A SUGGESTED TECHNIQUE FOR THE ILLUSTRATION AND PRACTICAL APPLICATION OF SOIL SURVEY DATA TO LAND DEVELOPMENT PLANNING

Thesis for the Degree of M. S.

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ABSTRACT

A SUGGESTED TECHNIQUE FOR THE ILLUSTRATION AND PRACTICAL APPLICATION OF SOIL SURVEY DATA TO LAND DEVELOPMENT PLANNING

by Robert Henry Gurnham

Soil survey information is gaining wide acceptance as a valuable basic tool for land development planning. Although much literature is available, there remains a need for information, in laymans terms, explaining what soil surveys are, what type of information they contain, and how the information can effectively be used by persons untrained in soil science.

Using Meridian Township, Ingham County, Michigan as an example, information contained in a modern soil survey is presented and a technique for compiling, analyzing, and graphically illustrating the soils data is discussed. The techniques presented are neither time-consuming nor highly technical but provide an effective means by which relevant information may be obtained and employed as a basic land planning tool.

A preliminary analysis of factors contributing to limition ratings of soils enables groups and subgroups of soils, with similar types of problems, to be prepared prior to undertaking the time-consuming, tedious task of

illustrating soils data. For instance, soils which are rated as having severe limitation problems for residential development can be classified as alluvial or non-alluvial soils. Non-alluvial soils can be further subgrouped if desired and needed for a particular use.

To avoid preparing a complicated, multi-factor map, a technique is presented which utilizes a series of reproducible, single-factor overlays. By combining different overlays, a series of maps can be produced to indicate such varied situations as: (1) ratings with or without public sewers; (2) effect of slope on limitation ratings; (3) drainage conditions; and many more.

Two special studies are presented which examine: (1) the feasibility of applying modern soil survey interpretation data to old agricultural soil survey maps; and (2) a technique for determining the feasibility of artificial drainage of soils based on engineering data available on soil interpretation sheets.

The author concluded that the practice of applying modern interpretation data to old survey maps should be avoided due to the possibility presenting misleading, erroneous, information. The investigation into artificial drainage showed indications of obtaining meaningful information but further study is needed.

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By

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CHAPTER I

PURPOSE AND OBJECTIVES

This thesis is written in an attempt to provide planners and other persons involved with land development with a better understanding of soil surveys and how soil data can be compiled, analyzed, and illustrated in a simple, but effective manner. Although concerned primarily with suburban land use, the techniques presented are applicable to other interpretations of soils data.

The author has often observed the results of soil survey interpretation maps prepared by persons unsure of the true value of soil surveys, or what soil surveys indicate. A review of soils and planning literature indicates a growing awareness of the potential value of soil survey information to land development planning. Numerous articles have been written regarding the value of modern soils data for practical, effective land-use planning, but few, if any, have been concerned with applied research findings. As a result, the author has witnessed the preparation of soil interpretation maps by lay people which resulted in misleading or erroneous information.

Using applied research methods, this thesis will provide some basic information for the practicing planner interested in the preparation of soil survey interpretation data by demonstrating techniques for compiling, analyzing, and illustrating data in simple, but effective, tables and maps.

By compiling and analyzing soils data as presented in this thesis, soil-related problems can be more clearly defined for subsequent use. It is not the intent of this thesis to investigate beyond identifying soil problems but it is sincerely hoped that this thesis will serve to stimulate future studies which will investigate the proper application of soils data to land planning policy and decision-making. The degree of importance soils should play in formulating overall planning policy and decisions requires careful investigation which should include the economics of overcoming soil problems, and the orderly arrangement of land development patterns.

CHAPTER II

LITERATURE REVIEW

Introduction

Available literature on soils or the use of soils information generally falls within one of two categories: (1) articles written at a highly technical level by soil scientists or engineers which are not intended for use by the layman; and (2) articles which emphasize the value of soil information or which explain how different agencies have benefited from using soils information, but which fail to explain how the layman might interpret and utilize the soils data.

The following quotations are taken from articles typical of the second category and serve to illustrate the type of article available:

> Later, the recent soil survey . . . of great help to the planning commission in determining a method of dealing with the large areas of vacant land. The fundamental data . . . has enabled the commission to regulate . . . to prevent the construction of subdivisions in undesirable places.[1]

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[1] S. S. Obenshain, H. D. Porter, and R. E. Devereux, Soil Survey for Urban Planning and Other Uses (Blacksburg, Virginia: Agricultural Experiment Station, Virginia Polytechnic Institute, Bulletin 538, 1964), p. 8.

> When foundations settle and crack, when new road pavements buckle and break, when septic tanks fail, or when floods drive people from their homes, the loss to the individual . . . is not the result of an unpredictable whim of Nature. It is the result of not knowing the soils on the landscape.[2]

Dr. Kurt Bauer, Executive Director of the Southeastern Wisconsin Regional Planning Commission estimates that the use of soil surveys in his seven-county area will save $300 million in the cost of residential land development alone in the next twenty-five years by avoiding development on highly undesirable soils.[3]

The Association of Bay Area Governments (nine-county area surrounding San Francisco, California), in cooperation with the Soil Conservation Service, uses soil survey maps to prepare planning studies which seek the best relationship between resources, economic pressures, and social needs. Some benefits derived from soil survey maps include:[4]

1) preserving prime agricultural land for farming and open spaces;

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[2]A. A. Klingebiel, "Land Classification for Use in Planning," _A Place to Live_, _Yearbook of Agriculture 1963_ (Washington, D. C.: Government Printing Office, 1963), p. 399.

[3]A. A. Klingebiel, "Costs and Returns of Soil Surveys," _Soil Conservation_, Volume 32, No. 1 (August, 1966), p. 1.

[4]Leonard R. Wohletz, "Soil Maps in Land Planning," _Soil Conservation_, Volume 32, No. 1 (August, 1966), p. 18.

2) routing highways and other public facilities in conformance with good land-use patterns;
3) guiding urban development so good farmlands are used for crops while the scenic, flood-free terraces, benches, and rolling hills are used for housing developments;
4) placing parks and wildlife where water, scenery, and soils are better adapted to recreational use than farming or housing;
5) using the steeper and more shallow soils for pasture, range, and woodlands.

As part of the requirements for earning a Master of Science Degree at Michigan State University, Donald E. Van Meter prepared an analysis of available literature on interpreting soils information for non-agricultural uses. In his conclusions, Mr. Van Meter states:

> Much literature is prepared for the public explaining how soil survey information can aid urban development. There are many people, however, that still do not realize what a soil survey is or how this type of information can benefit a community. More literature is needed prepared in a simple form and published in popular reading media discussing the uses of soil survey information for urban development.[5]

The conclusions drawn by Mr. Van Meter in his thesis tend to support the findings of this writer in regards to the type of information presently available to the layman.

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[5]Donald Eugene Van Meter, "An Analysis of Literature Interpreting Soils for Nonagricultural Uses" (unpublished Master's thesis, Michigan State University, 1965), p. 56.

Early Soil Surveys

In 1898, under the guidance of Professor Milton Whitney,[6] the first soil surveys were conducted in an attempt to find where, and how extensive were the soils best suited for the production of tobacco.

Through the use of test pits, borings, and exposures created by road and railroad cuts, the soil scientists studied the soil profile and other aspects of soils including color, porosity, structure, texture, and content of organic material. Soils were then classified by their characteristics, both internal and external, with special emphasis given to those features influencing the adaptation of land for the growing of grains, feed crops, and trees.

Great detail was not required for agricultural purposes so soil areas were generally mapped on small-scale maps. Accuracy of the maps depended on the uniformity of the type of soil, the size of the separate types of soil, and the particular association of soils being mapped. Due to the scale of the maps and size of certain soil areas, it was often necessary to include some small pockets of individual soils within the larger classifications. For example, soils classified as Conover loam might also include small pockets of Miami

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[6]Professor Milton Whitney, Chief, Division of Soils, United States Department of Agriculture.

loam and Brookston loam. Similarly, Brookston loam might include small areas of Brady and Conover soils.

As survey techniques improved and more information became available, other agencies became interested in the potential use of soil information. Today, in addition to farmers and agricultural workers, the use of soils information has spread to engineers, planning agencies, sanitarians, real estate brokers, developers and builders, tax assessors, and school boards, to name but a few.

Modern Soil Surveys

Users

As soil survey and mapping became more sophisticated, the potential uses for soil information increased. Engineers have found that a knowledge of the physical properties of soils is invaluable in computing water runoff when determining storm sewer needs or when designing and constructing road bases, foundations, and buildings, etc. Health departments are concerned with the porosity and permeability of soils in determining the suitability of an area for septic systems or any other health-related function concerning soils.

Planners, developers, landscape architects, etc., are concerned with the suitability of soils for development and landscaping. The present number of potential uses of soil information is unlimited and new uses are continuously being found. Today, soil surveys should be an integral part of the inventory required for a sound planning program as it represents ". . . the most complete and detailed single source of information about the physical and chemical nature of both large and small areas."[7] Soil surveys should not, however, be misinterpreted or considered a cure-all for all planning problems. Use of soil surveys ". . . must be with an understanding of how the maps were made and the accuracy of them."[8] "Though the use recommendation for any piece of land is influenced strongly by the characteristics of the soil, these characteristics themselves do not determine the land use recommendation."[9]

Soil Survey Maps

Modern soil surveys are often prepared over aerial photographs. The accuracy of modern soil maps is limited to: (1) soil complexity; (2) detail of examination; (3) scale of maps; and (4) skill and experience of the

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[7] Gerald W. Olson, Using Soil Surveys for Problems of the Expanding Population of New York State (New York: Cornell University, New York State College of Agriculture, 1964), p. 5.

[8] Ibid.

[9] Lindo J. Bartelli, "Use of Soils Information in Urban-Fringe Areas," Journal of Soil and Water Conservation, Volume 17, No. 3 (June, 1962), p. 99.

surveyor. It may be assumed that most modern soil maps are between 80 to 90 per cent accurate as mapping standards require that at least 85 per cent of a soil area must conform to the range of properties defined by the soil name. Therefore, 15 per cent may be slightly different from the main body but at any one spot, chances are five to one that the soil unit is correct.[10]

Another factor affecting the accuracy of the soil map is that it is not economically feasible to take test borings down to ten feet in all places. Knowledge of geology enables prediction of subsurface conditions with different degrees of certainty in different soils. Generally soil scientists can state that for a given soil, a given subsurface condition should persist in a certain percentage of the total number of sites where bedrock depth is greater than three feet.

Accompanying the survey maps, the United States Department of Agriculture Soil Conservation Service has prepared individual interpretation sheets for each soil series. These interpretation sheets give valuable engineering data pertaining to that particular soil, as well as recommended "use-limitation" ratings for a variety of urban, recreational, and agricultural uses.

Many agencies can obtain the information they desire from just referring to the limitation ratings. However,

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[10]Olson, Expanding Population, p. 6.

combining engineering information with the limitation ratings is the only way to maximize benefits from the soil survey. Limitation ratings for various soils are based on numerous factors, not common to all soils, which often can be solved through modern technology.

Interpretation Sheets

The information provided on each interpretation sheet is divided into two broad categories: (1) Engineering Interpretations; and (2) Degree of Limitation of Soil for Various Uses. Engineering Interpretations are further subdivided into: (1) Estimated Physical and Chemical Properties; (2) Suitability of Soil as a Resource Material; and (3) Factors Affecting Use. The Degree of Limitation of Soils for Various Uses is also subdivided into three categories: (1) Urban Uses; (2) Recreational Uses; and (3) Agricultural and Other Vegetation Uses.

Engineering Interpretations

"Estimated Physical and Chemical Properties" provides information on: (1) general profile of the soil; (2) the United States Department of Agriculture, Unified, and the American Association of State Highway Officials classification indexes; (3) the average percentage of the soil material which passes through standard sieves of Numbers 4, 10, and 200; (4) permeability; (5) available water capacity; (6) soil reaction; and (7) shrink-swell potential.

The "Suitability of the Soil as a Resource Material" indicates the suitability of using the soil for: (1) topsoil; (2) sand; (3) gravel; (4) borrow for highway fills; and (5) as an impermeable material for dams and levees.

The "Factors Affecting Use" serves as a quick reference to problems which might be encountered in using the soil for highway construction, foundations, dams, dikes or levees, septic disposal fields, sanitary land fills, and pond reservoir areas, etc.

Degree of Limitation of
Soil for Various Uses

Using the following ratings, the Soil Conservation Service provides information on the degree of limitations which a soil may have for various urban, recreational, and agricultural uses:

Slight:	relatively free of limitations or limitations are easily overcome.
Moderate:	limitations need to be recognized but can be overcome with good management and careful design.
Severe:	limitations are severe enough to make use questionable.
Very Severe:	extreme measures are needed to overcome the limitations and usage generally is unsound or not practical.

"Urban Uses" is subdivided into four basic types of development: (1) residences without public sewers; (2) residences with public sewers; (3) light industrial or commercial buildings; and (4) streets and highways.

"Recreational Uses" provides limitation ratings for six basic types of recreation activities: (1) cottages and utility buildings; (2) intensive camp sites; (3) picnic areas; (4) intensive play areas; (5) paths and trails; and (6) golf fairways.

"Agriculture and Other Uses" provides information on the limitations of soils for: (1) farm crops; (2) trees; and (3) lawns and shrubs.

In providing the limitation ratings, the Soil Conservation Service strongly emphasizes that the ratings are for soils in their natural condition and that artificial drainage or other technological changes could result in some soils being reclassified to a better limitation rating. It would be extremely helpful, for anyone using soil surveys, to review the particular factors contributing to the rating applied to a soil. Some of the factors affecting the usability of soils, which will be referred to throughout this report, are listed with a brief explanation as to how they affect a soil's suitability for various uses.

Texture.--Soil texture refers to the size and distribution of mineral grains present in a given soil which play an important role in the classification of soils, and in influencing the engineering properties of the soil.

Broadly speaking, there are three primary soil textures--sand, silt, and clay. The percentages of each, and the variation in size of each in a soil can indicate important physical properties of a soil.[11]

The relative amounts of silt and clay particles is provided on the interpretation sheets and is indicated by the percentage of material passing through the Number 200 sieve.

Bearing Capacity.--The amount of load or weight per unit of area, which can be placed upon a soil without causing more than a specified amount of displacement. Streets or foundations placed on soils with a poor bearing capacity, if not properly designed, can result in excessive or uneven settling with subsequent severe damage of the structure.[12]

Permeability.--The ease or difficulty with which water will flow or pass through the pores (open spaces between grains of soil) of soil. The permeability will affect the drainage of soil and, therefore, its

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[11]Asphalt Institute, Soils Manual for Design of Asphalt Pavement Structures, Manual Series No. 10 (College Park, Maryland: University of Maryland, 1961), p. 6.

[12]Clarence W. Dunham, Foundations of Structures (New York: McGraw-Hill Book Company, 1962), p. 18.

suitability for septic tank use, as well as other physical properties of the soil.

Capillarity.--The ability of water to rise above the standing ground water. Capillary water is held by the soil and cannot be removed by gravity alone. Coarse-grained soils have negligible capillary water whereas fine-grain soils may contain significant amounts.

For urban uses, capillary water creates problems due to its susceptibility to frost heave which can severely damage streets and slab-foundation structures.

Available Water Capacity.--Indicates available water in inches per inch of soil for the major horizons. Major significance is in agricultural interpretations but may be beneficial in studies on artificial drainage.

Shrink-swell Potential.--Indicates the volume change to be expected of the soil material with changes in moisture content.

Slope.--Slope provides information on the type of terraine in the area, i.e., relatively flat, slightly rolling, or steep hills.

The amount of slope has an important affect on the design and construction of septic tank filter fields, underground utilities, streets, subdivision design, erosion, and drainage, to name but a few items.

Flood Susceptibility.--Soils consisting of layers of water-borne deposits of solid particles indicate that the area is subject to frequent flooding, and are called alluvial soils.

Public Sewers.--Availability of public sewers can have a strong influence on the limitation rating of a soil. Many soils receive poor ratings due to limitations affecting septic tank filter fields but could be rated higher if public sewers were available and used.

Frost Susceptibility.--Soils containing large quantities of capillary water within depths subject to freezing, will shift or heave during the freezing-thawing periods and can cause severe damage to streets or slab foundations. Upon thawing, the excessive moisture can cause substantial changes in the bearing capacity and stability of the soil.

Frost action is most prevalent with soils having high capillarity. Hence, silts and find sands are more susceptible to frost than coarse sands and gravel or clay, which do not have high capillarity.[13]

Water Table.--A high or seasonally high water table has an important influence on the limitation rating of the soil. Areas with a high water table are generally low-lying, poorly drained, and often contain deposits of organic material.

High water-table soils are not usable for septic tank filter fields as they become saturated and inoperable.

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[13] *Ibid.*, p. 63.

In addition, a high water table presents serious problems in the construction of streets and foundations, and severely limits the growth of vegetation.

Seasonally high water tables are particularly important. During dry periods, soils may appear suitable for septic tank filter fields but may fail during wet periods. Both seasonally high and high water tables cause problem with wet basements and soil instability if proper precaution is not taken.

Drainage.--Limitation ratings recommended by the Soil Conservation Service recognize the natural drainage of soil, but indicate that artificial drainage may improve the limitation ratings of some soils.

Artificial drainage, as used in this report, means the removal of excess ground water and surface water. It may be accomplished by storm sewers or open ditches for the removal of surface water, and field or footing tiles for the removal of excess ground water.

It should be noted that some soils will present problems of subsidence if the excess ground water is removed.

Subsidence.--Removal of excess ground water can cause serious subsidence in organic soils which may occur over a period of many years. It can also affect mineral soils by removing the buoyancy of the top horizons of soil, thereby creating a heavier load on lower horizons. If large quantities of ground water are drained, the flow of water through the soils can adversely affect the stability of the soil.[14]

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[14]Gregory P. Tschebotarioff, Soil Mechanics, Foundations, and Earth Structures (New York: McGraw-Hill Book Company, Inc., 1951), p. 397.

CHAPTER III

AN EXAMPLE OF THE PRACTICAL APPLICATION OF SOILS INFORMATION TO LAND PLANNING

Introduction

Using Meridian Township, Ingham County, Michigan as an example, the writer will present a logical approach for the interpretation of soil survey information for land development planning. Although interested primarily in urban and suburban development, the techniques of data interpretation and illustration are suitable for other planning studies.

Brief mention has been made of some of the various uses different agencies have made of soil survey information. This study will present a brief background on Meridian Township and how soil survey information could be helpful in the formulation of land development planning. The study will then proceed to analyze the soils data available for the township and discuss the techniques used to illustrate the information in a simple, but effective, manner.

Background

Meridian Township, located next to Michigan State University and Lansing, Michigan, has been experiencing the evolution of a rural township to a suburban community and will likely become an urban community in the future. As the population of the township increased, so did the problems commonly associated with rapid development. Subdivisions were platted on marginal soils, septic systems failed, and the demand for a central sewage collection system increased. During the early 1960's a major interceptor was installed to serve the most heavily populated areas of the township. Continued expansion, however, necessitates that careful planning be undertaken to maximize use of existing utilities and to guide future development into a logical, orderly, pattern of growth.

During the mid-1960's, as part of a regional planning program, a soil survey was prepared of the township. Recognizing the value of soils information, the township has initiated a program of compiling and illustrating the soil survey information in a series of meaningful maps.

Proposed Uses of Soils Data

Basically, soils information maps fall into one of two categories: (1) general-purpose interpretation maps; and (2) single-factor interpretation maps. Both types of maps can be useful for planning purposes. The "general-purpose" maps present a broad, overall view of soil limitations whereas the "single-purpose" maps illustrate a particular aspect or limitation factor.

Broadly speaking, there are three basic types of communities which can benefit from the general-purpose type soil map: (1) the community which is agriculturally-oriented and therefore desirous of preserving soils best suited for agricultural uses; (2) communities which are primarily interested in recreational uses of land; and (3) communities which are primarily suburban or urban in character.

Communities primarily interested in preserving lands best suited for farm crops and pastures will find the mapping of "land capability class and soil management groups," presented on the individual soil interpretation sheets, useful in delineating areas best suited for these purposes. In addition, the delineation of limitation ratings for residential development without public sewers would be useful.

Recreation-oriented communities will want to investigate the suitability of soils for various types of recreational activities including suitability for cottages, camp sites, intensive play areas, paths and trails, and golf fairways. Additional investigation of slope will help locate areas best suited for winter sports such as ski hills or tobogan runs. Studies of soil permeability and drainage will help locate areas most suitable for artificial lake or pond development.

Like Meridian Township, most suburban communities will benefit from the careful study and application of all types of soils information. Depending upon the degree of urbanization, the community desires information on limitation factors for development with and without public sewers. Knowledge of which soils are unsuitable for septic tank use, but which may become usable for development if sewers are installed, can be of tremendous value in preliminary planning of major sewer installations as well as in determining suitability of the land for subdividing. Information on seasonally high water table soils, or alluvial soils, can help prevent development in areas which soils are not suitable for septic tank operation. Knowledge of potential soil problems in advance of construction can help avoid unnecessary addition expenses which would be incurred in attempting to overcome the particular problem.

In addition to mapping the general limitation factors of soils, certain single-purpose (or single-factor) maps might prove useful in various planning studies. For the most part, information for the single-purpose maps can be derived from the engineering interpretation data on the individual interpretation sheets. Following is a brief summary of some of the possible single-purpose maps.

Slope

A single-purpose map delineating the various degrees of slope can be beneficial to the planner as well as to the engineer. Generally planners prefer to avoid excessively steep or very flat areas for residential development because of the problems incurred with underground utilities, erosion, or poor drainage. Engineers benefit from knowledge of slope in preliminary calculations of storm-water run-off and in designing sanitary and storm water systems and street locations.

Drainage

Natural drainage characteristics provides information on areas with inadequate drainage and helps delineate areas where artificial drainage would be beneficial.

Corrosion Hazard

Although not of particular importance for planning purposes, knowledge of corrosion potential is important to engineers in designing construction criteria for the installation of concrete or metal utilities.

Sanitary Land-fill

For communities seeking areas suitable for sanitary land fills, the soil interpretation sheets provide information which would help avoid soils which would present difficulties.

Resource Material

Information on which soils are suitable for obtaining various resource materials such as sand, gravel, top soil, or borrow for highway fills can be of use in determining minimum hauling distances, etc. for different types of resource materials.

The writer has attempted to illustrate but a few of the many single-purpose maps which can be prepared from the soil survey interpretation sheets. A review of the interpretation sheets would reveal many other possible maps depending on the needs of the community.

Analysis of Soils Data for Meridian Township

Because of its changing character, from rural to urban, Meridian Township would benefit from knowing which soils can be developed without public sewers, and which soils would present development problems regardless of the availability of public sewers. The mapping of soil limitation ratings is a time-consuming, tedious process and warrants preliminary study so as to avoid unnecessary, or unuseful, work. Following is the technique used for analyzing the soils information prior to undertaking any mapping program.

Residential Use Without Public Sewers

To determine the general limitations of soils within the township, the use-limitation ratings recommended by the United States Department of Agriculture Soil Conservation Service for residential development without public sewers were reviewed. The first phase of the review was to prepare a list of all soils within the township and their recommended limitation ratings. As indicated earlier, the limitation ratings are given as: (1) slight; (2) moderate; (3) severe; and (4) very severe. The soils were then grouped according to ratings and the interpretation sheets were reviewed to determine what limitating factors affected each group.

In preparing Tables 1 and 2, "Soils Rated Slight or Moderate for Residential Development Without Public Sewers" and "Soils Rated Severe and Very Severe for Residential Development Without Public Sewers," respectively, it became apparent that some soils actually had a range of limitation ratings which the recommended rating, by itself, did not disclose. For example, Metea, Sisson, and Tuscola soils are rated as slight but can actually range from slight to moderate. Similarly, many soils rated as moderate may actually range from moderate to severe. Although a subjective opinion, this writer feels that for planning purposes, soils having a range of ratings should be so delineated, and that the possible best rating, as given by the Soil Conservation Service, is not sufficient. This opinion was further substantiated with discussions with Mr. Ray Swift, Ingham County Sanitarian, who indicated that many permits for septic tank filter fields have been denied on Miami soils within Meridian Township because percolation tests did not meet Ingham County Health Department minimum standards. A look at Table 1 shows that Miami soil is actually rated as moderate to severe.

TABLE 1.--Soils rated slight or moderate for residential development without public sewers.

Soils	Comment	Soils	Comment
	Slight[a,b]		
Boyer	c	Oakville	c
Bronson	c	Oshtemo	c
Elmdale	d	Perrin	c
Fox	c	Sisson	e
Hillsdale	-	Spinks	c
Lapeer	-	Tuscola	e
Metea	e		
	Moderate[b]		
Berrien	-	Ottawa	-
Brady	c,f	Ottawa-poor	c,f
Celena	g	Owosso	g
Kendallville	g	Spinks-poor	c,f
Matherton	h	Tedrow	c,f
Miami	g	Wasepi	c,f

a = All soils rated moderate on slopes of six to twelve per cent; b = All soils rated severe if slope exceeds 12 per cent; c = Possible contamination of shallow water supplies; d = Water table within three feet of surface during wet periods; e = Slight to moderate due to moderately slow or slow percolation; f = Moderate to severe depending on depth to ground water; g = Moderate to severe due to moderately slow percolation; h = Severe due to wet conditions which may saturate filter fields.

The preparation of Table 1 also disclosed that many soils, although not presenting serious limitations for septic tank filter fields, do have the potential problem of shallow ground water contamination if filter fields are used. Table 2 indicated soils which are subject to flooding, and soils which are predominantly organic in nature and possess peculiar limitation problems for any type of development.

TABLE 2.--Soils rated severe or very severe for residential development without public sewers.

Soils	Comment	Soils	Comment
		Severe	
Algansee	a,d,e	Lenawee	b,c
Barry	b,c	Locke	b,d
Berville	b,c	Macomb	b,d
Blount	d	Maumee	b,c
Brookston	b,c	Metamora	b,d
Ceresco	b,c,e	Pewamo	b,c
Cohoctah	b,c,e	Rimer	b,d
Colwood	b,c	Sebewa	b,c
Conover	b,d	Shoals	b,c,e
Genesee	e	Sloan	b,c,e
Gilford	b,c	Teasdale	b,d
Granby	b,c	Washtenaw	b,c
Kibbie	b		
		Very Severe	
Adrian	c,f	Linwood	c,f
Carlisle	c,f	Rifle	c,f
Edwards	c,f	Tawas	c,f
Greenwood	c,f	Wallkill	c,e,f
Houghton	c,f		

a = Possible contamination of shallow water supplies; b = Severe due to wet conditions which may saturate filter fields; c = High water table; d = Seasonally high water table; e = Susceptible to stream overflow; f = Unstable organic material.

In order to obtain more meaningful soil interpretations, the writer prepared Table 3, "Proposed Limitation Ratings for Residential Development Without Public Sewers." This table separates into special groups those soils possessing these problems.

1. Although filter field contamination may not affect the quality of water pumped from deep wells, its potential effect on shallow wells, as well as its effect on the total urban environment is not to be ignored. Therefore, to focus attention on this special problem, they are grouped separately.
2. Soils subject to flooding should definitely be treated as a special problem, particularly in suburban and urban communities.
3. Because of the uniqueness, all organic soils should be treated separately.

Residential Development with Public Sewers

Reviewing the factors listed in Tables 1 and 2, and the special problems indicated in Table 3, it is apparent that many soils receive poor ratings because they present problems if septic systems are to be used. Many of these problems could be reduced or eliminated if public sewers were available and used. Because not all problems affecting the soils are septic-tank oriented, public

TABLE 3.--Proposed limitation ratings for residential development without public sewers.

Slight	Slight to Moderate[a]	Moderate
Hillsdale	Elmdale	Berrien
Lapeer	Metea	Ottawa
	Sisson	
	Tuscola	

Moderate to Severe[b]	Severe		Very Severe
Celena	Barry	Lenawee	Adrian
Kendallville	Berville	Locke	Carlisle
Matherton	Blount	Macomb	Edwards
Miami	Brookston	Maumee	Greenwood
Owosso	Colwood	Metamora	Houghton
	Conover	Pewamo	Linwood
	Gilford	Rimer	Rifle
	Granby	Sebewa	Tawas
	Kibbie	Teasdale	Wallkill[c]

Special Problem-Contamination		Special Problem-Flood[d]
Slight	Moderate	
Boyer	Brady	Algansee
Bronson	Ottawa-poor	Ceresco
Fox	Spinks-poor	Cohoctah
Oakville	Tedrow	Genesee
Oshtemo	Wasepi	Shoals
Perrin		Sloan
Spinks		Washtenaw

a = Rated as slight in Table 1, but have slight to moderate problems; b = Rated as moderate in Table 1, but have moderate to severe problems; c = Also flood susceptible; d = Rated severe in Table 2.

sewers will not improve limitation ratings of all soils. Using the interpretation sheet information, a new table was prepared to see which soils would be re-rated if public sewers were available.

As shown in Table 4, "Limitation Ratings for Residential Development with Public Sewers," the installation and use of public sewers would result in sixteen soils being re-rated to slight, and ten soils being re-rated to moderate. It should be noted that the resultant improvements are over the ratings recommended in Table 3, and not necessarily over the ratings recommended in Tables 1 and 2 by the Soil Conservation Service.

Comparing Tables 3 and 4, it is noted that the rating given for some soils rated severe, and all soils rated very severe, do not change even if public sewers are available. Table 5, "Limitation Ratings Unaffected by Public Sewer Availability," indicates these soils.

Streets and Highways

Although most soils have the same limitation ratings as designated for residential development, a few have ratings which differ due to problems of frost heave, bearing capacity, or extensive cuts and fills. Ratings for residential construction, regardless of public sewer availability, are based on houses having basements which will be supported by the lower horizons of soil. Streets

TABLE 4.--Limitation ratings for residential development with public sewers.

Soil	Comment	Soil	Comment
	Slight[a]		
Boyer	c	Miami	d
Bronson	c	Oakville	c
Celina	d	Oshtemo	c
Elmdale	b	Owosso	d
Fox	c	Perrin	c
Hillsdale	-	Sisson	b
Kendallville	d	Spinks	c
Lapeer	-	Tuscola	b
Metea	b		
	Moderate[e]		
Berrien	-	Metamora	f,g
Brady	c	Ottawa	-
Kibbie	f	Ottawa-poor	c
Locke	f	Spinks-poor	c
Macomb	f,g	Teasdale	f
Matherton	d	Tedrow	c
		Wasepi	c

a = Moderate on slopes of 6 to 12 per cent; severe on slopes exceeding 12 per cent; b = Rated slight to moderate in Table 3; c = Rated "Special Problem-Contamination" in Table 3; d = Rated moderate to severe in Table 3; e = Rated severe if slope exceeds 12 per cent; f = Rated severe in Table 3; g = Moderate to severe.

TABLE 5.--Limitation ratings unaffected by public sewer availability.

Soil	Comment	Soil	Comment
	Severe		
Algansee	a	Gilford	-
Barry	-	Granby	-
Berville	-	Lenawee	-
Blount	-	Maumee	-
Brookston	-	Pewamo	-
Ceresco	a	Rimer	-
Cohoctah	a	Sebewa	-
Colwood	-	Shoals	a
Conover	-	Sloan	a
Genesee	a	Washtenaw	a
	Very Severe		
Adrian	b	Linwood	b
Carlisle	b	Rifle	b
Edwards	b	Tawas	b
Greenwood	b	Wallkill	a,b
Houghton	b		

a = Susceptible to stream overflow; b = Organic soil.

and highways are supported by the upper horizons which may have an entirely different bearing capacity, and which may be subject to frost heave.

Although not stated by the Soil Conservation Service on the interpretation sheets, it is reasonable to assume that soils presenting frost heave problems for street and highway construction would also affect parking lots, carports, and, in some cases, residences constructed on slab foundations. Therefore, investigations into limitation problems for streets and highways can also serve to point out potential problems for any construction with large, paved surfaces which are exposed to potential frost.

Table 6, "Limitation Ratings for Streets and Highways Different Than Residential Ratings," indicates those soils which have a poorer rating for streets than for residences. Soils not indicated in Table 6 have the same rating as shown in Tables 3 and 4.

As indicated, with the exception of three soils--Metea, Sisson, and Tuscola,--all soils in Table 6 have a better rating for streets and highways than for residences without public sewers. Conversely, except for Berrien, Ottawa, and Algansee, the soils listed are rated worse than residences with public sewers.

Light Industrial and Commericial Use

Included on the interpretation sheets are recommendations for buildings intended for light industrial or commercial use. Ratings are based on buildings which are three stories or less in height and have a presumptive bearing value of 6,000 pounds per square foot or less. It is also assumed that only public sewers would be used.

Factors considered in recommending limitation ratings are: (1) bearing capacity; (2) shrink-swell

TABLE 6.--Limitation ratings for streets and highways different than residential ratings.

Soil	Streets	Residences
Without Public Sewers[a]		
Berrien	S	M
Elmdale	S	S-M
Ottawa	S	M
Metea	M	S-M
Sisson	M	S-M
Tuscola	M	S-M
Algansee	M	SV
Locke	M	SV
Macomb	M	SV
Metamora	M	SV
Teasdale	M	SV
With Public Sewers		
Berrien	S	M
Ottawa	S	M
Celina	M	S
Kendallville	M	S
Metea	M	S
Miami	M	S
Owosso	M	S
Sisson	M	S
Tuscola	M	S
Algansee	M	SV
Kibbie	SV	M

a = Disregarding "Special Problem-Contamination"; S = slight; M = moderate; SV = severe.

potential; (3) sheer strength; (4) depth to bedrock; (5) water table and natural drainage; (6) flood hazard; (7) soil stability; and (8) compressibility of the soil.

A review of the interpretation sheets for Meridian Township indicated that limitation ratings for light industrial and commercial use were identical to ratings applied to residential construction with public sewers (Table 4).

Factors Affecting Soils

The preparation of Tables 1 through 6 has provided an insight to the broad, over-all limitation ratings of the soils for residential, light industrial and commercial buildings, and streets and highways. It has not, however, provided any indication as to how the limitation factors relate to each other. To obtain this information, each major limitation rating group was analyzed to determine what the limiting factors are.

Soils Rated Very Severe

Table 5 indicated that nine soils are rated as very severe in Meridian Township for any of the urban types of development investigated. Reviewing the interpretation sheets for these nine soils it is noted that they all have the same, common limitation problems:

1. Unstable organic material.
2. High water table.
3. Very poor bearing capacity.
4. Very high compressibility.
5. Excessive and uneven settling.
6. Buildings subject to shifting and cracking.
7. Streets, driveways, parking areas subject to shifting, cracking, uneven settlement, and break-up.

Only one basic factor was noted which would permit classifying the nine soils into two subgroups. Some of the soils contain organic material to a depth of less than forty-two inches while others have a depth greater than forty-two inches. This possible sub-grouping may be important in future studies investigating the possibility of overcoming limitation problems for development. Pockets of organic material less than forty-two inches can be excavated and the organic material replaced with suitable fill material. In Meridian Township, the nine organic soils may be sub-grouped accordingly:

Less Than 42 Inches	Greater Than 42 Inches
Adrian	Carlisle
Edwards	Greenwood
Linwood	Houghton
Tawas	Rifle
	Wallkill

Soils Rated Severe

It has already been noted in Table 3 that soils rated severe can be grouped as alluvial or non-alluvial. Within Meridian Township there are eight soils which are susceptible to flooding: (1) Algansee; (2) Ceresco; (3) Cohoctah; (4) Genesee; (5) Shoals; (6) Sloan; (7) Washtenaw; and (8) Wallkill.

Reviewing the non-alluvial soils, there are two possible sub-groups: (1) soils rated severe without public sewers but which are rated moderate or slight if public sewers are available; and (2) soils rated severe regardless of sewers.

Soils which are rated severe without public sewers but rated better if sewers are available are:

Moderate to Severe Without Sewers, Slight with Sewers	Moderate to Severe Without Sewers, Moderate with Sewers	
Celena	Brady	Ottawa-poor
Kendallville	Kibbie	Spinks-poor
Miami	Locke	Teasdale
Owosso	Macomb	Tedrow
	Matherton	Wasepi
	Metamora	

According to Table 6, only one soil--Kibbie--presents severe problems for streets and highways even though residential development with sewers is rated as presenting only moderate problems.

Non-alluvial soils which retain the severe rating regardless of public sewer availability are:

Barry	Colwood	Lenawee
Berville	Conover	Maumee
Blount	Gilford	Pewamo
Brookston	Granby	Rimer
		Sibewa

In reviewing the separate interpretation sheets for these soils it is noted that they all have some common limitation problems but that some soils also have their own unique problems. Common problems shared by all soils rated severe are:

1. Seasonally high or high water table.
2. Wet depressions that may pond.
3. Wet basements.
4. Filling and grading required in many areas.

Limitation problems not common to all soils are indicated in Table 7, "Special Limitation Problems for Severe Soils."

TABLE 7.--Special limitation problems for severe soils.

Soils	Limitation Factor				
	1	2	3	4	5
Barry; Sebewa	H	FG	X		X
Berville; Brookston; Colwood; Lenawee; Pewamo	H	PF	X	X	X
Conover	S	PF	X	X	X
Gilford	H	FG			X
Granby; Maumee	H	FG		X	X
Rimer	S	PF			

1 = Ground water table: H-high; S-seasonally high; 2 = Bearing capacity: FG-fair to good; PF-poor to fair; 3 = Frost susceptible; 4 = Material flows when wet; 5 = Construction difficult when wet.

Soils Rated Moderate

Soils rated moderate can often be improved if public sewers are available. Soils indicated in Table 3 as having the special problem of possible contamination, and soils rated as having slight to moderate problems can be re-rated to slight with public sewers. Soils which fall under this classification include:

Boyer	Oshtemo
Bronson	Perrin
Elmdale	Sisson
Fox	Spinks
Metea	Tuscola
Oakville	

Three soils within this group--Metea, Sisson, and Tuscola--still present moderate problems for streets and highways even though they are rated slight for residences with public sewers. The factors which contribute to the moderate rating for streets and highways are:

Metea: Fair to poor bearing capacity and fair to poor subgrade material.

Sisson and Tuscola: Fair to poor bearing capacity; subject to frost heave and cracking; material liquifies readily and has poor stability in cuts and fills.

Regardless of the availability of public sewers, many soils retain the moderate rating for residential construction. Soils in this category are:

Berrien	Ottawa
Brady	Ottawa-poor
Kibbie	Spinks-poor
Locke	Teasdale
Macomb	Tedrow
Matherton	Wasepi
Metamora	

Table 8, "Limitations for Soils Rated Moderate" indicates the variety of factors contributing to this rating.

TABLE 8.--Limitations for soils rated moderate.

Soils	Limitation Factors								
	1	2	3	4	5	6	7	8	9
Berrien; Ottawa	-	FP	-	-	MH	-	-	X	-
Brady; Ottawa-poor; Spinks-poor; Tedrow; Wasepi	S	FG	-	X	L	-	-	-	-
Kibbie	S	FP	X	X	L	X	X	-	X
Locke; Teasdale	S	FG	X	X	L	-	X	-	X
Macomb; Metamora	S	FP	X	X	M	-	X	-	X
Matherton	S	FG	X	X	L	X	X	-	X

1 = Water table: S-seasonally high; 2 = Bearing capacity: FP-fair-poor; FG-fair-good; 3 = Wet depressions; 4 = Wet basements; 5 = Volume change: L-low; M-moderate; H-high; 6 = Material flows when wet; 7 = Frost susceptible; 8 = Moderate limitations for foundation material; 9 = Construction difficult when wet.

With the exception of Kibbie, Berrien, and Ottawa soils in this group are rated as presenting moderate problems for streets and highways. Of the three exceptions, Berrien and Ottawa are rated as slight while Kibbie is rated as severe.

Soils Rated Slight

As indicated in Table 3, only two soils should be rated as presenting slight problems for residential construction without public sewers. Both soils, Hillsdale and Lapeer, are also rated as slight for streets and highways. As indicated in Table 4, seven additional soils may be rated as presenting only slight problems if public sewers are provided but would still present moderate problems for streets and highways. All of these soils have poor to fair bearing capacity in the upper horizons and, with the exception of Metea, are subject to frost heave.

Summary of Preliminary Investigation

The preliminary investigation into soil limitation problems of Meridian Township indicated that all soils may be placed in one of four major limitation groups: (1) slight; (2) moderate; (3) severe; or (4) very severe. All soils rated as very severe are organic, contain high water tables, and are not suitable for any urban-type development. Soils rated as severe can be further grouped as alluvial and non-alluvial. In many cases, installation of a public sewer system can overcome the severe limitation problems and the soils can be re-rated to either moderate or slight categories. Moderate and slight limitation problems do not present serious difficulties for development and what problems do exist, can be overcome.

It should be emphasized that the preliminary investigation also disclosed that all soils rated as slight or moderate are automatically rated as moderate where the slope is from 6-12 per cent, and severe if slope exceeds 12 per cent.

CHAPTER IV

PRESENTATION OF SOILS DATA

Introduction

As indicated in Chapter III, compilation of soils data allows the grouping of numerous soils with similar limitation factors into a few simple groups or subgroups. Depending upon the ultimate use of the soils information, several different types of maps can be prepared which will simplify the application of soils information to various planning and engineering studies. However, the preparation of illustrative soils material is a tedious, time consuming task and care should be exercised in determining the technique most suited for the intended uses of the data.

The ultimate use of illustrated soils information will generally range from work-purpose maps to presentation maps. All maps should be simple, yet contain the required information, and properly prepared for easy interpretation by various persons or agencies with varying degrees of soils knowledge.

Presentation maps can take two forms: (1) the large, color-coded map for use before large groups of people; or (2) small maps suitable for inclusion in printed reports. Two methods of preparing presentation material are possible; either a large color-coded map can be used for small group use, or color slides can be prepared for projection before large groups.

Unfortunately, the color-coded maps are not particularly useful for work purposes in that they are not reproducible by standard techniques. Therefore, it is more desirable to prepare reproducible work maps first, in a form readily converted to presentation use.

The major problem of color-coded maps is the fact that the two common reproduction techniques are not satisfactory. Conversion of color tones to distinguishable shades of black, gray, and white requires a knowledgeable understanding of photography. Without special photographic equipment and film, the practical use of black and white films is limited to four, or possibly five, shades of black and white.

The alternative method, and the one recommended herein, involves the preparation of master maps utilizing various patterns. Extra care taken at this point will result in a master map easily reproduced at scale, by a variety of commercial techniques, for work purposes or for reproduction for presentation or report use. Prepared at a large scale, the maps can be photographically altered to any desired scale. Presentation maps can be prepared by coloring a print of the map with any type of color media such as pencil, air brush, or commercially available sheets of transparent, adhesive color media.

Selection of Mapping Technique for Meridian Township

Prior to starting any mapping, an analysis of the townships present, as well as future, use of the soils information was made. The following factors ultimately dictated the techniques employed:

1. Soils do not change; limitation ratings can, as indicated earlier.
2. The physical, man-made features of the township such as roads and utilities are subject to constant change.
3. Soils information will be used for a variety of planning and engineering studies, and will be needed in several forms such as work maps, presentation maps, and ultimately, in report form.

Because of the above factors, it was decided not to present soils data directly on a base map of the township due to the future problem of adding street improvements on the map as they occurred. Consequently, by presenting soils data on overlay maps, properly registered with a base map, the problem of correcting or updating the base map without redrafting soils data would be eliminated.

To eliminate complex coding systems, the soil maps would be prepared as a series of overlays which could be combined in various sequences, to provide desired information. The technique used will be discussed later.

Preparation of Maps

Soil delineations for Meridian Township were illustrated on a series of aerial photographs at a scale of one-inch equals one-thousand feet. The first preparatory phase was to transfer the soil area delineations from the numerous individual photographs onto a single map of the township. In this aspect, a base map at the same scale as the photographs was available (if no map, at a suitable scale existed, a suitable map would have been photographically enlarged or reduced to the scale of the photographs).

A reasonably transparent, reproducible copy of the base map (called a sepia print) was obtained from a commercial firm. After registering (lining-up) each photograph with the respective area on the sepia print, the soil information was transferred to the sepia by tracing it. The resulting product enables printing copies of the map for rough-work purposes.

In preparing the sepia base-soils map, only soil areas were delineated. Thus, all consequent work required continuously referring back to the photographs for soil code numbers. It is recommended, therefore, that as soil areas are transferred to the sepia, the soil code also be transferred. A simplified method would be to prepare an alphabetical list of all soils and their code numbers (some soils have several code numbers) and re-number the soils. The simplified code would aid in all future soil studies, i.e., in Meridian Township, poorly drained Spinks soils would be coded "52" instead of 7212,7352 or 7355. Similarly, Sisson would be "49" rather than 2043,2095,4363 and 4365. For slope information, the letter code should also be noted.

Coding of Maps

Referring back to Tables 3 and 5, it is noted that three groups of soils have limitation ratings which do not change regardless of the availability of public sewers. The three groups: alluvial; organic; and severe regardless of sewers, will have the same limitation rating for most maps. Therefore, they were delineated on the first map which will be referred to herein as the base soil map. By placing these soils on a base soil map, the need to delineate them on several maps has been eliminated. Additional soils information can be placed on overlays to the base soil map.

The preparation of the base map, as well as the overlays, was done in two stages. The first stage consisted simply of marking on a print of the soils map, in color, the three groups of soil. In addition, all soils marked as disturbed were also delineated.

Upon completion of the rough map, a sheet of frosted mylar was placed over the rough map and registration points indicated. Using four different patterns of zip-a-tone, a final map was prepared, see Illustration 1.

It is suggested that the two steps be taken due to the problems which would occur if only the final step was taken. The finished soil base map is, in effect, an overlay which can be used with the separate street map of the township. Consequently, any revisions to the street map will not necessitate revising the soil map.

First Overlay--Ratings with Public Sewers

Referring to Table 4, all soils rated slight or moderate were indicated on the rough soils map used for the preparation of the base soils map. To serve as a check procedure both the slight and moderate soils were color-coded on the rough map. Upon completion, all soil areas should have been color-coded as alluvial, organic, severe, moderate or slight. Areas left white on the map are soils overlooked in the coding process and should be corrected.

Using the same technique for preparing the finished base soils map, an overlay map was prepared on mylar to indicate soils rated moderate. Soils rated as slight were left blank and will appear as white when prints are prepared, see Illustration 2.

Illustration 1.--Soils Base Map

Illustration 2.--First Overlay

Illustration 3 shows how the combined soils base map and first overlay would appear. When placed over, or printed with, a street base map, the result would be soil limitation ratings for residential development with public sewers.

Second Overlay--Ratings Without Sewers

In similar fashion, a second overlay was prepared to indicate limitation ratings without public sewers. Using the same code for slight, moderate and severe, as was used on the first overlay and base soils map respectively, soils rated as moderate, and soils rated severe which did not appear on the base soils map were delineated. In addition, soils rated slight to moderate and moderate to severe were delineated. Soils falling within the "Special Problem-Contamination" category were simply coded as slight or moderate as indicated in Table 3. If contamination data is desired, it can be shown on a simple overlay using a cross-hatch pattern.

Third Overlay--Slope

Thus far, the first and second overlays indicate only the ratings recommended for a particular series but do not represent limitation changes resulting from slope. As mentioned earlier, all soils rated as slight are actually rated moderate if slope is 6 to 12 per cent.

Illustration 3.--Combined Soils Base Map and First Overlay

Similarly, all soils rated as slight or moderate are rated severe if slope exceeds 12 per cent.

Using the same code patterns for moderate and severe as used on earlier overlays, a third overlay was prepared with the moderate code pattern on slopes of 6 to 12 per cent and the severe pattern on slopes exceeding 12 per cent.

This overlay, printed with the base soils map and either overlay 1 or 2 gives the total limitation ratings. The reason for indicating slope effect on a separate overlay, is to illustrate the effect of slope without creating a complex code system on the earlier maps.

Fourth Overlay--Streets and Highways

A fourth overlay indicating soils with a worse rating than for residential development was prepared using the same code patterns for moderate and severe as used on earlier maps.

Object of Overlays

The preparation of the base soils map and four overlays provides greater latitude for use and a less complicated code system then would be required if all of the information were illustrated on one map. Examples of latitude are:

1. Base soils map, plus overlay number 1 indicates limitation ratings of soils for residential use with public sewers, ignoring the possible effect of slope.
2. Base soils map, plus overlays 1, 3, and 4 presents total problems for both streets and subdivisions or residential construction.
3. Base soils map, plus overlays 1 and 2 can be used to indicate areas where ratings would be improved if public sewers were installed.

Printing Problems

Although this system requires the sandwiching of several overlays if a particular information print is required, printing on a flat bed or vacuum frame printer will present no problems. With the possible exception of the slope or contamination overlays, there will be only a minimum, if any, occurrence of two patterns overlapping. Designed as suggested, each overlay compliments the other when combined.

It is not recommended that any two or more overlays be printed with a standard roller-type map copying machine. The outer overlay must travel a greater distance than the overlay immediately next to the roller. Consequently, the resulting print could be as much as half an inch out-of-line with the base map.

CHAPTER V

SPECIAL PROBLEMS

Use of Old Survey Maps

Introduction

In their constant search for new information, many planners have questioned whether or not old agricultural soil survey maps could be used for planning purposes. The writer has observed many attempts at applying modern interpretation data to old survey maps with varied success. In 1965 the writer prepared a paper titled, "Background Information Regarding the Use of Soil Surveys as a Tool for Planning," in which new interpretation data was applied to an old agricultural soil survey map for Meridian Township, Ingham County, Michigan.

It was the result of this paper that encouraged the writer to investigate further, the practice of using old survey maps.

Problem

As mentioned earlier, soil maps have been prepared and published since the early 1900's. The numerous changes and refinements in technology and knowledge of soil properties which has evolved since the first surveys were prepared can drastically influence the accuracy of the older maps. The second problem is that many of the older maps were prepared at very small scales such as one-inch equals one-mile. Naturally, soil area delineations at this scale cannot compare with delineations prepared on a larger-scale map as used today.

The Soil Conservation Service, realizing the limitations of using the older maps for any kind of detailed planning, warns against the indiscriminate use of applying modern interpretation data to the older maps when they state:

> The interpretation sheets should be used only with soil surveys of medium or detailed intensity, that have been prepared according to standard procedures of the National Cooperative Survey. It is not intended that they be used with "Land-Type" surveys, Low-intensity surveys, or general soil maps.

Determined to find out what problems would occur, the writer compared results of applying interpretation data to an old map with the new map prepared for Meridian Township.

Methodology

Using simple comparative analysis techniques, emperical observations were made on the results of applying modern interpretation data to the old survey map and comparing it to the modern map. As a result of the comparison, a more detailed comparison was made for just one section.

Preparation of maps involved the photographic enlargement of the smaller-scale old survey map (Meridian Township, Ingham County, Michigan, 1933 series) to the identical size as was used for other studies in this report. Referring to Table 1, a simple two-category code index was prepared combining all soils rated slight or moderate in one group, and severe and very severe in a second group.

Because the old survey map did not indicate slope, and because Meridian Township is relatively flat, the limitation rating applied for soils with less than a 6 per cent slope were used. Limitation ratings used for soils indicated on the old survey were:

Slight-Moderate	Severe-Very Severe
Bellefontaine	Brookston
Berrien	Carlisle
Brady	Conover
Coloma	Genesee
Fox	Granby
Hillsdale	Greenwood
Miami	Griffin
Oshtemo	Houghton
Ottawa	Kirston
Plainfield	Maumee
	Rifle
	Wallkill
	Washtenaw

These two categories were then color-coded onto the enlarged copy of the old soil survey map.

Inasmuch as the new soil surveys do indicate slope, the effect of slope was used in the ratings on the new survey map. Limitation ratings were also grouped, as on the old map, with information derived from Tables 1 and 2.

The comparison was made by overlaying the old map on the new map with all areas of conflict being noted. Illustration 4, "Comparison of Old and New Soil Maps" indicates the areas of conflict in soil limitation ratings.

As indicated in the illustration, there are large areas which differ in limitation ratings. To gain a better understanding of the reasons for the differences, a typical section (section 5) was selected for a more detailed investigation. Section 5 of the old map was photographically enlarged to the same scale of the new map and the soil limitation ratings of slight, moderate, severe, and very severe were color-coded on both maps and compared. Illustration 5, "Comparison of Soil Limitations for Section 5" indicates the conflicts between the two maps.

Comparing the two maps by soil type, it is noted that within areas delineated as Miami loam on the old map, the new map shows areas of Miami, Brookston, Conover, Lenawee, and Carlisle. Similarly, areas delineated as Carlisle on the old map actually contain areas of Boyer, Spinks, Miami, Wasepi, Brookston, Colwood, and others. Table 9, "Comparison of Soil Types for Section 5" indicates how the maps conflict.

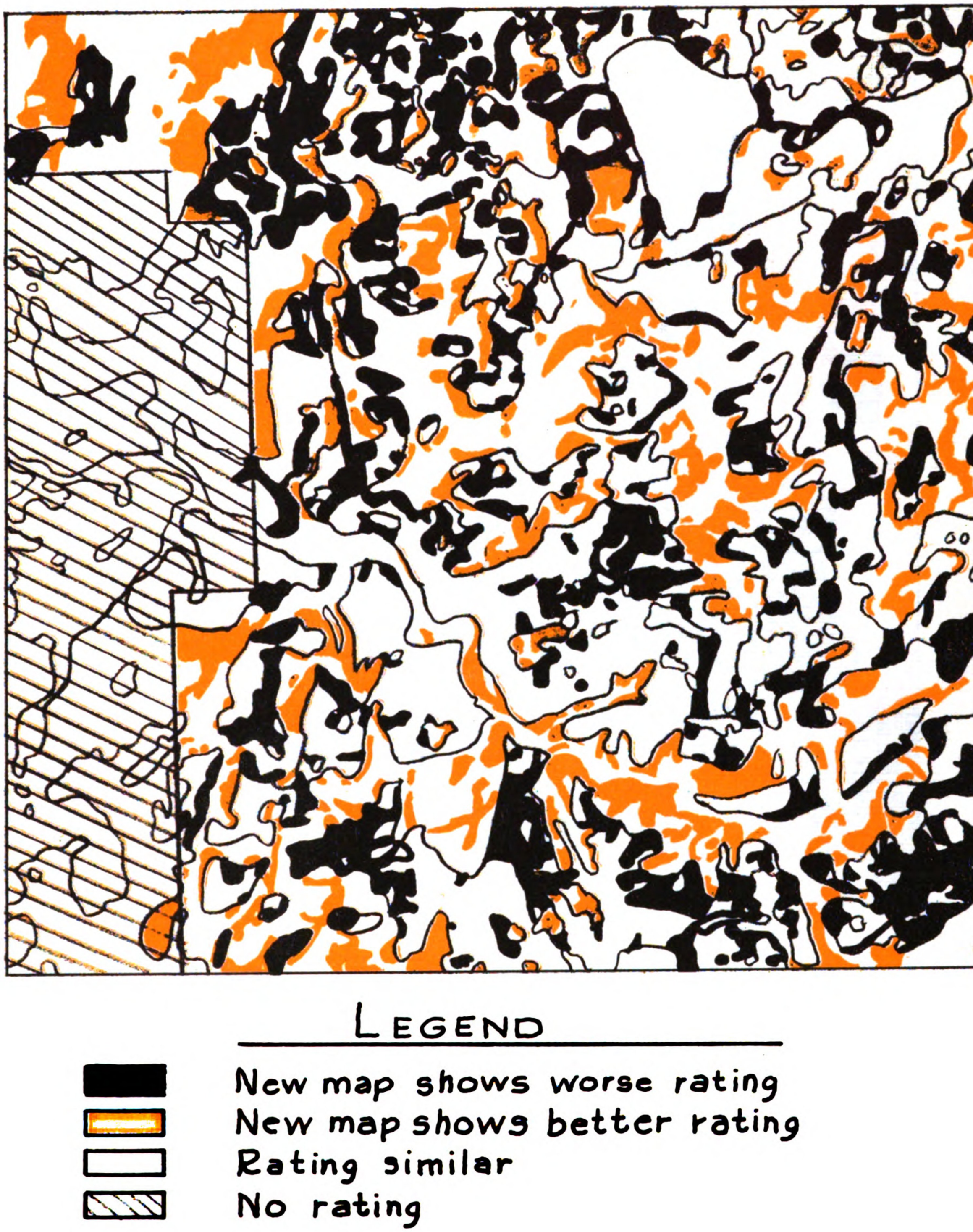

Illustration 4.--Comparison of Old and New Soil Maps

Illustration 5.--Comparison of Soil Limitations for Section 5

TABLE 9.--Comparison of soil types for Section 5.

Soil[a]	Rating	Old Soil Survey Map									
		Bel.	Hills.	Osh.	Brady	Miami	Ott.	Con.	Brook.	Wall.	Car.
		S	S	S	M.	M	M	SV	SV	SV	VSV
Boyer b	S			X					X		X
Metea	S								X		
Spinks b	S										X
Tuscola b	S								X		
Celena	M								X		
Miami	M	X	X	X	X	X	X	X		X	X
Owosso	M	X	X								
Spinks c	M	X	X								X
Wasepi	M		X		X			X			X
Brookston	SV	X		X		X		X	X		X
Colwood	SV				X				X		X
Conover	SV	X			X	X			X		X
Gilford	SV										X
Lenawee	SV				X					X	
Macomb	SV										X
Miami d,e	SV	X	X		X						X
Spinks d	SV	X									
Carlisle	VSV	X	X	X	X	X		X		X	X
Tawas	VSV										X

[a]Small letter following some soils indicates slope: b = 2-6%; c = 6-12%; e = over 12%.

[b]Ratings: S = slight; M = moderate; SV = severe; VSV = very severe.

Conclusion

In light of the over-whelming evidence of numerous differences of soil limitation ratings between the old and new survey maps, and the warnings against attempting such use of old survey maps, the writer concludes that the application of modern soil interpretation data to old (pre-1933 series) soil survey maps carries the strong possibility of resulting in erroneous or misleading information and, therefore, should be avoided for any detailed planning work.

Feasibility of Artificial Drainage

Problem

Throughout the preliminary investigation, it was noted that many of the soils which presented problems for development were those with a seasonally high or high water table and with somewhat poor or worse natural drainage. The interpretation sheets indicated that many soil limitation ratings could be changed if artificial drainage were provided. However, the interpretation sheets gave little, if any, indication as to which soils could feasibly be drained.

We have reviewed how the installation of public sewers can improve the rating for many soils, but learned that public sewers alone will not improve all soil limitation problems. The writer investigated soils within

Meridian Township to determine if there was any criteria on the interpretation sheets which might serve as a starting point for any studies relating to artificial drainage feasibility. To do this, and to clarify what the writer refers to when using the term artificial drainage, a review of drainage characteristics and problems is necessary.

Drainage Characteristics

Reviewing the interpretation sheets for soils within Meridian Township, it was noted that they are generally classed in one of five categories: (1) well drained; (2) moderately well drained; (3) somewhat poorly drained; (4) poorly drained; and (5) very poorly drained. Soils which were well drained or moderately well drained did not present limitation problems that were related to ground water, although some soils did have problems related to capilary water. Somewhat poorly drained soils all had seasonally high water tables, and the poorly drained and very poorly drained soils all had high water tables. In addition to the water table problems, many of these soils also had problems related to capillary water, or were flood susceptible.

Generally problems related to seasonally high or high ground water tables are: (1) wet basements; (2) depressions which may pond; (3) serious volume change upon wetting or drying; and (4) for plants, a restricted root zone. Capillary water problems refer to frost heave and, in some cases, volume change in fine textured materials. The installation of public sanitary sewers does not serve to reduce these problems and artificial drainage must be considered.

Types of Artificial Drainage

For purposes of this study, the term artificial drainage will refer to any physical improvements which will result in the removal or level-control of excess ground water, freely given-up by soils.

Artificial drainage systems can range from surface water removal before it enters the ground, to sub-surface removal of excess water. Surface water removal can be accomplished through public storm sewer drains or open ditches which carry excessive water, by gravity, to a discharge point such as a stream, river, or lake.

Sub-surface drainage can also be accomplished by open ditches, field tiles, or in the case of buildings, by footing tiles. In addition to gravity drainage systems, it is also possible to lower the ground water by pumping but this method will not be considered in this report.

Regardless of the type of artificial drainage system used, gravity or pump, they will not remove capillary water from the soil. Therefore, the feasibility of artificial drainage must necessarily be limited to advantages gained if excess ground water is removed.

The feasibility of artificial drainage will, in part, be dependent upon the relative topography of the areas in question, the texture of the soil, and the permeability of the soil.

The relative topography of the area to be drained will dictate whether or not a conventional gravity-type drainage system is workable. The texture and permeability of the soil will determine how fast an area can be drained, and how far apart drainage facilities must be installed. If the soil has a dense texture and slow permeability, the drainage facilities must be placed much closer than if the texture is relatively loose (such as with coarse sand) with rapid permeability.

In attempting to determine if any guidelines could possibly be prepared from existing data on the soil interpretation sheets, the writer researched many various approaches. Many of the methods proved inconclusive or became too cumbersome to be practical. One method, using "available water" data as the main criteria, does show some promise although field observations would have to be conducted before definite conclusions could be made.

A Suggested Approach

A review of soils data for Meridian Township disclosed that although most soils classed as well or moderately well drained did not present frost heave problems, a few of the soils did. Since these soils all have good drainage, it is a fair assumption that soils which are susceptible to frost heave are those soils which retain water above the ground water table level through capillary action. Therefore, using frost susceptibility and capillary water or "available water capacity," it should be possible to derive a simple method for determining which soils will retain capillary water if artificially drained, and which ones would not. Assuming that soils retaining capillary water consist of fine-grain materials, it may be assumed that these soils would present the most difficulty for artificial drainage.

Analysis

Because most soils have two or three horizons indicated on the interpretation sheets, and the thickness of the horizons is variable for different soils, it was necessary to assign some "value-index" to each horizon based on its thickness. This was done by simply taking the average thickness for each horizon for each soil to the nearest one-half foot and placing it in tabular form as shown:

Soil	Horizon*		
	1	2	3
Barry	1 foot	2.5 feet	1.5 feet
Berville	1 "	2 "	2 "
Ceresco	1 "	4 "	0 "

*Each soil was calculated to a total depth of five feet only.

Based on the assumption that, if a well drained soil is susceptible to frost heave, then it must be due to capillary water. The amount of available water is an indication of soil capillarity, the writer decided to use water availability as the principal source of information.

Reviewing the water availability index of the interpretation sheets, it was noted that the index values ranged from .02 to .30. Each value represented a multiple of .02 so that figure was assigned a value of one. Thereafter, each available water index figure was assigned the value equal to its multiple of .02. For example, .08 is four times .02 so it was assigned a value of four. Similarly, .30 is fifteen times .02 so it was assigned a value of fifteen.

Multiplying the horizon value times the available water index value for each horizon, and adding the total scores for the horizons of each soil, a total value for each soil was obtained. An example of the method is shown below.

Soil	Horizons			Available Water			Scores			Total
Barry	1	2.5	1.5	7	7	5	7	18	8	33
Berville	1	2	2	9	9	8	9	18	16	43
Ceresco	1	4	0	6	4	0	6	16	0	22

The last step in this analysis was to list all well or moderately well drained soils and their total values and indicate whether or not they were susceptible to frost. Following is a list of values derived for well and moderately well drained soils.

Moderately Well and Well-Drained Soils			
Frost Susceptible		Not Frost Susceptible	
Celena	42	Berrien	19
Genesee	46	Boyer	19
Kendallville	42	Bronson	24
Miami	41	Elmdale	35
Owosso	32	Fox	20
Sisson	42	Hillsdale	35
Tuscola	41	Lapeer	32
		Metea	33
		Oakville	13
		Oshtemo	24
		Ottawa	19
		Perrin	18
		Spinks	26

As indicated, all soils moderately well or well-drained that are not frost susceptible received total values of thirty-five or less while all soils susceptible (except Owosso) had values of forty-one or more. Searching the interpretation sheets for some clue as to why Owosso soil rated so low, it was learned that the first horizon was not susceptible to frost but that frost affected the soil at a depth of eighteen to forty-two inches. If the system is reworked, and the first horizon is omitted, the value rises considerably.

If the findings are applied to the other, less well-drained soils, it should be possible to classify the soils as to whether or not artificial drainage would be beneficial to them. Following is how the soils rated:

Improved				Not Improved			
Barry	33	Ottawa-p	30	Berville	43	Kibbie	42
Brady	30	Rimer	32	Blount	41	Lenawee	41
Gilford	19	Sebewa	25	Brookston	44	Macomb	43
Granby	13	Spinks-p	26	Colwood	43	Pewamo	41
Locke	30	Teasdale	32	Conover	43		
Matherton	22	Tedrow	27				
Metamora	33	Wasepi	20				
Maumee	15						

Implication of Study

It has been stated that there are two basic types of water-related problems for soils: (1) excess ground water causing wet basements, etc.; and (2) capillary water which causes frost heave.

Ground water problems such as wet basements can be relieved through the use of footing tiles which drain excess water away from basement walls. However, footing tiles will not relieve problems of wet depressions that pond or reduce the shrink-swell potential of soils with this type problem. In addition, they will not relieve problems associated with frost heave. Field tiles or open ditches may reduce problems of high water for streets and highways but if the soil contains capillary water, the problem of frost heave will persist.

The significance of the study is that it shows that some soils, affected by seasonally high or high water tables can be improved with artificial drainage whereas others would still retain problems related to capillary water. Soils indicated as "improved" would lose their capillary water-related problems and soils listed as "not improved" would not lose capillary problems.

A second indication of the study would be to show that some soils will give up their excess water more readily than others. However, this aspect of the study would warrant further analysis.

Use of Study Findings

Earlier investigation indicated how limitations for many soils could be overcome through the installation of public sewers. Although more investigations and field research is needed, a system similar to that proposed in this study might be useful to planners and engineers attempting to evaluate the benefits which would be gained if an artificial drainage system were installed.

If artificial drainage will only relieve some of the problems such as wet basements and depressions which pond, but will not significantly reduce frost heave and other soil-moisture problems such as volume change, soil stability, etc., the cost-benefit ratio of any proposed artificial drainage system may indicate the proposed project as not economically feasible.

CHAPTER VI

SUMMARY

Literature

Reviews of available literature regarding soil surveys and land development planning indicate that although much has been written on the benefits and value of applying soil survey data to land planning, very little, if any, has been written explaining how the planner, untrained in soil science, can put soils data to use.

Soil surveys were first conducted in 1898 for agricultural purposes. As survey and mapping techniques improved, the number of potential users of soils data increased. Today, planners, engineers, sanitarians and real estate developers are but a few of the numerous professions utilizing soils data.

Modern soil surveys are prepared over aerial photographs and are accompanied by detailed interpretation sheets. The interpretation sheets provide two basic types of information: (1) engineering data; and (2) degree of limitation of soil for various uses. To maximize the benefits of utilizing soils data, the user should understand, and use, both types of information.

Engineering interpretations are subdivided into: (1) estimated physical and chemical properties; (2) suitability of soil as a resource material; and (3) factors affecting use. Information on soil limitations is also subdivided into three groups: (1) urban uses; (2) recreational uses; and (3) agricultural and other vegetation uses. Using four basic limitation ratings--slight, moderate, severe, and very severe--the United States Department of Agriculture Soil Conservation Service provides information on potential soil problems for various uses.

Under "urban uses," the Soil Conservation Service rates soils for: (1) residences with public sewers; (2) residences without public sewers; (3) light industrial or commercial buildings; and (4) streets and highways. "Recreational uses" provides limitation ratings for six types of activity: (1) cottages and utility buildings; (2) intensive camp sites; (3) picnic areas; (4) intensive play areas; (5) paths and trails; and (6) golf fairways. "Agricultural and other uses" provides ratings for: (1) farm crops; (2) trees; and (3) lawns and shrubs.

In providing limitation ratings, the Soil Conservation Service strongly emphasizes that the proposed ratings are for soils in their natural condition and that artificial drainage or other improvements could result in some soils being reclassified to a better rating. Ratings do not consider other factors which require consideration in formulating development plans such as location and land value.

Practical Application

Using Meridian Township, Ingham County, Michigan as a case study, soil survey information was compiled and analyzed prior to developing a technique for the simple, yet effective graphic illustration of the soils data. Because of the urbanizing character of the township, information on the use of soils both with and without public sewers was required. To obtain the information, the first phase of the analysis involved limitation ratings for residential development without public sewers. In the analysis, the writer determined that the four basic ratings did not present sufficiently detailed information and proposed that eight ratings be used. Two of the ratings would clarify which soils fell between two of the basic ratings, and two covered special problems of flooding and possible contamination of shallow ground water supplies.

Additional analyses indicated which soils received a better rating if public sewers were available, and which soils would present problems for street construction even though rated good for residential development.

Reviewing the factors contributing to limitation ratings, it was noted that subgroups of each basic rating group could be prepared to indicate specific problems for certain soils. For example, soils rated as severe can be classified as alluvial soils or non-alluvial soils. Non-alluvial soils can be further subgrouped as: (1) soils rated severe without public sewers but which are rated moderate or slight if sewers are available; and (2) soils rated severe regardless of public sewer availability. Soils rated severe regardless have four common problems: (1) seasonally high or high water table; (2) wet depressions that may pond; (3) wet basements; and (4) filling and grading required in many areas. In addition, some soils have additional problems of susceptibility to frost heave, poor bearing capacity, or unstable material, etc.

Presentation of Data

Upon compiling and analyzing the soils data into meaningful groups, the user must next determine how the data can best be graphically illustrated for his needs. The technique presented included a series of single-factor overlays on a mylar-base material suitable for reproduction. By combining several overlays, varied situations such as: (1) effect of slope on soil ratings; (2) ratings with or without sewers; and (3) drainage, can be obtained. Major advantages to this technique include elimination of complicated coding schemes, avoidance of unnecessary duplication of soils data, and the ability to correct or alter one factor without the necessity of changing the entire map.

Special Studies

Two special studies were presented dealing with the use of old agricultural soil maps, and the feasibility of artificial drainage for certain soils. The author concluded that the use of old maps should be avoided for detailed planning studies. Determining feasibility of artificial drainage of soils based on availability of water and horizon thickness showed some potential but more field work is required.

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