Hydrologic Characteristics of Nebraska Soils

By JACK T. DUGAN

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

The International System (SI) is a consistent system of metric units adopted by the Eleventh General Conference of Weights and Measures in 1960. Selected factors for converting inch-pound units used in this report to SI units are given below.

INCH-POUND UNITS	MULTIPLY BY	TO OBTAIN SI UNITS
inch	25.40	millimeter
inch per hour	25.40	millimeter per hour
inch per inch	25.40	millimeter per millimeter
foot	0.3048	meter
mile	1.609	kilometer

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Abstract

The influence of the physical characteristics of soil on hydrology is frequently neglected. In this report, the effects of five characteristics on the hydrologic responses of soils in Nebraska are evaluated quantitatively, soils are grouped through use of a simplified coding system according to similarities in hydrologic responses, and are mapped according to these responses.

General soils maps of the U.S. Department of Agriculture Soil Conservation Service and data for the physical properties of the soils proved well-suited to hydrologic interpretation. This interpretation of the maps and data led to the selection of three characteristics as classification variables: Average permeability of the 60-inch soil profile, average maximum soil slope, and depth to the seasonal high water table. Permeability of the least permeable horizon and available water capacity, although not needed as classification variables, are useful in explaining some of the hydrologic responses of soils.

The primary soil units used in groupings and interpretation of the soils for this study are the soil associations. A computer program is presented that sorts the soils into groups and calculates statistics for each group. The 147 soil associations in Nebraska were thus sorted into 29 hydrologic soil groups. The location and extent of these hydrologic soil groups are shown on maps at scales of 1:750,000 and 1:250,000 for the State.

INTRODUCTION

Soils are an accumulation of materials possessing a broad range of physical characteristics. They are not static but dynamic bodies undergoing constant alteration by living organisms, the atmospheric environment, and further deposition of inorganic materials. Soils have a significant influence on both human activity and natural processes. The importance of the soil's physical characteristics to hydrology has received limited recognition in contrast to that received in agricultural and engineering applications. In numerous areal hydrologic studies, these characteristics are neglected or receive only superficial treatment, even though they are of critical importance in understanding both surface- and ground-water hydrology.

Soils have a significant effect on the relationships of precipitation to surface-water runoff, ground-water recharge, and consumptive water requirements. Particularly important in these relationships are soil permeability, available water capacity, and soil slope, because they influence the infiltration rates of precipitation into the soil and the volume of water that can be retained within the soil zone.

No system based on the interaction of soil characteristics has been readily available for identifying and estimating quantitatively those characteristics of the soils that have significant effects on hydrology. However, recent analysis of ground-water problems in Nebraska, using numerical-simulation models of hydrologic systems, has indicated the need for such a system. To obtain required data for these models, it was necessary to analyze and assign quantitative values to the physical characteristics of the soil in a substantial part of the State. Subsequent improvements and simplifications have resulted in a uniform method presented herein that can be used by hydrologists, planners, and water managers with limited knowledge of soil science.

Purpose and Scope

This report has two purposes. The first is to provide interpretive maps that can be used to evaluate quantitatively the physical characteristics of the soil that significantly affect the hydrology of Nebraska. The second is to describe the method used in analyzing existing data for these physical characteristics and in compiling and presenting results in the maps.

No new field or laboratory data were obtained for this report. Rather, emphasis was placed on interpreting existing data for those physical characteristics of soils that have hydrologic significance. Furthermore, no attempt was made to provide specific applications of the data in the maps. In this report, the study of the soils was confined to those materials composing the upper 60 inches of the soil profile, which is the standard soil profile in the study area. In selected instances, the profile considered was less than 60 inches where shallower soils occur over a bedrock surface.

Data are presented for five hydrologic characteristics of the soils, each of which is important in understanding soil response to water. These data are presented in 12 large maps and attendant tables (pls. 1–12). The first is a generalized map (1:750,000 scale) for the entire State. The remaining 11 are standard U.S. Geological Survey quadrangle maps that provide a hydrologic interpretation of the soils at a more applicable scale (1:250,000).

The method for determining numerical values of the selected characteristics presented provides a basis for analyzing hydrologic responses of soils in a variety of applications and spatial comparisons. This method has potential for us wherever adequate soils maps and data are available.

Sources of Data

Data used for this report were obtained from both published and unpublished materials of the U.S. Department of Agriculture Soil Conservation Service and the University of Nebraska Conservation and Survey Division. These materials include a series of published general soil area maps depicting soil associations at the 1:250,000 scale on standard U.S. Geological Survey bases. Explanations accompanying the maps include general physical descriptions of the soils and percentages of individual soil series comprising given associations. Published data by the Soil Conservation Service describing individual soil series provide the information needed for computing the hydrologic characteristics of the mapped soil associations.

Acknowledgment

The author thanks James R. Culver, Nebraska State Soil Scientist, U.S. Department of Agriculture Soil Conservation Service, for providing both published and unpublished soils maps and data and for offering valuable suggestions for grouping and describing the soils.

GENESIS AND CLASSIFICATION OF THE SOILS

The soils of Nebraska possess physical characteristics that are quite variable. The natural processes forming the soils and their subsequent classification are indicative of the variability. An understanding of the range of hydrologic characteristics of the soils of the State is best gained through a comprehension of their genesis and classification.

Genesis

The development of the soils in Nebraska are a product of several environmental factors operating in relation to one another. A report by the U.S. Department of Agriculture Soil Survey Staff (1951, p. 3) states: "The morphology of each soil, as expressed in its profile, reflects the combined effects of the particular set of genetic factors responsible for its development." These genetic factors or causal antecedents of soil development determine the physical characteristics and, therefore, the hydrologic properties of the soil. According to Donahue and others (1971, p. 86–87), these soil-forming factors and the nature of their role are (1) parent material (passive), (2) relief or topography (passive), (3) climate (active), (4) biosphere (active), and (5) time (neutral).

Whereas parent material (fig. 1) is a passive factor in soil formation, its effect on the characteristics of the soil within the State is significant. Two-thirds to three-fourths of the State is mantled by materials that are eolian (wind-deposited) in origin. This includes the fine sand material principally in the north-central part of the State (fig. 1) and the silty loess that covers most of the southern and eastern parts of the State. In a small area of southeastern Nebraska, some soils have developed on modified glacial till. Residual soils, which have been formed in place on predominantly shale, sandstone, or siltstone bedrock, are present mostly along the the northern and western boundaries of the State and account for less than one-fifth of the soils of the State. Alluvial soils, which typically reflect surrounding upland conditions and show minimal soil development, cover a small part of the State, being confined mainly to the larger stream valleys.

Topography, another passive factor, affects principally the rate of soil development. Steep topography usually retards the rate of development if other soil-forming factors are constant. Types of topography in the State are shown in figure 2. Only in limited areas of the State, as on bluffs, escarpments, and dissected plains, is soil development greatly restricted by topography. Soils in these areas show minimal weathering and shallow development.

Climate is an active factor that influences soil development in several ways. The weathering of the original constituents, movement of products of weathering, leaching, and other processes are dependent on the climatic elements. A progressive change in climate exists across the study area, from a semiarid, cold-winter type in the west to a continental subhumid type in the east. Mean annual precipitation (fig. 3) varies from less than 15 inches in western Nebraska to more than 36 inches in extreme southeastern Nebraska. The depth of soil development, degree and depth of clay accumulation (illuviation), and presence or depth of calcium carbonates, among other properties of the soil, are related to precipitation. From west to east across the State, the depth and degree of soil development increases significantly as mean annual precipitation increases. The increased precipitation in the eastern part of the State results in an increased accumulation of clays in the subsoil—an argillic horizon—as the result of downward movement of the clays. Also, as precipitation increases, the proportion of calcium carbonate in the soil decreases, and the zone of calcium-carbonate accumulation moves downward.

The range in mean annual temperatures across the State is not significant and probably has a limited effect in differentiating soils. The long winters, in which frozen soil conditions occur and significant biological activities are absent, retard the rate of soil development. Caution, however, needs to be used in relating present climatic conditions to past soil development, since some climatic variations have occurred during the formation of the present soils.

Biotic activity, particularly botanic, is an active soil-forming factor that closely reflects the climatic environment. Almost the entire State, with the exception of some

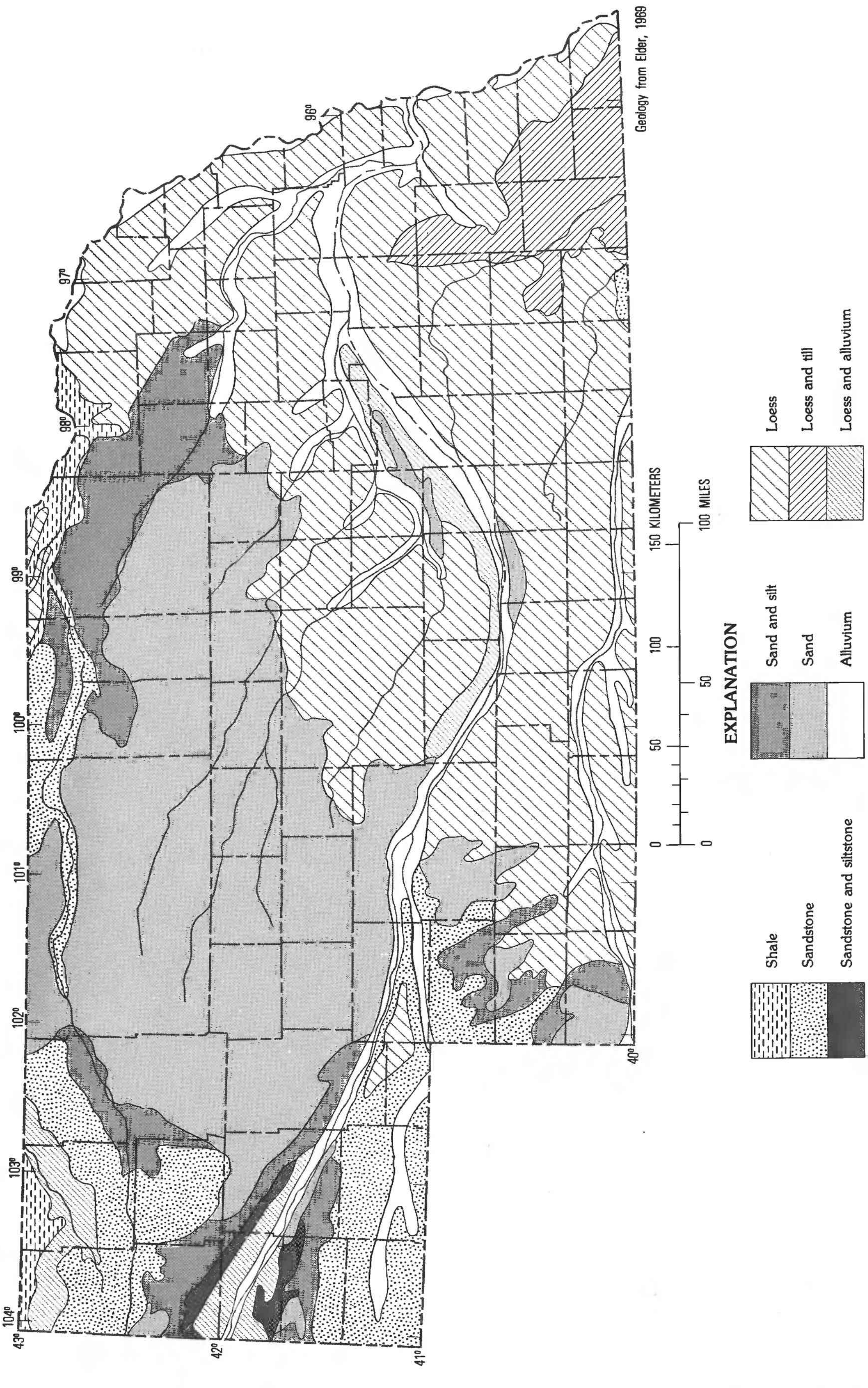


Figure 1. Parent materials of soils.

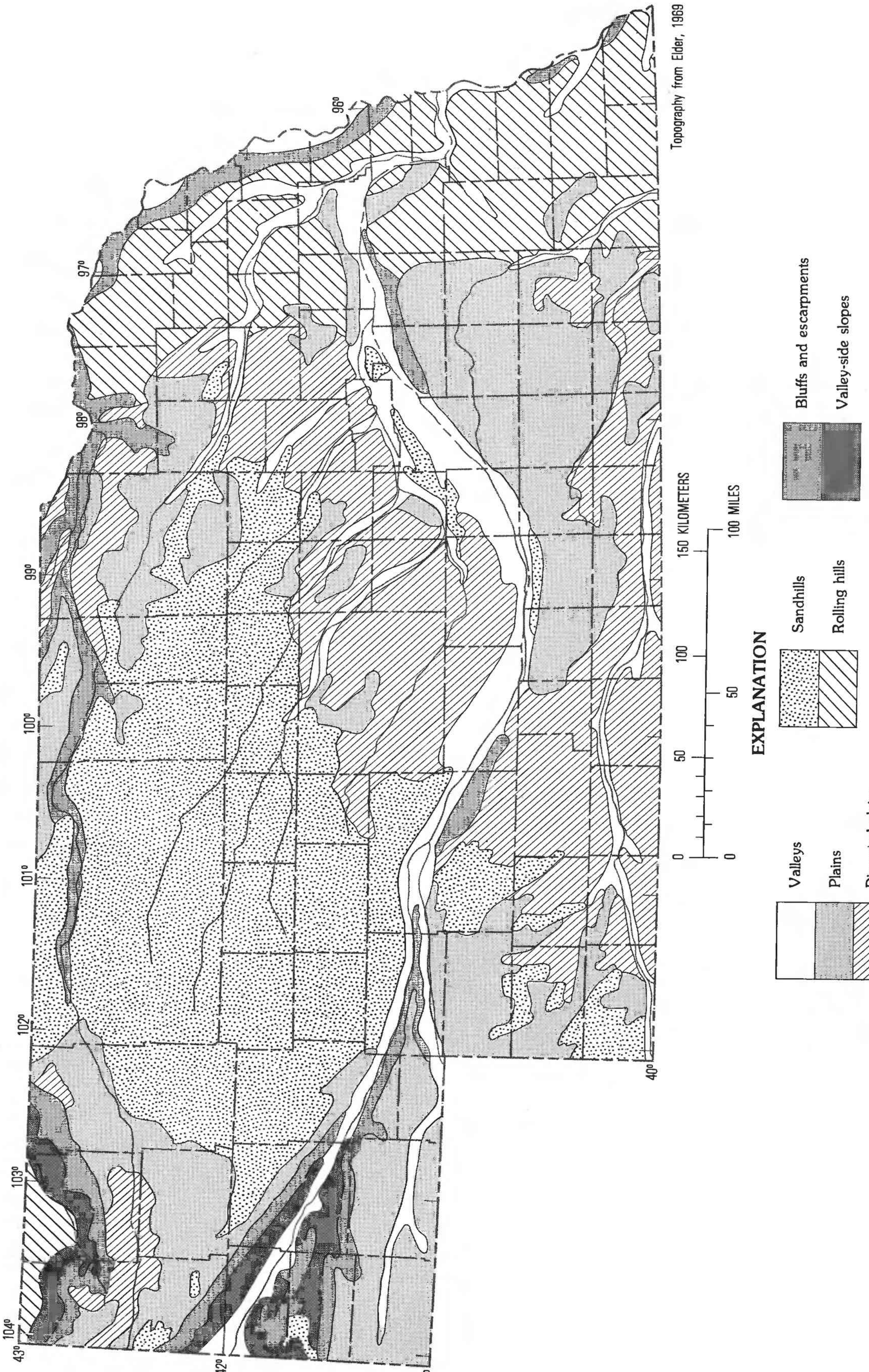
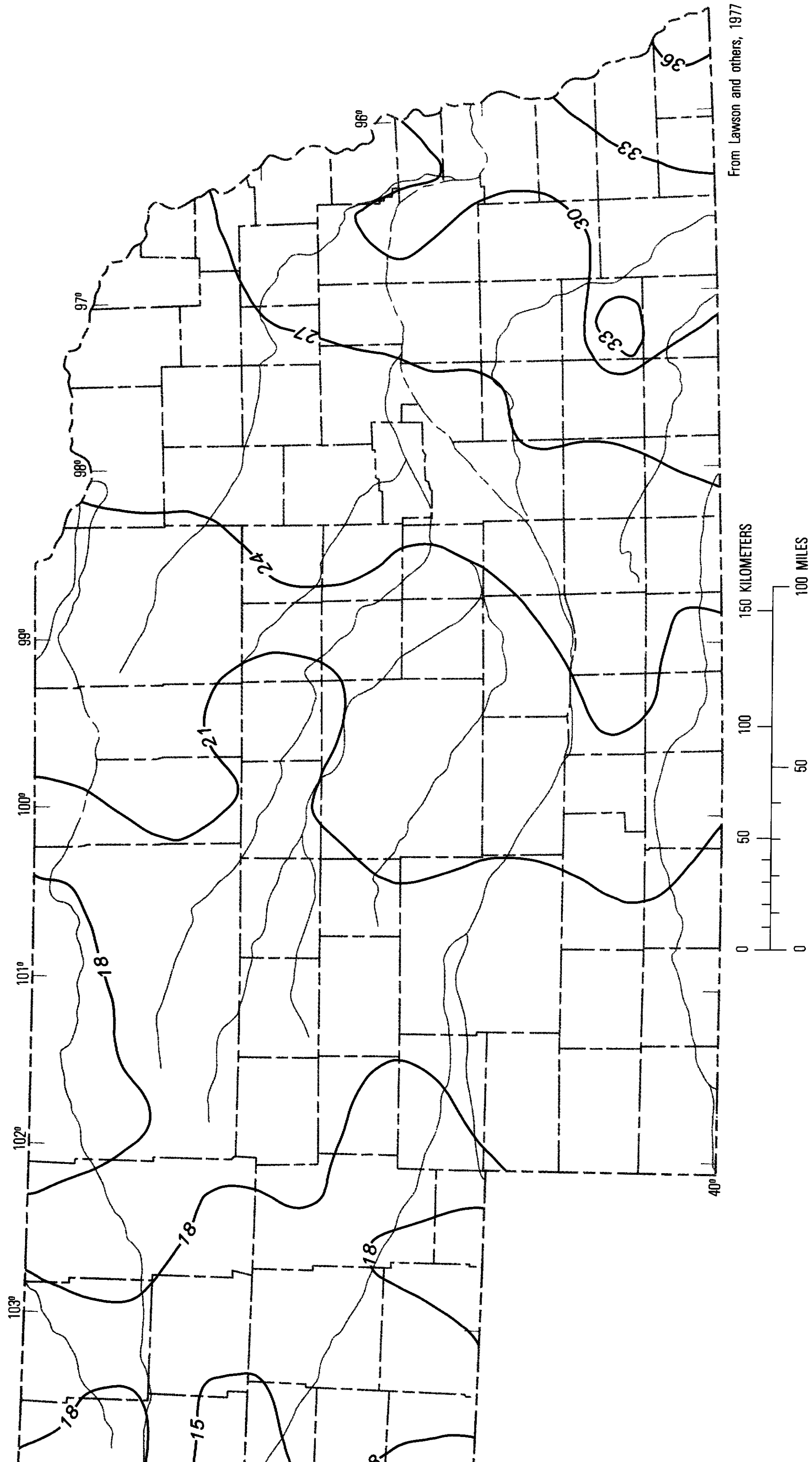


Figure 2. Types of topography.



EXPLANATION

—30— LINE OF EQUAL MEAN ANNUAL PRECIPITATION—
Interval 3 inches

Figure 3. Mean annual precipitation, 1941–70.

steep escarpments, is a natural grassland. The nature of this grassland, however, changes as mean annual precipitation varies across the study area. In the western third of the State, it can be classified as short-grass disclimax prairie, in the central third as mixed or mid-grass prairie, and in the eastern third and in the Sandhills region as true prairie dominated by tall species.

Grassland soils are noted for their greater accumulation and more uniform distribution of organic matter, with depth, than forest soils (Fork and Turk, 1972, p. 216). Infiltration of precipitation tends to increase as the organic matter within the soil increases (Donahue and others, 1971, p. 208). Furthermore, organic matter in the surface layer, or a vegetative mulch, reduces the impact of rain, permitting deeper penetration and less runoff (Donahue and others, 1971, p. 197). The organic-matter content of the soil increases from west to east in the study area as the grasses become progressively taller and average precipitation increases. The tall grasses of the eastern part of the State have much more extensive root system that create greater amounts of organic matter in the soil profile than do the shorter grasses of central and western Nebraska.

Most soils of Nebraska may be considered to be relatively youthful, having developed in deposits that are late Pleistocene or younger. With a moderate rate of weathering under the present climatic regime and the rather recent deposition of most parent materials, the soils of the State are not extensively or deeply weathered.

Classification

The soil classification of the U.S. Soil Conservation Service is designed to meet a number of purposes, including practical applications as well as an international system of classifying soils. This classification, therefore, is necessarily more complex than the one developed for this study, which serves the single purpose of classifying soil according to its hydrologic responses. The hydrologic groupings that result, however, are compatible with the Soil Conservation Service classification in that they are dependent on the interpretation of selected soil characteristics of the basic Soil Conservation Service classification units—the soil series. In this report, spatial groupings of the soil series into soil associations are arranged on the basis of their hydrologic compatibility.

The current Soil Conservation Service system has six classification categories:

Orders—Soil orders are differentiated by the presence or absence of diagnostic horizons or features chiefly reflective of the soil-forming processes and contrasting climates.
Suborders—Suborders within a soil order are differentiated principally on the basis of soil properties resulting from differences in soil moisture and temperature.
Great Groups—These are subdivisions of suborders that are based on differentiating horizons or soil features, such as those of minerals, clays, or humus accumulation.
Subgroups—Great Groups generally consist of three subgroups classified on the degree or intensity of the characteristics used to distinguish Great Groups.
Families—Soil families are determined by properties considered to be important to plant growth and engineering purposes, such as reaction (pH), horizon thickness, texture, and structure.
Series—The several series within a family are based on narrower ranges of the same characteristics used in differentiating families. These characteristics must be observable and mappable in the field (Donahue and others, 1971, p. 105).

The first two classifications, Orders and Suborders, are based on conceptual inferences about soil genesis, whereas the remaining four classifications are based on factual or measurable characteristics of the soil. The classification system developed for this study is similar to the last four classifications in that the differentiating properties are measurable.

The predominant soil order of Nebraska is the Mollisol (fig. 4). Soils of this order are characterized by a surface horizon that is thick, dark colored, high in base saturation (percentage of cation-exchange capacity saturated with calcium, magnesium, sodium, and potassium), and granular in structure. Entisols, whch are soils with no diagnostic horizon, occupy the sandhills and are typical of soils derived from sandy parent materials that are resistant to weathering. Some Ardisols, which contain minimal organic matter and are dry in all horizons at least 6 months of the year, exist in the western part of the State.

The distribution of the Great Groups of Nebraska are shown in figure 4. Their descriptions are as follows:

Typic Ustolls—Mollisols in areas with a warm to hot growing season that is intermittently dry for long periods during summer.
Aridic Ustolls—Mollisols that are similar to the Typic Ustolls but that are in areas subject to longer and more intense dry periods.
Udic Ustolls—Mollisols that are similar to the Typic Ustolls but that are in areas which have fewer or shorter dry periods.
Udolls—Mollisols in areas with a warm, moist growing season.
Psamments—Entisols with sandy or loamy sand textures.
Orthids—Aridisols without a horizon of clay accumulation.
Orthents—Entisols with clayey or loamy textures or Entisols characterized by shallow soils developed on bedrock.
Argids—Aridisols that have a horizon of clay accumulation.

Classification by the preceding Great Groups obviously

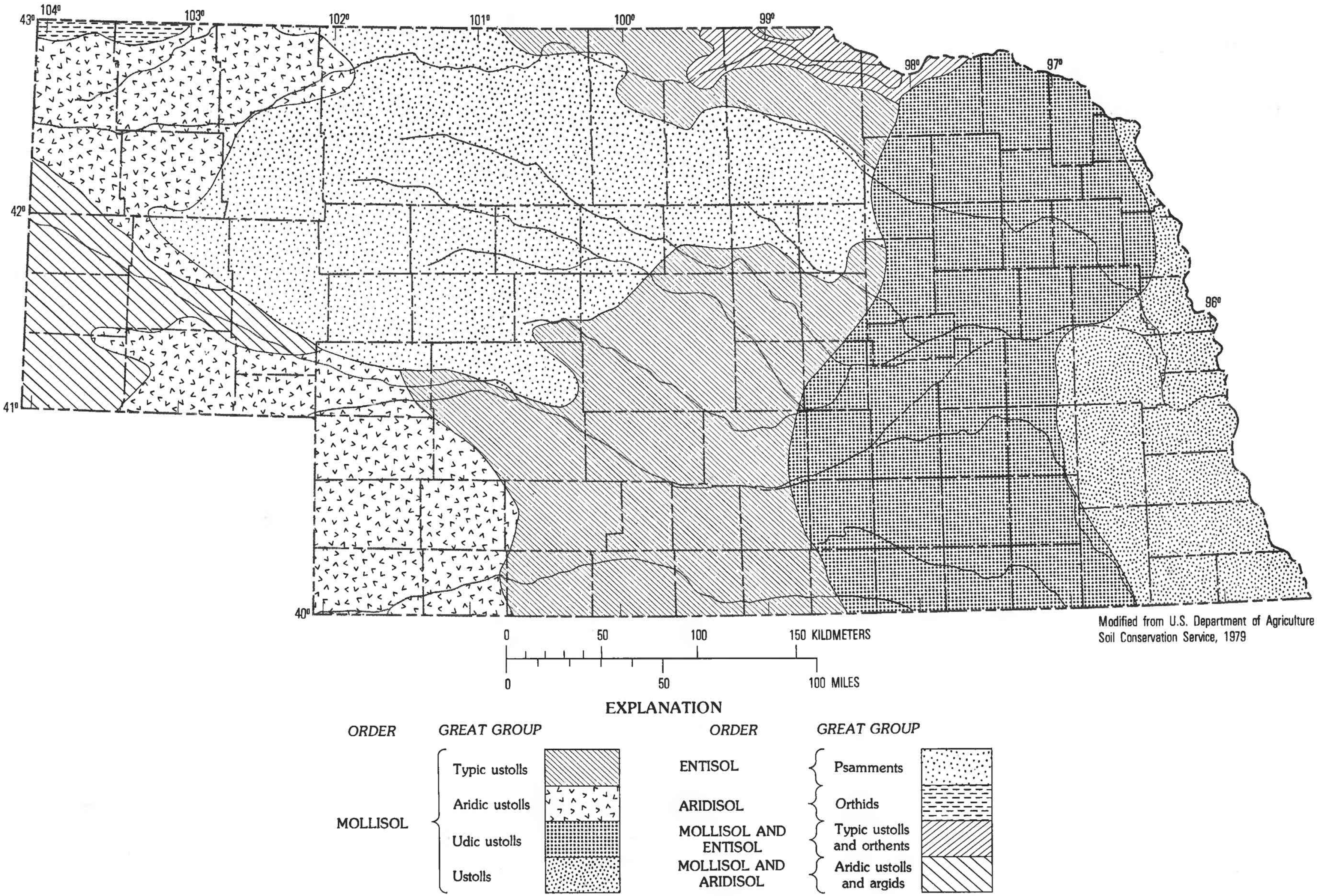


Figure 4. General classification of the soils.

does not provide sufficient detail to evaluate the hydrologic characteristics of the soils. Conversely, use of detailed soil maps composed of individual soil-map units at a scale of 1:20,000, or less, commonly is too complex for practicable interpretation of hydrologic characteristics within a large geographic area. In order to gain sufficient detail for evaluating the surficial hydrology, yet maintain simplicity, the soil associations can be grouped readily by selected physical characteristics. The 1:250,000 scale general soils maps depicting these associations provide an adequate working scale for this grouping.

An association is not a defined category within the Soil Conservation Service classification, but it is the basis for the derivation of the mapping units described in this study. A soil association is defined as a group of soil series occurring in a geographical area in a regular pattern on the landscape (Elder, 1969, p. 2). The individual soil series composing an association may, or may not, have similar physical characteristics.

The use of soil associations could present problems in working with large-scale maps (1:24,000 scale or larger) because of the possibility of having quite divergent soil conditions within definable areas of the mapping units. Use of detailed soil maps would be necessary in these instances, because they portray relatively more homogeneous soil conditions within a given mapping unit. In this study, however, use of soil associations posed no significant problems because of the small map scale of 1:250,000.

CHARACTERISTICS AFFECTING HYDROLOGIC RESPONSES OF THE SOILS

Several characteristics affect the hydrologic responses of the soil. These include average permeability, permeability of the least permeable horizon, available water capacity, soil slope, and depths to the seasonal high water table. Each of these characteristics differs in its effect on the soil's physical responses to water, which in turn have a significant effect on an entire hydrologic system.

All five characteristics mentioned in the previous paragraph are important in understanding the hydrologic responses of soils. The use of only three, however, was required in grouping the soils on a hydrologic basis—average permeability, soil slope, and depth to the seasonal high water table. The other two are closely related to permeability, as will be discussed subsequently; only those that operate independently of one another were chosen for differentiating soil groups.

The runoff characteristics of streams are affected largely by permeability, available water capacity, and soil slope. Overland runoff generally is minimal where soils are permeable, allowing for rapid infiltration and percolation.

Recharge to ground-water reservoirs is determined largely by these same characteristics. Soil permeability, which governs significantly the percolation of precipitation to the zone of saturation, can vary several magnitudes, thus greatly affecting recharge to a reservior. Consumptive-water requirements of domestic crops and natural vegetation indirectly influence ground-water recharge. Those requirements are dependent on the soil's available water capacity, which largely determines the amount of precipitation or supplemental irrigation water needed to sustain plant growth. Furthermore, the available water capacity determines the amount of soil moisture that can be held within the soil zone and that is available for evapotranspiration. Soil slope is important in that it governs the time available for precipitation to infiltrate the soil; generally, the lesser the slope, the more time available for infiltration.

Permeability of 60-Inch Soil Profile

Permeability is the rate at which soil, under saturated conditions, transmits water in a vertical direction under a unit head of pressure. Physical properties of soil such as texture (size groups of individual soil grains), structure (aggregation of primary soil particles into compound particles or clusters), and porosity (volume of interconnected pore space available for fluid transmission) affect permeability (U.S. Department of Agriculture Soil Survey Staff, 1951). The U.S. Geological Survey defines "intrinsic permeability" as the measure of the relative ease with which a porous medium can transmit a liquid under a potential gradient. Intrinsic permeabilty is a property of the medium only and is independent of the liquid's nature and of the force causing movement. This property of the medium is dependent on the shape, size, and interconnections of the pores (Lohman and others, 1972).

Infiltration and percolation are characteristics of the soil similar to permeability, but with certain differences in definitions. While permeabilty refers to the movement of water "within" the soil, infiltration pertains to the movement of water "into" the soil, and percolation to the movement "through" the soil. The factors that determine permeability are virtually the same for infiltration and percolation (Donahue and others, 1971, p. 208).

In this study, the Soil Conservation Service unit of measurement for permeability, inches per hour, was used. The average permeability is computed for the standard Soil Conservation Service 60-inch profile, except for shallow soils over bedrock. In Nebraska, the permeability of the soils in the study area ranges from less than 0.06 inch per hour for clay soils to more than 16.0 inches per hour for sandy soils.

Permeability of Least Permeable Horizon

In addition to an average permeabiltiy for the 60-inch soil profile, the permeability of the least permeable horizon is significant in each soil. In most well-developed soils, the horizon of least permeability occurs in the B-horizon, which is typically 12–24 inches below the surface, where clay accumulation is common for the soils of the study area. Commonly, the composite permeability for the 60-inch profile obscures the permeability of relatively impermeable horizons that may be more significant in affecting percolation rates than the composite permeability.

Whereas this horizon can be quite significant to hydrology, it is not one of the grouping characteristics in this report, because the data used to derive the permeability of the least permeable horizon are included in those data used to derive the average permeability of the 60-inch profile (tables 1 and 3). Therefore, to avoid redundance, only average permeability of the 60-inch profile was used in defining the hydrologic soil groups.

Available Water Capacity

Available water capacity is the capacity of the soil to hold water for use by most plants. It is the difference between the amount of water in the soil at field capacity (the amount of water held in soil after the gravitational water has been drained away) and at the wilting point (moisture content at which soil can not supply water at a rate sufficient to maintain the turgor of a plant resulting in permanent wilting). The capacity of the soil to hold water is related both to the total surface area of the soil particles and to pore-space volume, and thus is dependent on soil texture and structure. The hydrologic term "specific retention" is almost synonymous with "available water capacity" or "moisture-holding capacity" (Lohman and others, 1972). A curve describing available water capacity is lowest for coarse-textured materials such as sand, reaches its maximum for medium-textured materials such a silt loam, and declines slightly for fine-textured materials such as clays (U.S. Department of Agriculture, 1955, p. 120). Available water capacity is approximately the inverse of permeability and is dependent on the same physical properties as permeability. Only one of these characteristics is necessary for classifying the hydrologic soil groups; permeability was selected for this purpose. However, because it is significant for other uses, available water capacity was computed for soil.

In this report, the Soil Conservation Service unit of measurement for available water capacity of "inches of water per inch of soil" is used. In Nebraska, available water capacity ranges from 0.07 inch per inch for sandy soils to 0.22 inch per inch for silty clay loam soils.

Soil Slope

Soil slope is expressed as the difference in elevation, in feet, for each 100 ft of horizontal distance and is given as a percentage. Thus, a 10-foot elevation difference for 100 ft of horizontal distance is a 10 percent slope. Slope groupings for soils normally are given in ranges from the minimum to maximum slopes associated with the particular soils. In this report, averages are computed from maximum slopes, on the premise that overland flow in a particular area is determined more by the greater slopes than by the lesser ones. Other characteristics of slope, such as shape (concave or convex) and length, are not considered, because these factors are difficult to quantify.

Depth to the Seasonal High Water Table

Depth to the seasonal high water table is the depth of the highest water table normally measured on an annual basis. This does not include occasional perching conditions as a result of a relatively impermeable horizon above the zone of permanent saturation. Usually the season of highest water-table conditions in the State occurs during early spring. This characteristic is essential in evapotranspiration estimation. Furthermore, the structure of the soil can be highly altered by long periods of saturation. In this report, this characteristic typically differentiates topographic position of the soils. Those soils characterized by high water-table conditions most commonly represent flood plains or subirrigated meadows in the sandhills. Those characterized by greater depths to the water table represent upland or high terrace positions.

COMPUTATION OF CHARACTERISTICS AFFECTING HYDROLOGIC RESPONSES OF THE SOILS

The computational procedures used in this report follow an explicit, systematic approach in order that they can be evaluated for application in areas other than Nebraska. Because each characteristic considered in this report differs as to its unit of measurement and the phenomenon it represents, computations for each require different procedures. The procedures used for each characteristic for the various soil units will now be described in detail. Computations were made in the following sequence: for individual soil horizons within a profile; for the profile of each soil series; for the soil association; and for the hydrologic soil group.

Permeability of 60-Inch Soil Profile and Available Water Capacity

Similar procedures were used for computing permeability and available water capacity; both characteristics have data in similar formats although in different units:

1. A soil-horizon average for each characteristic was derived from the midpoint of the range of values for that characteristic. For example, for a permeability range of 0.6 to 2.0 inches per hour, the average permeability assigned was 1.3 inches per hour.

2. Next, a weighted soil-profile average for the characteristic was computed. The computational procedure for a hypothetical soil can best be explained by referring to the following table:

Position of soil horizon (inches)	Thickness (inches) (1)	Average permeability (inches per hour) (2)	Result of (1)×(2)	Average available water capacity (inches per hour) (3)	Result of (1)×(3)
0–10	10	1.3	13.0	0.22	2.2
10–30	20	.4	8.0	.17	3.4
30–60	30	3.3	99.0	.12	3.6
Totals	60	---	120.0	----	9.2

Weighted average for soil series:
Permeability (inches per hour) 2.0
Available water capacity (inches per inch) 0.15

To compute the weighted-average permeability for the soil profile, the thickness of each horizon was multiplied by its average permeability. Results were then summed, and this total was divided by the thickness of the profile. From the example above, dividing the total of 120.0 by the profile thickness of 60 inches resulted in a weighted average permeability for the soil profile of 2.0 inches per hour. The same procedure was used for computing the weighted average available water capacity for the soil profile. Dividing the total of 9.2 by 60 inches resulted in a weighted average available water capacity for the profile of 0.15 inch per inch.

3. After determining the permeability of the 60-inch soil profile and the available water capacity for the individual soil series, the weighted averages for the soil associations were computed from percentages of the association area occupied by the various soil series. The Hastings-Crete-Fillmore association serves as an example.

Soil series	Percentage of area (1)	Average permeability (inches per hour) (2)	Result of (1)×(2)	Average available water capacity (inches per inch) (3)	Result of (1)×(3)
Hastings . . .	45	0.81	0.36	0.20	0.09
Crete	45	.47	.21	.18	.08
Fillmore . . .	10	.73	.07	.18	.02

Weighted average for soil association:
Permeability (inches per hour) 0.64
Available water capacity (inches per inch) 0.19

The permeability and available water capacity for a given hydrologic soil grouping are the simple averages of all the associations composing that particular group.

Permeability of Least Permeable Horizon

The permeability of the least permeable horizon for each hydrologic soil group was derived quite simply. The horizon with the least permeability of each soil in the group, regardless of the thickness or position, was determined from the published data, and an average of the range in permeability was assigned to that horizon.

The soil association average for permeability of the least permeable horizon was derived by using the same percentage-weighting procedure used previously. The Hastings-Crete-Fillmore association serves as an example:

Soil series	Percentage of area (1)	Average permeability of least permeable horizon (inches per hour) (2)	Result of (1)×(2)
Hastings . . .	45	0.40	0.18
Crete	45	.06	.03
Fillmore . . .	10	.13	.01
Weighted average for soil association			0.22

Soil Slope

The method for determining soil slope differed significantly from the methods for determining other characteristics. Because slope commonly is given in rather large ranges from minimum to maximum, an average value is of limited significance. No data exist that indicate the proportion of soils within certain slope ranges, nor the slope length or frequency. The slope that was derived for this study is a weighted average of the maximum slopes of the individual soil series. As indicated previously, the rationale for the use of average maximum slope is based on the premise that the greater slopes dictate the rate of surface runoff. The resultant average maximum slopes are considered relative values rather than absolute ones.

The calculation of the average maximum slope for a given soil association is relatively simple. Using the Coly-Holder-Uly association as an example, it is as follows:

Soil series	Percentage of area (1)	Slope range (percent)	Maximum slope (percent) (2)	Result of (1)×(2)
Coly	45	6–30	30	13.50
Holder	33	3–11	11	3.63
Uly	22	6–15	15	3.30
Average maximum slope for the association				20.43

Depth to Seasonal High Water Table

The determination of the depth to seasonal high water table is relatively straightforward. The Soil Conservation Service (U.S. Department of Agriculture Soil Conservation Service, 1978) denotes whether the seasonal high water table beneath a given soil series is greater than or less than 6 feet. An element of subjectivity, however, exists because certain associations include soils having water tables that are both greater than and less than 6 feet. In this report, if depths to the seasonal high water table in any of the principal soils of an association were less than 6 feet, then the entire association was considered to have a shallow water table. The grouping according to depth to water results in a dichotomous method that indicates only whether the water table present is high or low.

Computed values for the five hydrologic characteristics of the 147 soil associations within Nebraska are given in table 1. The soil-group classification and soil-group code will be discussed in the subsequent section. The soil-series data used in computing values for the soil associations are given in table 3, Supplemental Information.

GROUPING AND MAPPING OF SOILS BY HYDROLOGIC CHARACTERISTICS

The soil associations in table 1 were assigned to a lesser number of groups on the basis of the three characteristics indicated earlier. The grouping method used involved five permeability, five slope, and two depth-to-water classes that could produce a potential of 50 hydrologic groups. The limits of each class for each of the three characteristics and their code number are listed in table 2.

Each soil association was assigned a three-digit soil-group code, which is shown in table 1. As an example of the interpretation of the code, a soil association with a classification of 222 has an average permeability of the 60-inch soil profile of 1.0 to 2.0 inches per hour, an average maximum soil slope from 3 to 10 percent, and a depth to water that is greater than 6 feet (see table 2).

A computer program was developed using the sorting routine of the Statistical Analysis System (SAS)[1] (Barr and others, 1976). The hydrologic limits for each of the 50 potential groups were indicated in the program, which then sorted the soil associations into their respective groups and computed the group means, standard deviations, and ranges. The use of a computer to sort and classify a limited number of soil associations (147) and classification variables (3) is not an absolute necessity, but it allows rapid and accurate sorting and computation of statistics. Obviously, the greater the number of soils, the more classification variables included, or the more complex the statistical analysis, the greater the need for computer assistance. The source program (SAS access), partial data input, and the programming statements for the sorting and statistical procedures are shown in the Supplemental Information.

The resultant sorting procedure produced only 31 of the potential 50 groups. Two groups consisted of only one soil association each, so these were reassigned to other groups with only slight differences, in order to minimize the number of mapping units. Other minor readjustments and shifts of soil associations to different hydrologic groups were made as a result of suggestions by James R. Culver, State Soil Scientist of the U.S. Soil Conservation Service, in order to group soils that (1) possessed unique characteristics, such as shallow soil development (less than 60 inches) over bedrock or extremely slow permeabilities, or (2) to reduce the complexity of mapping units. None of these readjustments were significant compromises to the objectivity of the classification method. The ultimate classification resulted in 29 hydrologic soil groups.

These 29 hydrologic soil groups are the basic soil interpretive units presented in plates 1–12. The generalized 1:750,000 scale Nebraska map (pl. 1) is color-keyed to the five permeability classes and grouped by the number code (last two digits) for slope and depth to water table. The 1:250,000 scale quadrangle maps of parts of Nebraska (pls. 2–12) present the same information as the 1:750,000 scale map, but less generalized.

The explanations accompanying plates 2–12 include a description of the soils in each mapped hydrologic soil group and the table of values for the five hydrologic characteristics. These values represent the simple averages for the soil associations composing each hydrologic soil group.

The mapping units and their hydrologic characteristics in this report need to be interpreted from the perspective that the resultant values represent average values of possibly quite diverse soil conditions. Soils form a continuum over the landscape. The boundary between soils, in some places, is quite distinct or abrupt, whereas in other places one soil may grade gradually into another. Even individual mapping units composed of soil series commonly contain quite dissimilar soils.

The initial mapping units that provide the basis for the hydrologic interpretation of the soils in this report are the soil associations, which are geographic units and are not classified according to similar physical properties. Thus, conditions within a small area of a mapping unit may possibly vary significantly from the average condition. This is certainly evident in respect to topographic conditions reflected by soil slope, which can range from zero to more than 60 percent within a short distance. Variations in permeability also can vary several magnitudes within a small area.

The reader needs to be aware of the interpretive limitations mentioned above that result from the generalized scope of this study. More detailed analysis of the hydrologic characteristics of the soil at specific sites within the State may require the use of county soil surveys with typical mapping scales of 1:20,000. Data for selected soil series in Nebraska (table 3) can aid in the hydrologic interpretation of these county soil surveys.

[1]The use of brand names in this report is for identification only and does not constitute endoresment by the U.S. Geological Survey.

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydro-logic soil-group code
1	Albaton-Haynie	0.81	0.70	0.17	1	< 6	111
2	Altvan-Rosebud	1.20	.90	.14	11	> 6	232
3	Aowa-Alcester-Kennebec	1.21	1.21	.22	3	< 6	211
4	Bankard-Glenberg-Haverson	10.22	2.92	.10	3	< 6	511
5	Bazile-Paka-Thurman	6.55	1.62	.14	9	> 6	422
6	Belfore-Moody	.67	.65	.19	3	> 6	112
7	Blyburg-Blencoe-Luton	.99	.77	.19	2	< 6	111
8	Bridget-McCook-Duroc	1.54	1.30	.18	5	> 6	312
9	Bridget-Tripp-Cheyenne	2.72	1.18	.17	4	> 6	322
10	Bristow-Lynch	.16	.10	.10	29	> 6	142
11	Brunswick-Paka-Simeon	9.39	4.92	.13	26	> 6	452
12	Bufton-Orella-Norrest	.46	.25	.16	28	> 6	142
13	Busher-Sarben-Tassel	5.31	4.00	.15	30	> 6	452
14	Canyon-Alliance-Rosebud	1.64	.98	.17	17	> 6	232
15	Canyon-Bridget-rock outcrop	1.98	1.30	.18	37	> 6	352
16	Canyon-Rosebud-rock outcrop	1.83	.90	.17	36	> 6	352
17	Caruso-Silver Creek-Humbarger	1.82	.83	.18	1	< 6	211
18	Cass-Inavale	8.73	2.52	.11	3	> 6	412
19	Clarno-Nora-Betts	1.00	.70	.18	11	> 6	232
20	Colby-Canyon	1.75	1.31	.19	60	> 6	352
21	Colby-Ulysses	1.31	1.31	.20	47	> 6	252
22	Coly-Holder-Uly	1.31	1.31	.21	21	> 6	242
23	Coly-Uly	1.31	1.31	.22	51	> 6	252
24	Coly-Uly-Holdrege	1.30	1.30	.21	22	> 6	242
25	Cozad-Hord	1.30	1.30	.19	3	> 6	212
26	Creighton-Oglala-Canyon	1.30	1.30	.16	24	> 6	242
27	Crete-Hastings	.58	.22	.19	7	> 6	112
28	Crete-Mayberry	.40	.13	.16	7	> 6	122
29	Crofton-Alcester-Nora	1.30	1.30	.22	25	> 6	242
30	Dix-Altvan	12.70	4.12	.09	22	> 6	542
31	Dundy-Pivot-Dunn	11.28	6.47	.10	5	> 6	522
32	Els-Valentine-Ipage	13.00	13.00	.07	12	< 6	521
33	Elsmere-Dailey	12.71	8.05	.07	4	< 6	521
34	Elsmere-Ipage-Loup	12.65	6.35	.09	2	< 6	511
35	Gayville-Silver Creek	1.83	.09	.17	2	< 6	211
36	Geary-Holdrege-Kipson	1.26	1.22	.20	14	> 6	232
37	Geary-Jansen-Meadin	7.60	1.21	.14	15	> 6	432
38	Gibbon-Luton	1.42	.67	.18	1	< 6	211
39	Gibbon-Wann	2.94	1.20	.19	2	< 6	311
40	Glenberg-Bankard-Yockey	6.56	3.46	0.11	2	> 6	412
41	Gothenburg-Platte	17.60	2.70	.05	3	< 6	511
42	Hastings	.81	.40	.20	9	> 6	112
43	Hastings-Crete-Fillmore	.64	.25	.19	4	> 6	112
44	Hastings-Fillmore	.80	.36	.20	5	> 6	112
45	Hastings-Geary	.99	.72	.20	12	> 6	132
46	Hastings-Holder	.99	.73	.21	7	> 6	112
47	Haverson-Tripp-Glenberg	2.32	1.53	.15	2	> 6	312
48	Hersh-Valentine	5.80	5.80	.13	8	> 6	422
49	Hobbs-Hord	1.48	1.30	.20	2	> 6	312
50	Hobbs-Hord-Cozad	1.58	1.30	.20	2	> 6	312
51	Holder	1.30	1.30	.21	9	> 6	222
52	Holder-Coly-Geary	1.29	1.27	.20	17	> 6	232
53	Holdrege	1.30	1.30	.20	4	> 6	222
54	Holdrege-Coly-Nuckolls	1.30	1.30	.21	18	> 6	232
55	Holdrege-Coly-Uly	1.30	1.30	.20	15	> 6	232

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings—Continued

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydro-logic soil-group code
56	Holdrege-Hall	1.18	1.03	0.20	2	> 6	212
57	Holt-Manter	6.29	3.58	.13	15	> 6	432
58	Hord	1.30	1.30	.21	3	> 6	212
59	Hord-Anselmo-Dunday	3.40	2.59	.17	5	> 6	322
60	Hord-Hall	1.13	.90	.21	3	> 6	212
61	Ida-Monona	1.30	1.20	.21	46	< 6	252
62	Inavale-Boel-Barney	12.71	6.03	.07	2	< 6	511
63	Janise-Minatare	1.20	.23	.15	2	< 6	111
64	Jansen-Meadin	14.12	1.31	.10	18	> 6	532
65	Jansen-O'Neill	12.80	1.31	.10	5	> 6	522
66	Jayem-Haxtun-Rosebud	3.26	2.56	.14	5	> 6	322
67	Jayem-Keith	2.92	2.92	.16	6	> 6	322
68	Jayem-Sarben-Valent	6.00	4.40	.12	8	> 6	422
69	Kadoka-Keith-Mitchell	1.30	1.30	.21	12	> 6	232
70	Keith-Alliance-Rosebud	1.23	1.04	.19	5	> 6	222
71	Kenesaw-Hersh	2.03	2.03	.19	11	> 6	332
72	Kennebec-Nodaway-Zook	1.11	1.05	.20	1	< 6	211
73	Kipson-Benfield	.82	.74	.19	23	> 6	142
74	Kuma-Keith-Goshen	1.31	1.31	.19	2	> 6	212
75	Kyle-Buffington	.26	.17	.12	4	> 6	122
76	Labu-Sansarc	.13	.13	.10	35	> 6	152
77	Lancaster-Hedville	1.30	1.30	.17	20	> 6	142
78	Las-Las Animas-McCook	8.10	.90	.13	2	< 6	411
79	Lawet-Elsmere-Gannett	7.24	2.67	.13	2	< 6	411
80	Lawet-Wann-Lex	4.28	1.18	.16	2	< 6	311
81	Loup-Elsmere-Dunday	11.84	2.79	.10	3	< 6	511
82	Luton-Forney	.21	.06	.13	1	< 6	111
83	Marshall-Ponca	1.31	1.31	.20	13	> 6	232
84	McCook-Munjor-Inavale	5.47	2.64	.16	2	> 6	412
85	Minnequa-Penrose	1.46	1.18	.17	31	> 6	152
86	Mitchell-Epping	1.30	1.30	.20	19	> 6	232
87	Mitchell-Otero	4.45	4.45	.17	15	> 6	332
88	Monona-Ida	1.30	1.30	.21	27	> 6	242
89	Moody-Bazile-Trent	2.76	.96	.17	5	> 6	322
90	Moody-Nora-Judson	1.25	1.22	.20	10	> 6	222
91	Moody-Fillmore	1.13	1.00	.19	6	> 6	212
92	Moody-Thurman	5.15	2.12	.15	11	> 6	432
93	Morrill-Burchard	.77	.40	.16	17	> 6	132
94	Nora-Crofton-Moody	1.28	1.26	.20	18	> 6	232
95	Nora-Crofton-Judson	1.30	1.30	.21	18	> 6	232
96	Nora-Moody-Judson	1.27	1.25	.19	12	> 6	232
97	Nuckolls-Holdrege-Campus	1.30	1.30	.19	15	> 6	232
98	Oglala-Duroc-Creighton	1.30	1.30	.18	9	> 6	222
99	Oglala-Jayem	2.52	2.52	.18	11	> 6	332
100	O'Neill-Blendon-Hord	8.26	1.30	.14	4	> 6	422
101	O'Neill-Dunday-Meadin	13.03	2.17	.09	9	> 6	522
102	O'Neill-Meadin-Jansen	14.65	1.30	.09	14	> 6	532
103	Onita-Reliance-Ree	.83	.61	.18	5	> 6	122
104	Otero-Bridget-Mitchell	7.62	7.62	.14	10	> 6	422
105	Pawnee-Wymore-Burchard	.27	.17	.13	11	> 6	122
106	Pierre-Samsil-Kyle	.08	.08	.08	32	> 6	152
107	Platte-Leshara-Alda	9.92	.99	.14	2	< 6	411
108	Redstoe-Gavins-Loretto	1.70	1.70	.17	21	> 6	242
109	Rosebud-Alliance	1.08	.68	.17	5	> 6	222
110	Rosebud-Alliance-Kuma	1.13	.84	.17	4	> 6	222

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings—Continued

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydro-logic soil-group code
111	Rosebud-Alliance-Canyon	1.12	.79	.17	11	> 6	232
112	Sarpy-Onawa-Haynie	3.63	.43	.15	3	< 6	311
113	Sharpsburg	.62	.40	.20	17	> 6	132
114	Sharpsburg-Fillmore	.64	.34	.19	5	> 6	112
115	Sharpsburg-Pawnee-Burchard	.48	.33	.16	10	> 6	132
116	Simeon-Meadin	14.68	8.32	.06	30	> 6	542
117	Simeon-Meadin-Betts	12.04	6.39	.08	31	> 6	542
118	Steinauer-Pawnee-Burchard	.61	.31	.14	26	> 6	142
119	Tassel-Mariaville-Ronson	6.58	3.08	.16	47	> 6	452
120	Tassel-Busher-rock outcrop	8.20	4.00	.14	40	> 6	452
121	Tassel-Busher	8.20	4.00	.15	36	> 6	452
122	Thurman-Boelus-Nora	8.58	2.86	.14	13	> 6	432
123	Thurman-Hadar-Ortello	10.51	2.56	.10	10	> 6	532
124	Tripp-Alice	2.38	1.90	.17	4	> 6	322
125	Tripp-Keith-Alliance	1.30	1.26	.19	4	> 6	222
126	Uly-Coly-Holdrege	1.30	1.30	.21	18	> 6	232
127	Uly-Holdrege-Coly	1.30	1.30	.21	13	> 6	232
128	Ulysses-Keith-Colby	1.30	1.30	.21	12	> 6	232
129	Valent	11.13	6.00	.06	45	> 6	552
130	Valent-Dailey	11.60	7.75	.06	25	> 6	542
131	Valent-Sarben-Otero	9.95	7.15	.11	19	> 6	542
132	Valent-Tassel	11.10	6.00	.09	36	> 6	542
133	Valentine	13.00	13.00	.07	45	> 6	552
134	Valentine-hilly and rolling	13.00	13.00	.07	60	> 6	552
135	Valentine-Dunday	12.38	11.47	.08	26	> 6	542
136	Valentine-Els	13.00	13.00	.07	23	< 6	541
137	Valentine-Elsmere-Gannett	12.33	9.75	.08	30	< 6	541
138	Valentine-Hersh	10.12	10.12	.10	13	> 6	532
139	Valentine-Simeon	13.00	13.00	.06	27	> 6	542
140	Valentine-Tassel	12.53	10.93	.09	25	> 6	542
141	Valentine-Thurman	12.88	10.75	.08	14	> 6	532
142	Wewela-Valentine-Anselmo	5.17	4.93	.12	13	> 6	432
143	Wood River	.95	.13	.19	2	> 6	112
144	Wymore-Pawnee	.24	.13	.14	10	> 6	122
145	Zook-Leshara-Wann	1.73	.53	.16	2	< 6	211
146	Valentine-Els-Wildhorse	13.00	13.00	.07	20	< 6	541
147	Wildhorse-Els-Hoffland	12.70	10.75	.06	3	< 6	511

CONCLUSIONS

A quantitative evaluation of the soil's hydrologic characteristics depicted in this report should be adaptable to the requirements of various types of streamflow or runoff models and in the simulations of ground-water systems. The ability of the soil to transmit water (permeability), its storage capabilities (available water capacity), runoff potential (soil slope, permeability, and available water capacity), and effect on evaporation (depth to the seasonal high water table) account for the principal hydrologic responses of the soil. Therefore, data for the soils presented herein reflect almost all the measurable hydrologic responses of the land surface.

The emphasis in this report on the hydrologic characteristics of the soil, particularly for numerical modeling purposes, need not preclude other applications of the data. The grouping system used in this report, based on the hydrologic characteristics of the soil, can provide information for other spatial interpretations such as may be needed to determine the soil's irrigation potential and responses, erosional potential, and soil-vegetation relationships in a system compatible with the Soil Conservation Service classification. Specific applications of the data in numerical modeling and these other purposes are beyond the scope of this report but should be apparent to those requiring such information.

The techniques used in generating and analyzing the

Table 2. Number code for hydrologic grouping of the soil associations

Average permeability of 60-inch soil profile		Average maximum soil slope		Depth to seasonal high water table	
Code number	Range (inches per hour)	Code number	Range (percent)	Code number	(Feet)
1	Less than 1.0	1	0–3	1	Less than 6
2	1.0 to 2.0	2	3–10	2	Greater than 6
3	2.0 to 5.0	3	10–20		
4	5.0 to 10.0	4	20–30		
5	Greater than 10.0	5	Greater than 30		

hydrologic characteristics of the soils in Nebraska are applicable in other areas where adequate data and soil maps are available. These procedures need not be confined to the same mapping scales nor necessarily to the same characteristics. They can be applied readily to studies requiring greater detail, the use of large mapping scales, or lower levels of soil classification. Furthermore, the number of hydrologic characteristics can be decreased or increased with varying ranges to accommodate required detail.

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SUPPLEMENTAL INFORMATION

Information in this section is provided for those who may wish to apply the methods and data in this report for their own areas. Data in the table on soil series should be useful in that they represent characteristics observable and mapped in the field. As such, they are data that can provide the degree of detail needed for interpreting the hydrologic characteristics of the soil in more specific areas.

The description of the computer program should be useful as a model for sorting soils into logical groupings. Probably, however, modifications will need to be made in the ranges of values for the various characteristics so that they will apply appropriately to the specific area being studied.

Computer Program for Sorting Soils into Hydrologic Groups and Calculating Statistics

This section provides the computer program used to sort the soil associations into hydrologic soil groups and to compute the group statistics. The Statistical Analysis System (SAS) (Barr and others, 1976) serves as the source program for the procedures performed. The program consists of the following elements:

Table 3. Hydrologic characteristics of selected soil series

Table 3.--Hydrologic characteristics of selected soil series

Soil series	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
Albaton	0.40	0.20	0.13	0-02	< 6
Alcester	1.30	1.30	.20	2-60	> 6
Alda	12.10	1.30	.10	0-02	< 6
Alice	4.90	3.30	.14	0-06	> 6
Alliance	1.30	1.10	.18	0-12	> 6
Altvan [1]	1.30	1.30	.20	0-15	> 6
Anselmo	4.00	4.00	.16	0-20	> 6
Aowa	1.10	1.10	.20	0-02	> 6
Bankard	12.80	4.00	.07	0-06	> 6
Barney	13.00	13.00	.06	0-03	< 6
Bazile	7.40	.40	.12	0-11	> 6
Belfore	.40	.40	.19	0-04	> 6
Benfield [1]	.30	.13	.20	5-25	> 6
Betts	.85	.40	.18	2-40	> 6
Blencoe	.80	.06	.18	0-02	< 6
Blendon	7.15	1.30	.13	0-06	> 6
Blyburg	1.30	1.30	.20	0-06	> 6
Boel	12.47	3.30	.09	0-30	< 6
Boelus	5.01	1.30	.18	0-11	> 6
Bridget	1.30	1.30	.19	0-20	> 6
Bristow [1]	.13	.13	.09	6-40	> 6
Brunswick [1]	11.90	3.30	.14	11-30	> 6
Buffington	.70	.40	.17	0-06	> 6
Bufton	.33	.33	.19	0-20	> 6
Burchard	.58	.40	.16	2-17	> 6
Busher [1]	4.00	4.00	.16	1-30	> 6
Campus	1.30	1.30	.17	1-10	> 6
Canyon [1]	1.30	1.30	.17	2-50	> 6
Caruso	1.20	1.10	.19	0-02	< 6
Cass	5.81	1.30	.15	0-02	> 6
Cheyenne	12.20	.40	.09	0-03	> 6
Clarno	.85	.40	.18	0-15	> 6
Colby	1.30	1.30	.20	0-30	> 6
Coly	1.30	1.30	.21	3-30	> 6
Cozad	1.84	1.30	.18	0-30	> 6
Creighton	1.30	1.30	.16	0-20	> 6
Crete	.47	.13	.18	0-11	> 6
Crofton	1.30	1.30	0.22	2-60	> 6
Dailey	13.00	13.00	.06	0-12	> 6
Dix	15.17	6.00	.07	0-30	> 6
Dunday	9.37	4.00	.10	0-11	> 6
Dunn	6.24	.33	.13	0-03	< 6
Duroc	1.30	1.30	.17	0-06	> 6
Els	13.00	13.00	.07	0-03	< 6
Elsmere	12.47	4.00	.08	0-02	< 6
Epping	1.30	1.30	.20	0-03	> 6
Fillmore	.73	.06	.18	0-01	< 6
Forney	.06	.06	.12	0-01	< 6
Gannett	9.28	3.30	.10	0-02	< 6
Gavins	1.30	1.30	.17	9-40	> 6
Gayville	.88	.06	.16	0-01	> 6
Geary	1.20	1.10	.19	0-15	> 6
Gibbon	2.23	1.10	.20	0-02	< 6
Glenberg	4.90	4.00	.10	0-03	> 6
Goshen	1.30	1.30	.20	0-03	> 6
Gothenburg	18.58	3.30	.04	0-02	< 6
Hadar	5.44	.40	.13	0-12	> 6
Hall	.91	.40	.20	0-06	> 6
Hastings	.81	.40	.20	0-11	> 6
Haverson	1.57	1.30	.16	0-03	> 6
Haxton	3.41	1.30	.15	0-10	> 6
Haynie	1.30	1.30	.22	0-05	> 6
Hedville [1]	1.30	1.30	.15	3-30	> 6
Hersh	4.00	4.00	.15	0-30	> 6
Hobbs	1.62	1.30	.20	0-06	> 6
Hoffland	11.80	4.00	.10	0-02	< 6
Holder	1.30	1.30	.21	0-11	> 6
Holdrege	1.30	1.30	.20	0-11	> 6
Holt	3.30	3.30	.14	0-15	> 6
Hord	1.30	1.30	.21	0-06	> 6
Humbarger	1.30	1.30	.18	0-06	> 6
Ida	1.30	1.30	.21	2-40	> 6
Inavale	12.73	4.00	.07	0-11	> 6
Ipage	13.00	13.00	.08	0-03	< 6
Janise	1.30	1.30	0.19	0-02	< 6
Jansen	11.60	1.30	.10	0-30	> 6
Jayem	4.00	4.00	.14	0-10	> 6
Judson	1.30	1.30	.22	0-09	> 6
Kadoka	1.30	1.30	.20	0-15	> 6
Keith	1.30	1.30	.21	0-18	> 6
Kenesaw	1.30	1.30	.21	0-11	> 6
Kennebec	1.30	1.30	.22	0-05	< 6
Kipson [1]	1.30	1.30	.18	1-25	> 6
Kuma	1.30	1.30	.18	0-03	> 6
Kyle	.06	.06	.10	0-09	> 6
Labu [1]	.13	.13	.11	2-30	> 6
Lancaster [1]	1.30	1.30	.17	1-12	> 6
Las	8.24	.40	.13	0-01	< 6
Las Animas	10.30	1.30	.10	0-03	< 6
Lawet	1.34	1.10	.19	0-02	< 6
Leshara	1.75	.40	.20	0-02	< 6
Lex	13.60	1.30	.09	0-02	< 6
Loretto	3.30	3.30	.19	0-12	> 6
Loup	12.46	1.30	.10	0-02	< 6
Luton	.32	.06	.14	0-01	< 6
Lynch [1]	.20	.06	.12	2-30	> 6
Manter	10.77	4.00	.12	0-30	> 6
Mariaville	1.30	1.30	.20	3-40	> 6
Marshall	1.30	1.30	.20	0-20	> 6
Mayberry	.20	.13	.12	2-10	> 6
McCook	1.98	1.30	.19	0-02	> 6
Meadin	17.19	1.30	.08	0-35	> 6
Minatare	.95	.06	.10	0-02	< 6
Minnequa	1.30	1.10	.17	2-10	> 6
Mitchell	1.30	1.30	.20	0-20	> 6
Monona	1.30	1.30	.22	0-30	> 6
Moody	1.18	1.10	.19	0-17	> 6
Morrill	.84	.40	.16	2-18	> 6
Munjor	6.40	4.00	.13	0-02	> 6
Nodaway	1.30	1.30	.21	0-03	< 6
Nora	1.30	1.30	.19	0-30	> 6
Norrest	.57	.40	.15	0-40	> 6
Nuckolls	1.30	1.30	0.20	3-30	> 6
Oglala	1.30	1.30	.18	0-30	> 6
Onawa	2.42	.13	.19	0-02	< 6
O'Neill	14.27	1.30	.09	0-09	> 6
Onita	.58	.40	.18	0-06	> 6
Orella	.56	.06	.10	1-25	> 6
Ortello	11.28	1.30	.11	0-30	> 6
Otero	13.00	13.00	.10	0-15	> 6
Paka	1.30	1.30	.20	0-40	> 6
Pawnee	.16	.13	.12	0-11	> 6
Penrose	1.30	1.30	.16	2,40	> 6
Pierre	.06	.06	.10	0-25	> 6
Pivot	16.60	13.00	.06	0-06	> 6
Platte	15.30	1.30	.07	0-02	< 6
Ponca	1.30	1.30	.19	6-30	> 6
Redstoe	1.30	1.30	.16	2-25	> 6
Ree	1.30	1.30	.17	0-15	> 6
Reliance	.82	.40	.17	0-15	> 6
Rosebud [1]	.93	.40	.16	0-20	> 6
Ronson	4.00	4.00	.13	0-30	> 6
Samsil	.13	.13	.10	2-45	> 6
Sansarc	.13	.13	.10	2-40	> 6
Sarben	5.63	4.00	.15	1-30	> 6
Sarpy	5.70	.13	.07	0-09	> 6
Sharpsburg	.62	.40	.20	0-18	> 6
Silver Creek	2.99	.13	.17	0-02	< 6
Simeon	13.00	13.00	.05	0-30	> 6
Steinauer	1.00	.40	.15	6-40	> 6
Tassel [1]	11.00	4.00	.14	3-45	> 6
Thurman	12.53	4.00	.09	0-30	> 6
Trent	1.30	1.30	.19	0-02	> 6
Tripp	1.30	1.30	.19	0-09	> 6
Uly	1.30	1.30	.22	0-30	> 6
Ulysess	1.30	1.30	.20	0-15	> 6
Valent	11.13	6.00	.06	0-50	> 6
Valentine	13.00	13.00	.07	0-60	> 6
Wann	3.81	1.30	0.17	1-20	> 6
Wewela	.61	.06	.13	0-09	> 6
Wildhorse	13.00	13.00	.05	0-02	< 6
Wood River	.95	.13	.19	0-03	> 6
Wymore	.28	.13	.16	0-11	> 6
Yockey	1.30	1.30	.18	0-02	< 6
Zook	.43	.13	.14	0-02	< 6

[1]Soil profile less than 60 inches, usually occurring over bedrock.

1. The initial two statements provide access to the available SAS programs.

2. The next three statements pertain to a description of the input information, the data-set name, input format, and type of input (cards). The input format contains the variable names and column position:

SOILNUM 1–3 —soil-association number
SOILNAME 4–19—soil-association name
PERM 20–25—average permeability of the soil profile, in inches per hour
LPH 26–31—permeability of the least permeable horizon
WHC 32–35—average available water capacity of the soil profile, in inches per inch
SLOPE 36–38—soil slope or gradient as a percentage
DTW 39–41—minimum depth to the permanent water table, in feet

3. Following the term "cards" is a partial listing of the input data for the 145 soil associations as described under the input format.

4. Beginning with the term "Title" and concluding with the "/*" are the programming statements for sorting the soil associations into hydrologic soil groups and calculating the statistics.

5. Following the "/*" is a sample of the output in condensed form showing soil associations in a hydrologic soil group, together with selected statistics.

For a more comprehensive understanding of the programming requirements, refer to the SAS program manual (Barr and others, 1976).

INPUT:

```
// EXEC SAS,REGION=448K,TIME.SAS=10
//SYSIN DD *
DATA SOIL;
INPUT SOILNUM 1-3 SOILNAME $ 4-19 PERM 20-25 LPH 26-31 WHC 32-35
      SLOPE 36-38
DTW 39-41;
CARDS;
  1  ALBATON-HAYNIE   .61    .70 .17  1   4
  2  ALTVAN-ROSEBUD  1.20    .90 .14 11   6
  3AOWA-ALCEST-KENN  1.21   1.21 .22  3   5
  4BANK-LAS-GLENBRG 10.22   2.92 .10  3   5
  5BAZILE-PAKA-THUR  6.55   1.62 .14  9   6
  6    BELFORE-MOODY  .67    .65 .19  4   6
  7BLYP-BLENC-LUTON   .99    .77 .19  2   4
  8BRIDG-MCCOK-DURC  1.44   1.30 .18  5   6
  9BRIDG-TRIP-CHEYN  2.72   1.18 .17  4   6
 10    BRISTOW-LYNCH  .16    .10 .10 29   6
       ϟ            ϟ             ϟ
118 STENER-PAW-BURC   .61    .31 .14 26   6
119 TASL-MARVIL-RON  6.58   3.08 .16 47   6
120 TASSEL-ROCKOUTC 11.00   4.00 .14 50   6
121 TASL-VALT-BUSHP  9.43   4.66 .12 35   6
122 THUR-BOLUS-NORA  8.58   2.86 .14 13   6
123 THUR-HADAR-ORTL 10.51   2.56 .10 10   6
124      TRIPP-ALICE  2.38   1.90 .17  4   6
125 TRIP-ALLC-ROSER  1.21   1.02 .16  4   6
126 ULY-COLY-HOLDRG  1.30   1.30 .21 18   6
127 ULY-HOLDRG-COLY  1.30   1.30 .21 13   6
128 ULYS-KETH-COLBY  1.30   1.30 .21 12   6
129           VALENT 11.13   6.00 .06 45   6
130 VALENT-JAY-DALY  9.45   6.71 .08 19   6
131  VALENT-OTR-BRW 11.67   7.01 .09 21   6
132 VALENT---TASSEL 11.10   6.00 .09 36   6
133        VALENTINE 13.00 13.00 .07 45   6
134 VALENTINE-HILLY 13.00 13.00 .07 60   6
135 VALENTNE-DUNDAY 12.38 11.47 .08 26   6
136  VALENTINE--ELS 13.00 13.00 .07 23   5
137 VALTNE-ELSM-GAN 12.33   9.75 .08 30   3
138 VALENTINE-HERSH 10.12 10.12 .10 13   6
139 VALENTINE-SIMEN 13.00 13.00 .06 27   6
140 VALENTINE-TASEL 12.53 10.93 .09 25   6
141 VALNTNE-THURMAN 12.88 10.75 .08 14   6
142 WEWELA-VAL-ANSM  5.17   4.93 .12 13   6
143       WOOD RIVER  .86    .13 .19  2   6
144 WYMORE---PAWNEE   .24    .13 .14 10   6
145 ZOOK-LESHR-WANN  1.73    .52 .16  2   5
TITLE HYDROLOGIC PROPERTIES OF NEBRASKA SOILS;
PROC PRINT;
DATA S111; SET SOIL; IF PERM<1.0 AND SLOPE=<3 AND DTW=<5;
PROC PRINT; TITLE S111; PROC MEANS;
DATA S112; SET SOIL; IF PERM<1.0 AND SLOPE=<3 AND DTW>5;
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PROC PRINT; TITLE S151; PROC MEANS;
DATA S152; SET SOIL; IF PERM<1.0 AND SLOPE=>30 AND DTW>5;
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PROC PRINT; TITLE S551; PROC MEANS;
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PROC PRINT; TITLE S552; PROC MEANS;
/*
```

SAMPLE OUTPUT:

S532 11:51 THURSDAY, JUNE 18, 1981 56

OBS	SOILNUM	SOILNAME	PERM	LPH	WHC	SLOPE	DTW
1	64	JANSEN-MEADIN	14.12	1.31	0.10	18	6
2	102	ONEIL-MEAD-JANS	14.65	1.30	0.09	14	6
3	123	THUR-HADAR-ORTL	10.51	2.56	0.10	10	6
4	138	VALENTINE-HERSH	10.12	10.12	0.10	13	6
5	141	VALNTNE-THURMAN	12.88	10.75	0.08	14	6

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PERM	5	12.45600000	2.06192386	10.12000000	14.65000000	0.92212038	62.28000000	4.2515300	16.554
LPH	5	5.20800000	4.80417215	1.30000000	10.75000000	2.14849110	26.04000000	23.0800700	92.246
WHC	5	0.09400000	0.00894427	0.08000000	0.10000000	0.00400000	0.47000000	0.0000800	9.515
SLOPE	5	13.80000000	2.86356421	10.00000000	18.00000000	1.28062485	69.00000000	8.2000000	20.750
DTW	5	6.00000000	0.00000000	6.00000000	6.00000000	0.00000000	30.00000000	0.0000000	0.000

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Hydrologic Characteristics of Nebraska Soils

By JACK T. DUGAN

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Dallas L. Peck, Director

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

The International System (SI) is a consistent system of metric units adopted by the Eleventh General Conference of Weights and Measures in 1960. Selected factors for converting inch-pound units used in this report to SI units are given below.

INCH-POUND UNITS	MULTIPLY BY	TO OBTAIN SI UNITS
inch	25.40	millimeter
inch per hour	25.40	millimeter per hour
inch per inch	25.40	millimeter per millimeter
foot	0.3048	meter
mile	1.609	kilometer

Hydrologic Characteristics of Nebraska Soils

By Jack T. Dugan

Abstract

The influence of the physical characteristics of soil on hydrology is frequently neglected. In this report, the effects of five characteristics on the hydrologic responses of soils in Nebraska are evaluated quantitatively, soils are grouped through use of a simplified coding system according to similarities in hydrologic responses, and are mapped according to these responses.

General soils maps of the U.S. Department of Agriculture Soil Conservation Service and data for the physical properties of the soils proved well-suited to hydrologic interpretation. This interpretation of the maps and data led to the selection of three characteristics as classification variables: Average permeability of the 60-inch soil profile, average maximum soil slope, and depth to the seasonal high water table. Permeability of the least permeable horizon and available water capacity, although not needed as classification variables, are useful in explaining some of the hydrologic responses of soils.

The primary soil units used in groupings and interpretation of the soils for this study are the soil associations. A computer program is presented that sorts the soils into groups and calculates statistics for each group. The 147 soil associations in Nebraska were thus sorted into 29 hydrologic soil groups. The location and extent of these hydrologic soil groups are shown on maps at scales of 1:750,000 and 1:250,000 for the State.

INTRODUCTION

Soils are an accumulation of materials possessing a broad range of physical characteristics. They are not static but dynamic bodies undergoing constant alteration by living organisms, the atmospheric environment, and further deposition of inorganic materials. Soils have a significant influence on both human activity and natural processes. The importance of the soil's physical characteristics to hydrology has received limited recognition in contrast to that received in agricultural and engineering applications. In numerous areal hydrologic studies, these characteristics are neglected or receive only superficial treatment, even though they are of critical importance in understanding both surface- and ground-water hydrology.

Soils have a significant effect on the relationships of precipitation to surface-water runoff, ground-water recharge, and consumptive water requirements. Particularly important in these relationships are soil permeability, available water capacity, and soil slope, because they influence the infiltration rates of precipitation into the soil and the volume of water that can be retained within the soil zone.

No system based on the interaction of soil characteristics has been readily available for identifying and estimating quantitatively those characteristics of the soils that have significant effects on hydrology. However, recent analysis of ground-water problems in Nebraska, using numerical-simulation models of hydrologic systems, has indicated the need for such a system. To obtain required data for these models, it was necessary to analyze and assign quantitative values to the physical characteristics of the soil in a substantial part of the State. Subsequent improvements and simplifications have resulted in a uniform method presented herein that can be used by hydrologists, planners, and water managers with limited knowledge of soil science.

Purpose and Scope

This report has two purposes. The first is to provide interpretive maps that can be used to evaluate quantitatively the physical characteristics of the soil that significantly affect the hydrology of Nebraska. The second is to describe the method used in analyzing existing data for these physical characteristics and in compiling and presenting results in the maps.

No new field or laboratory data were obtained for this report. Rather, emphasis was placed on interpreting existing data for those physical characteristics of soils that have hydrologic significance. Furthermore, no attempt was made to provide specific applications of the data in the maps. In this report, the study of the soils was confined to those materials composing the upper 60 inches of the soil profile, which is the standard soil profile in the study area. In selected instances, the profile considered was less than 60 inches where shallower soils occur over a bedrock surface.

Data are presented for five hydrologic characteristics of the soils, each of which is important in understanding soil response to water. These data are presented in 12 large maps and attendant tables (pls. 1–12). The first is a generalized map (1:750,000 scale) for the entire State. The remaining 11 are standard U.S. Geological Survey quadrangle maps that provide a hydrologic interpretation of the soils at a more applicable scale (1:250,000).

The method for determining numerical values of the selected characteristics presented provides a basis for analyzing hydrologic responses of soils in a variety of applications and spatial comparisons. This method has potential for us wherever adequate soils maps and data are available.

Sources of Data

Data used for this report were obtained from both published and unpublished materials of the U.S. Department of Agriculture Soil Conservation Service and the University of Nebraska Conservation and Survey Division. These materials include a series of published general soil area maps depicting soil associations at the 1:250,000 scale on standard U.S. Geological Survey bases. Explanations accompanying the maps include general physical descriptions of the soils and percentages of individual soil series comprising given associations. Published data by the Soil Conservation Service describing individual soil series provide the information needed for computing the hydrologic characteristics of the mapped soil associations.

Acknowledgment

The author thanks James R. Culver, Nebraska State Soil Scientist, U.S. Department of Agriculture Soil Conservation Service, for providing both published and unpublished soils maps and data and for offering valuable suggestions for grouping and describing the soils.

GENESIS AND CLASSIFICATION OF THE SOILS

The soils of Nebraska possess physical characteristics that are quite variable. The natural processes forming the soils and their subsequent classification are indicative of the variability. An understanding of the range of hydrologic characteristics of the soils of the State is best gained through a comprehension of their genesis and classification.

Genesis

The development of the soils in Nebraska are a product of several environmental factors operating in relation to one another. A report by the U.S. Department of Agriculture Soil Survey Staff (1951, p. 3) states: "The morphology of each soil, as expressed in its profile, reflects the combined effects of the particular set of genetic factors responsible for its development." These genetic factors or causal antecedents of soil development determine the physical characteristics and, therefore, the hydrologic properties of the soil. According to Donahue and others (1971, p. 86–87), these soil-forming factors and the nature of their role are (1) parent material (passive), (2) relief or topography (passive), (3) climate (active), (4) biosphere (active), and (5) time (neutral).

Whereas parent material (fig. 1) is a passive factor in soil formation, its effect on the characteristics of the soil within the State is significant. Two-thirds to three-fourths of the State is mantled by materials that are eolian (wind-deposited) in origin. This includes the fine sand material principally in the north-central part of the State (fig. 1) and the silty loess that covers most of the southern and eastern parts of the State. In a small area of southeastern Nebraska, some soils have developed on modified glacial till. Residual soils, which have been formed in place on predominantly shale, sandstone, or siltstone bedrock, are present mostly along the the northern and western boundaries of the State and account for less than one-fifth of the soils of the State. Alluvial soils, which typically reflect surrounding upland conditions and show minimal soil development, cover a small part of the State, being confined mainly to the larger stream valleys.

Topography, another passive factor, affects principally the rate of soil development. Steep topography usually retards the rate of development if other soil-forming factors are constant. Types of topography in the State are shown in figure 2. Only in limited areas of the State, as on bluffs, escarpments, and dissected plains, is soil development greatly restricted by topography. Soils in these areas show minimal weathering and shallow development.

Climate is an active factor that influences soil development in several ways. The weathering of the original constituents, movement of products of weathering, leaching, and other processes are dependent on the climatic elements. A progressive change in climate exists across the study area, from a semiarid, cold-winter type in the west to a continental subhumid type in the east. Mean annual precipitation (fig. 3) varies from less than 15 inches in western Nebraska to more than 36 inches in extreme southeastern Nebraska. The depth of soil development, degree and depth of clay accumulation (illuviation), and presence or depth of calcium carbonates, among other properties of the soil, are related to precipitation. From west to east across the State, the depth and degree of soil development increases significantly as mean annual precipitation increases. The increased precipitation in the eastern part of the State results in an increased accumulation of clays in the subsoil—an argillic horizon—as the result of downward movement of the clays. Also, as precipitation increases, the proportion of calcium carbonate in the soil decreases, and the zone of calcium-carbonate accumulation moves downward.

The range in mean annual temperatures across the State is not significant and probably has a limited effect in differentiating soils. The long winters, in which frozen soil conditions occur and significant biological activities are absent, retard the rate of soil development. Caution, however, needs to be used in relating present climatic conditions to past soil development, since some climatic variations have occurred during the formation of the present soils.

Biotic activity, particularly botanic, is an active soil-forming factor that closely reflects the climatic environment. Almost the entire State, with the exception of some

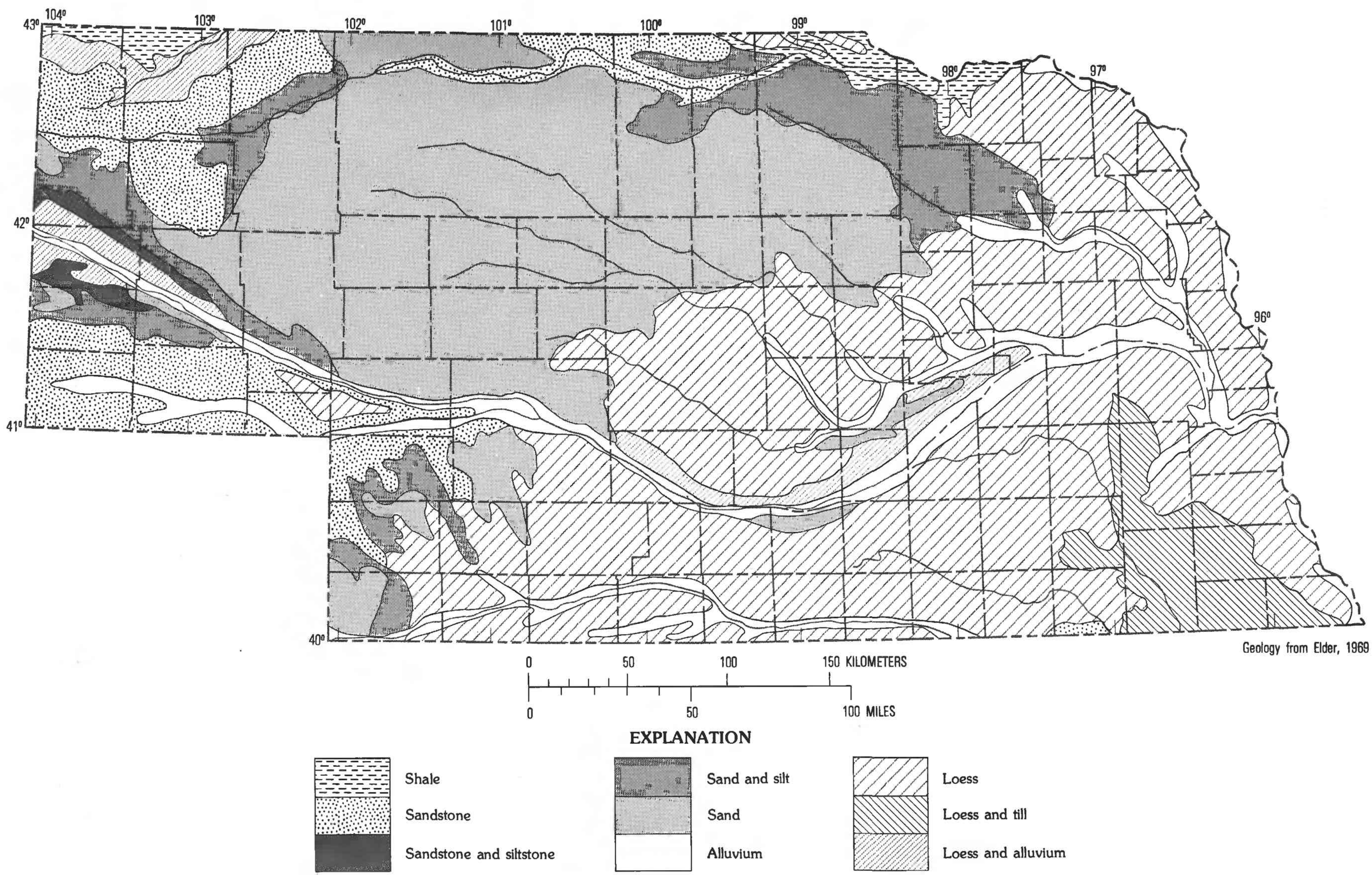


Figure 1. Parent materials of soils.

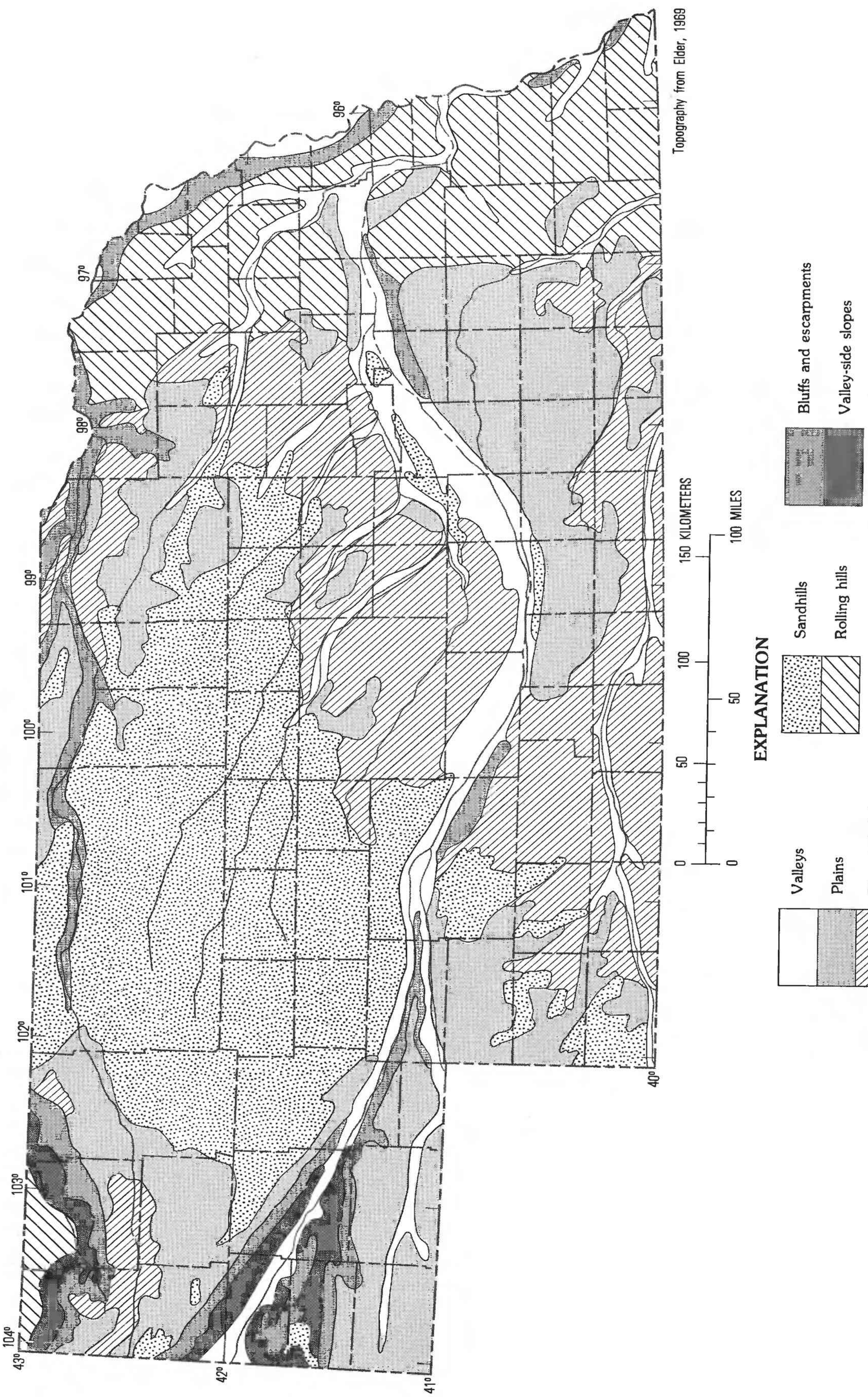
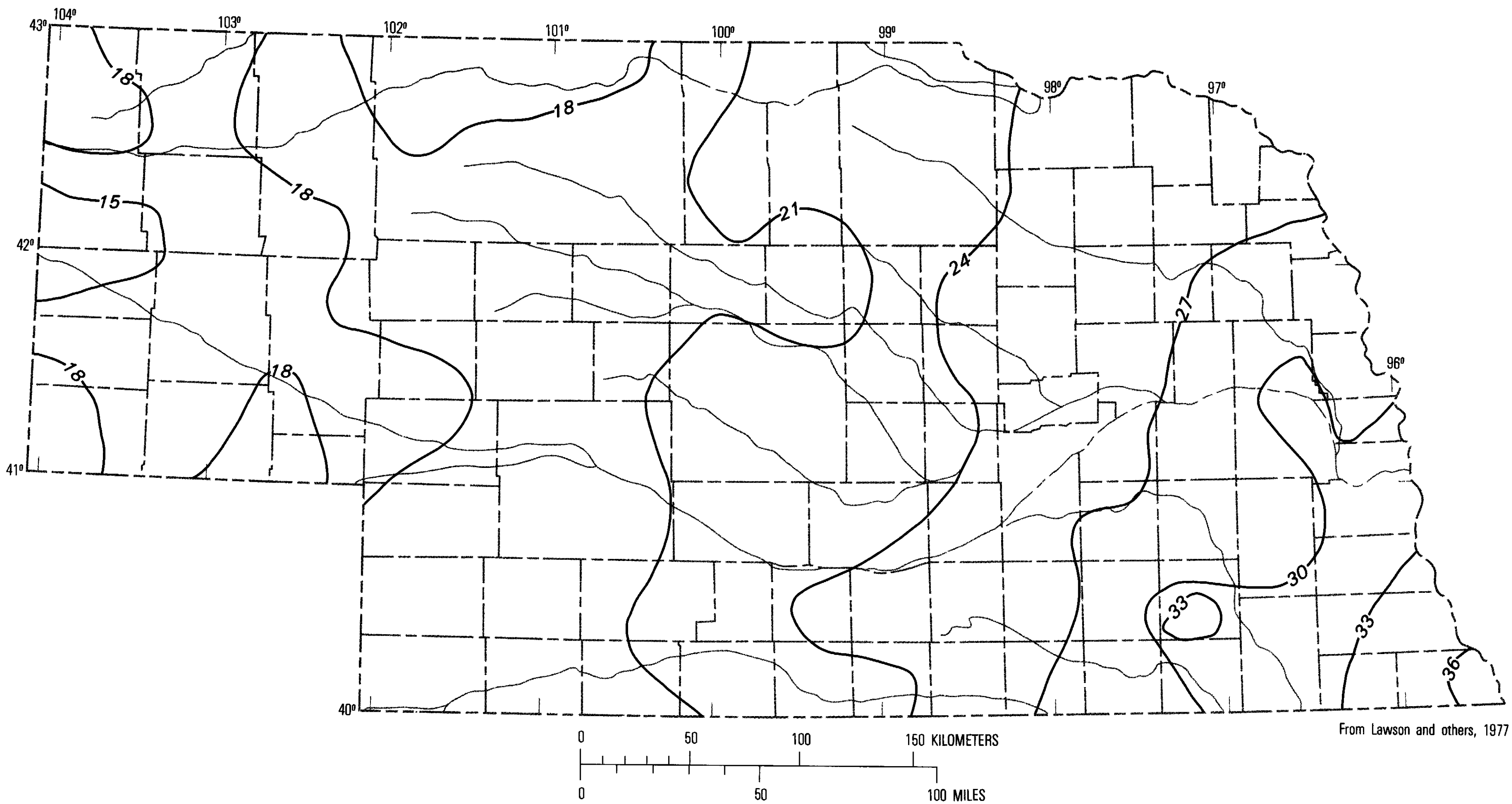


Figure 2. Types of topography.



EXPLANATION

—30— LINE OF EQUAL MEAN ANNUAL PRECIPITATION—
Interval 3 inches

Figure 3. Mean annual precipitation, 1941–70.

steep escarpments, is a natural grassland. The nature of this grassland, however, changes as mean annual precipitation varies across the study area. In the western third of the State, it can be classified as short-grass disclimax prairie, in the central third as mixed or mid-grass prairie, and in the eastern third and in the Sandhills region as true prairie dominated by tall species.

Grassland soils are noted for their greater accumulation and more uniform distribution of organic matter, with depth, than forest soils (Fork and Turk, 1972, p. 216). Infiltration of precipitation tends to increase as the organic matter within the soil increases (Donahue and others, 1971, p. 208). Furthermore, organic matter in the surface layer, or a vegetative mulch, reduces the impact of rain, permitting deeper penetration and less runoff (Donahue and others, 1971, p. 197). The organic-matter content of the soil increases from west to east in the study area as the grasses become progressively taller and average precipitation increases. The tall grasses of the eastern part of the State have much more extensive root system that create greater amounts of organic matter in the soil profile than do the shorter grasses of central and western Nebraska.

Most soils of Nebraska may be considered to be relatively youthful, having developed in deposits that are late Pleistocene or younger. With a moderate rate of weathering under the present climatic regime and the rather recent deposition of most parent materials, the soils of the State are not extensively or deeply weathered.

Classification

The soil classification of the U.S. Soil Conservation Service is designed to meet a number of purposes, including practical applications as well as an international system of classifying soils. This classification, therefore, is necessarily more complex than the one developed for this study, which serves the single purpose of classifying soil according to its hydrologic responses. The hydrologic groupings that result, however, are compatible with the Soil Conservation Service classification in that they are dependent on the interpretation of selected soil characteristics of the basic Soil Conservation Service classification units—the soil series. In this report, spatial groupings of the soil series into soil associations are arranged on the basis of their hydrologic compatibility.

The current Soil Conservation Service system has six classification categories:

Orders—Soil orders are differentiated by the presence or absence of diagnostic horizons or features chiefly reflective of the soil-forming processes and contrasting climates.
Suborders—Suborders within a soil order are differentiated principally on the basis of soil properties resulting from differences in soil moisture and temperature.
Great Groups—These are subdivisions of suborders that are based on differentiating horizons or soil features, such as those of minerals, clays, or humus accumulation.
Subgroups—Great Groups generally consist of three subgroups classified on the degree or intensity of the characteristics used to distinguish Great Groups.
Families—Soil families are determined by properties considered to be important to plant growth and engineering purposes, such as reaction (pH), horizon thickness, texture, and structure.
Series—The several series within a family are based on narrower ranges of the same characteristics used in differentiating families. These characteristics must be observable and mappable in the field (Donahue and others, 1971, p. 105).

The first two classifications, Orders and Suborders, are based on conceptual inferences about soil genesis, whereas the remaining four classifications are based on factual or measurable characteristics of the soil. The classification system developed for this study is similar to the last four classifications in that the differentiating properties are measurable.

The predominant soil order of Nebraska is the Mollisol (fig. 4). Soils of this order are characterized by a surface horizon that is thick, dark colored, high in base saturation (percentage of cation-exchange capacity saturated with calcium, magnesium, sodium, and potassium), and granular in structure. Entisols, whch are soils with no diagnostic horizon, occupy the sandhills and are typical of soils derived from sandy parent materials that are resistant to weathering. Some Ardisols, which contain minimal organic matter and are dry in all horizons at least 6 months of the year, exist in the western part of the State.

The distribution of the Great Groups of Nebraska are shown in figure 4. Their descriptions are as follows:

Typic Ustolls—Mollisols in areas with a warm to hot growing season that is intermittently dry for long periods during summer.
Aridic Ustolls—Mollisols that are similar to the Typic Ustolls but that are in areas subject to longer and more intense dry periods.
Udic Ustolls—Mollisols that are similar to the Typic Ustolls but that are in areas which have fewer or shorter dry periods.
Udolls—Mollisols in areas with a warm, moist growing season.
Psamments—Entisols with sandy or loamy sand textures.
Orthids—Aridisols without a horizon of clay accumulation.
Orthents—Entisols with clayey or loamy textures or Entisols characterized by shallow soils developed on bedrock.
Argids—Aridisols that have a horizon of clay accumulation.

Classification by the preceding Great Groups obviously

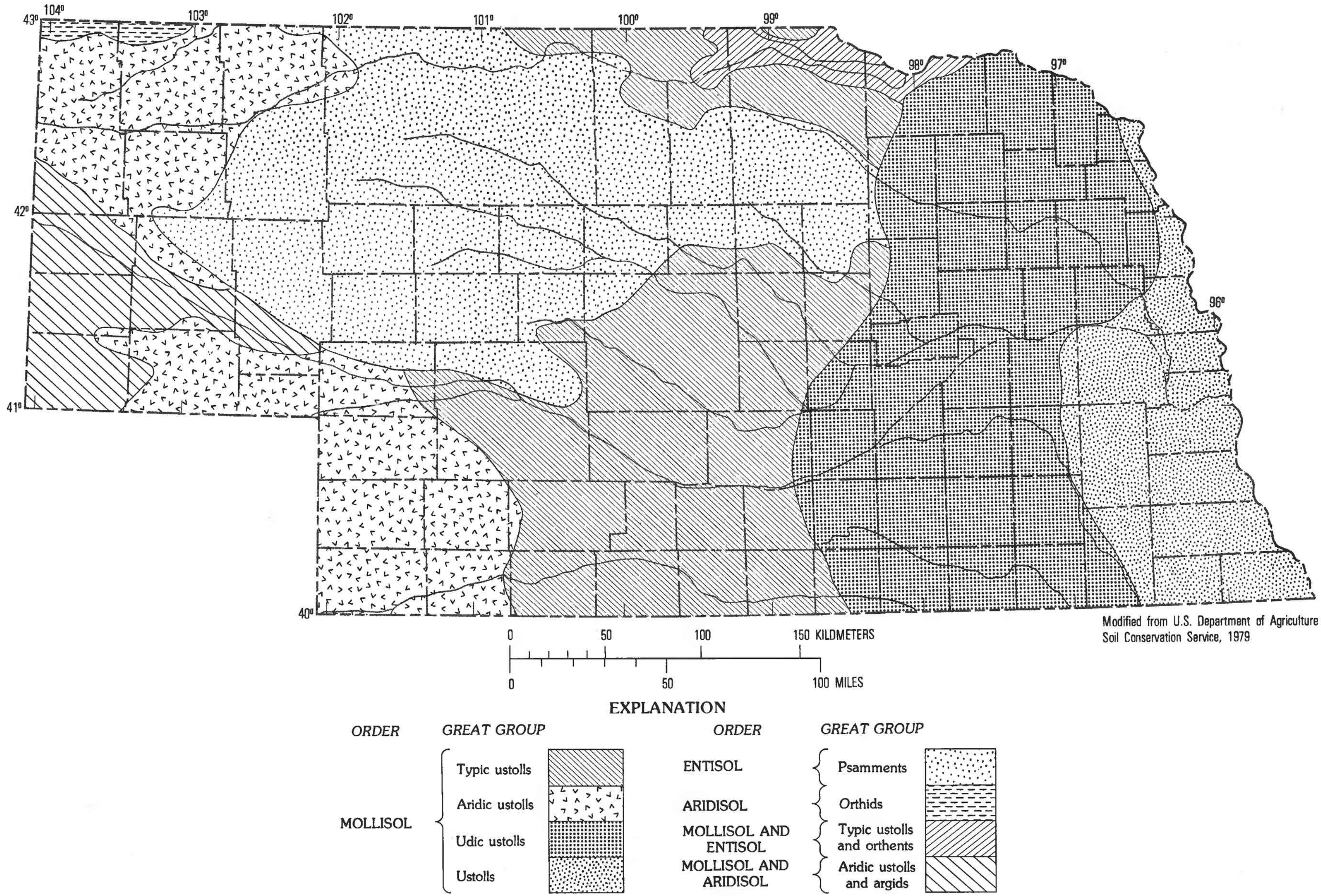


Figure 4. General classification of the soils.

does not provide sufficient detail to evaluate the hydrologic characteristics of the soils. Conversely, use of detailed soil maps composed of individual soil-map units at a scale of 1:20,000, or less, commonly is too complex for practicable interpretation of hydrologic characteristics within a large geographic area. In order to gain sufficient detail for evaluating the surficial hydrology, yet maintain simplicity, the soil associations can be grouped readily by selected physical characteristics. The 1:250,000 scale general soils maps depicting these associations provide an adequate working scale for this grouping.

An association is not a defined category within the Soil Conservation Service classification, but it is the basis for the derivation of the mapping units described in this study. A soil association is defined as a group of soil series occurring in a geographical area in a regular pattern on the landscape (Elder, 1969, p. 2). The individual soil series composing an association may, or may not, have similar physical characteristics.

The use of soil associations could present problems in working with large-scale maps (1:24,000 scale or larger) because of the possibility of having quite divergent soil conditions within definable areas of the mapping units. Use of detailed soil maps would be necessary in these instances, because they portray relatively more homogeneous soil conditions within a given mapping unit. In this study, however, use of soil associations posed no significant problems because of the small map scale of 1:250,000.

CHARACTERISTICS AFFECTING HYDROLOGIC RESPONSES OF THE SOILS

Several characteristics affect the hydrologic responses of the soil. These include average permeability, permeability of the least permeable horizon, available water capacity, soil slope, and depths to the seasonal high water table. Each of these characteristics differs in its effect on the soil's physical responses to water, which in turn have a significant effect on an entire hydrologic system.

All five characteristics mentioned in the previous paragraph are important in understanding the hydrologic responses of soils. The use of only three, however, was required in grouping the soils on a hydrologic basis—average permeability, soil slope, and depth to the seasonal high water table. The other two are closely related to permeability, as will be discussed subsequently; only those that operate independently of one another were chosen for differentiating soil groups.

The runoff characteristics of streams are affected largely by permeability, available water capacity, and soil slope. Overland runoff generally is minimal where soils are permeable, allowing for rapid infiltration and percolation.

Recharge to ground-water reservoirs is determined largely by these same characteristics. Soil permeability, which governs significantly the percolation of precipitation to the zone of saturation, can vary several magnitudes, thus greatly affecting recharge to a reservior. Consumptive-water requirements of domestic crops and natural vegetation indirectly influence ground-water recharge. Those requirements are dependent on the soil's available water capacity, which largely determines the amount of precipitation or supplemental irrigation water needed to sustain plant growth. Furthermore, the available water capacity determines the amount of soil moisture that can be held within the soil zone and that is available for evapotranspiration. Soil slope is important in that it governs the time available for precipitation to infiltrate the soil; generally, the lesser the slope, the more time available for infiltration.

Permeability of 60-Inch Soil Profile

Permeability is the rate at which soil, under saturated conditions, transmits water in a vertical direction under a unit head of pressure. Physical properties of soil such as texture (size groups of individual soil grains), structure (aggregation of primary soil particles into compound particles or clusters), and porosity (volume of interconnected pore space available for fluid transmission) affect permeability (U.S. Department of Agriculture Soil Survey Staff, 1951). The U.S. Geological Survey defines "intrinsic permeability" as the measure of the relative ease with which a porous medium can transmit a liquid under a potential gradient. Intrinsic permeabilty is a property of the medium only and is independent of the liquid's nature and of the force causing movement. This property of the medium is dependent on the shape, size, and interconnections of the pores (Lohman and others, 1972).

Infiltration and percolation are characteristics of the soil similar to permeability, but with certain differences in definitions. While permeabilty refers to the movement of water "within" the soil, infiltration pertains to the movement of water "into" the soil, and percolation to the movement "through" the soil. The factors that determine permeability are virtually the same for infiltration and percolation (Donahue and others, 1971, p. 208).

In this study, the Soil Conservation Service unit of measurement for permeability, inches per hour, was used. The average permeability is computed for the standard Soil Conservation Service 60-inch profile, except for shallow soils over bedrock. In Nebraska, the permeability of the soils in the study area ranges from less than 0.06 inch per hour for clay soils to more than 16.0 inches per hour for sandy soils.

Permeability of Least Permeable Horizon

In addition to an average permeabiltiy for the 60-inch soil profile, the permeability of the least permeable horizon is significant in each soil. In most well-developed soils, the horizon of least permeability occurs in the B-horizon, which is typically 12–24 inches below the surface, where clay accumulation is common for the soils of the study area. Commonly, the composite permeability for the 60-inch profile obscures the permeability of relatively impermeable horizons that may be more significant in affecting percolation rates than the composite permeability.

Whereas this horizon can be quite significant to hydrology, it is not one of the grouping characteristics in this report, because the data used to derive the permeability of the least permeable horizon are included in those data used to derive the average permeability of the 60-inch profile (tables 1 and 3). Therefore, to avoid redundance, only average permeability of the 60-inch profile was used in defining the hydrologic soil groups.

Available Water Capacity

Available water capacity is the capacity of the soil to hold water for use by most plants. It is the difference between the amount of water in the soil at field capacity (the amount of water held in soil after the gravitational water has been drained away) and at the wilting point (moisture content at which soil can not supply water at a rate sufficient to maintain the turgor of a plant resulting in permanent wilting). The capacity of the soil to hold water is related both to the total surface area of the soil particles and to pore-space volume, and thus is dependent on soil texture and structure. The hydrologic term "specific retention" is almost synonymous with "available water capacity" or "moisture-holding capacity" (Lohman and others, 1972). A curve describing available water capacity is lowest for coarse-textured materials such as sand, reaches its maximum for medium-textured materials such a silt loam, and declines slightly for fine-textured materials such as clays (U.S. Department of Agriculture, 1955, p. 120). Available water capacity is approximately the inverse of permeability and is dependent on the same physical properties as permeability. Only one of these characteristics is necessary for classifying the hydrologic soil groups; permeability was selected for this purpose. However, because it is significant for other uses, available water capacity was computed for soil.

In this report, the Soil Conservation Service unit of measurement for available water capacity of "inches of water per inch of soil" is used. In Nebraska, available water capacity ranges from 0.07 inch per inch for sandy soils to 0.22 inch per inch for silty clay loam soils.

Soil Slope

Soil slope is expressed as the difference in elevation, in feet, for each 100 ft of horizontal distance and is given as a percentage. Thus, a 10-foot elevation difference for 100 ft of horizontal distance is a 10 percent slope. Slope groupings for soils normally are given in ranges from the minimum to maximum slopes associated with the particular soils. In this report, averages are computed from maximum slopes, on the premise that overland flow in a particular area is determined more by the greater slopes than by the lesser ones. Other characteristics of slope, such as shape (concave or convex) and length, are not considered, because these factors are difficult to quantify.

Depth to the Seasonal High Water Table

Depth to the seasonal high water table is the depth of the highest water table normally measured on an annual basis. This does not include occasional perching conditions as a result of a relatively impermeable horizon above the zone of permanent saturation. Usually the season of highest water-table conditions in the State occurs during early spring. This characteristic is essential in evapotranspiration estimation. Furthermore, the structure of the soil can be highly altered by long periods of saturation. In this report, this characteristic typically differentiates topographic position of the soils. Those soils characterized by high water-table conditions most commonly represent flood plains or subirrigated meadows in the sandhills. Those characterized by greater depths to the water table represent upland or high terrace positions.

COMPUTATION OF CHARACTERISTICS AFFECTING HYDROLOGIC RESPONSES OF THE SOILS

The computational procedures used in this report follow an explicit, systematic approach in order that they can be evaluated for application in areas other than Nebraska. Because each characteristic considered in this report differs as to its unit of measurement and the phenomenon it represents, computations for each require different procedures. The procedures used for each characteristic for the various soil units will now be described in detail. Computations were made in the following sequence: for individual soil horizons within a profile; for the profile of each soil series; for the soil association; and for the hydrologic soil group.

Permeability of 60-Inch Soil Profile and Available Water Capacity

Similar procedures were used for computing permeability and available water capacity; both characteristics have data in similar formats although in different units:

1. A soil-horizon average for each characteristic was derived from the midpoint of the range of values for that characteristic. For example, for a permeability range of 0.6 to 2.0 inches per hour, the average permeability assigned was 1.3 inches per hour.

2. Next, a weighted soil-profile average for the characteristic was computed. The computational procedure for a hypothetical soil can best be explained by referring to the following table:

Position of soil horizon (inches)	Thickness (inches) (1)	Average permeability (inches per hour) (2)	Result of (1)×(2)	Average available water capacity (inches per hour) (3)	Result of (1)×(3)
0–10	10	1.3	13.0	0.22	2.2
10–30	20	.4	8.0	.17	3.4
30–60	30	3.3	99.0	.12	3.6
Totals	60	---	120.0	----	9.2

Weighted average for soil series:
Permeability (inches per hour) 2.0
Available water capacity (inches per inch) 0.15

To compute the weighted-average permeability for the soil profile, the thickness of each horizon was multiplied by its average permeability. Results were then summed, and this total was divided by the thickness of the profile. From the example above, dividing the total of 120.0 by the profile thickness of 60 inches resulted in a weighted average permeability for the soil profile of 2.0 inches per hour. The same procedure was used for computing the weighted average available water capacity for the soil profile. Dividing the total of 9.2 by 60 inches resulted in a weighted average available water capacity for the profile of 0.15 inch per inch.

3. After determining the permeability of the 60-inch soil profile and the available water capacity for the individual soil series, the weighted averages for the soil associations were computed from percentages of the association area occupied by the various soil series. The Hastings-Crete-Fillmore association serves as an example.

Soil series	Percentage of area (1)	Average permeability (inches per hour) (2)	Result of (1)×(2)	Average available water capacity (inches per inch) (3)	Result of (1)×(3)
Hastings . . .	45	0.81	0.36	0.20	0.09
Crete	45	.47	.21	.18	.08
Fillmore . . .	10	.73	.07	.18	.02

Weighted average for soil association:
Permeability (inches per hour) 0.64
Available water capacity (inches per inch) 0.19

The permeability and available water capacity for a given hydrologic soil grouping are the simple averages of all the associations composing that particular group.

Permeability of Least Permeable Horizon

The permeability of the least permeable horizon for each hydrologic soil group was derived quite simply. The horizon with the least permeability of each soil in the group, regardless of the thickness or position, was determined from the published data, and an average of the range in permeability was assigned to that horizon.

The soil association average for permeability of the least permeable horizon was derived by using the same percentage-weighting procedure used previously. The Hastings-Crete-Fillmore association serves as an example:

Soil series	Percentage of area (1)	Average permeability of least permeable horizon (inches per hour) (2)	Result of (1)×(2)
Hastings . . .	45	0.40	0.18
Crete	45	.06	.03
Fillmore . . .	10	.13	.01
Weighted average for soil association			0.22

Soil Slope

The method for determining soil slope differed significantly from the methods for determining other characteristics. Because slope commonly is given in rather large ranges from minimum to maximum, an average value is of limited significance. No data exist that indicate the proportion of soils within certain slope ranges, nor the slope length or frequency. The slope that was derived for this study is a weighted average of the maximum slopes of the individual soil series. As indicated previously, the rationale for the use of average maximum slope is based on the premise that the greater slopes dictate the rate of surface runoff. The resultant average maximum slopes are considered relative values rather than absolute ones.

The calculation of the average maximum slope for a given soil association is relatively simple. Using the Coly-Holder-Uly association as an example, it is as follows:

Soil series	Percentage of area (1)	Slope range (percent)	Maximum slope (percent) (2)	Result of (1)×(2)
Coly	45	6–30	30	13.50
Holder	33	3–11	11	3.63
Uly	22	6–15	15	3.30
Average maximum slope for the association				20.43

Depth to Seasonal High Water Table

The determination of the depth to seasonal high water table is relatively straightforward. The Soil Conservation Service (U.S. Department of Agriculture Soil Conservation Service, 1978) denotes whether the seasonal high water table beneath a given soil series is greater than or less than 6 feet. An element of subjectivity, however, exists because certain associations include soils having water tables that are both greater than and less than 6 feet. In this report, if depths to the seasonal high water table in any of the principal soils of an association were less than 6 feet, then the entire association was considered to have a shallow water table. The grouping according to depth to water results in a dichotomous method that indicates only whether the water table present is high or low.

Computed values for the five hydrologic characteristics of the 147 soil associations within Nebraska are given in table 1. The soil-group classification and soil-group code will be discussed in the subsequent section. The soil-series data used in computing values for the soil associations are given in table 3, Supplemental Information.

GROUPING AND MAPPING OF SOILS BY HYDROLOGIC CHARACTERISTICS

The soil associations in table 1 were assigned to a lesser number of groups on the basis of the three characteristics indicated earlier. The grouping method used involved five permeability, five slope, and two depth-to-water classes that could produce a potential of 50 hydrologic groups. The limits of each class for each of the three characteristics and their code number are listed in table 2.

Each soil association was assigned a three-digit soil-group code, which is shown in table 1. As an example of the interpretation of the code, a soil association with a classification of 222 has an average permeability of the 60-inch soil profile of 1.0 to 2.0 inches per hour, an average maximum soil slope from 3 to 10 percent, and a depth to water that is greater than 6 feet (see table 2).

A computer program was developed using the sorting routine of the Statistical Analysis System (SAS)[1] (Barr and others, 1976). The hydrologic limits for each of the 50 potential groups were indicated in the program, which then sorted the soil associations into their respective groups and computed the group means, standard deviations, and ranges. The use of a computer to sort and classify a limited number of soil associations (147) and classification variables (3) is not an absolute necessity, but it allows rapid and accurate sorting and computation of statistics. Obviously, the greater the number of soils, the more classification variables included, or the more complex the statistical analysis, the greater the need for computer assistance. The source program (SAS access), partial data input, and the programming statements for the sorting and statistical procedures are shown in the Supplemental Information.

The resultant sorting procedure produced only 31 of the potential 50 groups. Two groups consisted of only one soil association each, so these were reassigned to other groups with only slight differences, in order to minimize the number of mapping units. Other minor readjustments and shifts of soil associations to different hydrologic groups were made as a result of suggestions by James R. Culver, State Soil Scientist of the U.S. Soil Conservation Service, in order to group soils that (1) possessed unique characteristics, such as shallow soil development (less than 60 inches) over bedrock or extremely slow permeabilities, or (2) to reduce the complexity of mapping units. None of these readjustments were significant compromises to the objectivity of the classification method. The ultimate classification resulted in 29 hydrologic soil groups.

These 29 hydrologic soil groups are the basic soil interpretive units presented in plates 1–12. The generalized 1:750,000 scale Nebraska map (pl. 1) is color-keyed to the five permeability classes and grouped by the number code (last two digits) for slope and depth to water table. The 1:250,000 scale quadrangle maps of parts of Nebraska (pls. 2–12) present the same information as the 1:750,000 scale map, but less generalized.

The explanations accompanying plates 2–12 include a description of the soils in each mapped hydrologic soil group and the table of values for the five hydrologic characteristics. These values represent the simple averages for the soil associations composing each hydrologic soil group.

The mapping units and their hydrologic characteristics in this report need to be interpreted from the perspective that the resultant values represent average values of possibly quite diverse soil conditions. Soils form a continuum over the landscape. The boundary between soils, in some places, is quite distinct or abrupt, whereas in other places one soil may grade gradually into another. Even individual mapping units composed of soil series commonly contain quite dissimilar soils.

The initial mapping units that provide the basis for the hydrologic interpretation of the soils in this report are the soil associations, which are geographic units and are not classified according to similar physical properties. Thus, conditions within a small area of a mapping unit may possibly vary significantly from the average condition. This is certainly evident in respect to topographic conditions reflected by soil slope, which can range from zero to more than 60 percent within a short distance. Variations in permeability also can vary several magnitudes within a small area.

The reader needs to be aware of the interpretive limitations mentioned above that result from the generalized scope of this study. More detailed analysis of the hydrologic characteristics of the soil at specific sites within the State may require the use of county soil surveys with typical mapping scales of 1:20,000. Data for selected soil series in Nebraska (table 3) can aid in the hydrologic interpretation of these county soil surveys.

[1]The use of brand names in this report is for identification only and does not constitute endorsement by the U.S. Geological Survey.

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydrologic soil-group code
1	Albaton-Haynie	0.81	0.70	0.17	1	< 6	111
2	Altvan-Rosebud	1.20	.90	.14	11	> 6	232
3	Aowa-Alcester-Kennebec	1.21	1.21	.22	3	< 6	211
4	Bankard-Glenberg-Haverson	10.22	2.92	.10	3	< 6	511
5	Bazile-Paka-Thurman	6.55	1.62	.14	9	> 6	422
6	Belfore-Moody	.67	.65	.19	3	> 6	112
7	Blyburg-Blencoe-Luton	.99	.77	.19	2	< 6	111
8	Bridget-McCook-Duroc	1.54	1.30	.18	5	> 6	312
9	Bridget-Tripp-Cheyenne	2.72	1.18	.17	4	> 6	322
10	Bristow-Lynch	.16	.10	.10	29	> 6	142
11	Brunswick-Paka-Simeon	9.39	4.92	.13	26	> 6	452
12	Bufton-Orella-Norrest	.46	.25	.16	28	> 6	142
13	Busher-Sarben-Tassel	5.31	4.00	.15	30	> 6	452
14	Canyon-Alliance-Rosebud	1.64	.98	.17	17	> 6	232
15	Canyon-Bridget-rock outcrop	1.98	1.30	.18	37	> 6	352
16	Canyon-Rosebud-rock outcrop	1.83	.90	.17	36	> 6	352
17	Caruso-Silver Creek-Humbarger	1.82	.83	.18	1	< 6	211
18	Cass-Inavale	8.73	2.52	.11	3	> 6	412
19	Clarno-Nora-Betts	1.00	.70	.18	11	> 6	232
20	Colby-Canyon	1.75	1.31	.19	60	> 6	352
21	Colby-Ulysses	1.31	1.31	.20	47	> 6	252
22	Coly-Holder-Uly	1.31	1.31	.21	21	> 6	242
23	Coly-Uly	1.31	1.31	.22	51	> 6	252
24	Coly-Uly-Holdrege	1.30	1.30	.21	22	> 6	242
25	Cozad-Hord	1.30	1.30	.19	3	> 6	212
26	Creighton-Oglala-Canyon	1.30	1.30	.16	24	> 6	242
27	Crete-Hastings	.58	.22	.19	7	> 6	112
28	Crete-Mayberry	.40	.13	.16	7	> 6	122
29	Crofton-Alcester-Nora	1.30	1.30	.22	25	> 6	242
30	Dix-Altvan	12.70	4.12	.09	22	> 6	542
31	Dundy-Pivot-Dunn	11.28	6.47	.10	5	> 6	522
32	Els-Valentine-Ipage	13.00	13.00	.07	12	< 6	521
33	Elsmere-Dailey	12.71	8.05	.07	4	< 6	521
34	Elsmere-Ipage-Loup	12.65	6.35	.09	2	< 6	511
35	Gayville-Silver Creek	1.83	.09	.17	2	< 6	211
36	Geary-Holdrege-Kipson	1.26	1.22	.20	14	> 6	232
37	Geary-Jansen-Meadin	7.60	1.21	.14	15	> 6	432
38	Gibbon-Luton	1.42	.67	.18	1	< 6	211
39	Gibbon-Wann	2.94	1.20	.19	2	< 6	311
40	Glenberg-Bankard-Yockey	6.56	3.46	0.11	2	> 6	412
41	Gothenburg-Platte	17.60	2.70	.05	3	< 6	511
42	Hastings	.81	.40	.20	9	> 6	112
43	Hastings-Crete-Fillmore	.64	.25	.19	4	> 6	112
44	Hastings-Fillmore	.80	.36	.20	5	> 6	112
45	Hastings-Geary	.99	.72	.20	12	> 6	132
46	Hastings-Holder	.99	.73	.21	7	> 6	112
47	Haverson-Tripp-Glenberg	2.32	1.53	.15	2	> 6	312
48	Hersh-Valentine	5.80	5.80	.13	8	> 6	422
49	Hobbs-Hord	1.48	1.30	.20	2	> 6	312
50	Hobbs-Hord-Cozad	1.58	1.30	.20	2	> 6	312
51	Holder	1.30	1.30	.21	9	> 6	222
52	Holder-Coly-Geary	1.29	1.27	.20	17	> 6	232
53	Holdrege	1.30	1.30	.20	4	> 6	222
54	Holdrege-Coly-Nuckolls	1.30	1.30	.21	18	> 6	232
55	Holdrege-Coly-Uly	1.30	1.30	.20	15	> 6	232

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings—Continued

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydro-logic soil-group code
56	Holdrege-Hall	1.18	1.03	0.20	2	> 6	212
57	Holt-Manter	6.29	3.58	.13	15	> 6	432
58	Hord	1.30	1.30	.21	3	> 6	212
59	Hord-Anselmo-Dunday	3.40	2.59	.17	5	> 6	322
60	Hord-Hall	1.13	.90	.21	3	> 6	212
61	Ida-Monona	1.30	1.20	.21	46	< 6	252
62	Inavale-Boel-Barney	12.71	6.03	.07	2	< 6	511
63	Janise-Minatare	1.20	.23	.15	2	< 6	111
64	Jansen-Meadin	14.12	1.31	.10	18	> 6	532
65	Jansen-O'Neill	12.80	1.31	.10	5	> 6	522
66	Jayem-Haxtun-Rosebud	3.26	2.56	.14	5	> 6	322
67	Jayem-Keith	2.92	2.92	.16	6	> 6	322
68	Jayem-Sarben-Valent	6.00	4.40	.12	8	> 6	422
69	Kadoka-Keith-Mitchell	1.30	1.30	.21	12	> 6	232
70	Keith-Alliance-Rosebud	1.23	1.04	.19	5	> 6	222
71	Kenesaw-Hersh	2.03	2.03	.19	11	> 6	332
72	Kennebec-Nodaway-Zook	1.11	1.05	.20	1	< 6	211
73	Kipson-Benfield	.82	.74	.19	23	> 6	142
74	Kuma-Keith-Goshen	1.31	1.31	.19	2	> 6	212
75	Kyle-Buffington	.26	.17	.12	4	> 6	122
76	Labu-Sansarc	.13	.13	.10	35	> 6	152
77	Lancaster-Hedville	1.30	1.30	.17	20	> 6	142
78	Las-Las Animas-McCook	8.10	.90	.13	2	< 6	411
79	Lawet-Elsmere-Gannett	7.24	2.67	.13	2	< 6	411
80	Lawet-Wann-Lex	4.28	1.18	.16	2	< 6	311
81	Loup-Elsmere-Dunday	11.84	2.79	.10	3	< 6	511
82	Luton-Forney	.21	.06	.13	1	< 6	111
83	Marshall-Ponca	1.31	1.31	.20	13	> 6	232
84	McCook-Munjor-Inavale	5.47	2.64	.16	2	> 6	412
85	Minnequa-Penrose	1.46	1.18	.17	31	> 6	152
86	Mitchell-Epping	1.30	1.30	.20	19	> 6	232
87	Mitchell-Otero	4.45	4.45	.17	15	> 6	332
88	Monona-Ida	1.30	1.30	.21	27	> 6	242
89	Moody-Bazile-Trent	2.76	.96	.17	5	> 6	322
90	Moody-Nora-Judson	1.25	1.22	.20	10	> 6	222
91	Moody-Fillmore	1.13	1.00	.19	6	> 6	212
92	Moody-Thurman	5.15	2.12	.15	11	> 6	432
93	Morrill-Burchard	.77	.40	.16	17	> 6	132
94	Nora-Crofton-Moody	1.28	1.26	.20	18	> 6	232
95	Nora-Crofton-Judson	1.30	1.30	.21	18	> 6	232
96	Nora-Moody-Judson	1.27	1.25	.19	12	> 6	232
97	Nuckolls-Holdrege-Campus	1.30	1.30	.19	15	> 6	232
98	Oglala-Duroc-Creighton	1.30	1.30	.18	9	> 6	222
99	Oglala-Jayem	2.52	2.52	.18	11	> 6	332
100	O'Neill-Blendon-Hord	8.26	1.30	.14	4	> 6	422
101	O'Neill-Dunday-Meadin	13.03	2.17	.09	9	> 6	522
102	O'Neill-Meadin-Jansen	14.65	1.30	.09	14	> 6	532
103	Onita-Reliance-Ree	.83	.61	.18	5	> 6	122
104	Otero-Bridget-Mitchell	7.62	7.62	.14	10	> 6	422
105	Pawnee-Wymore-Burchard	.27	.17	.13	11	> 6	122
106	Pierre-Samsil-Kyle	.08	.08	.08	32	> 6	152
107	Platte-Leshara-Alda	9.92	.99	.14	2	< 6	411
108	Redstoe-Gavins-Loretto	1.70	1.70	.17	21	> 6	242
109	Rosebud-Alliance	1.08	.68	.17	5	> 6	222
110	Rosebud-Alliance-Kuma	1.13	.84	.17	4	> 6	222

Table 1. Hydrologic characteristics of soil associations and their assigned soil groupings—Continued

	Soil associations	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)	Hydrologic soil-group code
111	Rosebud-Alliance-Canyon	1.12	.79	.17	11	> 6	232
112	Sarpy-Onawa-Haynie	3.63	.43	.15	3	< 6	311
113	Sharpsburg	.62	.40	.20	17	> 6	132
114	Sharpsburg-Fillmore	.64	.34	.19	5	> 6	112
115	Sharpsburg-Pawnee-Burchard	.48	.33	.16	10	> 6	132
116	Simeon-Meadin	14.68	8.32	.06	30	> 6	542
117	Simeon-Meadin-Betts	12.04	6.39	.08	31	> 6	542
118	Steinauer-Pawnee-Burchard	.61	.31	.14	26	> 6	142
119	Tassel-Mariaville-Ronson	6.58	3.08	.16	47	> 6	452
120	Tassel-Busher-rock outcrop	8.20	4.00	.14	40	> 6	452
121	Tassel-Busher	8.20	4.00	.15	36	> 6	452
122	Thurman-Boelus-Nora	8.58	2.86	.14	13	> 6	432
123	Thurman-Hadar-Ortello	10.51	2.56	.10	10	> 6	532
124	Tripp-Alice	2.38	1.90	.17	4	> 6	322
125	Tripp-Keith-Alliance	1.30	1.26	.19	4	> 6	222
126	Uly-Coly-Holdrege	1.30	1.30	.21	18	> 6	232
127	Uly-Holdrege-Coly	1.30	1.30	.21	13	> 6	232
128	Ulysses-Keith-Colby	1.30	1.30	.21	12	> 6	232
129	Valent	11.13	6.00	.06	45	> 6	552
130	Valent-Dailey	11.60	7.75	.06	25	> 6	542
131	Valent-Sarben-Otero	9.95	7.15	.11	19	> 6	542
132	Valent-Tassel	11.10	6.00	.09	36	> 6	542
133	Valentine	13.00	13.00	.07	45	> 6	552
134	Valentine-hilly and rolling	13.00	13.00	.07	60	> 6	552
135	Valentine-Dunday	12.38	11.47	.08	26	> 6	542
136	Valentine-Els	13.00	13.00	.07	23	< 6	541
137	Valentine-Elsmere-Gannett	12.33	9.75	.08	30	< 6	541
138	Valentine-Hersh	10.12	10.12	.10	13	> 6	532
139	Valentine-Simeon	13.00	13.00	.06	27	> 6	542
140	Valentine-Tassel	12.53	10.93	.09	25	> 6	542
141	Valentine-Thurman	12.88	10.75	.08	14	> 6	532
142	Wewela-Valentine-Anselmo	5.17	4.93	.12	13	> 6	432
143	Wood River	.95	.13	.19	2	> 6	112
144	Wymore-Pawnee	.24	.13	.14	10	> 6	122
145	Zook-Leshara-Wann	1.73	.53	.16	2	< 6	211
146	Valentine-Els-Wildhorse	13.00	13.00	.07	20	< 6	541
147	Wildhorse-Els-Hoffland	12.70	10.75	.06	3	< 6	511

CONCLUSIONS

A quantitative evaluation of the soil's hydrologic characteristics depicted in this report should be adaptable to the requirements of various types of streamflow or runoff models and in the simulations of ground-water systems. The ability of the soil to transmit water (permeability), its storage capabilities (available water capacity), runoff potential (soil slope, permeability, and available water capacity), and effect on evaporation (depth to the seasonal high water table) account for the principal hydrologic responses of the soil. Therefore, data for the soils presented herein reflect almost all the measurable hydrologic responses of the land surface.

The emphasis in this report on the hydrologic characteristics of the soil, particularly for numerical modeling purposes, need not preclude other applications of the data. The grouping system used in this report, based on the hydrologic characteristics of the soil, can provide information for other spatial interpretations such as may be needed to determine the soil's irrigation potential and responses, erosional potential, and soil-vegetation relationships in a system compatible with the Soil Conservation Service classification. Specific applications of the data in numerical modeling and these other purposes are beyond the scope of this report but should be apparent to those requiring such information.

The techniques used in generating and analyzing the

Table 2. Number code for hydrologic grouping of the soil associations

Average permeability of 60-inch soil profile		Average maximum soil slope		Depth to seasonal high water table	
Code number	Range (inches per hour)	Code number	Range (percent)	Code number	(Feet)
1	Less than 1.0	1	0–3	1	Less than 6
2	1.0 to 2.0	2	3–10	2	Greater than 6
3	2.0 to 5.0	3	10–20		
4	5.0 to 10.0	4	20–30		
5	Greater than 10.0	5	Greater than 30		

hydrologic characteristics of the soils in Nebraska are applicable in other areas where adequate data and soil maps are available. These procedures need not be confined to the same mapping scales nor necessarily to the same characteristics. They can be applied readily to studies requiring greater detail, the use of large mapping scales, or lower levels of soil classification. Furthermore, the number of hydrologic characteristics can be decreased or increased with varying ranges to accommodate required detail.

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SUPPLEMENTAL INFORMATION

Information in this section is provided for those who may wish to apply the methods and data in this report for their own areas. Data in the table on soil series should be useful in that they represent characteristics observable and mapped in the field. As such, they are data that can provide the degree of detail needed for interpreting the hydrologic characteristics of the soil in more specific areas.

The description of the computer program should be useful as a model for sorting soils into logical groupings. Probably, however, modifications will need to be made in the ranges of values for the various characteristics so that they will apply appropriately to the specific area being studied.

Computer Program for Sorting Soils into Hydrologic Groups and Calculating Statistics

This section provides the computer program used to sort the soil associations into hydrologic soil groups and to compute the group statistics. The Statistical Analysis System (SAS) (Barr and others, 1976) serves as the source program for the procedures performed. The program consists of the following elements:

Table 3. Hydrologic characteristics of selected soil series

Table 3.--Hydrologic characteristics of selected soil series

Soil series	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
Albaton	0.40	0.20	0.13	0-02	< 6
Alcester	1.30	1.30	.20	2-60	> 6
Alda	12.10	1.30	.10	0-02	< 6
Alice	4.90	3.30	.14	0-06	> 6
Alliance	1.30	1.10	.18	0-12	> 6
Altvan [1]	1.30	1.30	.20	0-15	> 6
Anselmo	4.00	4.00	.16	0-20	> 6
Aowa	1.10	1.10	.20	0-02	> 6
Bankard	12.80	4.00	.07	0-06	> 6
Barney	13.00	13.00	.06	0-03	< 6
Bazile	7.40	.40	.12	0-11	> 6
Belfore	.40	.40	.19	0-04	> 6
Benfield [1]	.30	.13	.20	5-25	> 6
Betts	.85	.40	.18	2-40	> 6
Blencoe	.80	.06	.18	0-02	< 6
Blendon	7.15	1.30	.13	0-06	> 6
Blyburg	1.30	1.30	.20	0-06	> 6
Boel	12.47	3.30	.09	0-30	< 6
Boelus	5.01	1.30	.18	0-11	> 6
Bridget	1.30	1.30	.19	0-20	> 6
Bristow [1]	.13	.13	.09	6-40	> 6
Brunswick [1]	11.90	3.30	.14	11-30	> 6
Buffington	.70	.40	.17	0-06	> 6
Bufton	.33	.33	.19	0-20	> 6
Burchard	.58	.40	.16	2-17	> 6
Busher [1]	4.00	4.00	.16	1-30	> 6
Campus	1.30	1.30	.17	1-10	> 6
Canyon [1]	1.30	1.30	.17	2-50	> 6
Caruso	1.20	1.10	.19	0-02	< 6
Cass	5.81	1.30	.15	0-02	> 6
Cheyenne	12.20	.40	.09	0-03	> 6
Clarno	.85	.40	.18	0-15	> 6
Colby	1.30	1.30	.20	0-30	> 6
Coly	1.30	1.30	.21	3-30	> 6
Cozad	1.84	1.30	.18	0-30	> 6
Creighton	1.30	1.30	.16	0-20	> 6
Crete	.47	.13	.18	0-11	> 6
Crofton	1.30	1.30	0.22	2-60	> 6
Dailey	13.00	13.00	.06	0-12	> 6
Dix	15.17	6.00	.07	0-30	> 6
Dunday	9.37	4.00	.10	0-11	> 6
Dunn	6.24	.33	.13	0-03	< 6
Duroc	1.30	1.30	.17	0-06	> 6
Els	13.00	13.00	.07	0-03	< 6
Elsmere	12.47	4.00	.08	0-02	< 6
Epping	1.30	1.30	.20	0-03	> 6
Fillmore	.73	.06	.18	0-01	< 6
Forney	.06	.06	.12	0-01	< 6
Gannett	9.28	3.30	.10	0-02	< 6
Gavins	1.30	1.30	.17	9-40	> 6
Gayville	.88	.06	.16	0-01	> 6
Geary	1.20	1.10	.19	0-15	> 6
Gibbon	2.23	1.10	.20	0-02	< 6
Glenberg	4.90	4.00	.10	0-03	> 6
Goshen	1.30	1.30	.20	0-03	> 6
Gothenburg	18.58	3.30	.04	0-02	< 6
Hadar	5.44	.40	.13	0-12	> 6
Hall	.91	.40	.20	0-06	> 6
Hastings	.81	.40	.20	0-11	> 6
Haverson	1.57	1.30	.16	0-03	> 6
Haxton	3.41	1.30	.15	0-10	> 6
Haynie	1.30	1.30	.22	0-05	> 6
Hedville [1]	1.30	1.30	.15	3-30	> 6
Hersh	4.00	4.00	.15	0-30	> 6
Hobbs	1.62	1.30	.20	0-06	> 6
Hoffland	11.80	4.00	.10	0-02	< 6
Holder	1.30	1.30	.21	0-11	> 6
Holdrege	1.30	1.30	.20	0-11	> 6
Holt	3.30	3.30	.14	0-15	> 6
Hord	1.30	1.30	.21	0-06	> 6
Humbarger	1.30	1.30	.18	0-06	> 6
Ida	1.30	1.30	.21	2-40	> 6
Inavale	12.73	4.00	.07	0-11	> 6
Ipage	13.00	13.00	.08	0-03	< 6
Janise	1.30	1.30	0.19	0-02	< 6
Jansen	11.60	1.30	.10	0-30	> 6

[1]Soil profile less than 60 inches, usually occurring over bedrock.

Table 3.--Hydrologic characteristics of selected soil series--Continued

Soil series	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
Jayem	4.00	4.00	.14	0-10	> 6
Judson	1.30	1.30	.22	0-09	> 6
Kadoka	1.30	1.30	.20	0-15	> 6
Keith	1.30	1.30	.21	0-18	> 6
Kenesaw	1.30	1.30	.21	0-11	> 6
Kennebec	1.30	1.30	.22	0-05	< 6
Kipson [1]	1.30	1.30	.18	1-25	> 6
Kuma	1.30	1.30	.18	0-03	> 6
Kyle	.06	.06	.10	0-09	> 6
Labu [1]	.13	.13	.11	2-30	> 6
Lancaster [1]	1.30	1.30	.17	1-12	> 6
Las	8.24	.40	.13	0-01	< 6
Las Animas	10.30	1.30	.10	0-03	< 6
Lawet	1.34	1.10	.19	0-02	< 6
Leshara	1.75	.40	.20	0-02	< 6
Lex	13.60	1.30	.09	0-02	< 6
Loretto	3.30	3.30	.19	0-12	> 6
Loup	12.46	1.30	.10	0-02	< 6
Luton	.32	.06	.14	0-01	< 6
Lynch [1]	.20	.06	.12	2-30	> 6
Manter	10.77	4.00	.12	0-30	> 6
Mariaville	1.30	1.30	.20	3-40	> 6
Marshall	1.30	1.30	.20	0-20	> 6
Mayberry	.20	.13	.12	2-10	> 6
McCook	1.98	1.30	.19	0-02	> 6
Meadin	17.19	1.30	.08	0-35	> 6
Minatare	.95	.06	.10	0-02	< 6
Minnequa	1.30	1.10	.17	2-10	> 6
Mitchell	1.30	1.30	.20	0-20	> 6
Monona	1.30	1.30	.22	0-30	> 6
Moody	1.18	1.10	.19	0-17	> 6
Morrill	.84	.40	.16	2-18	> 6
Munjor	6.40	4.00	.13	0-02	> 6
Nodaway	1.30	1.30	.21	0-03	< 6
Nora	1.30	1.30	.19	0-30	> 6
Norrest	.57	.40	.15	0-40	> 6
Nuckolls	1.30	1.30	0.20	3-30	> 6
Oglala	1.30	1.30	.18	0-30	> 6
Onawa	2.42	.13	.19	0-02	< 6
O'Neill	14.27	1.30	.09	0-09	> 6
Onita	.58	.40	.18	0-06	> 6
Orella	.56	.06	.10	1-25	> 6
Ortello	11.28	1.30	.11	0-30	> 6
Otero	13.00	13.00	.10	0-15	> 6
Paka	1.30	1.30	.20	0-40	> 6
Pawnee	.16	.13	.12	0-11	> 6
Penrose	1.30	1.30	.16	2,40	> 6
Pierre	.06	.06	.10	0-25	> 6
Pivot	16.60	13.00	.06	0-06	> 6
Platte	15.30	1.30	.07	0-02	< 6
Ponca	1.30	1.30	.19	6-30	> 6
Redstoe	1.30	1.30	.16	2-25	> 6
Ree	1.30	1.30	.17	0-15	> 6
Reliance	.82	.40	.17	0-15	> 6
Rosebud [1]	.93	.40	.16	0-20	> 6
Ronson	4.00	4.00	.13	0-30	> 6
Samsil	.13	.13	.10	2-45	> 6
Sansarc	.13	.13	.10	2-40	> 6
Sarben	5.63	4.00	.15	1-30	> 6
Sarpy	5.70	.13	.07	0-09	> 6
Sharpsburg	.62	.40	.20	0-18	> 6
Silver Creek	2.99	.13	.17	0-02	< 6
Simeon	13.00	13.00	.05	0-30	> 6
Steinauer	1.00	.40	.15	6-40	> 6
Tassel [1]	11.00	4.00	.14	3-45	> 6
Thurman	12.53	4.00	.09	0-30	> 6
Trent	1.30	1.30	.19	0-02	> 6
Tripp	1.30	1.30	.19	0-09	> 6
Uly	1.30	1.30	.22	0-30	> 6
Ulysess	1.30	1.30	.20	0-15	> 6
Valent	11.13	6.00	.06	0-50	> 6
Valentine	13.00	13.00	.07	0-60	> 6
Wann	3.81	1.30	0.17	1-20	> 6
Wewela	.61	.06	.13	0-09	> 6
Wildhorse	13.00	13.00	.05	0-02	< 6
Wood River	.95	.13	.19	0-03	> 6
Wymore	.28	.13	.16	0-11	> 6
Yockey	1.30	1.30	.18	0-02	< 6
Zook	.43	.13	.14	0-02	< 6

1. The initial two statements provide access to the available SAS programs.

2. The next three statements pertain to a description of the input information, the data-set name, input format, and type of input (cards). The input format contains the variable names and column position:

SOILNUM 1–3 —soil-association number
SOILNAME 4–19—soil-association name
PERM 20–25—average permeability of the soil profile, in inches per hour
LPH 26–31—permeability of the least permeable horizon
WHC 32–35—average available water capacity of the soil profile, in inches per inch
SLOPE 36–38—soil slope or gradient as a percentage
DTW 39–41—minimum depth to the permanent water table, in feet

3. Following the term "cards" is a partial listing of the input data for the 145 soil associations as described under the input format.

4. Beginning with the term "Title" and concluding with the "/*" are the programming statements for sorting the soil associations into hydrologic soil groups and calculating the statistics.

5. Following the "/*" is a sample of the output in condensed form showing soil associations in a hydrologic soil group, together with selected statistics.

For a more comprehensive understanding of the programming requirements, refer to the SAS program manual (Barr and others, 1976).

INPUT:

```
// EXEC SAS,REGION=448K,TIME.SAS=10
//SYSIN DD *
DATA SOIL;
INPUT SOILNUM 1-3 SOILNAME $ 4-19 PERM 20-25 LPH 26-31 WHC 32-35
      SLOPE 36-38
DTW 39-41;
CARDS;
  1  ALBATON-HAYNIE    .61    .70 .17  1   4
  2  ALTVAN-ROSEBUD   1.20    .90 .14 11   6
  3AOWA-ALCEST-KENN   1.21   1.21 .22  3   5
  4BANK-LAS-GLENBRG  10.22   2.92 .10  3   5
  5BAZILE-PAKA-THUR   6.55   1.62 .14  9   6
  6   BELFORE-MOODY    .67    .65 .19  4   6
  7BLYP-BLENC-LUTON    .99    .77 .19  2   4
  8BRIDG-MCCOK-DURC   1.44   1.30 .18  5   6
  9BRIDG-TRIP-CHEYN   2.72   1.18 .17  4   6
 10   BRISTOW-LYNCH    .16    .10 .10 29   6
      ϟ          ϟ          ϟ
118 STENER-PAW-BURC    .61    .31 .14 26   6
119 TASL-MARVIL-RON   6.58   3.08 .16 47   6
120 TASSEL-ROCKOUTC  11.00   4.00 .14 50   6
121 TASL-VALT-BUSHP   9.43   4.66 .12 35   6
122 THUR-BOLUS-NORA   8.58   2.86 .14 13   6
123 THUR-HADAR-ORTL  10.51   2.56 .10 10   6
124     TRIPP-ALICE   2.38   1.90 .17  4   6
125 TRIP-ALLC-ROSEB   1.21   1.02 .16  4   6
126 ULY-COLY-HOLDRG   1.30   1.30 .21 18   6
127 ULY-HOLDRG-COLY   1.30   1.30 .21 13   6
128 ULYS-KETH-COLBY   1.30   1.30 .21 12   6
129          VALENT  11.13   6.00 .06 45   6
130 VALENT-JAY-DALY   9.45   6.71 .08 19   6
131  VALENT-OTP-BRW  11.67   7.01 .09 21   6
132 VALENT---TASSEL  11.10   6.00 .09 36   6
133       VALENTINE  13.00  13.00 .07 45   6
134 VALENTINE-HILLY  13.00  13.00 .07 60   6
135 VALENTNE-DUNDAY  12.38  11.47 .08 26   6
136  VALENTINE--ELS  13.00  13.00 .07 23   5
137 VALTNE-ELSM-GAN  12.33   9.75 .08 30   3
138 VALENTINE-HERSH  10.12  10.12 .10 13   6
139 VALENTINE-SIMEN  13.00  13.00 .06 27   6
140 VALENTINE-TASEL  12.53  10.93 .09 25   6
141 VALNTNE-THURMAN  12.88  10.75 .08 14   6
142 WEWELA-VAL-ANSM   5.17   4.93 .12 13   6
143      WOOD RIVER    .86    .13 .19  2   6
144 WYMORE---PAWNEE    .24    .13 .14 10   6
145 ZOOK-LESHR-WANN   1.73    .52 .16  2   5
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/*
```

SAMPLE OUTPUT:

S532 11:51 THURSDAY, JUNE 18, 1981 56

OBS	SOILNUM	SOILNAME	PERM	LPH	WHC	SLOPE	DTW
1	64	JANSEN-MEADIN	14.12	1.31	0.10	18	6
2	102	ONEIL-MEAD-JANS	14.65	1.30	0.09	14	6
3	123	THUR-HADAR-ORTL	10.51	2.56	0.10	10	6
4	138	VALENTINE-HERSH	10.12	10.12	0.10	13	6
5	141	VALNTNE-THURMAN	12.88	10.75	0.08	14	6

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PERM	5	12.45600000	2.06192386	10.12000000	14.65000000	0.92212038	62.28000000	4.2515300	16.554
LPH	5	5.20800000	4.80417215	1.30000000	10.75000000	2.14849110	26.04000000	23.0800700	92.246
WHC	5	0.09400000	0.00894427	0.08000000	0.10000000	0.00400000	0.47000000	0.0000800	9.515
SLOPE	5	13.80000000	2.86356421	10.00000000	18.00000000	1.28062485	69.00000000	8.2000000	20.750
DTW	5	6.00000000	0.00000000	6.00000000	6.00000000	0.00000000	30.00000000	0.0000000	0.000

☆U.S. GOVERNMENT PRINTING OFFICE:1984—576-049 / 001

SCALE 1:750 000

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 KILOMETERS

Map based on "General Soil Maps of Nebraska", U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978-82).
Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978)

GENERALIZED HYDROLOGIC SOIL GROUPS IN NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

122 Clays to silty clays with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally formed on glacial till in the southeastern areas of the State and are characterized by very slow permeabilities. The Crete-Mayberry and Pawnee-Wymore-Burchard are representative associations.

142 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) very gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are most commonly formed in weathered shale and usually exhibit shallow soil development. They occur predominantly in the uplands of extreme northern and southeastern Nebraska and are represented by the Bufton-Orella-Norrest and Kipson-Benfield associations.

152 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are generally formed in weathered shale and are relatively shallow. They occur predominantly in extreme northwestern areas of the State and are represented by Labu-Sansarc and Pierre-Samsil-Kyle associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

352 Silt loams to sandstone with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Panhandle and southwest parts of the State in highly eroded uplands. They exhibit very shallow soil development on a sandstone surface and are represented by the Canyon-Bridget-rock outcrop and Canyon-Rosebud-rock outcrop associations.

411 Loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are along flood plains and are represented by the Las-Las Animas-McCook and Lawet-Elsmere-Gannet associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

452 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These are principally shallow residual soils formed in sandstone on highly eroded uplands in the northern Panhandle of the State and are represented by the Busher-Sarben-Tassel and Tassel-Busher associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

522 Loams to sands and gravels with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur in the uplands and are represented by the Jansen-O'Neill and O'Neill-Dunday-Meadin associations.

541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
122	.31	.17	.14	8	>6
142	.67	.54	.15	25	>6
152	.56	.46	.12	33	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
312	1.73	1.36	.18	3	>6
322	2.91	2.02	.16	3	>6
332	3.29	2.93	.18	12	>6
352	1.85	1.17	.18	44	>6
411	8.42	1.52	.13	2	<6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
452	7.54	4.00	.15	36	>6
511	12.90	3.99	.09	3	<6
522	12.37	3.32	.10	6	>6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6

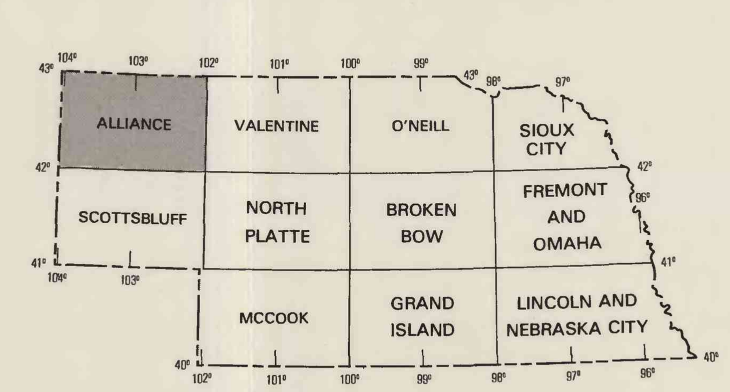
Map based on "General Soil Map of Alliance area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

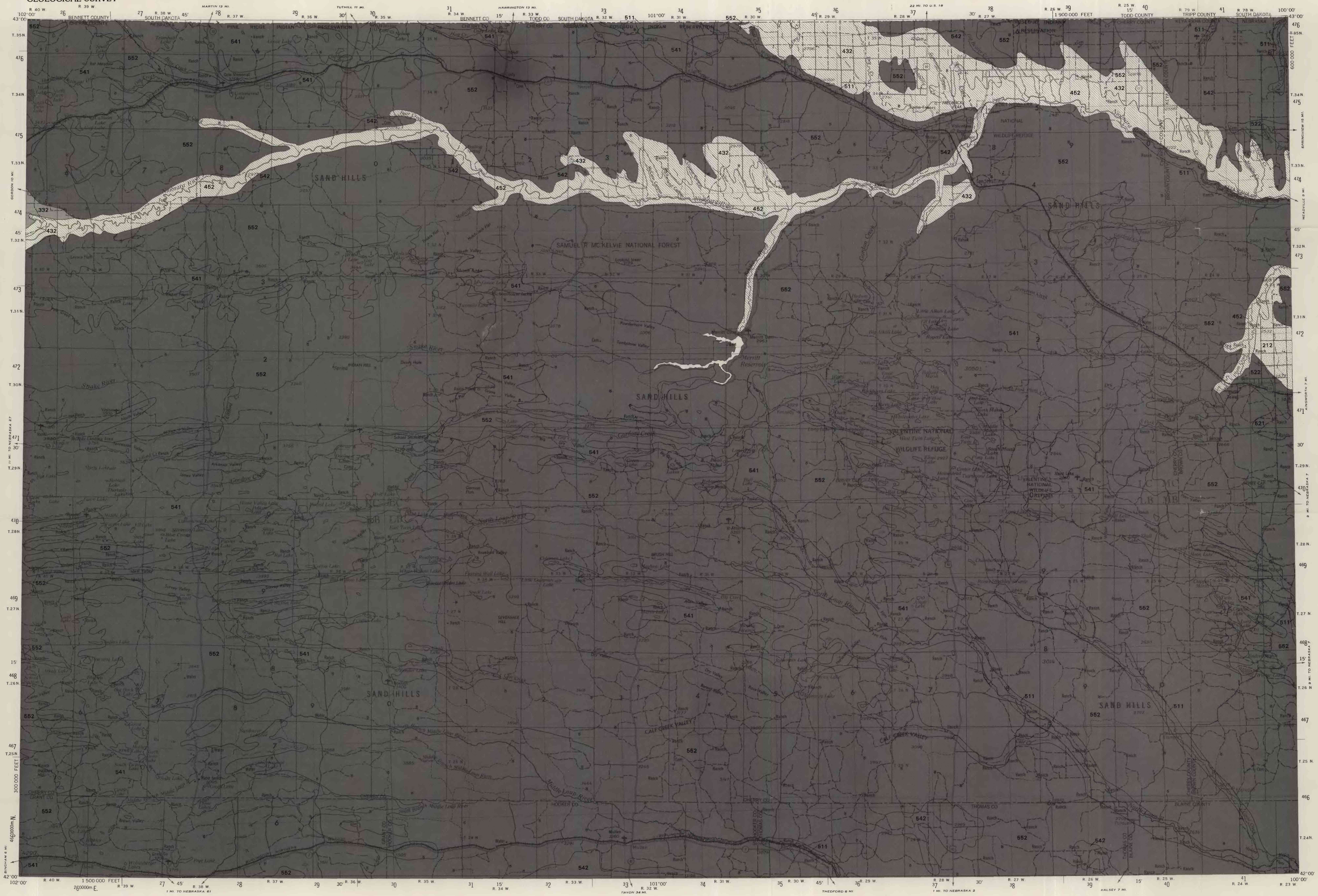
5 0 5 10 15 20 25 KILOMETERS

1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 12° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 10½° EASTERLY FOR THE CENTER OF THE EAST SIDE



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE ALLIANCE QUADRANGLE, NEBRASKA



DESCRIPTIONS OF THE SOIL GROUPS

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

452 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These are principally shallow residual soils formed in sandstone on highly eroded uplands in the northern Panhandle of the State and are represented by the Busher-Sarben-Tassel and Tassel-Busher associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

522 Loams to sands and gravels with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur in the uplands and are represented by the Jansen-O'Neill and O'Neill-Dunday-Meadin associations.

541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

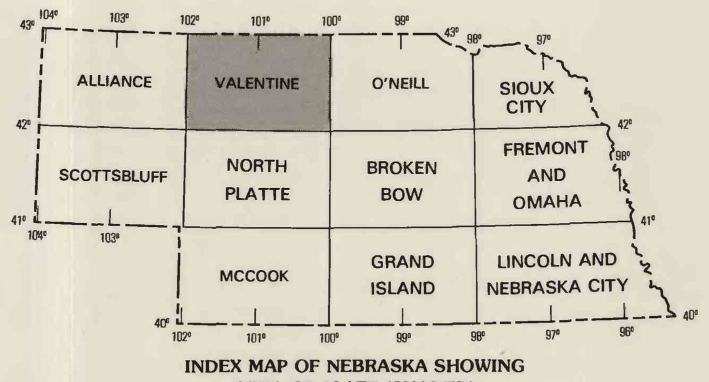
Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
212	1.23	1.14	.20	3	>6
332	3.29	2.93	.18	12	>6
432	6.56	2.94	.14	13	>6
452	7.54	4.00	.15	36	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
522	12.37	3.32	.10	6	>6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6

Map based on "General Soil Map of Valentine area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).

SCALE 1:250 000

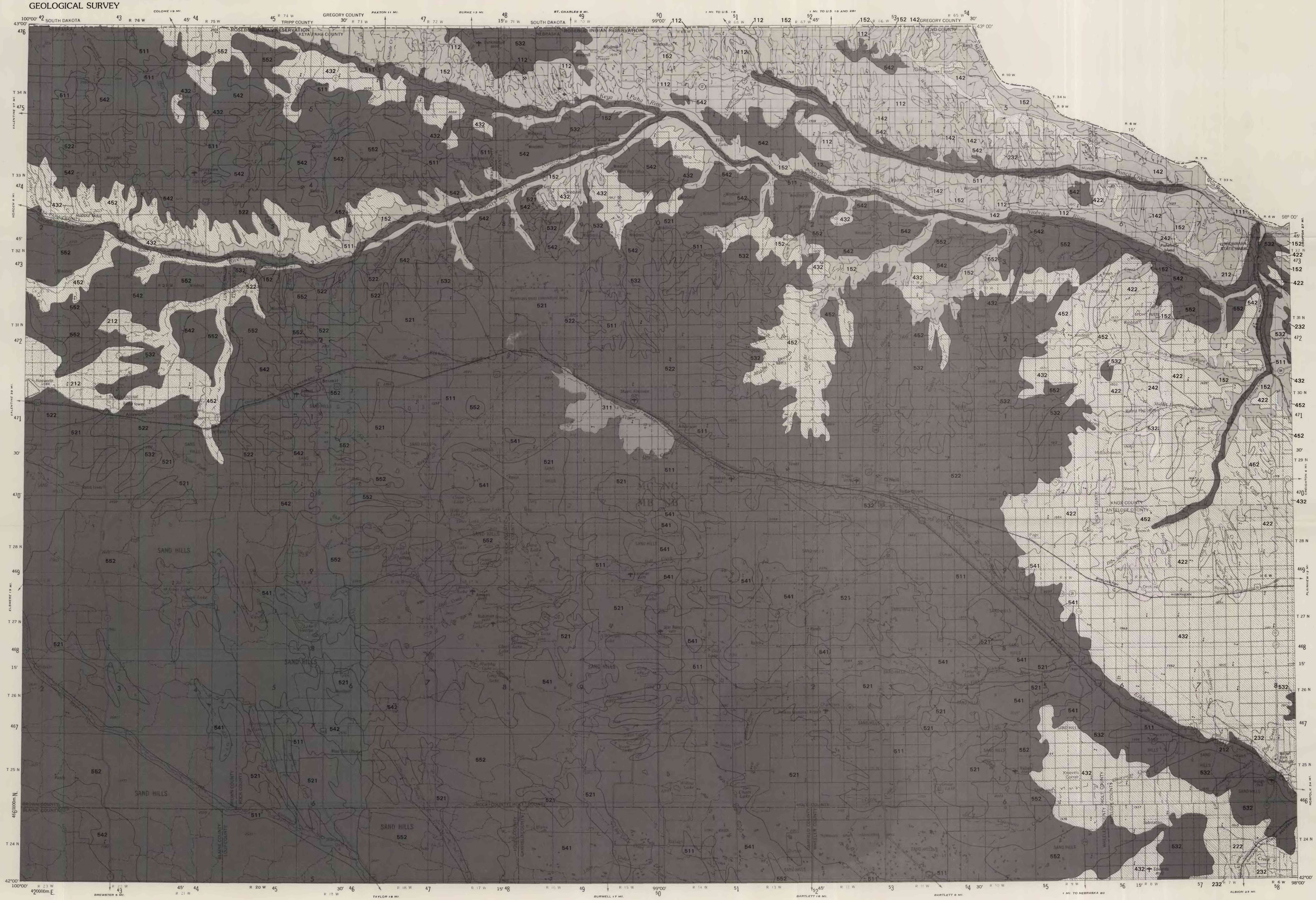
5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE VALENTINE QUADRANGLE, NEBRASKA

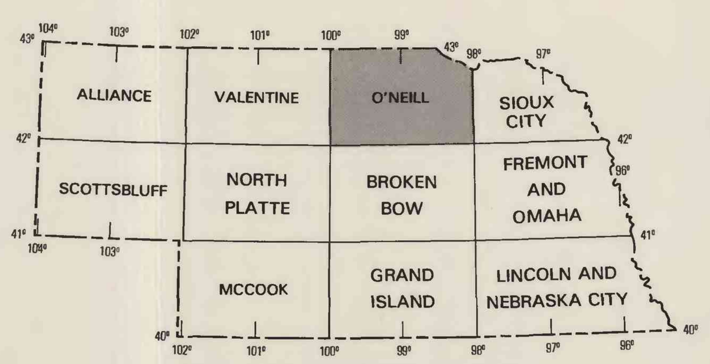


SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 9° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 7½° EASTERLY FOR THE CENTER OF THE EAST SIDE



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE O'NEILL QUADRANGLE, NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

112 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of the uplands and high terraces of the central and east-central areas of the State and are represented by the Belfore-Moody and Crete-Hastings associations.

142 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) very gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are most commonly formed in weathered shale and usually exhibit shallow soil development. They occur predominantly in the uplands of extreme northern and southeastern Nebraska and are represented by the Bufton-Orella-Norrest and Kipson-Benfield associations.

152 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are generally formed in weathered shale and are relatively shallow. They occur predominantly in extreme northwestern areas of the State and are represented by Labu-Sansarc and Pierre-Samsil-Kyle associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

452 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These are principally shallow residual soils formed in sandstone on highly eroded uplands in the northern Panhandle of the State and are represented by the Busher-Sarben-Tassel and Tassel-Busher associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

522 Loams to sands and gravels with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur in the uplands and are represented by the Jansen-O'Neill and O'Neill-Dunday-Meadin associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
112	.76	.41	.19	5	>6
142	.67	.54	.15	25	>6
.52	.56	.46	.12	33	>6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
311	3.61	.93	.16	2	<6
422	6.85	4.15	.13	8	>6
432	6.56	2.94	.14	13	>6
452	7.54	4.00	.15	36	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
522	12.37	3.32	.10	6	>6
532	12.46	5.21	.09	14	>6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6

Map based on "General Soil Map of O'Neill area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
152	.56	.46	.12	33	>6
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
312	1.73	1.36	.18	3	>6
322	2.91	2.02	.16	3	>6
411	8.42	1.52	.13	2	<6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
432	6.56	2.94	.14	13	>6
452	7.54	4.00	.15	36	>6
511	12.90	3.99	.09	3	<6
532	12.46	5.21	.09	14	>6
542	12.20	7.57	.08	27	>6

Map based on "General Soil Map of Sioux City area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

152 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are generally formed in weathered shale and are relatively shallow. They occur predominantly in extreme northwestern areas of the State and are represented by Labu-Sansarc and Pierre-Samsil-Kyle associations.

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshara-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

411 Loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are along flood plains and are represented by the Las-Las Animas-McCook and Lawet-Elsmere-Gannet associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

452 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These are principally shallow residual soils formed in sandstone on highly eroded uplands in the northern Panhandle of the State and are represented by the Busher-Sarben-Tassel and Tassel-Busher associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

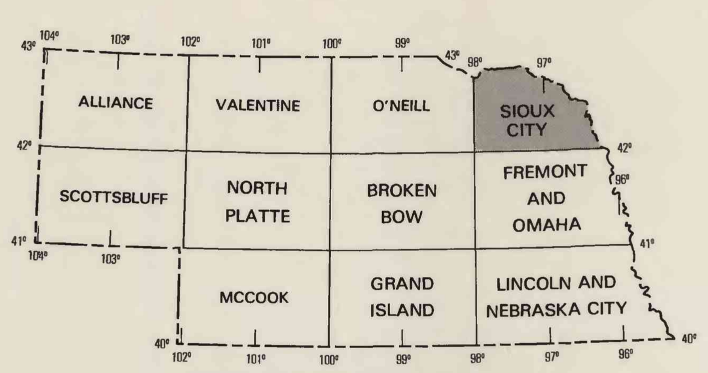
552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

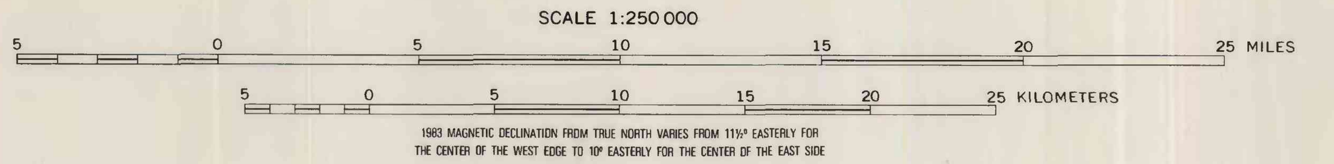
5 0 5 10 15 20 25 KILOMETERS

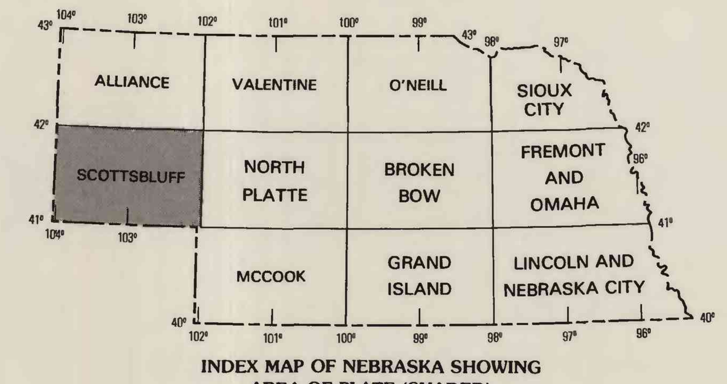
1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 7½° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 6½° EASTERLY FOR THE CENTER OF THE EAST SIDE



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE SIOUX CITY QUADRANGLE, NEBRASKA





INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

352 Silt loams to sandstone with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Panhandle and southwest parts of the State in highly eroded uplands. They exhibit very shallow soil development on a sandstone surface and are represented by the Canyon-Bridget-rock outcrop and Canyon-Rosebud-rock outcrop associations.

411 Loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are along flood plains and are represented by the Las-Las Animas-McCook and Lawet-Elsmere-Gannet associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

452 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These are principally shallow residual soils formed in sandstone on highly eroded uplands in the northern Panhandle of the State and are represented by the Busher-Sarben-Tassel and Tassel-Busher associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

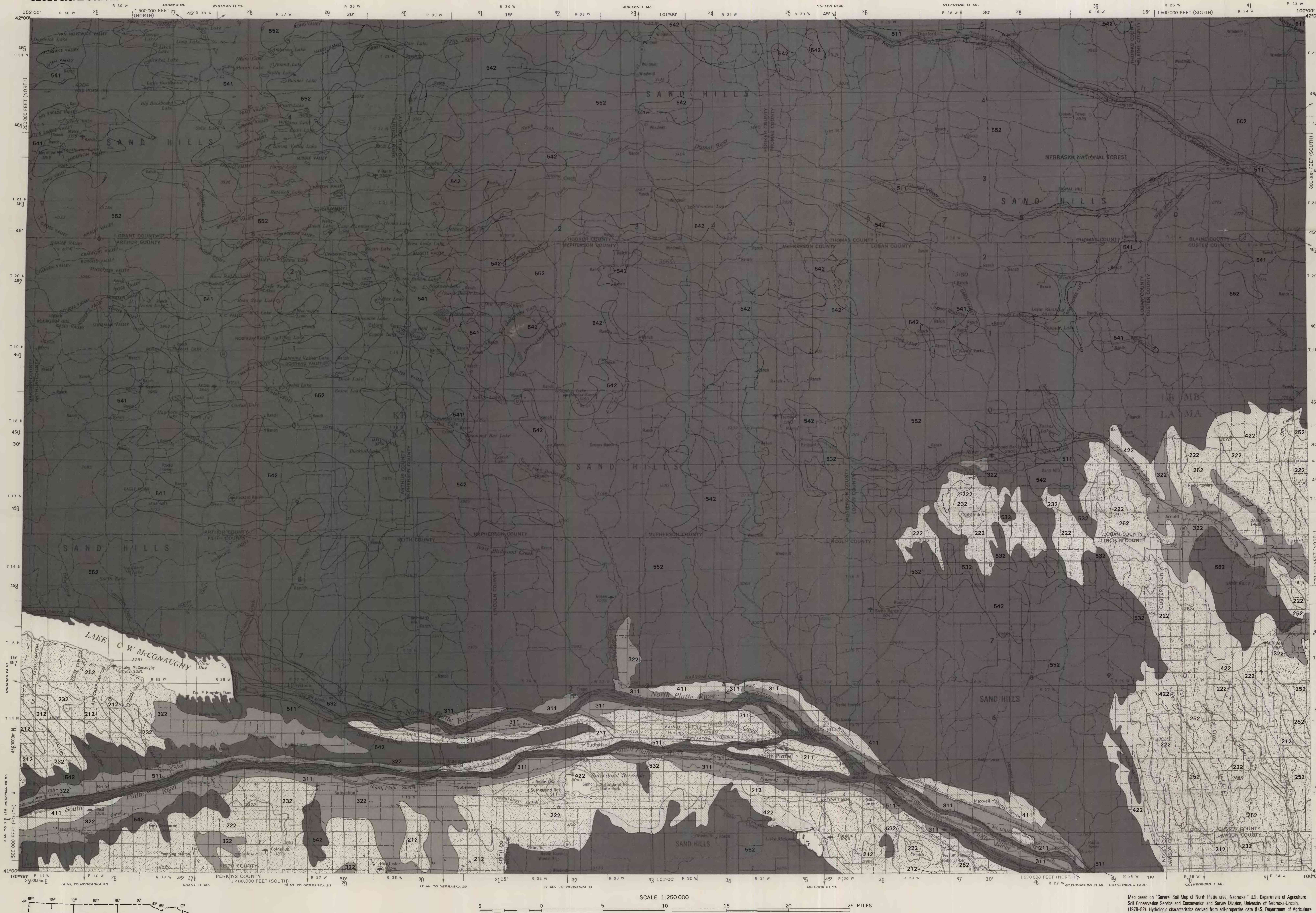
552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

Map based on "General Soil Map of Scottsbluff area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
322	2.91	2.02	.16	3	>6
332	3.29	2.93	.18	12	>6
352	1.85	1.17	.18	44	>6
411	8.42	1.52	.13	2	<6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
452	7.54	4.00	.15	36	>6
511	12.90	3.99	.09	3	<6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6

HYDROLOGIC SOIL GROUPS IN THE SCOTTSBLUFF QUADRANGLE, NEBRASKA



DESCRIPTIONS OF THE SOIL GROUPS

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshara-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

411 Loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are along flood plains and are represented by the Las-Las Animas-McCook and Lawet-Elsmere-Gannet associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

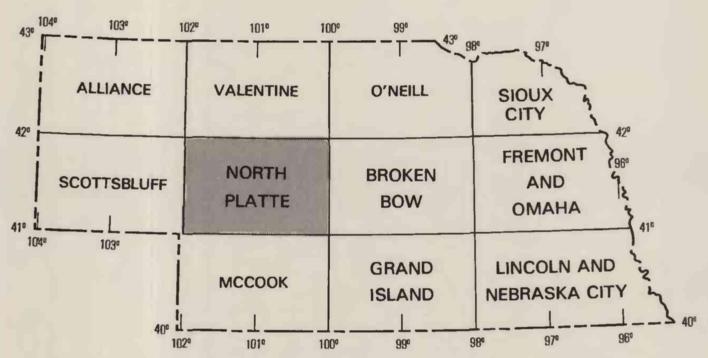
542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

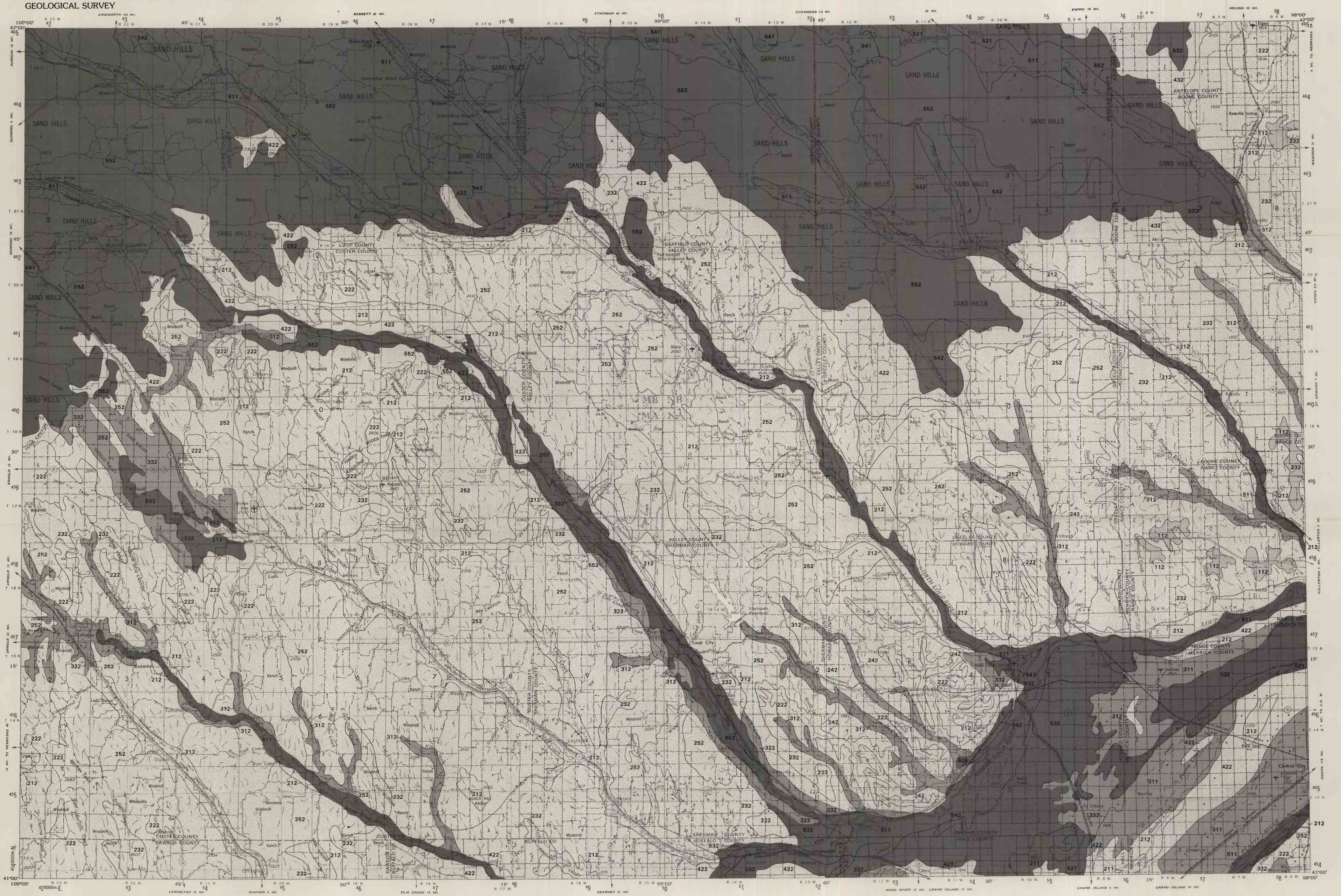
Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
322	2.91	2.02	.16	3	>6
411	8.42	1.52	.13	2	<6
422	6.85	4.15	.13	8	>6
511	12.90	3.99	.09	3	<6
532	12.46	5.21	.09	14	>6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6

Map based on "General Soil Map of North Platte area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE NORTH PLATTE QUADRANGLE, NEBRASKA



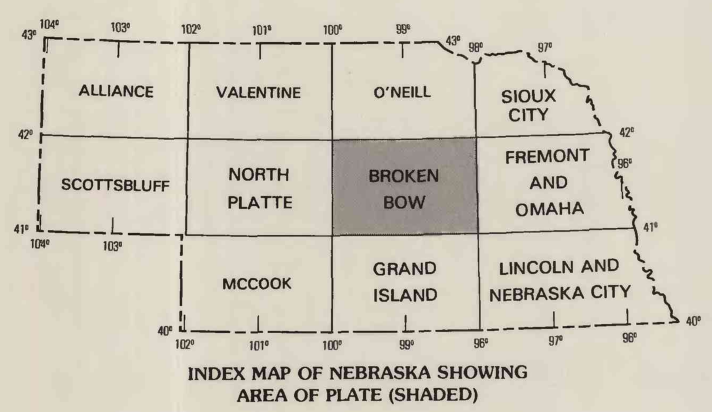
SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 9° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 7½° EASTERLY FOR THE CENTER OF THE EAST SIDE

Map based on "General Soil Map of Broken Bow area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE BROKEN BOW QUADRANGLE, NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

112 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of the uplands and high terraces of the central and east-central areas of the State and are represented by the Belfore-Moody and Crete-Hastings associations.

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshare-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic postion. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

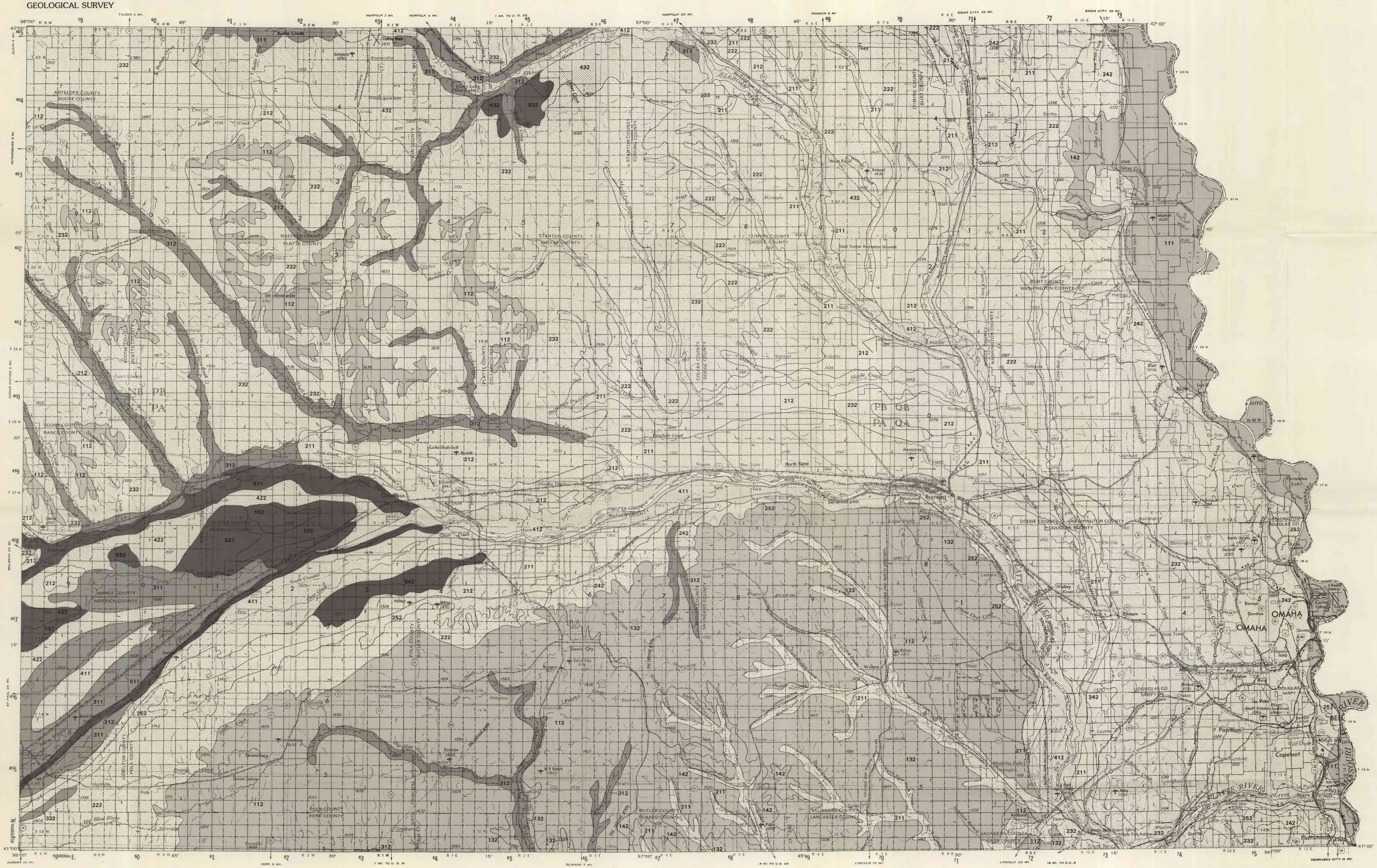
541 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) substantial areas having depths to seasonal high water table less than 6 feet. This hydrologic soil group is rather unique in that steeply sloping dunes alternate with subirrigated valleys with shallow water tables and seasonal ponding. The Valentine-Els and Valentine-Elsmere-Gannett associations represent these soils.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
112	.76	.41	.19	5	>6
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
312	1.73	1.36	.18	3	>6
322	2.91	2.02	.16	3	>6
332	3.29	2.93	.18	12	>6
422	6.85	4.15	.13	8	>6
432	6.56	2.94	.14	13	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
532	12.46	5.21	.09	14	>6
541	12.67	11.38	.08	27	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6



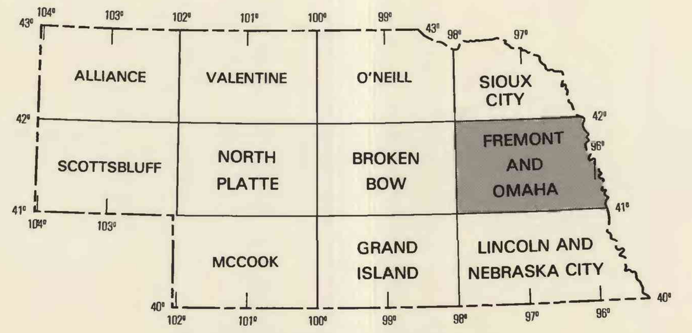
SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 7½° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 6° EASTERLY FOR THE CENTER OF THE EAST SIDE

Map based on "General Soil Map of Fremont and Omaha areas, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE FREMONT AND OMAHA QUADRANGLES, NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

112 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of the uplands and high terraces of the central and east-central areas of the State and are represented by the Belfore-Moody and Crete-Hastings associations.

132 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of uplands in the eastern areas of the State and are represented by the Hastings-Geary and Sharpsburg-Pawnee-Burchard associations.

142 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) very gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are most commonly formed in weathered shale and usually exhibit shallow soil development. They occur predominantly in the uplands of extreme northern and southeastern Nebraska and are represented by the Bufton-Orella-Norrest and Kipson-Benfield associations.

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshara-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

411 Loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are along flood plains and are represented by the Las-Las Animas-McCook and Lawet-Elsmere-Gannet associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
112	.76	.41	.19	5	>6
132	.72	.46	.18	14	>6
142	.67	.54	.15	25	>6
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
312	1.73	1.36	.18	3	>6
332	3.29	2.93	.18	12	>6
411	8.42	1.52	.13	2	<6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
432	6.56	2.94	.14	13	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
532	12.46	5.21	.09	14	>6
552	12.38	10.67	.07	50	>6

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER SUPPLY PAPER 2222
PLATE 10

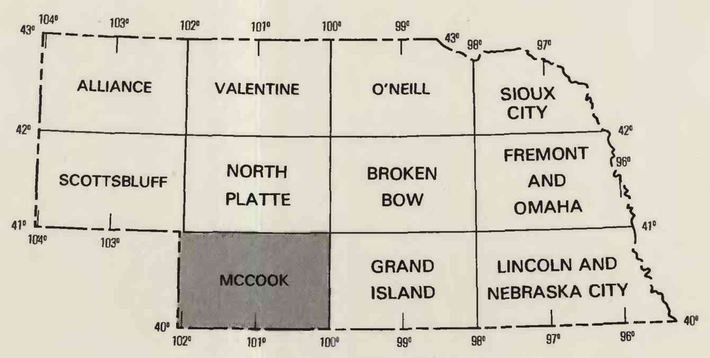
SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

1983 MAGNETIC DECLINATION FROM TRUE NORTH VARIES FROM 10° EASTERLY FOR THE CENTER OF THE WEST EDGE TO 9° EASTERLY FOR THE CENTER OF THE EAST SIDE

Map based on "General Soil Map of Mc Cook area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE MC COOK QUADRANGLE, NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

212 Silty clay loams to silt with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

322 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Moody-Bazile-Trent and Jayem-Haxton-Rosebud associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

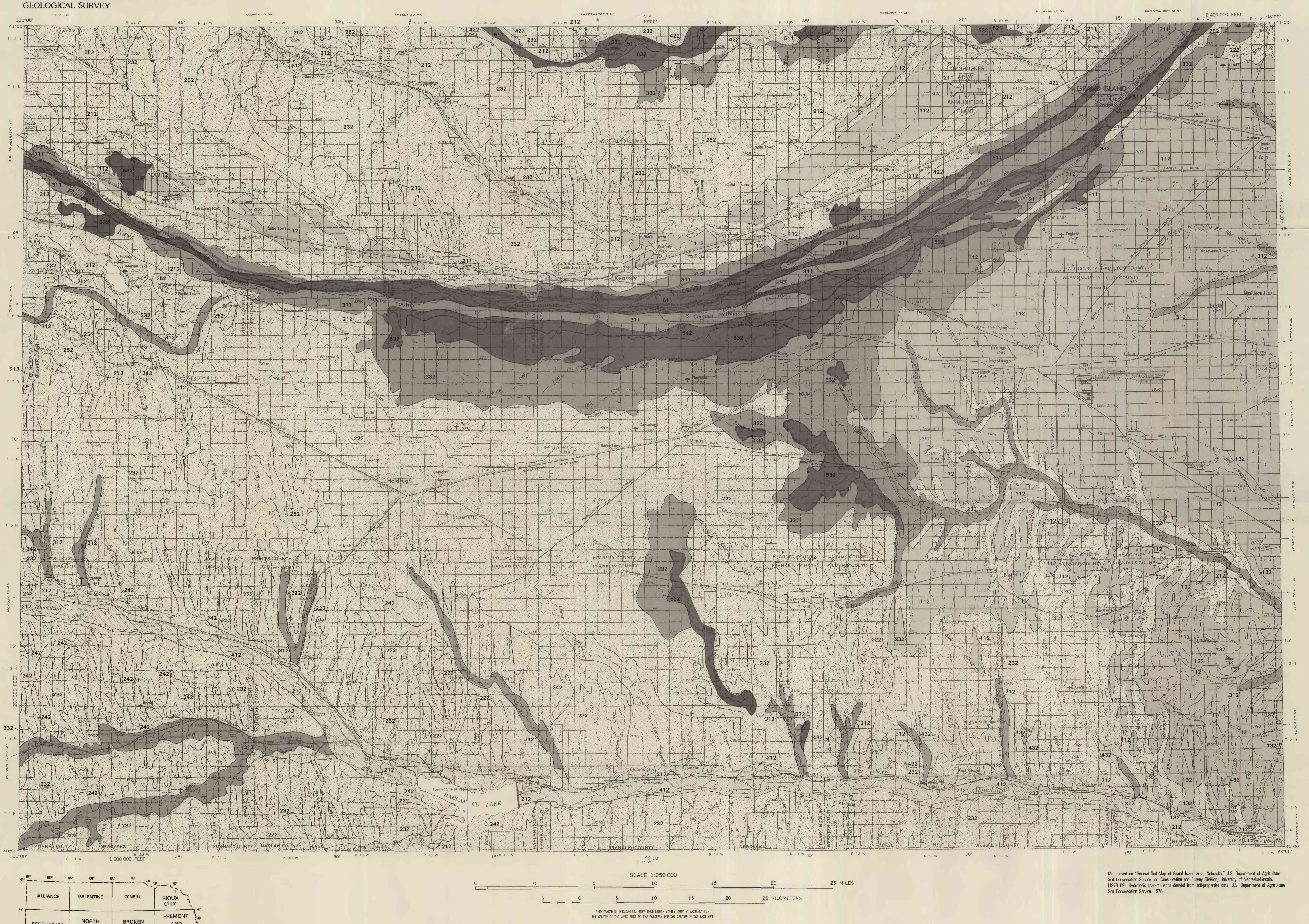
521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

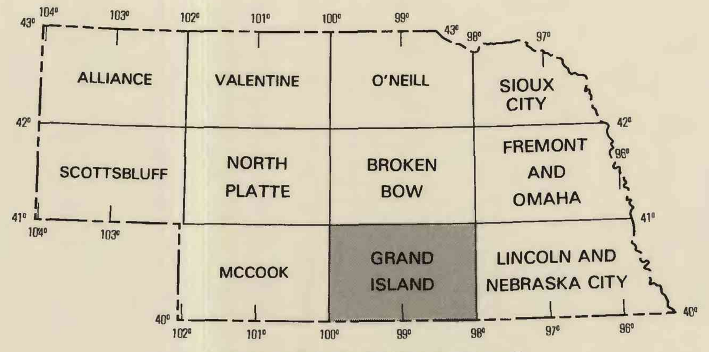
552 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) gentle to very steep slopes (maximum slopes exceeding 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are the most prevalent upland soils of the Sand Hills and are represented by the Valentine and Valentine, hilly and rolling associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
312	1.73	1.36	.18	3	>6
322	2.91	2.02	.16	3	>6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
542	12.20	7.57	.08	27	>6
552	12.38	10.67	.07	50	>6



Map based on "General Soil Map of Grand Island area, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978–82). Hydrologic characteristics derived from soil-properties data (U.S. Department of Agriculture Soil Conservation Service, 1978).



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE GRAND ISLAND QUADRANGLE, NEBRASKA

DESCRIPTIONS OF THE SOIL GROUPS

112 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of the uplands and high terraces of the central and east-central areas of the State and are represented by the Belfore-Moody and Crete-Hastings associations.

132 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of uplands in the eastern areas of the State and are represented by the Hastings-Geary and Sharpsburg-Pawnee-Burchard associations.

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshara-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

311 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are present in the Platte and Missouri River flood plains and are represented by the Gibbon-Wann and Lawet-Wann-Lex associations.

312 Silt loams to fine sandy loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

332 Silt loams to fine sandy loams with (a) permeabilities from 2.0 to 5.0 inches per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in transitional areas between the sandhills and silty uplands and are represented by the Kenesaw-Hersh and Oglala-Jayem associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

422 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 10 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands, terraces, and footslopes in transitional areas between sandy and silty soils and are represented by the Bazile-Paka-Thurman and Jayem-Sarben-Valent associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Thurman-Boelus-Nora and Moody-Thurman associations.

511 Fine sandy loams to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils are on flood plains and in Sand Hills valleys and are represented by the Gothenburg-Platte and Loup-Elsmere-Dunday associations.

521 Loamy fine sands to fine sands with (a) permeabilities exceeding 10 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) shallow water tables with depths to seasonal high water table less than 6 feet. These soils occupy extensive subirrigated valleys within the Sand Hills region and are represented by the Els-Valentine-Ipage and Elsmere-Dailey associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

542 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to very steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally found in the Sand Hills uplands and are represented by the Valentine-Tassel and Valentine-Simeon associations.

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
112	.76	.41	.19	5	>6
132	.72	.46	.18	14	>6
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
311	3.61	.93	.16	2	<6
312	1.73	1.36	.18	3	>6
332	3.29	2.93	.18	12	>6
412	7.52	3.05	.12	2	>6
422	6.85	4.15	.13	8	>6
432	6.56	2.94	.14	13	>6
511	12.90	3.99	.09	3	<6
521	12.86	10.53	.07	8	<6
532	12.46	5.21	.09	14	>6
542	12.20	7.57	.08	27	>6

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER SUPPLY PAPER 2222
PLATE 12

SCALE 1:250 000

HYDROLOGIC CHARACTERISTICS OF THE SOIL GROUPS

Soil group	Average permeability of 60-inch soil profile (inches per hour)	Average permeability of least permeable horizon (inches per hour)	Average available water capacity (inches per inch)	Average maximum soil slope (percent)	Depth to seasonal high water table (feet)
111	0.80	0.44	.16	2	<6
112	.76	.41	.19	5	>6
122	.31	.17	.14	8	>6
132	.72	.46	.18	14	>6
142	.67	.54	.15	25	>6
211	1.52	.73	.19	2	<6
212	1.23	1.14	.20	3	>6
222	1.23	1.09	.20	5	>6
232	1.28	1.21	.19	15	>6
242	1.37	1.31	.20	23	>6
252	1.31	1.27	.21	48	>6
312	1.73	1.36	.18	3	>6
412	7.52	3.05	.12	2	>6
432	6.56	2.94	.14	13	>6
532	12.46	5.21	.09	14	>6

DESCRIPTIONS OF THE SOIL GROUPS

111 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils are predominantly on larger flood plains and are represented by the Albaton-Haynie and Luton-Forney associations.

112 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of the uplands and high terraces of the central and east-central areas of the State and are represented by the Belfore-Moody and Crete-Hastings associations.

122 Clays to silty clays with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are principally formed on glacial till in the southeastern areas of the State and are characterized by very slow permeabilities. The Crete-Mayberry and Pawnee-Wymore-Burchard are representative associations.

132 Clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) nearly level to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are characteristic of uplands in the eastern areas of the State and are represented by the Hastings-Geary and Sharpsburg-Pawnee-Burchard associations.

142 Silty clays to silty clay loams with (a) permeabilities less than 1.0 inch per hour, (b) very gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are most commonly formed in weathered shale and usually exhibit shallow soil development. They occur predominantly in the uplands of extreme northern and sourtheastern Nebraska and are represented by the Bufton-Orella-Norrest and Kipson-Benfield associations.

211 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table less than 6 feet. These soils occur on low terraces and flood plains and are represented by the Zook-Leshara-Wann and Kennebec-Nodaway-Zook associations.

212 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are present on well-drained terraces and uplands in the central part of the State and are represented by the Hord-Hall and Holdrege-Hall associations.

222 Silty clay loams to silt loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) nearly level to strong slopes (maximum slopes 3 to 10 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed throughout the State and are represented by the Holdrege and Keith-Alliance-Rosebud associations.

232 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) very gentle to moderately steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed and significant within the State and are represented by the Holdrege-Coly-Uly and Ulysses-Keith-Colby associations.

242 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to steep slopes (maximum slopes 20 to 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are widely distributed within the State and are represented by the Coly-Uly-Holdrege and Monona-Ida associations.

252 Silty clay loams to loams with (a) permeabilities from 1.0 to 2.0 inches per hour, (b) gentle to very steep slopes (maximum slopes that exceed 30 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are common in central and southwestern portions of the State and are represented by the Colby-Ulysses and Coly-Uly associations.

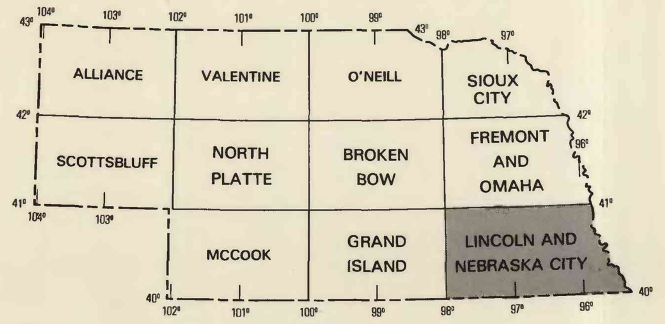
312 Silt loams to fine silty loams with (a) permeabilities from 1.5 to 5.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 2 to 5 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are found in many parts of the State on well-drained bottomlands and terraces and differ from those in group 212 because of slightly higher permeabilities and lower topographic position. The Haverson-Tripp-Glenberg and Hobbs-Hord-Cozad are representative associations.

412 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to very gentle slopes (maximum slopes 1 to 3 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are on flood plains, differing from the 411 soils only in the depths to water table, and are represented by the Cass-Inavale and Glenberg-Bankard-Yockey associations.

432 Fine sandy loams to fine sands with (a) permeabilities from 5.0 to 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils occur on uplands and high terraces in transitional areas between sandy and silty soils and are represented by the Nora and Moody-Thurman associations.

532 Loamy fine sands to fine sands with (a) permeabilities exceeding 10.0 inches per hour, (b) nearly level to steep slopes (maximum slopes 10 to 20 percent), and (c) depths to seasonal high water table exceeding 6 feet. These soils are represented by the Jansen-Meadin and Valentine-Hersh associations.

Map based on "General Soil Map of Lincoln and Nebraska City areas, Nebraska," U.S. Department of Agriculture Soil Conservation Service and Conservation and Survey Division, University of Nebraska-Lincoln, (1978-82). Hydrologic characteristics derived from soil-properties data U.S. Department of Agriculture Soil Conservation Service, 1978.



INDEX MAP OF NEBRASKA SHOWING AREA OF PLATE (SHADED)

HYDROLOGIC SOIL GROUPS IN THE LINCOLN AND NEBRASKA CITY QUADRANGLES, NEBRASKA