive utilization for range or forestry that is consistent with preservation of the soil and its plant cover. They are determined wholly on the basis of physical characteristics of the land, including its climatic environment, at the time of mapping.

Classes of land according to use capability may not be permanent in character. Permanent changes, such as removal of topsoil by accelerated erosion, accumulation of toxic salts, artificial drainage, or an increased availability of water for irrigation, may subsequently necessitate reclassification of the areas involved or reappraisal of the classifications. Introduction of new crops or of farming methods not previously known to be applicable may have a similar effect. Experience may demonstrate that some established practices do not insure adequate protection of the land, so that some reclassification or reappraisal of the previous classification may be necessary.

Classes of land according to use capability are defined in general terms. Before they are used on a specific survey, they must be sharpened or modified with reference to local conditions and practices. Therefore, the classes developed for different areas may not be precisely comparable, but they must conform with the principles of the general definitions.

In formulating general definitions of use capability an effort has been made to hold the number of classes to a minimum. A similar

effort should be made in establishing classes on each local survey. Usually four or five classes are sufficient to express the most significant variations in physical factors. In cultivated regions the symbols I, II, III, IV, and V are used to designate degrees of use capability ranging from areas in which the land can be cultivated safely (I) to those in which the land, because it cannot be cultivated safely, should be maintained in permanent vegetation for protection (V).

Classes of land according to use capability are determined wholly on the basis of physical characteristics of the land, that is, of the soil and its climatic environment. At least four groups of factors must be considered: (1) Permanence of the soil if cultivated (susceptibility to erosion); (2) productivity of the soil as conditioned by native fertility, capacity for retention and movement of water, salt content, aeration, or other factors; (3) the presence of any factor that would interfere with cultivation, such as stoniness or a hardpan layer; and (4) the climatic environment, particularly temperature and precipitation.

To aid in the determination of use capability a table (table 2, p. 21) should be prepared at the beginning of each survey or as soon thereafter as possible, showing significant variations in the physical factors (soil type, slope, and degree of erosion) such as govern land use capability within the prevailing climatic environment. This table is to be initiated by the chief of the survey party, developed in cooperation with local and regional technicians, and approved by cooperating agencies and by the regional conservator and the inspector. When properly completed, the recommendations for land use capability will furnish the necessary physical information to serve as a definite basis for soil conservation operations on the land. In those areas where detailed studies and surveys and work on the land have been carried out, sufficient information may be available to develop the table at the start of the survey. In all instances the table should be developed as rapidly as the information can be assembled, and completed before the survey is finished. After completion of the table the land use capability will be designated by the surveyor on the field sheets.

To the planning technician who uses the maps, the classes of land according to use capability will indicate at a glance the maximum intensity of agricultural use that can be practiced safely. An understanding of the reasons for placing a specific tract in a given class can be gained by examination of the separate factors expressed in the conservation survey symbol. The technician must then consider, in addition to the inventory of physical resources, the preferences of the farm owner or operator as well as the economic advisability of any system of cropping or any practice recommended.

In the general definitions no attempt has been made to consider the soil requirements of different crops. Some lands that are classed as I, for example, may not be wholly satisfactory for the production of all crops adapted to the region, but any land placed in this class must give moderate to high yields of one or more crops.

Classes of land according to use capability have been defined without reference to profitable or unprofitable cultivation, since the possibility of profit is frequently governed by such factors as accessibility of markets rather than by the nature of the soil or its climatic environment. The classes I, II, III, IV, and V express progressively increas-

ing degrees of difficulty involved in the safe and permanent utilization of land for crops, and classes VI, VII, VIII, and IX express similar capability gradations for range lands. It must be emphasized, however, that frequently the dividing line between any two classes necessarily is somewhat arbitrary. Moreover, the statements giving the limitations for cultivation in each class have been formulated in terms of prevailing methods of land management. Lands of class IV, for example, are designated as unsuitable, either because of erodibility or some other reason, for safe cultivation on a permanent basis. This means that from the standpoint of safety the cultivation requirements of these soils would be too exacting or difficult for practical use on a field scale; under different economic conditions, however, even more drastic measures, such as bench terraces on steep class IV lands, replenishment of topsoil on eroded IV lands, or extensive drainage operations on IV lands might be entirely practical. The lands would still be classified as IV, but the difficulties involved in their utilization could then be met effectively.

## CLASSES OF LAND ACCORDING TO USE CAPABILITY IN ARABLE REGIONS

Five classes of land according to use capability are recognized in regions of arable soils. Three classes, I, II, and III, indicate land that can be recommended for cultivation. The other two, classes IV and V, indicate land that should not be recommended for cultivation. In brief, the classes designate land—

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.

I. Land that, from the standpoint of inherent soil characteristics and environmental features, can be cultivated [5] permanently and safely with the production of moderate to high yields of the adapted farm crops without special practices or measures.

Land placed in class I must have all the following characteristics: (1) It is suitable for cultivation; that is, cultivation is not impeded by stones, rock ledges, a permanently high-water table, or any other condition that would interfere with the use of machinery for tillage. (2) It can be cultivated safely and permanently without special practices for the control of erosion; that is, erosion-promoting crops, such as corn or cotton, can be grown without danger of appreciable accelerated erosion. (3) It retains and supplies enough moisture and contains sufficient plant nutrients for the maintenance of those physical, chemical, and biological conditions in the soil that favor continued production of moderate to high yields of farm crops. Ordinary soil-building practices, including crop rotations and the use of fertilizers and soil amendments, may be commonly used on land of class I.

In regions where accelerated water erosion is prevalent, class I lands occur only on gentle slopes. In regions of wind erosion, class I

[5] Cultivation as used in these definitions means tillage of the soil, such as is practiced with intertilled crops and in preparing land for grain crops.

lands are of still more limited occurrence, since level land, as well as sloping land, is subject to wind erosion.

In the North Central States, where class I lands are of extensive occurrence, subdivision of the class may be desirable in some localities. The highly productive soils, such as Muscatine and Marshall, could be separated from the moderately productive soils, such as Miami and Clinton, that also belong to class I as here defined. If such distinction is made, the symbol Ia should be used for the more productive and Ib for the less productive types.

Examples: Adequately tile-drained Brookston silty clay loam or clay loam, a nearly level soil of the upland depressions derived from glacial drift, would be classified as I, while another area of the same soil, undrained, would be placed in a lower class, probably II, because special treatment is necessary to fit it for cultivation. Level, uneroded areas of Hagerstown silt loam, a productive Gray-Brown Podzolic soil derived from limestone, would probably be classified as I, but Hagerstown stony silt loam would not be placed in class I, even though level, because the stones interfere seriously with cultivation; such land would be placed in another class, probably IV. Huntington silt loam, a soil on the flood plains in limestone regions with rapid internal drainage, would be assigned to class I unless susceptibility to frequent overflow requires a lower classification. Marshall silt loam, a Prairie soil developed from loess, suitable for the grains commonly grown in the Corn Belt, includes large areas of I (or Ia) land, but, where it is moderately or severely eroded or subject to such erosion as requires strip cropping, controlled disposal of excess run-off water, or other soil-conserving practices, the land would be placed in class II or class III.

From this it can be seen that the Marshall soils, even though they are highly productive, may be placed in class I, II, or III. Productivity is only one factor in the determination of land use capability and is considered only in those instances where it is a limiting factor. A sloping area of Marshall silt loam, assigned to class III, may be much more productive than a level area of Grundy silt loam, although the latter would be assigned to class I because it needs no erosion-control or other special practices in order to produce moderate yields. Similar considerations would apply to such soils as the Newtonia, Houston, or Decatur.

In every instance the capability appraisal of the land is to be based on conditions existing at the time of mapping. In this connection it is well to recognize the fact that where an uneroded or but slightly eroded cultivated area is sufficiently steep to be susceptible to destructive washing, this susceptibility is in itself a present condition.

II. Land that, from the standpoint of inherent soil characteristics and environmental features, requires one or more special practices that are easily applied in order to be cultivated safely and permanently with the production of moderate to high yields of the adapted farm crops.

Special practices include soil-conserving measures, such as contour tillage, strip cropping, and terracing; the removal of stones that would interfere with cultivation; the installation of tile drains; or

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any other practices that require special attention. Soil-improving practices, such as rotation of crops and the use of fertilizers and lime, have become well established as ordinary practices in many parts of the country and are not generally considered special practices in those areas. Where these practices are not commonly used, they are to be considered as special practices.

III. Land that, from the standpoint of inherent soil characteristics and environmental features, requires complex or intensive measures in order to be cultivated safely and permanently with the production of moderate to high yields of the adapted farm crops.

Classes I, II, and III, as has been stated, include all lands that can be recommended for regular cultivation.

Land of classes II and III may be characterized by one or more of at least three different sets of factors: (1) Susceptibility to erosion if cultivated; (2) some physical obstacle such as stoniness or poor drainage; or (3) low productivity that requires special soil-improving practices other than those common to the locality for production of at least moderate yields of crops. Any one of these factors will cause land to be classified as II (rather than I), and in general two or more coexisting factors of such a nature, as well as a single factor of sufficient degree, would cause land to be placed in class III.

Since widely varying practices may be required on lands of classes II and III, additional symbols to denote groups of practices, such as those to prevent erosion or to correct unfavorable physical conditions, may be developed to assist in farm planning. Such a break-down is to be made only if the planning technicians determine that it will be useful. Only the major classes, I, II, III, IV, and V, are to be shown on maps submitted for publication. The separations, if shown, may be indicated by letters such as IIa to indicate practices for control of erosion and IIb for practices to correct unfavorable physical conditions, such as poor drainage or stoniness. Further subdivision to show specific erosion-control or other practices would tend to make the system complex and thus defeat one of the major purposes of the classification of land use capability. Care should be taken that all separations made express differences in land-using practices and that subdivisions within each major class are kept consistent with the definition of that class.

Examples: The Cecil soils of the southeastern Piedmont are extensive and occur on relief ranging from nearly level to steep. They are moderately productive under prevailing practices. Areas of Cecil soils having gentle slopes would be classified as I. Moderate slopes of 3 to about 12 percent would be placed for the most part in classes II and III, although eroded areas, stony areas, or other areas not suitable for cultivation would be placed in class IV or class V.

Norfolk sandy loam, under practices, such as the use of fertilizer, that are common in the localities where it occurs, is moderately to highly productive. Nearly level areas of this soil, not subject to erosion, would be placed in class I. Areas of Norfolk sand in the same locality are less productive and would be placed in class II or some lower class, even if not subject to erosion. For moderate yields, this soil requires fertilization in heavier amounts than are commonly

used. Obviously, gentle slopes that require simple erosion-control measures would never be placed in a class higher than II, regardless of the productivity of the soil.

Undrained Brookston clay probably would be classified as II because, while it can be made very productive, artificial drainage—a special practice—is necessary to make it cultivable.

In the semiarid portion of the southern Great Plains, smooth areas of the Pullman soils would probably be classed as II. These soils are deep and fertile, but special practices, such as level terracing for water conservation and special crop management, are necessary to preserve the soil and maintain permanent production of moderate yields. On the other hand, those areas of Pullman soils that have been affected by moderate to severe erosion and are deficient in coarse organic matter probably would be classed as III because of the need for considerable greater intensity of treatment, such as water-conservation measures, terracing, contour tillage, and repeated addition of crop residues, to maintain a constant supply of coarse organic matter.

The Zita soils, which are shallower than the associated Pullman soils, would be classed as III or IV. Where these soils have suffered moderate erosion, they probably would be classed as IV.

IV. Land that, from the standpoint of inherent soil characteristics or environmental features, is not suitable for regular or continuous cultivation with the production of moderate to high yields of the adapted crops but with adequate protection is suitable for uses that may involve short periods of cultivation.

Land in class IV may be characterized by steep slopes; severe erosion; physical obstacles, such as stoniness or very poor drainage; low productivity; or other qualities that make it unsuitable for regular cultivation. Some of the land in class IV may be safely used for limited or occasional cultivation, such as plowing to renew the stand of permanent pasture. In some regions land placed in class IV because it is too steep for row crops may be used for annual legumes or close-growing grains, provided such crops are planted to maintain effective cover throughout critical erosion periods.

Examples: Houston soils in the Black Belt of Texas having slopes between 6 and 10 percent are classified as IV, since they cannot be cultivated permanently without destructive erosion. The corresponding range for the Cecil soils of the southeastern Piedmont is generally from 12 to about 15 percent. Some land of both the Houston and Cecil soils having more gentle slopes might also be classed as IV because of advanced erosion. Some stony areas are classed as IV regardless of the slope.

Careful determination of the factors that characterize land of class IV must be made for each survey.

V. Land that, because of one or more inherent soil characteristics or environmental features, is not suitable for cultivation.

Most land of this class in humid regions can be utilized as woodland or for wildlife purposes. Some areas of class V land that are too steep for even occasional cultivation but that will support good grass may be suitable for permanent pasture. Land in class V is

characterized by steep, rough, or broken topography; extreme stoniness; very severe erosion; very poor drainage; or some other feature that prevents even occasional cultivation.

Summarizing this classification of land according to use capability in arable regions, class I land is that which can be cultivated, giving at least moderate yields of some crop without special practices. Land of class II is suitable for cultivation with simple practices, and class III is suitable for cultivation but requires complex or intensive practices. Land on which continuous cultivation is not recommended but which is suitable for other uses that may involve limited cultivation is assigned to class IV. Class V includes only land that is not suitable for cultivation.

## CLASSES OF LAND ACCORDING TO USE CAPABILITY IN GRAZING REGIONS

Proper management of range land, especially as to numbers of livestock units, seasonal use, and distribution, is necessary.

VI. Land that, because of inherent soil characteristics or environmental features, can be utilized effectively for permanent grazing without the practice of special measures to control soil erosion or to correct other unfavorable conditions.

VII. Land that, because of inherent soil characteristics or environmental features, can be permanently grazed through the use of good range management and measures to conserve rainfall and control soil erosion or to correct other unfavorable conditions.

VIII. Land that, because of inherent soil characteristics or environmental features, can be used effectively for permanent grazing under very strict range management.

Class VIII land includes areas that, because of shallow soil, low moisture-holding capacity or excessive run-off, severe erosion or high susceptibility to erosion, steep slopes, or low productive capacity, are not suitable for mechanical treatment but can be utilized for grazing under a system of management that includes stock adjustment, seasonal use, and proper distribution.

IX. Land that, because of inherent soil characteristics or environmental features, cannot be utilized effectively for grazing, such as barren tracts and inaccessibly steep areas.

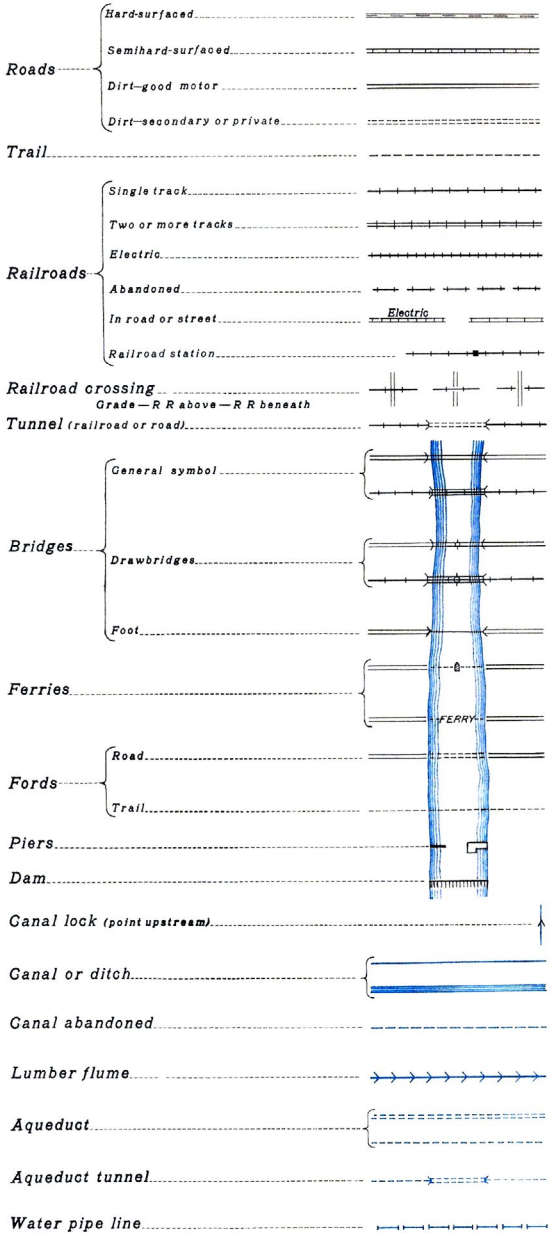
Lands of class IX may receive insufficient moisture, lack necessary fertility, or otherwise be unsuitable for production of forage. Examples would be deserts, bluffs, or cliffs, or excessively salty areas.

## TABLE FOR DETERMINING CLASSES OF LAND ACCORDING TO USE CAPABILITY

A table similar to table 2 should be prepared for each survey. This table is to be prepared jointly by all technicians and approved by the inspector and the regional conservator. Using the table, the class of land according to use capability can be determined readily for any area that has been mapped.

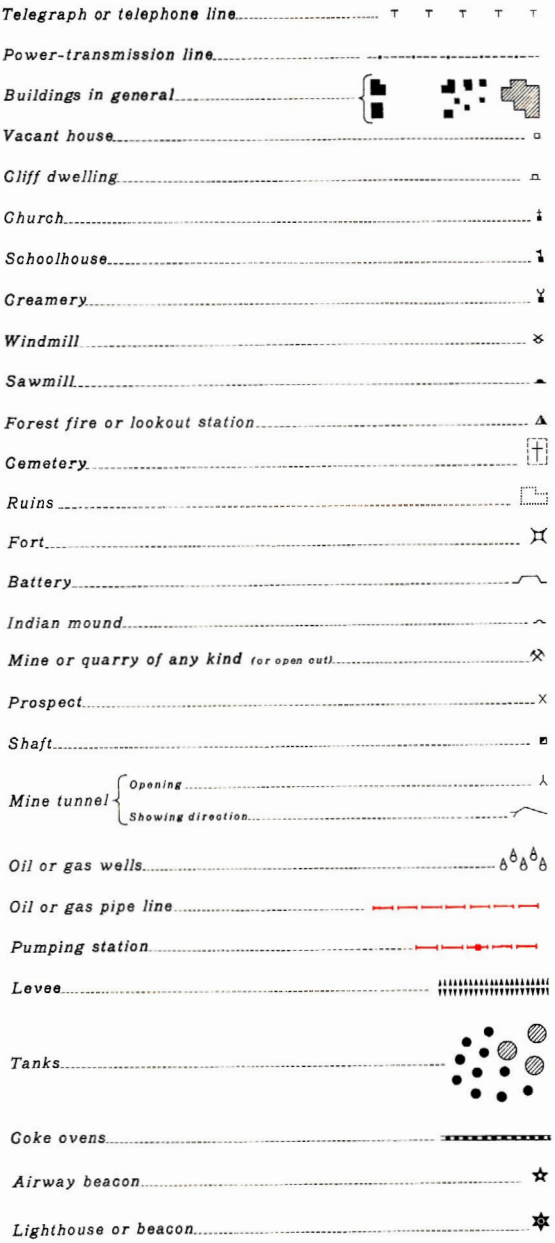
# CONVENTIONAL SIGNS AND SYMBOLS

# WORKS AND STRUCTURES



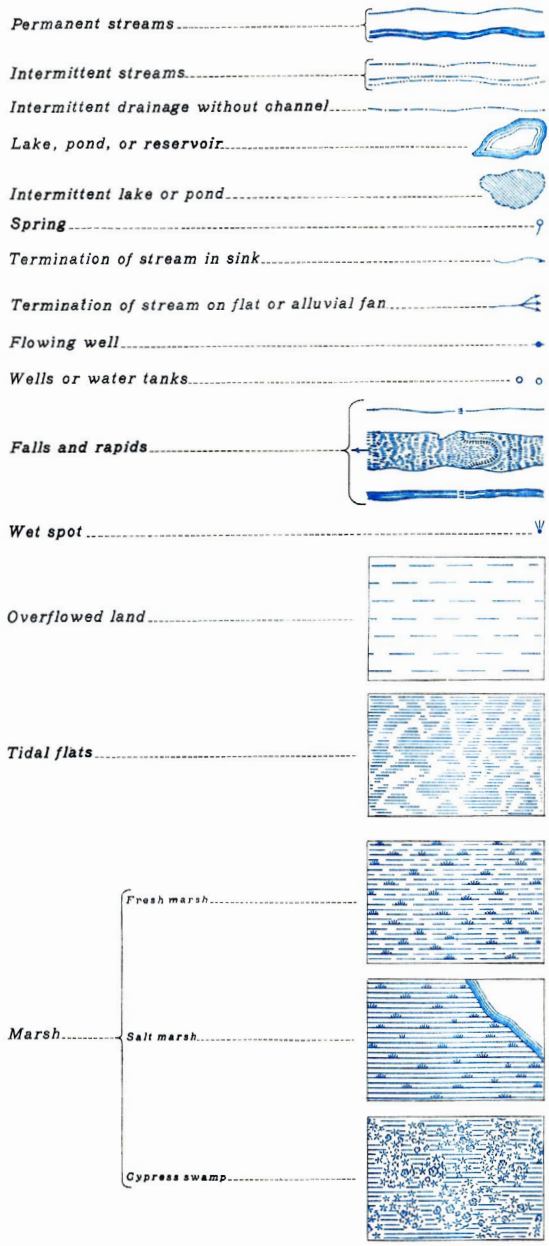

## SYMBOLS FOR USE IN MAPPING

## WORKS AND STRUCTURES — CONTINUED




SYMBOLS FOR USE IN MAPPING

# DRAINAGE




SYMBOLS FOR USE IN MAPPING

## BOUNDARIES, MARKS, AND MONUMENTS

*National, State, or Province line*

*County line*

*Civil township, district, precinct, or barrio*

*Reservation line*

*Land-grant line*

*City, village, or borough*

*Cemetery, small park, etc.*

*Boundary of area surveyed*

*Township, section, and quarter-section lines* (any one for township line alone, any two for township and section lines)

*Township and section corners recovered*

*Boundary monument*

*Farm boundary*

*Triangulation station*

*Permanent reference point or primary traverse-station*

*Permanent bench mark (and elevation)* B M 2240

*Supplementary bench mark (and elevation)* × 2240

*U. S. mineral or location monument*

*Soil sample location*

*Any located station or object* (with explanatory note)

## MISCELLANEOUS

*Rock outcrop*

*Stone*

*Gravel*

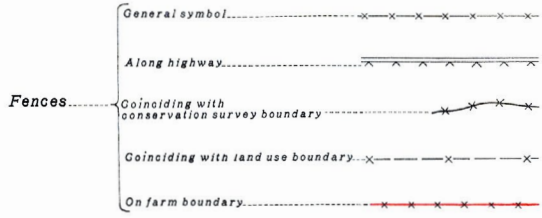
*Chert fragments*

*Made land*

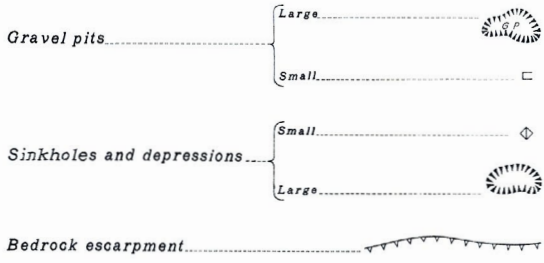
*Sand dune*

**SYMBOLS FOR USE IN MAPPING**

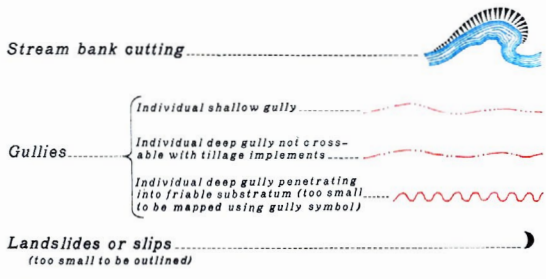
## WORKS AND STRUCTURES



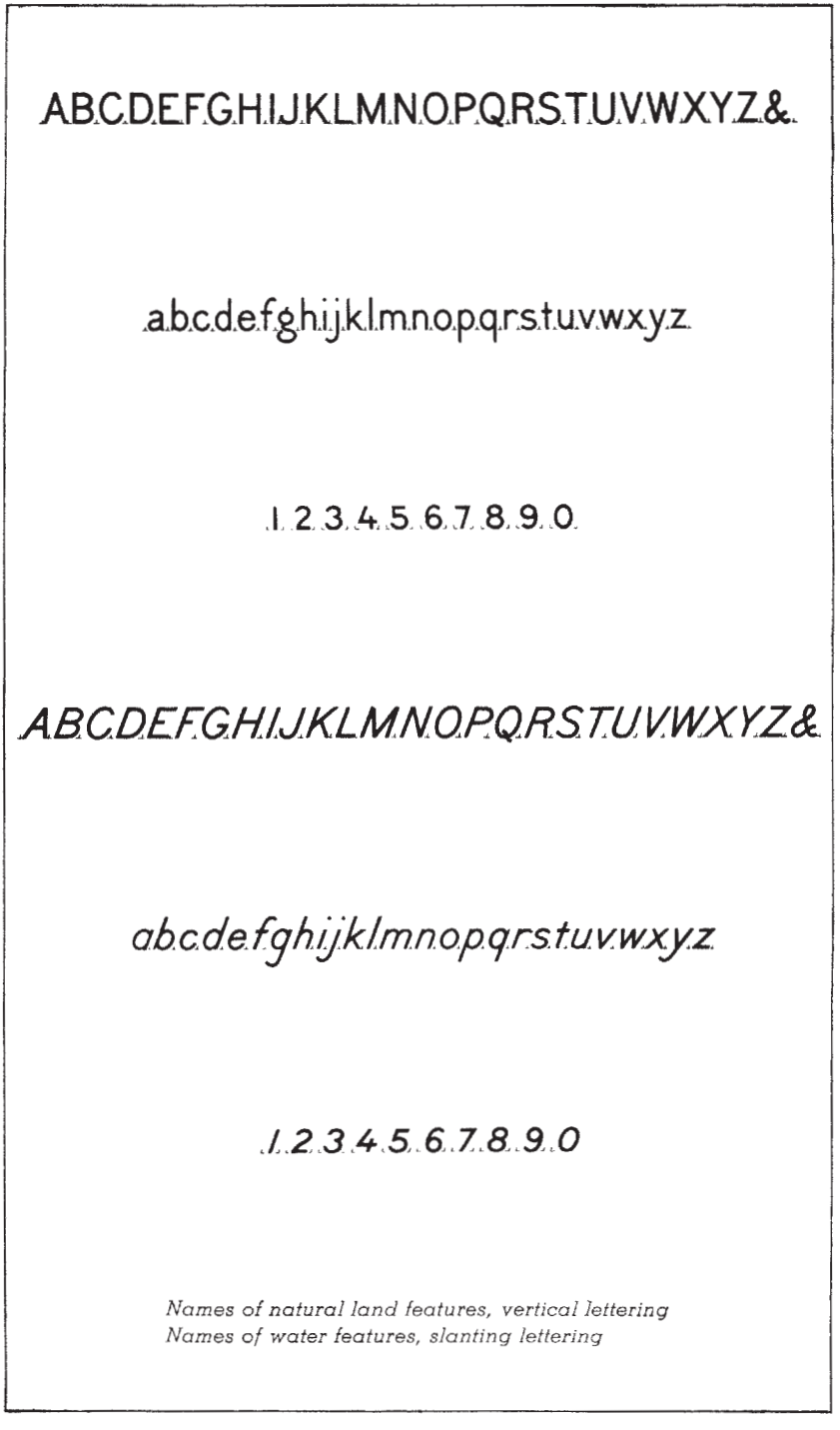

## RELIEF



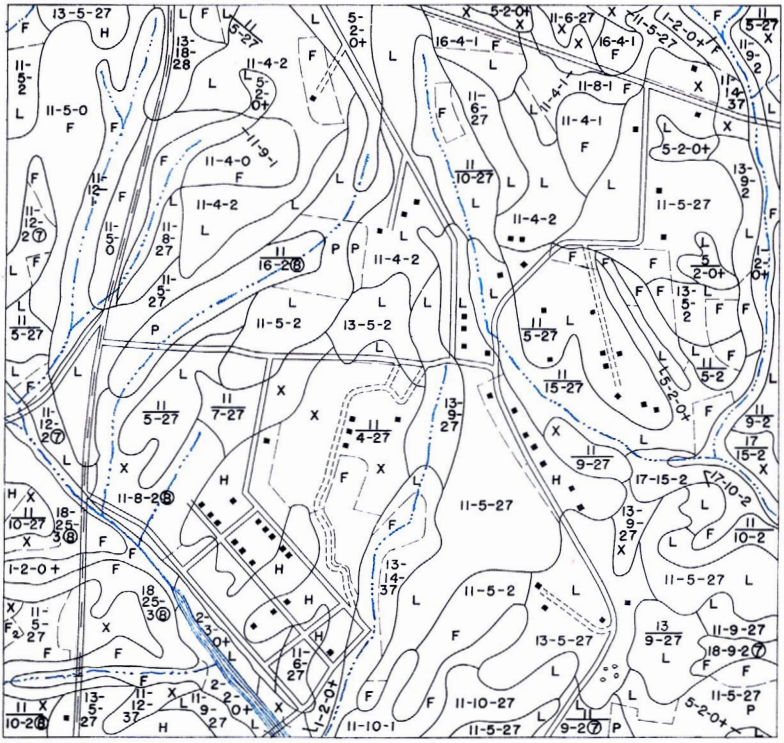

## MISCELLANEOUS



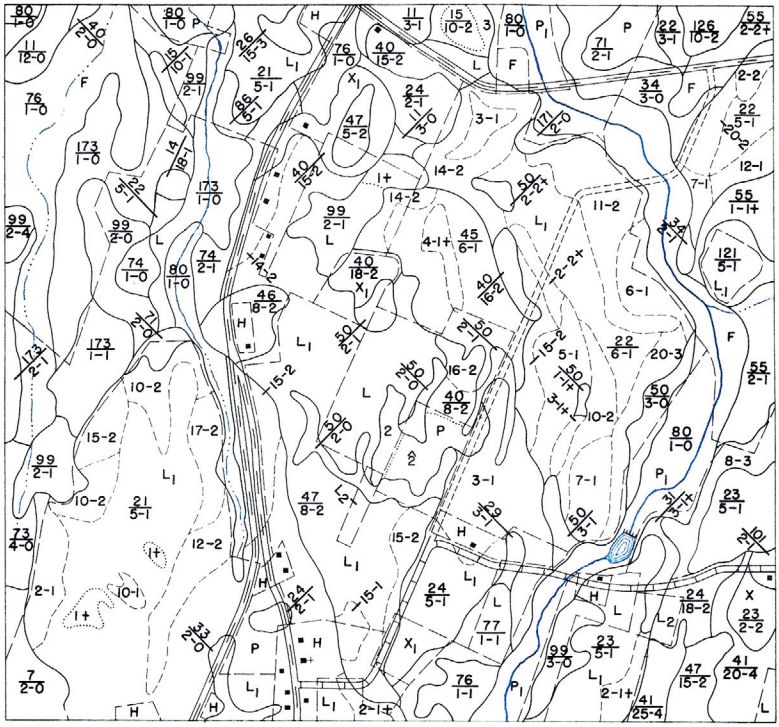

SYMBOLS FOR USE IN MAPPING



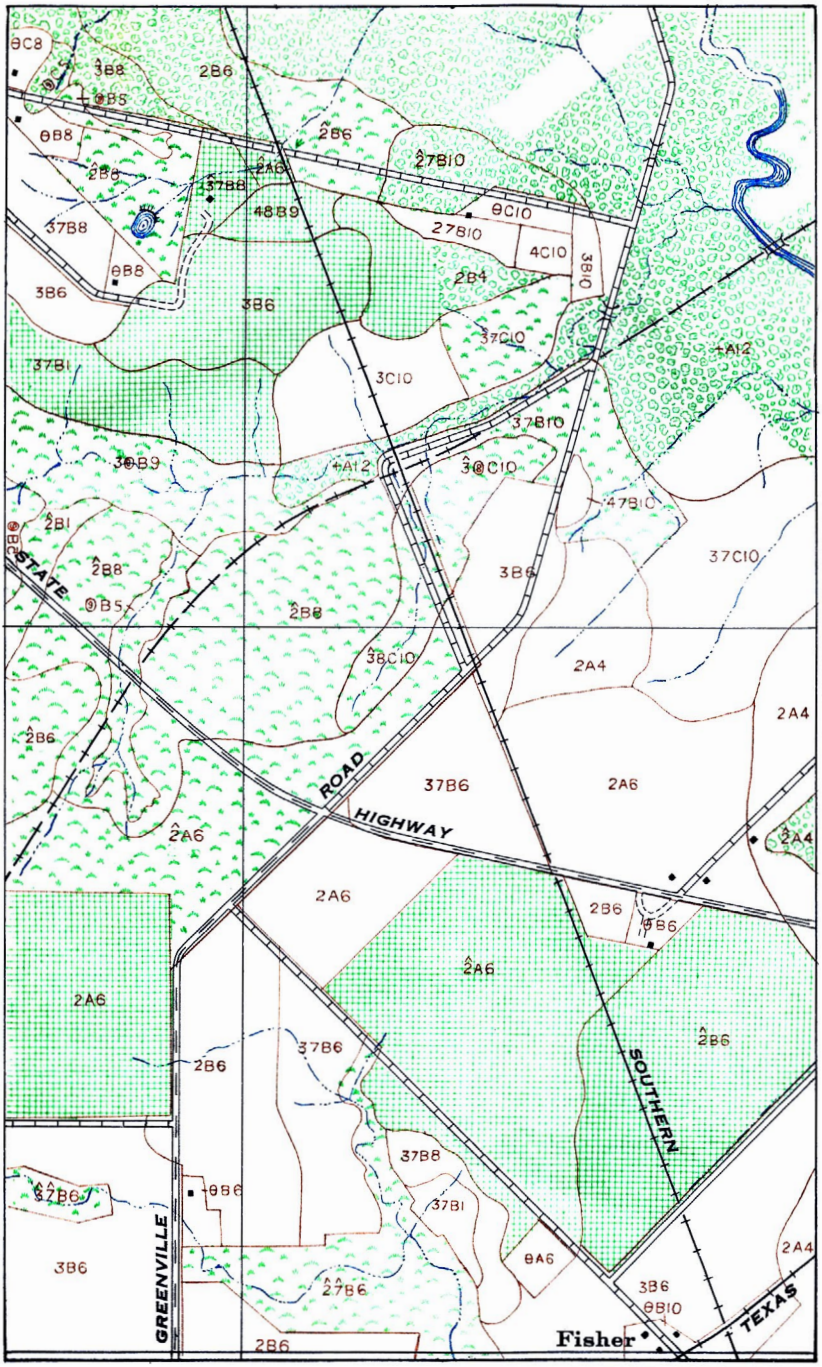

STYLES OF LETTERING FOR USE ON FIELD SHEETS



Sketch of part of a field sheet showing use of boundary lines and symbols. Original field sheet was an aerial photograph.



Sketch of part of a field sheet showing alternate method of the use of boundary lines and symbols.




Reprint of a small section of a soil conservation survey map. Green symbols show woodland, pasture, and idle land. Conservation survey boundaries in brown.

TABLE 2.—*Classes of land according to use capability for three soils in Winona County, Minn.*

| Field symbol and soil name | Slope and erosion characterizing class—[1] | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| 86, 87. Bertrand silt loam. | A+, A1, AΘ. | A17, A2, B1, B17, B2. | B27, C1, C17 CΘ. | | B28, B9, C2, C27, C3, D1, D17, D2, D27, E1, E17, E2, E27, F1, F17. |
| 56, 59. Carrington silt loam. | A1 | B0, B1, B2, B27. | C1, C17, C2, C27. | D27 | |
| 35. Dubuque silt loam. | | A1, B1, B2 | | B27, C0, C1, C17, C2. | B28, C27, C28, C3, C38, D1, D17, D2, D27, D28, D3, D37, D38, E1, E17, E2, E27, E28, E38, F17, F27. |

[1] Slope and erosion symbols have been changed to conform with the legend in this handbook. The slope classes are: A, less than 3 percent; B, 3–8; C, 8–15; D, 15–25; E, 25–35; and F, 35 percent and over.

Using this table, the surveyor or other technician can determine readily that an area of Bertrand silt loam, B slope, 27 erosion is placed in class III. Another area of the same soil on C slope with 3 erosion is placed in class V.

# INSTRUCTIONS FOR PREPARATION OF MAPS

## NAMES ON MAPS

The name of every important feature that will help to identify locations must be shown on the field sheets. It is the surveyor's responsibility to secure these names and to see that they are placed on the map in legible form. The correct spelling of every geographic name must be ascertained. Correct place names are published from time to time by the Board of Geographic Names, but fieldmen seldom have access to such lists. The surveyor is expected to show the names of all features as best he can, and if any doubt then exists, the correct name can be verified by the Section of Cartography. Different local names may be applied to a long watercourse in different communities. If such names are used without explanation, it appears to the draftsman as an error, but if the existence of both local names is verified in the field and noted on the map, the preferred name can be determined and used on the final map.

The style of lettering used on field sheets is shown in plate 6. If a name or other desired information would interfere with other features on the map, it should be shown on the margin.

## ORIENTATION OF MAPS

All symbols on field sheets must be oriented to be read from the south, except on aerial photographs where the flight lines are in a direct east-west direction. Then the symbols should be oriented to be read from the east. Where the flight lines were not directly north-

south, the symbol should be placed parallel to that edge of the sheet which permits them to be read approximately from the south. The orientation must be uniform on all sheets of each survey.

## RECORD ON BACK OF MAPS

Each field sheet must bear on the back the following information:

Name and number of survey, and State.
Kind of survey.
Names of men who mapped the sheet.
Date of survey.
Date of completion of the sheet.
By whom checked, and date or dates of checking.
Scale.

## INDEX MAPS

If a survey consists of several sheets, an index map (fig. 2) should accompany the sheets, showing the number of each sheet and its rela-

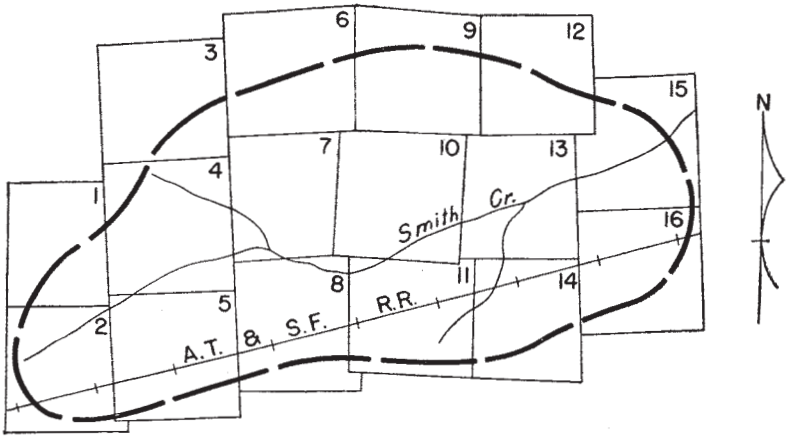



FIGURE 2.—Index map of a conservation survey

tive location, the boundary of the survey, and one or more prominent tie-in features, such as a railroad or a creek.

## MAPS FOR THE WASHINGTON OFFICE

The original field sheets or a good, legible copy of each completed survey should be thoroughly checked and delivered to the Washington office. Adjoining field sheets must be matched. Each set of field sheet is to be accompanied by a complete legend showing all symbols used. Each legend sheet must bear the name and number of the survey and the date the legend was adopted.

## DETAIL OF MAPPING

The detail of mapping will be determined by practicable application. No designation should be shown that is too small to be of significance for practical recommendations for land use and land treatment. On the other hand, on detailed surveys all conditions

should be indicated that are important for the development of a program for land use or water conservation. The degree of detail shown will be determined by the purpose of the survey.

The soil is ordinarily the first factor to be delineated in any survey. Many variations in the characteristics of soils occur, and the surveyor must decide on those variations that have significance and can be mapped consistently. After the soil-type boundary has been delineated, erosion and slope are considered in turn, and additional boundary lines are drawn if necessary.

## METHOD OF RECORDING DATA ON MAPS

Every survey will show the following: (1) The physical condition of the land, including soil type, slope, and character and degree of erosion; (2) present land use; and (3) land use capability. Methods of appraising each of these factors separately and the symbols by which they are to be designated have been presented in detail.

Boundaries are drawn to show all significant changes in soil types, slope groups, and erosion classes. Delineations of these factors are to be indicated by solid boundary lines drawn in black ink, and each delineated area is to be identified by a three-part compound symbol. Symbols should be arranged in fractional form, with the soil-type symbol in the numerator and the slope and erosion symbols, separated by a dash, in the denominator. A lineal or vertical arrangement may be used where the size and shape of the area do not permit the fractional form.

Present land use should be shown independently, using broken boundaries consisting of dashes about one-eighth inch in length. Where a land use boundary coincides with a soil, slope, and erosion boundary, a separate line need not be drawn. Land use symbols are separated from the composite symbol that denotes the three physical factors. Usually only one land use symbol is needed in each field or other delineation, but additional symbols should be used if there is any possibility of doubt regarding the correct interpretation. Part of a field sheet showing the method of using boundary lines and symbols is reproduced in plate 7. The plate also shows examples of lineal and vertical arrangements of the three-factor symbol and the method recommended for designating an area too small to contain a complete symbol—placing the symbol outside at a 45° angle.

An alternate method of showing soil types, slope, and erosion (pl. 8), which may be used if approved by all cooperating agencies and by the inspector, is as follows: Soil types are shown by solid lines, and, if slope and erosion are uniform within the delineated area, the three factors are shown by a compound symbol, as described in the foregoing paragraphs (p. 23). Changes in slope or in slope and erosion within the delineated soil area are shown by broken lines composed of $\frac{1}{16}$-inch dashes. Further changes in erosion class within an area that is uniform in soil type and slope are shown by a dotted line. In drawing boundary lines the soil boundary takes precedence over the slope boundary and the slope boundary over the erosion boundary; that is, solid boundaries define the limits of three factors—soil type, slope, and erosion; broken lines define the limits of the slope group or of the slope group and erosion class, but not of soil type; and dotted lines define the limits of the erosion class only.

If approved by the inspector as part of the survey plan, permanent roads may be used for land use boundaries. If this practice is adopted, it should be followed uniformly throughout the survey and should be described in the legend.

The boundary lines of every delineated area must be completely closed except where a double-line stream or a large body of water forms a part of the boundary.

Each field sheet must be complete within itself. In order to facilitate matching of adjoining sheets, features should be inked to, but not beyond, a line which is common to both sheets. On aerial photographs natural or cultural features, such as roads, fences, or streams, should be utilized as match lines if located near the margins of the sheets. If no such lines occur, arbitrary match lines should be drawn, preferably in green. In many cases match lines will be drawn before photographs are sent to the field.

The number of the adjoining sheet should be indicated in green near each margin. After the field sheet has been matched and checked, this number should be underscored in green, and the margin should be initialed by the surveyor doing the checking.

As stated on page 23, symbols denoting soil type (including depth of topsoil, if mapped), slope group (either the group designation or a numeral denoting percent of slope), and the kind and degree of erosion are to be arranged in the form of a fraction, with the soil symbol as the numerator and the slope and erosion symbols as the denominator. Slope symbols and erosion symbols should be separated by a dash. Component parts of complex erosion symbols should be arranged in the following order: Sheet erosion, gullies, water accumulations, wind removals, wind accumulations. (It is very unlikely that all these would be mapped on one area.) A sample symbol $\frac{81b}{6\text{–}2\text{⑧}}$ would be interpreted as follows: 81, Cecil fine sandy loam; b, 4 to 6 inches of topsoil remaining (these symbols will vary for each area and must be explained in the legend); 6, dominant slope of 6 percent; 2, loss of 25 to 75 percent of the topsoil; and ⑧, frequent gullies that cannot be crossed with tillage implements. The symbol does not show the slope group: it must be obtained from the legend.

## CORRELATION

To facilitate final correlation of a survey, all pertinent data are assembled for detailed consideration in correlation of soils by the Soil Correlation Committee, Soil Survey Division, and for review by the Department Committee on Soil and Erosion Surveys. These data consist of (1) an accurate field legend listing all features mapped, together with their field symbols; (2) a complete description of all features mapped; (3) the original field sheets, or copies that have been approved by the inspector; (4) a summary of planimetric measurements; (5) a copy of the inspector's correlation memorandum; (6) a collection of representative soil samples; and (7) tables of land classes according to use capability.

After necessary modifications, if any, the Department committee approves the classification, correlation, and nomenclature of all physical features mapped in the survey and submits its findings to

cooperating State or other agencies. After clearance by these agencies, a report, including recommendations for publication, is submitted to the Office of Land Use Coordination and to the bureau or bureaus responsible for the survey.

## RECORD OF APPROXIMATE AREA OF EACH SEPARATION

Definite information regarding the location and extent of minor soil separations and erosion classes is needed for correlation. Present methods of determining areas by cutting and weighing reveal the total acreage of each separation but not its location. Moreover, these acreages cannot in every case be made available in advance of correlation. Therefore each party chief is instructed to maintain a record of the approximate acreage and typical locations of each new delineation until he is sure that a significant area has been mapped. A copy of this record is to be submitted at the time the original field sheets are forwarded to Washington. It is not intended that this record involve any planimetric measuring in the field. If large acreages of delineations are mapped, that fact need only be stated, but the location and extent of delineations with a small total acreage should be known.

## SOIL SAMPLES

Soil samples will be required for all surveys on which correlation is anticipated. The inspector will designate soil types to be sampled. The most experienced soils man in the party should collect the samples, during the course of the survey if possible. Great care should be taken to see that they accurately represent the typical soil profiles as mapped. They should also be representative of the delineated area from which they are taken. At the time of sampling, a detailed description of each horizon should be written for the permanent records in Washington. In addition, the relief, drainage, and land use of each soil type should be given. Instructions for sampling and describing soils are given in the Soil Survey Manual (see footnote 3), pages 69–83.

The site for sampling should give free access to each principal horizon down to and including the parent material or substratum. A virgin site, if practicable, should be chosen. If a cultivated field is the only available source of the sample, the extent to which the original surface soil has been altered, particularly as to color, texture, and depth, should be determined if at all possible.

Only standard soil bags should be used in collecting the samples. They should contain not less, nor greatly more, than 1 pint of soil. Under no circumstances can any bag weighing more than 4 pounds be sent under frank. Bags must be securely tied with strong wrapping cord in preference to wire. Wet samples should be kept apart from others until they are thoroughly air-dried.

Standard franked tags, provided for the purpose, should be securely attached. The following information is required on each tag, carefully recorded in ink:

State and area symbol.
Sample number and depth.
Location (accurately described, for future reference).

Name of collector.
Name of soil type.
Field symbol used in mapping.
Concise description of layer sampled.
Number of bags used in type sample.

A bracket should follow the depth limit of the last sample of each profile, as 40–60″].

The samples should be sent directly to Washington, and the Washington office should be notified by letter of the number of bags mailed and the date of mailing.

## REPORTS

The results of surveys will be made available to agricultural workers, farmers, and other interested persons through published reports and maps (pl. 9). Reports must be well written, comprehensive, and authoritative. The following outline is suggested as a guide. The detailed organization of each report and the emphasis to be placed on the different parts will be governed by the purpose of the survey and by the nature of the conditions it reveals.

Material for reports will ordinarily be collected by all members of the survey party and by members of the regional and Washington staffs. For each survey one person, frequently the party chief, will be designated to assemble the material and write the first draft of the report. Reports will be based largely on (1) observations made during the survey; (2) tabulations based on planimetric measurements; (3) information and opinions derived from local sources; and (4) published or unpublished data collected from any available source (census, Weather Bureau, State agricultural experiment stations, and others). Census and Weather Bureau data will be furnished by the Washington or regional office.

In using this outline, the numbered headings can in most cases be used as titles of sections. Subheads indicated by letters are intended to suggest the content of each section, but they should not be used directly as subheads in the report except possibly in section 5.

An appendix will frequently be desirable for the presentation of material that cannot be used in the body of the report. In some reports brief but accurate descriptions of soil series or types may be desired. Selected tables of data from the survey may be used in some cases, depending somewhat on how this information has been handled in section 5.

### OUTLINE FOR REPORT

Erosion and Related Land Use Conditions in the _____ Watershed.

1. Introduction.
2. Description of the area:
   - *a.* Location, physiography, relief, elevation, drainage, vegetation.
   - *b.* Population, cities and towns, transportation, markets, industries.
3. Climate: *a.* Temperature, precipitation, evaporation, winds.
4. Agriculture.
   - *a.* Settlement and early agriculture, development of cropping systems, present crops.
   - *b.* Size of farms, labor, tenure of farms, kind of farm equipment.
   - *c.* Agricultural industries.
   - *d.* Practices affecting soil conservation and soil improvement.

5. The conservation survey:
   *a.* Methods and definitions.
   *b.* General erosion conditions.
   *c.* Soils.
   *d.* Slope classes.
   *e.* Present land use.
   *f.* Relation of erosion to other factors.
6. Sedimentation and soil erosion: *a.* A brief summary of the sedimentation survey, with mention of applicable data from the conservation survey.
7. Significance of physical land factors in erosion-control practices:
   *a.* Land suitable for crops on basis of conservation survey.
   *b.* Use of the conservation survey in planning erosion-control practices.
8. Appendix.

## SUGGESTED FIELD NOTES

The following set of questions is intended to suggest the kind of material that is desired in reports. Each surveyor is expected to keep field notes. With a good, complete set of field notes, planimetric data, and tables of climatic and census data, a good report can be written in a short time. Without such information, a good report cannot be written. Since some delay necessarily occurs between completion of the field survey and the correlation and tabulation of survey data, the complete report cannot be prepared by the party chief while he is in the field. However, if his field notes are complete and well-arranged, containing summaries of all the significant observations made by all members of the survey party, another person can complete the report without delay as soon as necessary data are available.

Questions are arranged according to probable section headings in the report, but very little further attempt has been made to organize the material. Some of the questions can be answered with a single word; other will require several pages; still others may not apply to a given survey and in that case need not be answered at all. On every survey there will be additional material, not covered specifically by any of the questions, that should be included. A complete set of field notes is expected from every field party. In most cases the party chief will be asked to prepare a finished draft of the report, but that duty may be assigned to some other person. The final draft of the report can never be any better than the information in these notes.

### BACKGROUND INFORMATION

1. Who were the surveyors? Give a complete list. Spell names correctly. If some worked only part of the time, indicate how long.
2. Who was in charge? If changes were made, indicate.
3. Who prepared this information? (If more than one member of the party assisted, indicate.)
4. What agencies or organizations cooperated? If some of the surveyors were employed by someone other than the Soil Conservation Service, indicate.
5. Other pertinent information.
6. What publications should be cited in the report? Give complete information. (See Literature Cited in any recent Department publication for form of citation.) Submit copies of State or local publications with your notes, if possible.

## INTRODUCTION

1. Why was the survey made? (As a basis for planning farms, for correlation with other investigations, to furnish information for general planning, or for other reasons?)
2. Why was this area selected?
3. What is the location of the area? Be specific. Give name of stream, if a watershed, and State, county, or other civil divisions. Reference to large cities or other points may help.
4. When was the survey made? when started? when completed? how many surveyors? minimum, maximum, and average amounts surveyed per day or per week?
5. What kinds of base maps were used?
6. What was the scale of field work?
7. What interesting incidents, facts, observations, or opinions might be used in the introduction of the report? (Submit several, if possible. This material may not be used in the completed report, but it helps greatly in describing and interpreting the survey.)
8. What other observations have you made, or what information have you gained that is of a general nature and should be used in the introduction? (Take as much space as you wish.)

## DESCRIPTION OF THE AREA

1. Where is it located? (Any overlap between this question and question 3 under the introduction will be eliminated later.)
2. What is the acreage of the area surveyed? (This information should be furnished as accurately as possible, but the exact acreage may not be determined until the planimetric map has been completed.)
3. What are the approximate dimensions of the area?
4. What are the important boundaries? (Rivers, lakes, international boundary, or other important feature.)
5. Describe the topography. Name the physiographic provinces in which the area occurs. Physiography and relief should be discussed separately, although not necessarily under separate headings. By physiography is meant the shape that a given area would have if the valleys of existing streams were filled. Usually the physiography can be described as a flat plain, a series of plains separated by escarpments, a series of sharp mountain ridges separated by lowland belts that may or may not be occupied by valleys, or a general mountainous region without any definite system of arrangement. By relief is meant the shape of the land surface in detail produced by the dissection of existing streams on the physiographic features. It should be stated whether the general course of the streams is across the belts of the physiographic features or parallel to them. It should also be stated whether the upland is smooth and whether it slopes off into the valleys of existing streams by rounded slopes or by angular slopes. Usually, where the geological formations are uniform, the slopes from the plain to the valley will be rounded. However, where a given plain is underlain by a bed of rock parallel to the surface of the plain, and if that bed of rock be resistant to erosion, the plain will as a rule drop to the valleys rather sharply. Such features as that and others that are significant should be brought out. The elevations of the main physiographic features

and the range in elevations within the area surveyed are also useful information. Prominent peaks or other features should be mentioned and named.

6. Describe the drainage of the area. This heading refers primarily to the surface drainage and can be handled very briefly if the surveyed area is a watershed. The internal drainage within soil profiles will be covered elsewhere. The names of principal streams and their tributaries should be given, and if the drainage system is incomplete, that fact should be noted.

7. Describe the native vegetation. If the area was originally covered with forests, give the names of the dominant trees. State also whether the growth was vigorous and dense or scant and scrubby. Give the character of the undergrowth within the forests, especially if that gives any suggestion as to the character of the soil, such as soil acidity. Similar information should also be given for present woodlands. Are any of the present woodlands on land that was formerly cultivated? Give the scientific names of important trees, grasses, or shrubs, if possible.

8. What are the principal cities and shipping points in the area?

9. Give the population of the principal cities and towns. Tables giving this information will be prepared if desired.

10. Give the population of the area, if available. A table giving the population of counties, townships, and other units included in the survey may be desirable.

11. What are the principal industries located in or near the area?

12. Describe briefly the highways, railroads, and other available methods of transportation.

13. Give any other information regarding the economic development of the area that you deem significant. Additional information regarding the nature of the population, schools, churches, or other institutions might be interesting.

## CLIMATE

1. Give the general features of the climate. Is the climate oceanic or continental? Are there wide variations in temperature between winter and summer? Is the rainfall well distributed in the growing season? Do conditions differ widely in various parts of the area surveyed due to physiography or the influence of bodies of water?

2. Give the mean annual temperature and the average and extreme dates of killing frosts. (This information will be compiled from Weather Bureau publications. If any good local sources of data are available, they should be investigated. State experiment stations or substations, for example, may have some interesting climatic data.)

3. Give your interpretation of the tables of climatic data that have been furnished you.

4. Give your interpretation of the tables regarding distribution of precipitation, intensity of rainfall, and the greatest precipitation on record. In addition, summarize all the information pertaining to these subjects that you can assemble. One or two incidents, such as the amount of erosion caused by a measured amount of rainfall on a given date might add greatly to the interest. If such an

incident is reported, be sure to obtain all pertinent facts. To state the amount of soil lost but omit the area of the field, for example, gives an incomplete account.

5. What important influence has the climate on agriculture and special crops? For example, can winter cover crops and vegetables be grown during the winter months. Can farm work be performed the year round? Is the soil frozen in winter?

## AGRICULTURE

1. When and where was the first settlement made?
2. Describe the early agriculture, giving the principal crops, the kinds of livestock, and any other information you can obtain.
3. Trace the changes and developments in agriculture from the early settlements until the present time. If there were significant periods in the agriculture or if any important changes occurred, describe them.
4. Name the important crops grown at the present time, and give the approximate acreage or percent of each. What percent of the cultivated land does each occupy?
5. From your experience on the survey, to serve until definite figures can be assembled, estimate:
   *a*. How much of the area is idle?
   *b*. How much is in woodland? and
   *c*. How much is in pasture?
6. Approximately what percent of the total land is in farms? Definite figures on a county basis are available in census data.
7. What is the average size and the range in size of farms?
8. What percent of the farm operators are owners, and what percent are tenants? (County figures are available in census data.) What kind of lease agreement is used?
9. Is most of the farming done with machinery, or is a great deal of hand labor employed? What kinds of farm equipment and machinery are used, and what is the condition of this equipment at the present time?
10. What are the numbers and kinds of livestock kept on farms? Give the extreme figures and something of the distribution as well as the averages.
11. Has the use of tractors displaced work stock to any great extent in recent years?
12. What types of farming are predominant? Cash crops; livestock; dairying; or other types? Are specialized types of farming practiced to any significant degree?
13. Are commercial fertilizers used to any great extent? What is the approximate relation of fertilizers used to the value of crops harvested or sold? What has been the history in the use of fertilizers? Has increased use of fertilizers been necessary as a result of soil erosion?
14. What effect have farming practices had upon soil erosion or upon soil deterioration of any kind? Have any significant changes occurred? Is there any trend now toward better use of the land or improved soil conservation practices?
15. Several tables will probably be desired to illustrate significant points regarding the agriculture of the area. Tables most commonly

used are the acreages and yields of crops, the numbers of livestock, the value of farm lands and buildings, and the number of tenants. Which of these tables or what other tables do you consider necessary for a good description of the agriculture?

16. Give the effect of current farm practices upon soil erosion. Is the land left unprotected for long periods? Are the cropping systems inadequate to provide good cover throughout critical erosion periods?

17. What are the average yields and the range in yields of the important crops?

### THE CONSERVATION SURVEY

1. Give a complete list of every soil separation mapped, giving the field number and the field name. A copy of the legend furnished for correlation will be sufficient. If a field name was not assigned, give the outstanding features by which the separation was identified. This list will not be used directly in the report at this point, but it will be used as a basis for one or two statements on factors mapped.

2. Give all the separations of present land use that were mapped. Define each of these in specific terms that apply to this survey. For example, does cropland as mapped include alfalfa meadows? orchards? What was the basis for distinguishing between idle land and cropland? between idle land and run-down pastures? between brushy idle land and woodland? between brushy pasture and pastured woodland? If a class of native grassland was recognized, how was this distinguished from pasture? Record all significant information that might have a bearing on the interpretation of the survey.

3. What slope groups were recognized, and what is the significance of each? What are the limits, in percent, of each slope group? Are they different for different soils? If so, describe in detail.

4. Give a complete list of all symbols that were used to designate erosion classes. This means that every class that was mapped should be listed, as 1, 2, 27, 3, 3R, 3F, etc.

5. Give the exact definitions that were used for special or unusual erosion classes, such as 0, +, Θ, W, or any others that were used.

6. Was stabilized erosion mapped? Describe the conditions that were regarded as stabilized erosion.

7. Group the erosion classes into not more than seven or eight general groups which indicate their significance in land use and the planning of erosion-control practices. The groups should be somewhat as follows: Recent alluvial deposits, no apparent erosion, slight erosion, moderate erosion, severe erosion, very severe erosion. Where wind erosion has been mapped, subdivision of these groups to indicate erosion by wind only, by water only, and by wind and water combined may be desirable. This information is essential for preparation of a good report. State whether the grouping submitted has been approved by the inspector.

8. What are the general characteristics of the soils? Note the outstanding features of the soils in general; the presence of large areas of shallow soils, poorly drained soils, or other significant variations from normal profiles; the character of parent rock; modifica-

tions of material, if any, by glacial action, alluvial transportation, or other methods; the general level of fertility; other significant facts about soils that have general application.

9. Group the soils of the area into not more than 10 or 12 groups, if possible, and preferably fewer, that express the important variations in native productivity, utilization, and kind or intensity of practices necessary for erosion control. Development of these groups will require considerable thought. The party chief may prepare it alone, but in every case the grouping should have the approval of the inspector and the regional technicians. The advice of State agricultural colleges and experiment stations will in many cases prove particularly helpful. In time it is hoped that a considerable body of field and laboratory measurements of permeability to water and run-off on different soil types will be available as additional factors to be considered in the grouping of soils. This grouping will form the basis for the main discussion of soils in the report, and it should not be made in a hasty or superficial manner.

10. Describe each group of soils. Give the features common to all members of the group. List the members, and give one or two distinguishing characteristics for each soil series. Ordinarily distinctions between the types of a series are apparent, but if any differences exist, such as differences in erodibility, they should be noted. Since the reports deal particularly with erodibility and erosion, the most definite and complete information that is available should be given for each group, and for individual members of a group if there are important variations.

11. Describe each soil series, including the variations that have been mapped on this survey. Profile descriptions of the soil samples will be useful in preparing these descriptions but cannot be substituted for them. Point out the location and the significance of important variations. What are the characteristics of the different types in each series?

12. Are there any geographical divisions for which conservation survey data (on soil types, slopes, erosion, and land use in relation to each other) should be assembled separately? If any such divisions exist, outline them accurately on a sketch map or index map of the area. (This information must be on hand before planimetric measurements are started.)

13. Discuss in full any other points regarding soils that should be presented. (Detailed descriptions of soil series or types, particularly the information called for in questions 11 and 13, will not appear in the report, but it may be added in an appendix in some cases.)

14. What, in general, are the slopes in the area? Use descriptive terms such as undulating, gently rolling, or rough and broken to describe the landscape, as well as giving the prevailing percentages of slope.

15. What is the approximate relative extent of each slope group mapped? (Estimate. Exact figures will be obtained later.)

16. Where does each slope group occur, typically? (Are the A slopes, for example, limited to flood plains, or flood plains and ridge tops?)

17. What other information relating to slope should be recorded?

18. How extensive and severe is erosion?

19. What conditions have encouraged accelerated erosion? Has erosion increased or decreased in recent years?

20. What types of erosion—sheet, gully, wind removals, wind accumulations—occur in the area?

21. Is gully erosion prominent? About what percentage of the area does it cover? What soils are particularly susceptible? Are friable C horizons exposed that give deep gullies? Does bedrock limit the average depth of gullies? Are there differences in the behavior of different soils?

22. Does a given degree of erosion, as 37, represent more serious erosion on some soils than on others? If so, explain why. Should the grouping of erosion classes (see question 7) be different on different soils?

23. Has accelerated erosion occurred primarily because slopes have been cultivated that are too steep for satisfactory control or because of failure to use proper practices on lands where erosion control is possible?

## THE SEDIMENTATION SURVEY

(For watersheds where a reservoir survey has been made)

An attempt will be made to estimate the volume of soil lost, as shown by the erosion survey, and to account for it as completely as is possible by estimating the volume of colluvial deposits, flood-plain deposits, deposits in the reservoir, and suspended material carried past the reservoir.

1. Have any observations been made of flood-plain deposits? How deep are they? What is the thickness of soil material deposited since accelerated erosion began?

2. How deep are the various types of colluvial deposits?

3. Are there any deposits in the lower parts of fields, on lower slopes, or in very narrow bottoms that are not mapped as alluvial or colluvial soil types? If so, how extensive are they? What is the average thickness?

What other observations would be useful in interpreting the sedimentation survey?

## SIGNIFICANCE OF PHYSICAL FACTORS IN LAND USE AND EROSION CONTROL

1. What physical limits can be set up for land that can be cultivated safely and permanently? Answer in several parts:

*a.* What soil types, if any, should not be recommended for cultivation? Give the outstanding reason, as stoniness, shallow profile, steep relief, low productivity, high water table, or other reason, for each.

*b.* What slopes are too steep for safe and permanent cultivation? (All slopes steeper than the lower limit of C slopes were in this classification on most of the former surveys.) If different on different soil types, give full information.

*c.* What erosion classes (or groups) designate damage so severe that cultivation should not be recommended?

Answers to these questions, applied to the survey data, will give a summary of the amount of potential cropland in the area and will

illustrate the manner in which classes of land according to use capability have been developed. The table for determination of land use capability should be given.

2. On the basis of the foregoing, what percentage of the total land in the watershed do you estimate is suitable for safe and permanent cultivation? (This estimated figure will not be used in the report but will furnish some guide until the planimetric data become available.)

3. How much land, suitable for crops from the foregoing analysis, is now in urban areas, recreational areas, farmyards, and other uses that prevent its use as cropland? (This estimate is necessary. Some farm land may be level, uneroded, and probably productive, but could not be made available for crops. Possibly a more accurate estimate can be made after planimetric data are available.)

4. Discuss the principles of planning erosion control and land use on farms in the area surveyed. Stress the fact that the conservation survey gives a definite basis for establishing minimum requirements that are absolutely necessary for preservation of the soil and that a set of practices for each farm is developed in accord both with these minimum requirements and with the needs and preferences of the owner and operator regarding the system of farming, the crops to be grown, and other considerations.

5. Discuss the use of specific erosion-control and other conservation practices on farms in the area surveyed. State specifically the limitations imposed by the physical factors of soil, slope, and erosion, particularly with reference to practices used on cropland. For example, are there any soil types that should not be terraced? What slopes may be terraced? What limitations in practices are conditioned by the various degrees or groups of erosion? Separate discussions of practices for cropland, pasture, and woodland may be desirable.

6. Are there any other phases of soil or water conservation that should be included and discussed? Examples might be erosion control on highways, disposal of water from highways, or others. Discuss each fully.

## CONDUCT OF THE SOIL CONSERVATION SURVEYOR TOWARD THE PUBLIC

The conduct of the fieldman toward the public should be courteous and gentlemanly at all times. The soil conservation surveyor is one of the first men in the Service to contact the man on the land, and first impressions are lasting. The surveyor should make an effort to answer all pertinent questions in a friendly manner and in a spirit of helpfulness. He should be prepared to go out of his way, when occasion demands, to explain the nature of the work and to point out its purposes. To do this successfully he must first be thoroughly familiar with it himself and completely in accord with its objectives The landowner or operator will be one of the parties to any cooperative agreement, and all persons have an equal right to know about the program. The surveyor must respect others' rights, whether they pertain to opinion or to property. Above all, he must avoid contention. An ounce of diplomacy may be more useful than a pound of argument.

# APPENDIX

## FACTORS USED IN GROUPING SOILS

After soils have been mapped according to series and types, it is sometimes desirable to simplify the classification by arranging them in groups. Such groupings may be made to show not only broad features of resemblance but also marked differences.

The following are some of the factors that should be considered in grouping soil types:

1. External features:
   - Site: Upland or lowland.
   - Original vetgetation: Timbered or grass.
   - Relief: Favorable or unfavorable for erosion control.
   - Drainage: Well-drained, poorly drained, or imperfectly drained.
2. Physical and chemical character of the soil horizons:[6]
   - Reaction: Neutral; mildly, strongly, very strongly alkaline; slightly, medium, strongly, very strongly, or extremely acid. State also if calcareous.
   - Salts and alkali.
   - Texture: Light, medium, heavy.
   - Structure: Granular, prismatic, columnar, nutlike, platy, crumb, fragmental, or phylliform.
   - Consistence: Loose, compact, mellow, friable, crumbly, plastic, sticky, hard, cemented.
   - Permeability: Favorable or unfavorable.
   - Moisture retention: Favorable or unfavorable.
3. Susceptibility to erosion:
   - Water erosion: Slight, moderate, severe.
   - Wind erosion: Slight, moderate, severe.
4. Present productiveness: High, medium, low.

## METHOD OF STATING SOIL DEPTHS AND SLOPE LIMITS

Confusion has occasionally arisen in stating the results of measurements, particularly the depth of soil horizons and the limits of slope groups. In order to secure uniformity the word "to" should be interpreted as meaning to and not beyond the value stated. In describing a soil horizon, the distance from the soil surface to the upper and lower limits of the horizon should be stated. For example, one horizon may be from 0 to 2½ inches, the next from 2½ to 4, and so on. If there are transition layers or any zones that are not sampled for any reason, that fact should be noted.

In establishing slope groups, limits are set up in the following manner: Group A, less than 2 percent; group B, 2 to 5 percent; and group C, 5 to 12 percent. In order that these limits of slope groups may be applied uniformly, land with a dominant slope of less than 2 percent should be mapped in group A. Land with a dominant slope of 2 percent and any area with a slope greater than 2 percent but less than 5 percent would be mapped in group B, and a 5-percent slope would be mapped in group C.

## SYMBOLS

Standard symbols for soil conservation survey base maps are shown in plates 1 to 4. Styles of lettering suitable for field sheets are given in plate 6. In plate 5 there is given a group of miscellaneous symbols that includes those for the

[6] These and other terms are defined in the following publication: U. S. DEPARTMENT OF AGRICULTURE. SOILS AND MEN. U. S. Dept. Agr. Yearbook 1938: 1162–1180. 1938.

designation of isolated gullies, cutting along banks of streams, and small detrimental deposits of erosional debris. In general, the symbols used follow those approved by the Federal Board of Surveys and Maps. Special symbols may be used to show additional features, but they must first be approved by the inspector and incorporated in the survey plan. Symbols and lettering on all maps must be distinct and legible. The ink used should be of a type that adheres to the paper and does not flake off. Inks containing dyes are available that will adhere to photographs but that cannot be erased without removing part of the paper.

If the project boundary occurs near a road or railroad and crosses back and forth, the surveyor should show all detail of the base map between the boundary line and the road or railroad, as indicated in figure 3.

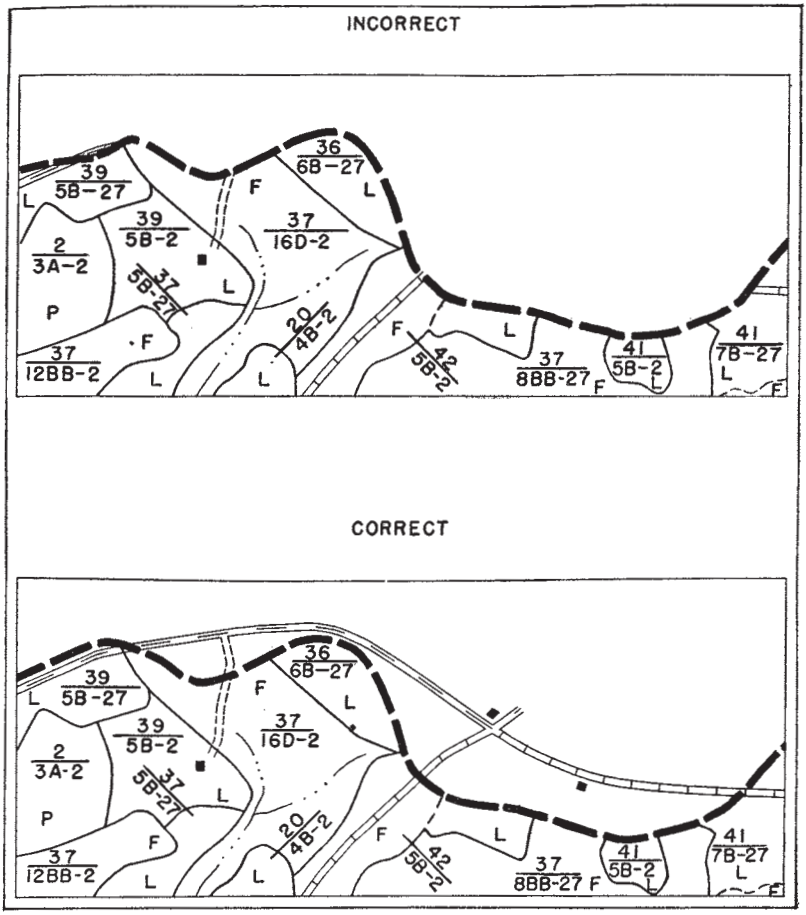



FIGURE 3.—Method of showing base-map detail along project boundary.

On detailed surveys permanent fences that do not coincide with other lines will be indicated by small black crosses on a fine broken black line, as shown in plate 5. Fences bordering highways, railroads, or other works may be indicated by using small v's along the structure symbol as illustrated with the dirt-road symbol. Fences that coincide with conservation survey boundaries, land use boundaries, or farm boundaries will be indicated by black crosses on such boundary lines. In areas affected by wind erosion, deep drifts along fences may be indicated as shown under Miscellaneous in plate 5. To indicate the depth of the drift and to mark those drifts that require leveling or other treat-

ment, the appropriate wind-erosion symbol may be used, as given in the example in plate 5.

Farm boundaries are to be shown only if there is a definite need for them, as on soil conservation districts, and if it has been determined that they can be shown to best advantage by the soil surveyor. If shown, they are to be indicated by red lines, except possibly on surveys for which the field sheets are to be reproduced by photography. On such surveys adoption of some other distinctive line may be advisable.

On all maps, including aerial photographs, occupied houses will be indicated by solid black squares, unoccupied houses by open squares.

## CLASSIFICATION OF FORAGE TYPES ON RANGE SURVEYS

For making range surveys, 18 forage types have been recognized. On conservation surveys these types may be mapped, if approved in the survey plan, to indicate cover on range lands in greater detail than is provided on pages 13–14. The following instructions for mapping forage types have been adopted by an inter-agency conference that included the Soil Conservation Service.[7]

### TYPE DESIGNATIONS

Types will be indicated by the proper type number followed by standard symbols to indicate the dominant species. Types containing a timber overstory will carry the principal timber species symbol after the type numbers. The number and symbols should give an accurate picture of the principal species.

Types will be designated according to aspect. For instance, if the type is predominantly a grass type with scattering timber, it will be shown as type 1 (grassland) followed by the timber symbol. The conspicuous or most important species or genus symbol will be shown first, followed by the minor species. Unless exceptional conditions prevail not more than three symbols will be shown in a designation. If less than three species are prominent the number of symbols should be reduced accordingly.

### SYMBOLS

Symbol lists for trees, shrubs, and herbaceous vegetation should be devised and standardized for regions. Symbols for all common and widely distributed genera and species should preferably be standardized for the entire range area.

The governing principle will be a three letter symbol—all capitals for the genus symbol and one capital and two lower-case letters for species. The genus symbol should, except for trees, consist of the first three letters of the genus name. In case of conflict the most common genus will carry the second or third letter changed to remove the conflict.

Species symbols will consist of the first letter of the Latin generic name, followed by the first two letters of the specific name. In case of conflicts the same rule will be applied as for removing conflicts in generic symbols. If the species determination is unimportant or if the species cannot be readily identified the genus symbol may be used. If there is a difference in forage value or general characteristics between species in the same genus, the species symbol should always be used.

### TYPE DESCRIPTIONS[8]

1. Grassland.—Grassland other than meadow and secondary meadow. Perennial grasses predominate and determine the aspect although weeds and browse may be present.

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[7] INTER-AGENCY RANGE SURVEY COMMITTEE. INSTRUCTIONS FOR RANGE SURVEYS AS FORMULATED BY THE INTER-AGENCY RANGE SURVEY COMMITTEE AND ADOPTED BY THE WESTERN RANGE SURVEY CONFERENCE. pp. 20–26. April 24, 1937. [Mimeographed.] [Quoted with slight editorial changes.]

[8] Type descriptions were developed by the Forest Service and have been used by them since 1914. In 1937 these descriptions with slight modifications were adopted as standard by the following agencies: Agricultural Adjustment Administration, Forest Service, Resettlement Administration (now Farm Security Administration), and Soil Conservation Service, of the Department of Agriculture, and the Bureau of Indian Affairs and Division of Grazing, of the Department of the Interior.

Examples of type are: Grama-buffalo grass, bunch grass, wheatgrass-sedge, alpine grassland, bluestem.

2. Meadow.—Areas where sedges, rushes, and moisture-enduring grasses predominate. Two classes of meadow are recognized:

*2W. Wet meadow or marsh.*—Meadow areas that are characterized principally by sedges and that remain wet or moist throughout the summer.

*2D. Dry meadow or flood plain.*—Meadow areas that are dominated by grasses rather than sedges and that occur as moist meadowlike areas in open timber or intermittent meadows, both of which become moderately dry by midsummer.

3. Perennial forbs (weeds other than desert weeds).—All untimbered areas where perennial weeds predominate over other classes of vegetation. There is very little true weed type, as a weed cover is usually temporary in character and is soon replaced by a more permanent vegetation if the disturbing factor is removed. If there is no great predominance of the weeds over the grass or brush vegetation and if it is possible to judge that the weed predominance is due to some unnatural factor, the weeds should be disregarded in designating the type and the more stable vegetation should be used as an index. The weeds will then be cared for in the subtype.

4. Sagebrush.—All untimbered lands where sagebrush or shrubby species of similar appearance predominate. The sagebrush lands usually differ in range values and in season of grazing from the areas that are classified as browse. Areas dominated by shrubby species of sagebrush, including big sagebrush (*Artemisia tridentata*), shall be classed as subtypes, as, for example, *Artemisia filifolia, A. cana,* and *A. tripartita.* Other shrubby species such as *Chrysothamnus* should be designated as subtypes when they become dominant in sagebrush areas.

The sagebrush and the browse types are sometimes difficult to distinguish from the grass and weed types if aspect rather than the dominant class of forage is used as the distinguishing characteristic. Sagebrush may form only 15 percent of the total vegetation of a type and still its aspect may be that of a sagebrush type. It may prove desirable, in a given region, to decide on a certain percentage, such as 20, of all the vegetation in the type as the minimum proportion of sagebrush that may be present if the area is still to be classified as type 4, provided, of course, that it does not already have the aspect of some other type. The same will hold true of the browse type.

5. Browse-shrub.—All untimbered lands where browse, except sagebrush or its subtypes, gives the main aspect to the type or is the predominant vegetation. It usually occupies the transition zone of the lower mountain slopes, foothills, and plateau areas. Examples of subtypes are mountain-mahogany, bitterbrush, willows, *Ceanothus*-manzanita, and California chaparral.

6. Conifer.—All range land in coniferous timber supporting grasses, weeds, or browse, either singly or in combination, except as provided under types 7 and 9. The forage may vary from a pure stand of pinegrass or some other grass to a pure stand of weeds or browse. It usually, however, consists of grasses, weeds, and browse, and the proportion of each species varies so widely that it is not thought advisable to attempt a division into types. These variations can best be represented by subtypes.

7. Waste.—All areas of dense timber and brush that have no value for grazing or have such slight value that they cannot be used economically, owing to either denseness of standing or down timber or sparseness of forage growth. Large areas of very sparse forage, unless within easy reach of a better type, shall be classified as waste because of the impracticability of running stock over so large an area to get such a small amount of feed. This type also includes areas not strictly in timber or brush and not barren that are so rough or inaccessible as to make their future use improbable.

The subtype designations generally encountered in this type are: 7T, Waste in dense timber; 7D, waste in down timber; 7B, waste in brush; 7R, waste areas where rocky character prevents use; and 7I, permanently inaccessible areas. Principal species of timber should be shown by symbols.

8. Barren.—All areas on which there is naturally no vegetation, or virtually none, including intermittent lake beds, saline flats, active sand dunes, shale, rock slides, and lava flows. Areas that have been denuded by overgrazing should not be confused with areas naturally barren. Areas containing only annuals for a part of the year should not be shown under 8, although these may be without vegetation for the remainder of the year.

9. Pinon-juniper.—Pinon, juniper, pinon-juniper, and digger pine. The character of the range in this type as to location, grazing capacity, and management is sufficiently distinct from the conifer type to justify a separate type. The forage may vary from a pure stand of grasses, weeds, or browse to a combination of any two or all. These variations can best be shown by subtype designations.

10. Broadleaf trees.—All range in deciduous timber. The combination of grasses, weeds, and browse, and the proportion of individual species will vary as in other types.

The principal subtypes are: Aspen, cottonwood, oak, birch, alder, and ash-elm, when they occur in tree form.

11. Cresote.—Areas where creosotebush (*Covillea tridentata*) constitutes the predominant vegetation.

12. Mesquite.—Areas where various species of the mesquite (*Prosopis*) give the characteristic aspect or constitute the predominant vegetation.

13. Saltbush.—Areas where the various salt desert shrubs of the *Atriplex* family form the predominant vegetation or give the characteristic aspect. There is sufficient significant difference in the range value and the use of saltbush areas to justify their separation from other desert or semidesert shrub types.

14. Greasewood.—Areas where greasewood (*Sarcobatus*) is the predominant vegetation or gives the characteristic aspect. This type usually occupies valley floors subject to overflow during flood periods or areas underlain with ground water at shallow depths where the soil is more or less saline. It is sufficiently different from other desert shrubs to justify an exclusive type.

15. Winterfat.—Areas where winterfat (*Eurotia*) gives a characteristic aspect or constitutes the predominant vegetation. Though commonly associated with other semidesert shrubs, the occurrence of this plant in Utah and Nevada as a type character is of sufficient extent to justify a separate type.

16. Desert shrub.—A general type that includes areas where other desert shrubs aside from those separated into individual types constitute the predominant vegetation or give the characteristic aspect. This type includes several genera that are quite distinctive in type habit, such as blackbrush (*Coleogyne*), coffeeberry (*Simmondsia*), catclaw (*Acacia, Mimosa*), gray molly (*Kochia*), hop-sage (*Grayia spinosa*), spiny horsebrush (*Tetradymia spinosa*), and little rabbitbrush (*Chrysothamnus stenophyllus*), but pure types of each are so limited in extent as not to justify a separate type. The plant symbols used will be sufficient to indicate the predominant species present.

17. Half shrub.—Areas where half shrubs constitute the dominant vegetation or give the characteristic aspect. Half shrubs are semiwoody perennials of low stature such as *Aplopappus, Gutierrezia, Artemisia frigida,* and *Eriogonum wrightii.* They commonly consist of a woody caudex from which herbaceous stems are produced that die back annually. These genera are sufficiently distinctive in habitat and of wide enough extent in certain localities to justify a separate type.

18. Annuals (weeds or grasses).—Areas in which annual weeds or annual grasses constitute the dominant vegetation. Both transitory stages and semipermanent conditions should be included, as for example: Russian-thistle, downy chess (*Bromus tectorum*), and desert weeds. The plant symbols used will be sufficient to indicate the predominant species present.

Abandoned lands.—Abandoned lands should be classified according to aspect. The boundaries should be hachured on the map.

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