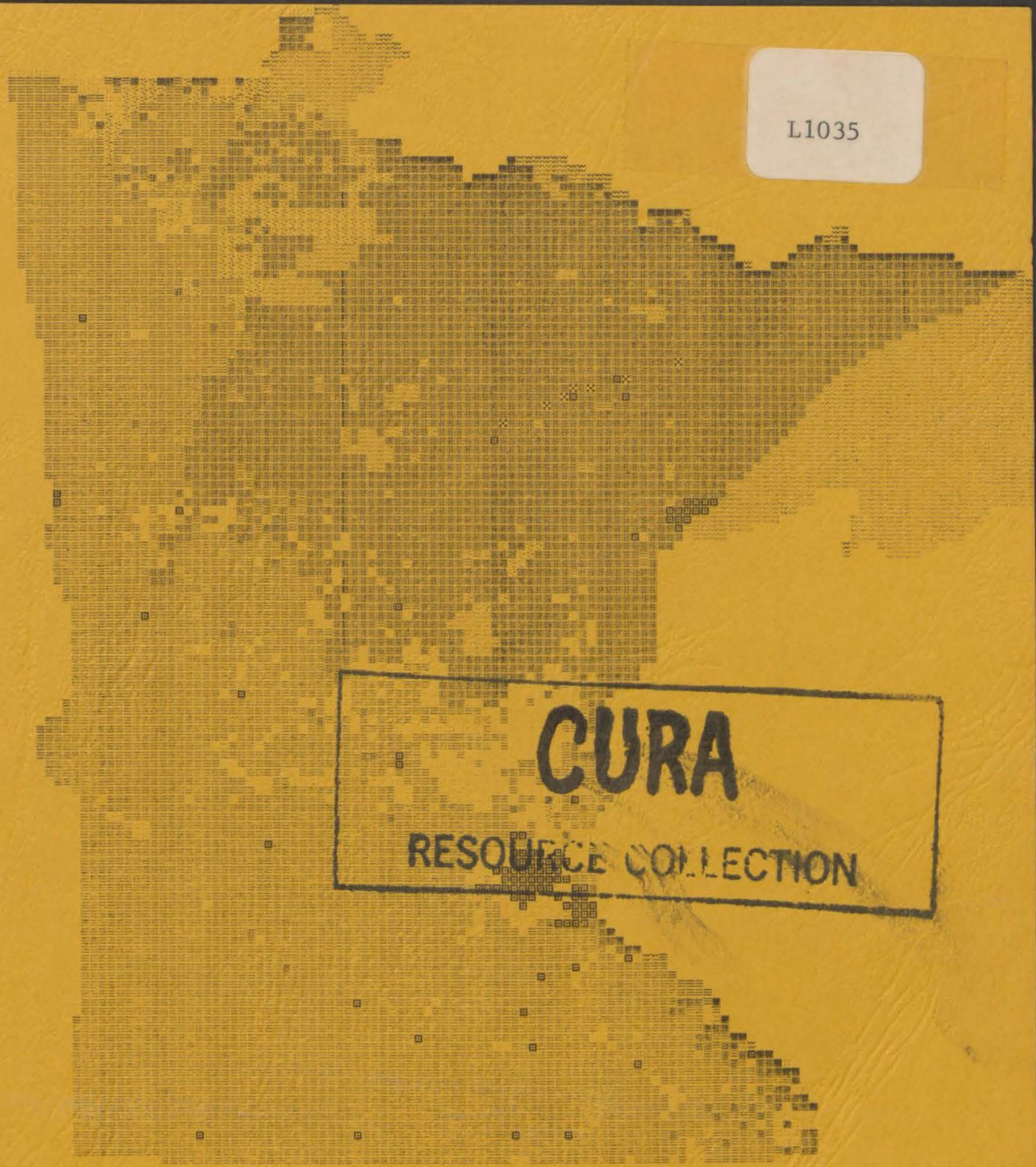

MLMIS

MINNESOTA LAND MANAGEMENT INFORMATION SYSTEM

Soils Information and Interpretive Procedures - 4004. Publ. by U of M: CURA's MLMIS office and the State Planning Agency by Jeffrey Anderson. January, 1976.

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MINNESOTA LAND MANAGEMENT INFORMATION SYSTEM (MLMIS) (CURA)

Soils Information and Interpretive Procedures - 4004. Publ. by U of M: CURA's MLMIS office and the State Planning Agency by Jeffrey Anderson. January 1976.

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UNIVERSITY OF MINNESOTA
CENTER FOR URBAN AND
REGIONAL AFFAIRS

STATE PLANNING AGENCY

SOILS INFORMATION AND INTERPRETIVE PROCEDURES

4004

JEFFREY ANDERSON JANUARY, 1976

THE MINNESOTA LAND MANAGEMENT INFORMATION SYSTEM STUDY

The Minnesota Land Management Information System project is an endeavor of the Center for Urban and Regional Affairs (CURA) of the University of Minnesota and the State Planning Agency. Important contributions to the project have been made by other executive and legislative branches of state government, numerous University departments, and other institutions.

The primary goal of this project is to improve the quality of public-private sector land use decisions. The project is doing this by building a data bank containing information on physical resources, relative accessibility to market of these resources, and information on current land use, zoning, and ownership patterns.

Concurrent with the data collection effort is a research program that is using the collected data to simulate land use decisions and conflicts.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The soil interpretive ratings discussed in this report culminate the work of an informal committee convened from December, 1973 through June, 1974. The members of the committee were:

Jeffrey Anderson	Minnesota Land Management Information System
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Lowell Hanson	Department of Soil Science, University of Minnesota
Les Maki	Minnesota State Planning Agency
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George Orning	Minnesota Land Management Information System
Richard Rust	Department of Soil Science, University of Minnesota
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Much of the information contained in this report is from unpublished documents prepared by: Edwin Bruns, Lowell Hanson, Richard Rust, and Jack Shea.

My special thanks to Dennis Asmussen for thoughtful assistance in the editing of this report and to Corinne Glader for her diligence in typing the manuscript.

INTRODUCTION

Soils information is one of the most significant physical elements in the computer files of the Minnesota Land Management Information System (MLMIS). This data is currently being used for pilot land use suitability studies in the Itasca County and Arrowhead Region land use studies. Soil interpretations are needed to predict the types of problems which are likely to occur when land is used for specific purposes, such as crop and forest production, outdoor recreation, and residential development.

This report attempts to answer the most fundamental questions about taxonomy and interpretation for the soils information currently being employed by MLMIS. Of course, these soil classification systems and interpretative methods change as new information about soils and refinements in interpretation accrue.

MINNESOTA'S TWO SOIL SURVEYS

The MLMIS has collected soil information from two principal sources. They are the Minnesota Soil Atlas and the Arrowhead Region soil survey. The Minnesota Soil Atlas is an effort of the Department of Soil Science of the University of Minnesota. The present coverage of the Minnesota Soil Atlas is complete for parts of north central Minnesota with additions to coverage underway. The Arrowhead Region soil survey was conducted by the U.S. Soil Conservation Survey under contract with the Arrowhead Regional Development Commission. Although the scale of the survey is smaller (1:62,000) than the county surveys more commonly prepared by the S.C.S. (1:15,000 - 20,000), the methods used and series identified are the same. Since each of these programs has used a unique approach to mapping Minnesota soils, this report will treat each separately and then follow with a discussion of their common features and interpretive techniques.

Minnesota Soil Atlas

The Minnesota Soil Atlas is a cooperative project conducted by the Department of Soil Science, University of Minnesota, and the U.S. Soil Conservation Service (S.C.S.). The Atlas provides basic soil information for broad land use planning purposes. It is not intended to replace the

more detailed county soil survey reports,* but rather to provide necessary soil information until the surveys can be completed. Where available, SCS surveys have been utilized in the development of the Minnesota Soil Atlas.

The Minnesota Soil Atlas consists of a generalized soil map and accompanying bulletin which provide information concerning the nature and character of the soil. The atlas maps, called sheets, are being published at a scale of 1:250,000. This scale is consistent with one series of U.S. Geological Survey topographic maps. The State of Minnesota will be covered by eleven Atlas sheets (see Appendix A). To date, three sheets have been published and the eight remaining are in final mapping stages. One additional map, the Twin Cities Sheet, which covers the Minneapolis-St.Paul seven county metropolitan area, has been added to the original Atlas list. This sheet is published at a scale of 1:125,000 to provide more detailed information on this highly developed urbanized area.

The mapping unit designed for use in the Atlas series is called the Soil Landscape Unit. This unit is designed to help the user with a minimum knowledge of soils to readily understand the basic properties of the mapped soils. The smallest area delineated in the Atlas is approximately 600 acres. As a result, a number of associated soils series, delineated in much greater detail, may be found within the soil landscape units on Soil Atlas maps. The Soil Landscape Unit is based on the following factors:

First Letter	1)	Texture of the underlying soil material usually below 5 feet: sandy (S), loamy or silty (L), clayey (C), mixed sandy and loamy (X), and mixed silty and clayey (Y).
Second Letter	2)	Texture of the upper material usually above 5 feet, or a significant part of it: (may be only upper 1 to 4 feet in soils with contrasting materials): sandy (S), loamy or silty (L), and clayey (C).
Third Letter	3)	Drainage: water table generally below rooting zone (W), or water table commonly in the rooting zone unless artificially drained (P).
Fourth Letter	4)	Color of surface soil as a reflection of accumulated organic matter: dark (D) and light (L).

* These surveys are published cooperatively by the Minnesota Agricultural Experiment Station and the Soil Conservation Service.

For example, a Clarion series would appear on the map as LLWD and would be interpreted from the map as a dark colored, well-drained soil over loamy material. Downs, Port Byron, and Ostrander soils could also be found within this soil landscape unit as well as smaller areas of other soils with contrasting texture and drainage.

In addition to the soil landscape unit itself, the Atlas identifies the specific physiographic entity upon which soil landscape units have evolved. These entities are termed geomorphic regions. Geomorphic regions are the topographic settings and constitute the parent material for soil development. Although, generally, the boundaries of the soil landscape units coincide with the boundaries of the geomorphic regions, in some cases a geomorphic boundary passes through a soil landscape unit. The map will then show similar adjacent soil landscape units differing only in the parent material and topography of the geomorphic region on which they developed. While a single soil landscape unit may be appropriate to classify a soil anywhere in the state, geomorphic regions do not have this mobility since they define unique combinations of geomorphological features.

Arrowhead Region Soil Survey

The U.S. Soil Conservation Service, under contract with the Arrowhead Regional Development Commission, mapped the soil associations[1] for the Arrowhead Region in 1973 and spring of 1974. Soil associations were identified from 1964 1:90,000 high altitude imagery of northeast Minnesota. Only limited field checking was undertaken to verify the character and boundaries of associations. In most cases, associations consist of known soil series. However, soil descriptions and interpretations were developed for some soils units different from already established series. Generally, the smallest soil unit identified on Arrowhead survey maps is approximately 160 acres. Organic (peat) soils pose a minor exception; since peat lands are so easily distinguished on air photos. Deposits of these smaller than 160 acres were usually mapped.

Because the Minnesota Soil Atlas and the Arrowhead Soil Survey use different schemes to map soils, it is important to note the basic character-

[1] Soil Association: A group of defined and named soil units that occur in an individual geographic pattern. The soils in an association may be derived from the same kind of parent material and be similar in characteristics, or they may be derived from different kinds of parent material and be dissimilar in characteristics.

istics of each. This permits the user to select the soil information source which best suits the needs of any land use analysis.

Minnesota Soil Atlas

a) Map scale is 1:250,000. Soil units of approximately 600 acres or more are mapped. Soil units smaller than 600 acres are included in larger soil units.

b) The mapping unit is the soil landscape unit which is composed of soil series having similar texture, drainage conditions, and color.

c) Geomorphic regions are delineated on the Soil Atlas sheets. Each geomorphic region is a specific physiographic unit in Minnesota and describes, for the soil landscape units located within it, the parent material for soil development as well as the topographic setting.

d) The Minnesota Soil Atlas is scheduled to publish soil maps and accompanying bulletins for the entire state of Minnesota.

Arrowhead Soil Survey

a) The map scale of this survey is 1:62,000, which discriminates soil units of approximately 160 acres or larger. Peat deposits of less than 160 acres may also be mapped.

b) The mapping unit is the soil association. The soil association is a common mapping unit used in soil classification.

c) This survey is only available for the Arrowhead Region of Minnesota.

SOIL INTERPRETATIONS

The physical and chemical properties of a soil unit determine its suitability for various uses. This is true whether the intended use involves construction, mining, waste disposal, or agriculture, for example. The process by which soil is evaluated for its use suitabilities is termed interpretation. By applying soil interpretive criteria to a study area, it is possible to specify the acreage and distribution of land suitable for various uses. Personnel from MLMIS, Department of Soil Science, and SCS have developed a system of interpreting (rating) the suitabilities of soils for crop production (grain and forage crops), forest production, and non-urban residential development, which is described below.

The soil landscape/geomorphic region combinations of the Minnesota Soil Atlas and the soil associations of the Arrowhead USSCS soil survey are rated in a similar fashion.

Soil Atlas Ratings

Each soil landscape unit within a geomorphic region is given a separate rating for each specified land use. The combination of soil landscape unit/geomorphic region is significant. As mentioned previously, the delineation of geomorphic regions provides information about the parent material of the soil landscape unit and assigns soil units to specific locations. Thus, similar soil landscape units in different geomorphic regions may be given separate ratings for any specified land use. The ratings for soil landscape units are stored in tabular form, called a J Table, on a deck of keypunch cards. For each 40 acre parcel, the computer can use the data on the soil landscape unit and geomorphic region as an address to locate the land use suitability ratings for that parcel on the J Table.

Arrowhead Survey Ratings

Each soil association of the Arrowhead Survey is given a specific rating for each specified land use. These ratings are also stored in tabular form (G Table).[2] The computer, again, uses the data on the soil association for any 40 acre parcel as an index to locate the suitability ratings for that parcel.

While both the Soil Atlas soil landscape unit/geomorphic region combinations and the Arrowhead associations are rated using the same soil interpretation scheme, any 40 acre parcel in the Arrowhead Region may have one rating for a particular land use on the J Table and a different rating for the same land use on the G Table. This is because the two mapping programs are prepared at different scales and employ different criteria in mapping units. However, over broad areas, the general ratings of the associations and soil landscape units are expected to be similar.

The interpretation or rating of soil suitabilities for various kinds of use, it must be emphasized, should be considered an initial and somewhat

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[2] The suitability ratings incorporated in the Land Use Interpretations (J and G Tables) are based largely on data in single sheet Soil Series Interpretations published by the Soil Conservation Service.

generalized analysis. Soil characteristics and performance under different uses are defined in gross rather than in detailed terms. Related to this is the size of our analysis unit (the 40 acre parcel) and the scale constraints of the soil landscape unit (resolution about 600 acres) and soil association unit (about 160 acres). Obviously, at the scale of the site, analysis based on such large units can be regarded only tentatively and field analysis must follow. Finally, the preparation of soil interpretations involves a bit of subjective judgement since ratings are principally derived from soil series descriptions. Therefore, the proportion of specific soil series in a soil landscape unit or soil association must be hypothesized before a rating can be given the larger units.

Soil Interpretations for Crop Production

Approximately 16 million acres of cropland are harvested yearly - a significant percentage of Minnesota's 51 million acres of land. The major crops include corn, soybeans, oats, hay, and wheat. They account for 88 percent of the total harvested cropland acreage.

In order to develop a generalized index for rating the quality of land for crop production, it was necessary to find a common unit of crop yield so that yield data for different crop varieties could be compared throughout the state. The total digestible nutrients (TDN) unit was chosen. TDN is an energy-based feed value term.[3] TDN values are available for all crops harvested in Minnesota.

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[3] A TDN value is the sum of all of the digestible organic nutrients - protein, fiber, nitrogen free extract, and fat. (The latter is multiplied by 2.25 because its energy value is approximately 2.25 times that of protein or carbohydrates.) The digestibility is on the basis of ruminant animals. Morrison, Frank B., Feeds and Feeding (The Morrison Publishing Co., Ithaca, New York), 1948.

Table 1: Crop Production Rating Relationships

Crop Productivity Index	TDN Yield Lbs/A	Equivalent TDN Yield: Corn Yield Bu/A	Alfalfa Hay Tons/A	Oats Yield Bu/A	Wheat Yield Bu/A
0	0- 582	0- 13	0 - .58	0- 26	0- 12
1	583-1165	14- 26	.59-1.2	27- 52	13- 24
2	1166-1747	27- 39	1.3 -1.7	53- 78	25- 36
3	1748-2330	40- 52	1.8 -2.3	79-104	37- 48
4	2331-2912	53- 65	2.4 -2.9	105-130	49- 61
5	2913-3494	66- 78	3.0 -3.5	131-156	62- 73
6	3495-4078	79- 92	3.6 -4.1	157-183	74- 85
7	4079-4659	93-105	4.2 -4.7	- -	86- 97
8	4660-5242	106-118	4.8 -5.2	- -	98-109
9	5243-5824	119-131	5.3 -5.8	- -	110-121

The relationship of soils to cropland productivity is assumed to be relatively constant over time. However, the absolute yield may change substantially because of changes in technology and possible modification of the soil environment itself through practices such as irrigation and drainage. One of the objectives in developing a rating scheme is to make it adjustable to change and to show the yield implications of modification practices. Therefore, yield ratings are made for both modified and unmodified soil conditions.

A ten category productivity rating scheme is being used. This is compatible with the Crop Equivalency Rating (CER) system which has been used in several individual county soil survey interpretations. One cropland productivity rating defines the highest category, 9 (equal to the range of 90 to 100 in the CER system), as the most productive cropland in the state. At the present time, the 9 rating would be equivalent to 119 to 131 bushels of corn per acre or the range of 5,243 to 5,824 pounds of TDN/acre. See Table 1.

Productivity ratings are made for both grain and forage crops because of differences in potential yield and value of the two types of commodity. The ratings are based on the yields produced by the top one-third of

commercial farmers. The rating of either a soil landscape unit or soil association is based on the percentages of soil series occupying the larger unit and the yield rating assigned the component series. For example, Unit 1 could have 50% of soil A with a rating of 8 and 50% of soils B and C with a rating of 4. These are averaged and Unit 1 is given a rating of 6. This rating gives a realistic estimate of total crop production that can be expected from an area of Unit 1 if soils are properly managed. The rating does not consider overhead costs (land clearing, drainage, etc.) engendered in farming.

Ratings for grain are based on corn for much of the state. However, corn is not well adapted to the northern part of the state, and in these areas small grains are used as a rating standard.

Soil Interpretation for Forest Production

The rating of soils for forest production is based upon the potential growth rates of the key species (tree species best suited) for a particular soil type. Two measures of growth rate are employed (see Table 2). The site index of any tree species is the measure of the rate of upward linear growth of a species. The second measure, growth class, is volumetric. It expresses growth rate in cubic feet per acre per year. Table 2 relates both measures by tree species type.

The growth classes at the top of Table 2 are arranged in four classes, although class 1 is reserved for soils for which no key species or growth rates are available, e.g., prairie soils in western Minnesota. Classes 2 through 4 rank increasing productivity rates for each species listed vertically on the left of Table 2. Notice that no site index numbers appear under some growth class categories for most of the species listed. Such blanks indicate that for the growth class categories above, no realistic rating can be assigned that species. Jack pine, for instance, never manifests growth class rates above category 3 in Minnesota under normal management conditions (Table 2) no matter what the soil type.

In those instances when a soil unit is composed of contrasting soil types, an average of the productivity by the key species for each component soil type is computed. For example, if Soil Unit I is composed of 60% soil type A and 40% soil type B, the growth class for type A (key species Aspen), 4, is averaged with the growth class for type B (key species Black Spruce), 2, such that Soil Unit I has an overall rating of class 3.

The resource capability approach utilized in the rating procedure for forest products omits a number of significant variables. Questions of existing cover type, desirability and marketability of species, accessibility to markets, tree size, and other economic and technological considerations are not included. Growth figures taken from forest survey data represent an average of the full range of management. Variation in annual production due to different levels of management intensity is not considered. The incorporation of these variables into analysis should proceed from the resource capability/analysis of this first stage.

Table 2: Annual Production by Species and Site Index

Class	4	3	2	1
Growth (cu.ft./A/yr.)	80+	50-80	-50	Not Rated
Species	- - - -	S I T E I N D E X -		- - - - - -
Red Pine	62+	47-61	-46	
Jack Pine		59-70	-58	
White Spruce	50+			
Tamarack	44+	31-39		
Cedar			-38	
Hardwoods	75+	60-74	-59	
Oak		49-68	-48	
Aspen	70+	53-69	-52	
Black Spruce			-40	

Source: North Central Forest Experiment Station Unpublished Data.

Soil Interpretations for Residential Development

Rating soil capability for residential development involves the interpretation of six soil characteristics. Each of these characteristics uniquely affects a site's physical capability to support residential development, since each may pose a hazard to one or more aspect(s) of development. The ratings for each soil landscape unit are based on the interpretation of the dominant soil series within the soil landscape unit. The ratings assume a typical residential site to have the following attributes: 1) 80,000 square feet minimum lot size, 2) two story single family detached dwelling with basement, and 3) on site water supply and sewage disposal.

The six soil characteristics referenced for residential development include:

Soil Strength: The expected soil performance when used for residential development. Ratings consider bearing strength, shear strength, and shrink-swell characteristics.[4] Soils with slight limitations are given a rating of "1," moderate a rating of "2," and severe a rating of "3."

Flooding: A temporary covering of land surface by water from any source, such as stream overflow and runoff from adjacent slopes. Soils which are flood-free or flooded only under unusual circumstances are given a rating of "1." Soils occasionally flooded (likely less than once in two years) are given a rating of "2." Soils subject to more frequent flooding are given a rating of "3."

Wetness: The degree of saturation throughout the year based on natural conditions without artificial drainage. Ratings assigned as follows:

1 = (Slight) Well to excessively drained soils.

2 = (Moderate) Moderately well and somewhat poorly drained soils.

3 = (Severe) Poor and very poorly drained soils.

Slope: The hazard of erosion and degree of difficulty in working with the landscape for residential development. Ratings assigned as follows:

1 = (Slight) zero to six percent slopes.

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[4] Soil Conservation Service, Guide for Interpreting Engineering Uses of Soils, November 1971.

2 = (Moderate) six to twelve percent slopes.

3 = (Severe) over twelve percent slopes.

Septic Field: Suitability or limitations are based on soil permeability and the depth to water table or bedrock. Slope is not considered in this rating. Limitation is based on these items in Guide Sheet Three[5] and ratings assigned as follows:

1 = Slight

2 = Moderate

3 = Severe

Groundwater Contamination: Indicates the hazard of contaminant leaching through the soil profile. Two categories are developed. A rating of "1" is given to those soils in which there is no serious hazard of contamination. Only well to somewhat poorly drained soils underlain by sandy or gravelly material or bedrock are considered as having a potential hazard.

The limitations of the 40 acre parcel prohibit the use of this data for specific residential site selection. The residential rating given a particular parcel reflects the dominant condition found in an entire soil landscape unit or soil association. Individual tracts or lots may differ greatly in suitability from this dominant condition.

The significance of the hazard ratings is a function of the particular development being planned. It may be necessary to consider a combination of the residential ratings when determining the suitability of the soil to support development. Some ratings may be more significant than others, depending on the nature of the structure. All of the soil limitations considered in the rating scheme can be overcome at a cost. The cost may be quite modest; for example, to ameliorate a soil strength problem for a single family frame house by employing larger foundation footings. However, in other cases - heavy duty roads or large buildings - the soil strength factor may be quite important. Slope is a factor that may be interpreted in a positive or negative manner, depending on the values of the user. Steep slopes usually involve higher construction and service costs for intensive uses such as residential, commercial, or industrial. However, steep slopes and high relief usually have a high amenity value and are often preferred building sites.

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[5] Soil Conservation Service, op.cit., footnote 4, p. 23.

OTHER SOIL INFORMATION STORED ON MLMIS COMPUTER FILES

Each bulletin published with the Minnesota Soil Atlas sheets provides tabular information describing the character of the geomorphic areas and the soil landscape units found within them. This data was converted to numerical expressions and stored on a J Table with the land use ratings for the respective geomorphic area/soil landscape unit combinations. This additional data has not been used by MLMIS, but such information may prove useful for more intensive analysis of soils, especially for agricultural purposes.

The legend for the Arrowhead Soil Survey provides information on slope, local relief, and landform type of mapped units. This information has been converted to numerical expressions and is stored on the G Table.

Appendix B of this report contains the descriptive legends for the J and G Tables. Since the same rating scheme (for crop production, forest production, and non-urban residential development) was applied to the soils listed in both the Minnesota Soil Atlas and the Arrowhead Soil Survey, the legend of the J and G Tables for the land use ratings are identical. The additional data compiled for the geomorphic region/soil landscape unit combinations and the soil associations do not conform to a common format, therefore, the legends for these portions of the J and G Tables (J14-J25 and G14-G16) are not identical.

SUMMARY AND RECOMMENDATIONS

The value of the soils information in the Minnesota Soil Atlas, the Arrowhead Soil Survey, and the soil rating scheme has not been thoroughly tested. However, the current application of this soils data to the problem of locating lands best suited for crop production, forest production, and non-urban residential development in the Arrowhead Region should be instructive.

The further development of the soils information component of MLMIS will be enhanced by the implementation of the following recommendations:

1) The standardization and careful documentation of soil interpretive procedures is desirable as increasing numbers of clients begin to use MLMIS soils information in planning and resource management. Appendix C contains

two versions of a rating format for soils interpretation. The quick reference sample rating sheet shown is the one used for interpretation presently. The proposed rating format, the second item in Appendix C, would provide more thorough documentation of the procedures employed in interpretation.

2) The present system should be thoroughly tested. The observed performance of a soil should be reflected by the rating assigned that soil. Verification can only be accomplished by extensive field work. MLMIS could conduct suitability studies in relatively small areas where the utility of the soil rating scheme can be carefully evaluated. Only one study (Forestry Demonstration Case, MLMIS Report 4003) used field work to support the predictions it made concerning the production of aspen in nine Itasca townships. This type of research should be conducted simultaneously with broad regional studies in order to assure that the latter are based on reliable data.

3) Soils information requires updating as better source material becomes available. Revisions in the interpretations will be necessary as new types of land use questions are asked. MLMIS is not properly staffed to handle this task alone. A soils information review committee of members from the Department of Soil Science and MLMIS staff should be convened to assure that the most recent information is available in a format useful to current land use questions.

4) Since, ultimately, soil capability ratings are intended for use by local planners and other local land use decision makers, it is important that members of local units of government be involved in the development of soil interpretations. They are the best judges of their own needs for soil information and its application. Also, their early involvement in the process may render them more receptive to land use recommendations emanating from MLMIS and other agencies and groups influencing land use planning.

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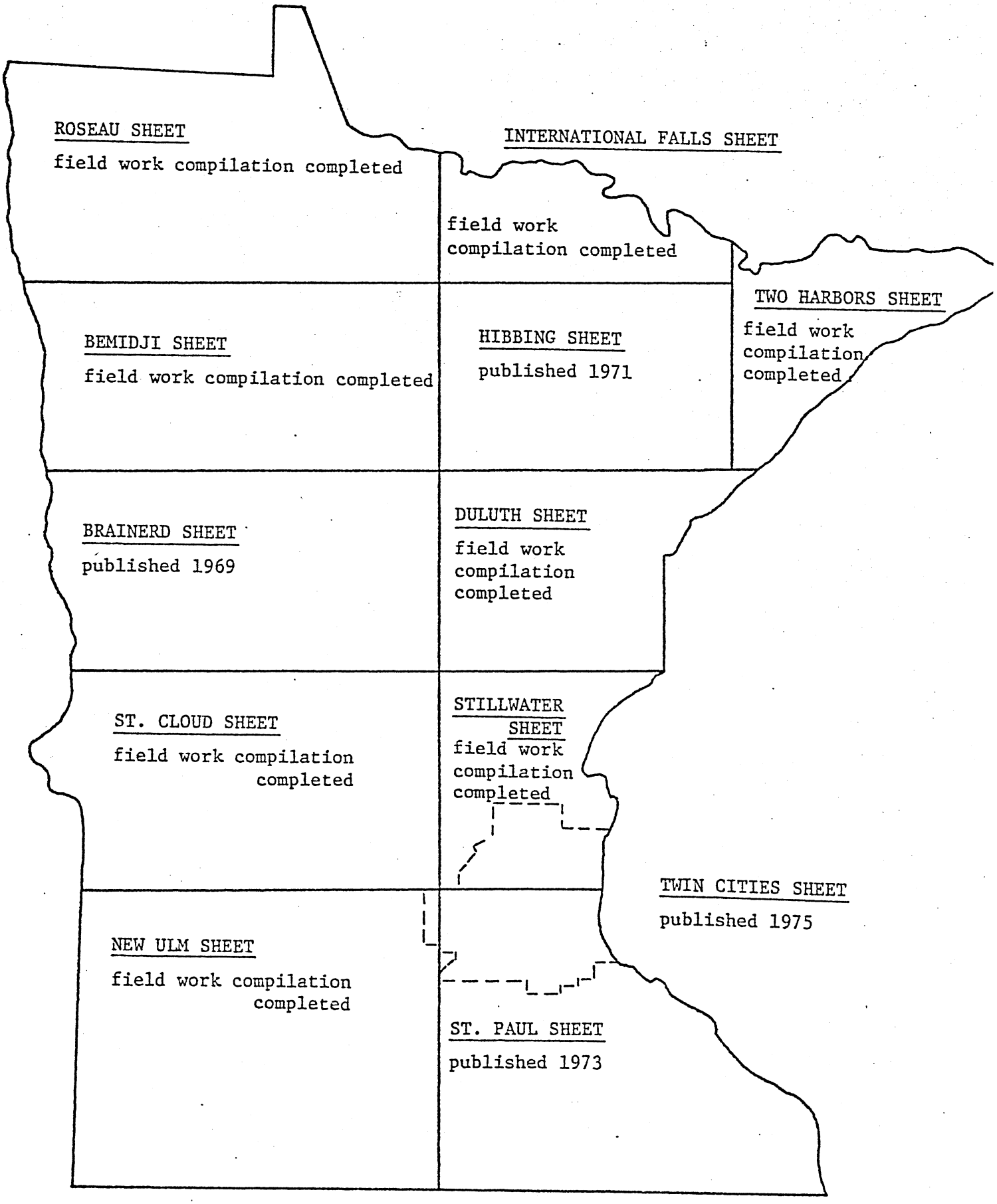
A P P E N D I X A

STATUS OF MINNESOTA SOIL ATLAS



STATUS OF MINNESOTA SOIL ATLAS

A P P E N D I X B

DESCRIPTIVE LEGENDS FOR "J" TABLE AND "G" TABLE

DESCRIPTIVE LEGEND FOR J TABLE

J1: Crop production ratings for forage crops on specified soil type.

J1 Level	State CER Code	Equivalent TDN Yield Lbs/A	Corn Yield Bu/A	Alfalfa Hay Tons/A
0	0	0- 582	0- 13	0- .58
1	1	583-1165	14- 26	.59-1.2
2	2	1166-1747	27- 39	1.3 -1.7
3	3	1748-2330	40- 52	1.8 -2.3
4	4	2331-2912	53- 65	2.4 -2.9
5	5	2913-3494	66- 78	3.0 -3.5
6	6	3495-4078	79- 92	3.6 -4.1
7	7	4079-4659	93-105	4.2 -4.7
8	8	4660-5242	106-118	4.8 -5.2
9	9	5243-5824	119-131	5.3 -5.8

J2: Crop production ratings for grain crops on specified soil type. See Table J1.

J3: Soil modification practice recommended to increase crop production.

Level	Description
1	no modification recommended
2	drainage
3	irrigation
4	drainage and irrigation

J4: Crop production ratings for forage crops using modifications recommended by J3 level. See Table J1.

J5: Crop production ratings for grain crops using modifications recommended by J3 Level. See Table J1.

J6: The forest species used to determine growth class (J7) for soil type.

Level	Description	Level	Description
00	no species recommended	06	Hardwoods
01	Red Pine	07	Oak
02	Jack Pine	08	Aspen
03	White Spruce	09	Black Spruce
04	Tamarack		
05	Cedar		

J7: The growth class for the forest species shown in J6:

ANNUAL PRODUCTION BY SPECIES AND SITE INDEX

CLASS (LEVEL)	4	3	2	1
GROWTH (cu.ft./A/yr.)	80+	50-80	-50	Not Rated
SPECIES	- - - - - -	S I T E	I N D E X - -	- - - - - -
Red Pine	62+	47-61	-46	
Jack Pine		59-70	-58	
White Spruce	50+			
Tamarack	44+	31-39		
Cedar			-38	
Hardwoods	75+	60-74	-59	
Oak		49-68	-48	
Aspen	70+	53-69	-52	
Black Spruce			-40	

SOURCE: North Central Forest Experiment Station Unpublished Data.

J8: Soil strength - soil performance regarding shear strength, shrink-swell, and plasticity.

Level	Description
1	good - essentially sandy soils
2	fair - essentially loamy soils
3	poor - essentially clayey soils

J9: Flooding - a temporary covering of land surface by water from a source such as stream overflow and runoff from adjacent slopes.

Level	Description
1	none, rare, slight - unlikely, but possible under unusual conditions
2	occasional, moderate - likely but less than once in 2 years
3	frequent, often - more often than once in 2 years

J10: Wetness - the degree of saturation throughout the year without artificial drainage.

Level	Description
1	slight - well to excessively well drained soils
2	moderate - moderately well and somewhat poorly drained soils
3	severe - poor and very poorly drained soils

J11: Slope - reflects hazard of erosion and degree of difficulty in working with landscape for urban uses.

Level	Description
1	slight 0-6 percent slopes
2	moderate 6-12 percent slopes
3	severe over 12 percent slopes

J12: Septic field - limitations based on permeability, texture, drainage, and depth to water table or bedrock.

Level	Description
1	slight
2	moderate
3	severe

J13: Groundwater contamination hazard - indicates the hazard of leaching of contaminants through the soil profile.

Level	Description
1	slight
2	moderate
3	severe

*J14: The percent of geomorphic region which the soil landscape occupies.

*J15: Type of physiographic feature from which the landscape unit has developed.

Level	Description
10	Bottomland
11	Depressions
12	Eskers
20	Lake Plain
30	Upland
40	Outwash
50	Bog
51	Bog and Outwash
60	Moraine
61	Kame Moraine
70	Drumlins
71	Interdrumlins
80	Till Plains
81	Till Plains, shallow over rock
99	No natural relief

*J16: Topography and position of the landform described by J15 level.

Level	Description
10	Depressions
11	Depressional to nearly level
12	Depressional to level
20	Level
21	Nearly level
22	Nearly level to undulating
23	Nearly level to gently sloping
24	Nearly level to sloping
25	Nearly level to gently rolling
26	Nearly level to rolling
30	Undulating
31	Undulating to gently rolling
32	Undulating to rolling
40	Gently sloping
41	Gently sloping to sloping
42	Sloping
50	Gently rolling to rolling
51	Rolling
52	Rolling to hilly
53	Rolling to steep
60	Narrow
61	Narrow elongated
62	Low broad
63	Frequently flooded
64	Sand capped
99	No natural relief

*J17 Soil texture in the rooting zone of specified soil type.

Level	Description
11	Sand
12	Sand to loamy sand
22	Loam sand
23	Loamy sand to sandy loam
33	Sandy loam
34	Sandy loam to loam
41	Loam to sand and gravel
44	Loam
45	Loam to clay loam
46	Loam to silt loam
48	Loam and silty clay
55	Clay loam
57	Clay loam to silty clay loam
66	Silt loam
67	Silt loam to silty clay loam
77	Silty clay loam
78	Silty clay loam to silty clay
88	Silty clay
89	Silty clay to clay
90	Peat
99	Clay

*J18: Thickness of soil texture in rooting zone.

Level	Description
1	1 - 2 ft.
2	1 - 3
3	1 - 4
4	2 - 3
5	2 - 4
6	3
7	4
98	undetermined

*J19: Soil texture in the substratum of the specified soil type.

Level	Description
02	Sand and gravel to rock
05	Clay loam, loam to rock
11	Sand
12	Sand and gravel
21	Sandy loam to sand and gravel
22	Gravel
23	Gravel to sandy loam
33	Sandy loam
34	Sandy loam to loam
44	Loam
46	Loam to silt loam
49	Loam and clay
51	Clay loam to sand and gravel
54	Clay loam to loam
55	Clay loam
58	Clay loam to silty clay
66	Silt loam
77	Silty clay loam
81	Silty clay to sand
88	Silty clay
89	Silty clay to clay
90	Peat
99	Clay

*J20: Thickness and depth of soil texture in the substratum.

Level	Description	
	begins at depth of:	and extends to:
1	2 ft.	undetermined
2	3	undetermined
3	4	undetermined
4	1	4
5	2	4
6	3	5
7	2	20
8	3	20
9	4	20
98	undetermined	undetermined

*J21: Inches of available water to 5 ft.

Level	Description
1	0 - 4
2	0 - 8
3	0 -12
4	4 - 8
5	4 -12
6	8 -12
7	12+
98	undetermined

*J22: Drainage class of specified soil.

Level	Description
11	Wet
14	Wet to poorly drained
22	Marshy
23	Marshy to very poorly drained
33	Very poorly drained
34	Very poorly to poorly drained
44	Poorly drained
45	Poorly to somewhat poorly
55	Somewhat poorly
56	Somewhat poorly to moderately well
66	Moderately well drained
67	Moderately well to well drained
77	Well drained
78	Well to excessively drained
88	Excessively drained

*J23: pH range of specified soil.

Level	Description
1	less than 4.5
2	4.5 - 5.0
3	5.1 - 5.5
4	5.6 - 6.0
5	6.1 - 6.5
6	6.6 - 7.3
7	7.4 - 7.8
8	7.9 - 8.4
9	8.5 - 9.0
10	more than 9.1
11	less than 6.0
12	more than 6.0
13	more than 7.2

*J24: Available phosphorus in specified soil.

Level	Description
1	Low
2	Low to medium
3	Medium
4	High
5	Variable, low to high

*J25: Available potassium in specified soil.

Level	Description
1	Low
2	Low to medium
3	Medium
4	High
5	Variable, low to high

* NOTE: Levels of soil variables J14 - J25 are appropriate only for soils covered by the Hibbing Sheet of the Minnesota Soil Atlas. New levels for these variables may be devised when other Atlas sheets are interpreted for MLMIS data files.

DESCRIPTIVE LEGEND FOR G TABLE

G1: Crop production ratings for forage crops on specified soil type.

G1 Level	State CER Code	Equivalent TDN Yield Lbs/A	Corn Yield Bu/A	Alfalfa Hay Tons/A
0	0	0- 582	0- 13	0- .58
1	1	583-1165	14- 26	.59-1.2
2	2	1166-1747	27- 39	1.3 -1.7
3	3	1748-2330	40- 52	1.8 -2.3
4	4	2331-2912	53- 65	2.4 -2.9
5	5	2913-3494	66- 78	3.0 -3.5
6	6	3495-4078	79- 92	3.6 -4.1
7	7	4079-4659	93-105	4.2 -4.7
8	8	4660-5242	106-118	4.8 -5.2
9	9	5243-5824	119-131	5.3 -5.8

G2: Crop production ratings for grain crops on specified soil type. See Table G1.

G3: Soil modification practice recommended to increase crop production.

Level	Description
1	no modification recommended
2	drainage
3	irrigation
4	drainage and irrigation

G4: Crop production ratings for forage crops using modifications recommended by G3 level. See Table G1.

G5: Crop production ratings for grain crops using modifications recommended by G3 level. See Table G1.

G6: The forest species used to determine growth class (G7) for soil type.

Level	Description	Level	Description
00	no species recommended	05	Cedar
01	Red Pine	06	Hardwoods
02	Jack Pine	07	Oak
03	White Spruce	08	Aspen
04	Tamarack	09	Black Spruce

G7: The growth class for the forest species shown in G6:

ANNUAL PRODUCTION BY SPECIES AND SITE INDEX

CLASS (LEVEL)	4	3	2	1
GROWTH (cu.ft./A/yr.)	80+	50-80	-50	Not Rated
SPECIES	-----	SITE INDEX	-----	------
Red Pine	62+	47-61	-46	
Jack Pine		59-70	-58	
White Spruce	50+			
Tamarack	44+	31-39		
Cedar			-38	
Hardwoods	75+	60-74	-59	
Oak		49-68	-48	
Aspen	70+	53-69	-52	
Black Spruce			-40	

SOURCE: North Central Forest Experiment Station Unpublished Data.

G8: Soil strength - soil performance regarding shear strength, shrink-swell, and plasticity.

Level	Description
1	good - essentially sandy soils
2	fair - essentially loamy soils
3	poor - essentially clayey soils

G9: Flooding - a temporary covering of land surface by water from a source such as stream overflow and runoff from adjacent slopes.

Level	Description
1	none, rare, slight - unlikely, but possible under unusual conditions
2	occasional, moderate - likely but less than once in 2 years
3	frequent, often - more often than once in 2 years

G10: Wetness - the degree of saturation throughout the year without artificial drainage.

Level	Description
1	slight - well to excessively well drained soils
2	moderate - moderately well and somewhat poorly drained soils
3	severe - poor and very poorly drained soils

G11: Slope - reflects hazard of erosion and degree of difficulty in working with landscape for urban uses.

Level	Description
1	slight - 0-6 percent slopes
2	moderate - 6-12 percent slopes
3	severe - over 12 percent slopes

G12: Septic field - limitations based on permeability, texture, drainage, and depth to water table or bedrock.

Level	Description
1	slight
2	moderate
3	severe

G13: Groundwater contamination hazard - indicates the hazard of leaching of contaminants through the soil profile.

Level	Description
1	slight
2	moderate
3	severe

G14: Predominant slope (in percent).

Level	Description	Level	Description
1	0 - 1 %	7	0 -35
2	0 - 2	8	12 -35
3	0 - 6	9	12 -45
4	0 -12	10	6 -60
5	2 -25	11	30 -60
6	12 -25		

G15: Local relief (difference in feet between the lowest and the highest point for the area of any association).

Level	Description	Level	Description	Level	Description
1	0 - 2 ft.	11	2 - 15 ft.	21	3 - 50 ft.
2	0 - 3	12	5 - 15	22	5 - 50
3	2 - 3	13	0 - 20	23	20 - 50
4	0 - 4	14	2 - 20	24	5 - 60
5	0 - 5	15	5 - 20	25	15 - 60
6	3 - 6	16	5 - 25	26	10 - 75
7	0 - 10	17	0 - 30	27	20 - 75
8	5 - 10	18	10 - 30	28	10 -100
9	2 - 12	19	5 - 35	29	50 -100
10	0 - 15	20	5 - 40	30	15 -150

G16: Landform type.

Level	Description
0	Not Identified
1	Glacial Lake Plain
2	Glacial Lake Plain and Aeolian Plain
3	Lake Plain
4	Till Plain
5	Drift Areas
6	Ground Moraine
7	Moraine
8	Moraine and Drumlin Areas
9	Outwash Plain and Sandy Moraine
10	Outwash Plain
11	Outwash and Eskers
12	Eskers and Outwash Area
13	Shallow to Bedrock
14	Bedrock Outcrop
15	Flood Plain
16	Bogs
17	Raised Bogs

A P P E N D I X C

SAMPLE RATING SHEET

SAMPLE RATING SHEET

SOIL ATLAS LAND USE INTERPRETATIONS.

GEOMORPHIC AREA Prairie River Plain, Sandy (20) RATING BY _____

COUNTIES _____ DATE _____

		CROP PRODUCTION					FOREST		URBAN RESIDENTIAL				
Soil Landscape Unit	Slope	Un-Mod. F	Un-Mod. G	Modified Type Mod.	Modified F	Modified G	Species	Growth Class	Soil Strength	Flood	Wetness	Slope	Septic Field	Groundwater Contamination
SSWL	0-12	4	1	1	4	1	R Pine	7	1	1	1	2	1	3
P	0- 2	0	0	2	3	0	B Spruce	2	3	3	3	1	3	1
LLWL	6-12	6	2	1	6	2	Aspen	9	2	1	2	2	3	1
CCWL	2- 6	5	2	1	5	2	Aspen	9	3	1	2	1	3	1
CCPL	0- 2	4	1	2	5	2	Aspen	7	3	1	3	1	3	1
LLPL	0- 2	4	1	2	5	2	Aspen	8	2	1	3	1	3	1
SLWL	0- 6	5	2	1	5	2	R Pine	7	1	1	2	1	1	3
CSWL	0- 6	4	1	1	4	1	Aspen	8	2	1	2	1	1	1
SSPL	0- 2	2	0	2	3	1	Aspen	6	1	2	3	1	3	1

Crop Production - F=Forage, G=Grain; Modified - 1=Normal, 2= Drainage, 3=Irrigation, 4=Drainage & Irrigation. Rating Code (crop equivalent rating) - 0 through 9, 0=12 bu. corn or 582 lbs. TDN/A, 9=119 to 131 bu. corn or 5243 to 5824 lbs. TDN/A.

Forest Suitability - Species - written out; Growth Class - 1 through 9 - 1=not rated, 2=>20, 3=20 to 40, 4=40 to 50, 5=50 to 60, 6=60 to 70, 7=70 to 80, 8=80 to 90, 9=90+ cu.ft./A/yr.

Urban Residential - 1=slight limitations, 2=moderate limitations, 3=severe limitations.

GEOMORPHIC REGION _____

SOIL LANDSCAPE UNIT _____

PRINCIPAL SOIL SERIES IN SOIL LANDSCAPE UNIT (SLU)	% OF LANDSCAPE UNIT
a.	_____
b.	_____
c.	_____
d.	_____

1. CROP PRODUCTION - FORAGE

Comments and assumptions:

Yield potentials for individual series

a. :

b. :

c. :

d. :

Forage production rating for soil landscape unit: _____

Comments:

2. CROP PRODUCTION - GRAIN

Comments and assumptions:

Yield potentials for individual series

a. :

b. :

c. :

d. :

Grain production rating for soil landscape unit: _____

Comments:

3. RECOMMENDED MODIFICATION PRACTICE

Comments and assumptions:

Recommended modification for individual series:

a. :

b. :

c. :

d. :

Modification recommended for soil landscape unit: _____

Comments:

4. MODIFIED CROP PRODUCTION - FORAGE

Comments and assumptions:

Yield potentials for individual series

a. :

b. :

c. :

d. :

Modified forage production rating for soil landscape unit: _____

Comments:

5. MODIFIED CROP PRODUCTION - GRAIN

Comments and assumptions:

Yield potentials for individual series

a. :

b. :

c. :

d. :

Modified grain production rating for soil landscape unit: _____

Comments:

6. and 7. KEY SPECIES AND FOREST PRODUCTIVITY POTENTIAL

Comments and assumptions:

Species and site indices for individual series

a.
1. :
2. :
3. :

b.
1. :
2. :
3. :

c.
1. :
2. :
3. :

d.
1. :
2. :
3. :

Key species and growth class for soil landscape unit: _____, _____

Comments:

8. SOIL STRENGTH

Comments and assumptions:

Soil texture class and plasticity index for individual series

a. :

b. :

c. :

d. :

Strength rating for soil landscape unit: _____

Comments:

9. FLOODING

Comments and assumptions:

Flooding of individual series

a. :

b. :

c. :

d. :

Flood rating for soil landscape unit: _____

Comments:

10. SOIL WETNESS

Comments and assumptions:

Soil wetness of individual series

a. :

b. :

c. :

d. :

Soil wetness rating for soil landscape unit: _____

Comments:

11. SLOPE

Comments and assumptions:

Slope characteristics of individual series

a. :

b. :

c. :

d. :

Slope rating for soil landscape unit: _____

Comments:

12. SEPTIC FIELD

Comments and assumptions:

Septic field suitability of individual series

a. :

b. :

c. :

d. :

Septic field rating for soil landscape unit: _____

Comments:

13. GROUNDWATER CONTAMINATION HAZARD

Comments and assumptions:

Contamination hazard of individual series

a. :

b. :

c. :

d. :

Contamination hazard rating for soil landscape unit: _____

Comments: